BIOLOGICAL ASSESSMENT
TEMPORARY MODIFICATIONS TO THE INTERIM OPERATING PLAN FOR JIM WOODRUFF DAM AND THE ASSOCIATED RELEASES TO THE APALACHICOLA RIVER

INTRODUCTION

On 7 March 2006, the U.S. Army Corps of Engineers, Mobile District (Corps), submitted a request to initiate formal consultation pursuant to Section 7 of the Endangered Species Act (ESA) regarding the impact of releases from the Jim Woodruff dam to the Apalachicola River, under the existing water control plan operations, on Federally listed endangered or threatened species and critical habitat for those species. Operations regarding releases to the Apalachicola River were described in an Interim Operations Plan (IOP) for Jim Woodruff Dam, since consultation on the overall project operations for the Apalachicola, Chattahoochee, Flint Rivers (ACF) system would be deferred until future efforts to update the water control plans and basin manual for the system. Species of concern include the threatened Gulf sturgeon (*Acipenser oxyrinchus desotoi*) and critical habitat for the Gulf sturgeon; the endangered fat threeridge mussel (*Amblema neislerii*); the threatened purple bankclimber mussel (*Elliptoideus sloatianus*); and the Chipola slabshell mussel (*Eliptio chipolaensis*). During the consultation process, a proposed revision to the IOP plan was developed and submitted for consideration on 12 June 2006. A final Biological Opinion (BO) for the Jim Woodruff Dam IOP (as described in the 12 June 2006 letter) was issued by the U.S. Fish and Wildlife Service (USFWS), Panama City Field Office on 5 September 2006, and incorporated additional modifications to the IOP in order to avoid or minimize incidental take of listed mussels.

The BO included five reasonable and prudent measures (RPMs) for further limiting the amount of incidental take associated with water management operations at Jim Woodruff Dam. For each of the five RPMs, the BO also included specific terms and conditions which must be met in order to assure compliance with the RPMs. In accordance with RPM3 of the BO, the IOP was further modified to include a drought provision measure that identifies the reservoir, climatic, hydrologic, and/or listed species conditions that allow supporting a higher minimum flow in the Apalachicola River, and water management measures to be implemented when conditions reach the identified drought trigger point(s). A biological assessment (BA) describing the drought provision modifications and associated impacts was submitted to USFWS on 16 February 2007. On 28 February 2007 the USFWS approved the drought provision modifications to the IOP. We are currently operating under the provisions of this version of the IOP. The IOP specifies two parameters applicable to the daily releases from Woodruff: a minimum discharge (Table 1) in relation to average basin inflows (daily average in cubic feet per second [cfs]) and maximum fall rate (vertical drop in river stage [ft/day]) (Table 2), with incorporation of a desired minimum flow (6,500cfs) and the required minimum flow (5,000 cfs), and a drought "trigger" to determine those conditions when the required

Table 1. IOP Minimum Discharge from Woodruff Dam by Month and by Basin Inflow (BI) Rates

Months		Basin Inflow (cfs)[a]	Releases from Woodruff Dam (cfs)
March - May	High	>= 35,800	not less than 25,000
	Mid	>= 18,000 and < 35,800	>= 70% BI; not less than 18,000
	Low	< 18,000	>= BI; not less than 6,500 (Desired Flow)[b] >= BI; not less than 5,000 (Required Flow)
June - February	High	>= 23,000	not less than 16,000
	Mid	>= 10,000 and < 23,000	>= 70% BI; not less than 10,000
	Low	< 10,000	>= BI; not less than 6,500 (Desired Flow)[b] >= BI; not less than 5,000 (Required Flow)

[a] The running 7-day average daily inflow to the Corps ACF reservoir projects, excluding releases from project storage.

[b] Drought Provision: When Composite Storage is within Zones 1 and 2, then the higher minimum release of 6,500 cfs would be maintained. When Composite Storage falls below the top of Zone 3, then release will be reduced to the 5,000 cfs minimum; when Composite Storage is restored to above the top of Zone 2 (i.e., within Zone 1), then the higher minimum release of at least 6,500 cfs would again be maintained. Composite Storage is the combined conservation storage of Lake Sidney Lanier, West Point Lake, and Walter F. George.

Table 2. IOP Maximum Fall Rate for Discharge from Woodruff Dam by Release Range

Approximate Release Range (cfs)	Maximum Fall Rate (ft/day)
≥ 30,000[a]	Fall rate is not limited[b]
≥ 20,000 and < 30,000	1.0 to 2.0
> 16,000 and < 20,000	0.5 to 1.0
> 8,000 and ≤ 16,000	0.25 to 0.5
≤ 8,000	0.25 or less

[a] Consistent with safety requirements, flood control purposes, and equipment capabilities, the IOP indicates that the Corps will attempt to limit fall rates to the lower value specified for each release range.

[b] For flows greater than 30,000 cfs, it is not reasonable or prudent to attempt to control down ramping rate, and no ramping rate is required.

minimum flow would be more prudent than the desired minimum flow. The drought trigger is based upon Composite Storage within the ACF system. The Composite Storage is calculated by combining the storage of Lake Sidney Lanier, West Point Lake, and Walter F. George Lake. Each of the individual storage reservoirs consists of four Zones. These Zones are determined by the operational guide curve for each project. The Composite Storage utilizes the four Zone concept as well; i.e., Zone 1 of the Composite Storage represents the combined storage available in Zone 1 for each of the three storage reservoirs.

Consistent with the operational decisions approved in the BO, the current IOP also includes a volumetric balancing of releases in cases where storage is used to follow the ramping rates specified in the IOP. Following rain events, the required ramping rates are often more gradual than the actual decline in basin inflows, and potential over-releases and additional drain on reservoir storage could occur, especially when trying to match releases to the computed 7-day average basin inflow. In order to avoid over-releases and conserve storage during critical periods, the volume of releases can be balanced during and following rain events. Releases after the rainfall events are adjusted to account for any computed under-release or over-release, to assure that net releases are balanced to meet the computed volume of basin inflow over time. The volumetric balancing computations do not include releases for flood control or other special releases not prescribed by the IOP, but primarily account for possible over-releases that occur due to the ramping rate restrictions. Due to a significant credit accumulating in the Corps volumetric balancing account since September 2006 (attributable to down ramping) and subsequent volumetric balancing activities in April 2007, the Corps and USFWS mutually agreed that improvements in the tracking procedures that more clearly address the goals of volumetric balancing (generally assure required releases are made while recognizing the complexities of water management) were needed. Therefore, by letter dated 16 May 2007 the Corps submitted documentation of these clarifications to the volumetric balancing accounting system that simplified a complex computation procedure and refined the decision and accounting system to more clearly demonstrate the impacts on storage and whether releases meet the IOP flow releases schedule.

The IOP was developed in consultation with the USFWS to provide for releases in support of federally listed species on the Apalachicola River, consistent with the requirements of the current water control plan (1989 Draft Water Control Plan for the ACF Basin). During development of the IOP it was agreed that HEC-5 hydrologic modeling data for the 1939-2001 period would be used to analyze the impact of the IOP on listed species. The results of this analysis indicated that the IOP would manage composite storage in the federal reservoirs in a manner that met the needs of consumptive demands and minimum releases through the worst drought of record (1999-2001 drought representing the critical period). However, in the current year (2007) throughout much of the ACF Basin various precipitation and drought indices have reached record lows and reservoir elevations at the federal projects are lower than were observed or simulated with the IOP in place during this time of year for the critical period evaluated.

Throughout this summer the Corps has monitored the composite storage within the system and the forecast of an exceptionally severe and long lasting drought. Appendix A includes a recent memo drafted by our staff meteorologist that documents the severity of the current drought and forecasts of a dry winter and spring. Appendix B includes a presentation documenting the National Oceanic and Atmospheric Administration's (NOAA) drought analysis and winter forecast.

In early September the Corps and USFWS began informal consultation discussions regarding the potential need to modify the IOP to allow temporary deviations due to the extraordinary drought conditions occurring in the ACF Basin this year and the likelihood of these conditions persisting throughout the remainder of this year and the following year. As discussed between the Corps and USFWS, in conformance with the Draft Water Control Plan (1989) for the ACF Basin and the provisions of the IOP, the Corps has been releasing a minimum flow of at least 5,000 cfs from Jim Woodruff Dam since late May 2007. The 7-day basin inflows during this same period were considerably lower than 5,000 cfs for substantial periods (average approximately 2,500 cfs during July - September) resulting in a substantial reduction in storage from the upstream reservoirs. In mid October, the Corps informed USFWS that recent 7-day basin inflows were averaging less than 2,000 cfs and that the composite storage for the system was in Zone 4 (lowest zone) and projected to continue to drop significantly over the next 30-60 days. Lake Lanier was the only Federal reservoir within the ACF basin with conservation storage remaining to support downstream water users and the 5,000 cfs minimum flow and the extremely dry conditions were resulting in rapidly declining availability of this storage. Due to the likelihood of current conditions continuing through the end of this year and into the winter and spring of 2008, and only a limited amount of conservation storage being available to support the 5,000 cfs minimum flow, we agreed to consider immediate measures to reduce the continuing drawdown of Composite Storage and to maintain the Corps' ability to serve the various authorized project purposes for the federal reservoirs including fish and wildlife conservation.

As we discussed, some of the drought contingency measures under consideration would require further evaluation and consultation discussion, but certain measures could be implemented at that time without causing adverse effects to the listed species. Therefore, both agencies agreed on 17 October 2007 to use volumetric balancing credits to allow storage of inflows greater than 5,000 cfs (storage volume limited to account balance) in the event of rainfall within the basin. Also, by letter dated 19 October 2007, the Corps requested a temporary modification of the IOP consisting of an immediate suspension of the maximum fall rate schedule (Table 2) until 1 March 2008. As described in the letter, elimination of the down-ramping provision would improve our ability to conserve storage to the maximum extent practicable. The Corps determined that this temporary modification of the IOP may affect, but was not likely to adversely effect the threatened Gulf sturgeon, endangered fat threeridge mussel, threatened purple bankclimber mussel, and threatened Chipola slabshell; and would not result in destruction or adverse modification of habitat designated and proposed as critical habitat for the Gulf sturgeon and the mussels. By letter dated 19 October 2007 the USFWS concurred with this determination and approved the temporary modification of the IOP.

As described above, we recognized that additional temporary modifications of the IOP would be necessary in order to avoid depleting the conservation storage in the system. At that point, no storage would remain in the conservation pool at Lake Lanier or the other Federal reservoirs and our ability to serve the various authorized project purposes for the federal reservoirs, including fish and wildlife conservation would be significantly limited. It should be noted that bottom of conservation pool does not equate to no water remaining in the reservoirs. The inactive storage at each of the reservoirs combined still contains 1,856,550 acre-feet of water. However, operational flexibility regarding water management within the basin is acutely impaired within the inactive storage pool and the Apalachicola River would experience flows significantly lower than previously recorded. Adverse impacts to listed species (especially the listed mussel species) are reasonably certain to occur as flows on the Apalachicola River drop below 5,000 cfs. The intent of any modification to the IOP would be to minimize adverse impacts to listed species in the Apalachicola River while making allowances for increased storage opportunities and/or reductions in the demand of storage in order to provide continued support to project purposes, minimize impacts to other water users, and have greater assurance of future ability to sustain flows for listed species during a severe multi-year drought, as currently being experienced in the ACF basin. The extremely dry conditions experienced this year have resulted in an urgent need for additional temporary modifications to the existing IOP protocols in order to replenish storage in the Federal reservoirs in order to avoid potentially significant impacts to endangered species in the Apalachicola River. This BA has been prepared to address the potential effects of the proposed temporary modification to the IOP. In addition, a description of several alternatives considered during development of the proposed action is provided; as well as, discussion on why these alternatives failed to meet the intent of the temporary modification.

DESCRIPTION OF PROPOSED ACTION

The proposed action (referred to as Exceptional[1] Drought Operations (EDO) throughout this assessment) is a temporary modification of the existing IOP as approved by USFWS on 28 February 2007. As described above, the intent of any modification to the IOP would be to minimize adverse impacts to listed species in the Apalachicola River while making allowances for increased storage opportunities and/or reductions in the demand of storage in order to provide continued support to project purposes, minimize impacts to other water users, and provide greater assurance of future sustained flows for species and other users during a severe multi-year drought, currently being experienced in the ACF basin.

Consistent with the IOP which uses Composite Storage to trigger whether the desired minimum flow (6,500 cfs) or the required minimum flow (5,000 cfs) is maintained; the proposed action also uses Composite Storage to determine when the EDO is required. The Composite Storage is calculated by combining the storage of Lake Sidney Lanier, West Point Lake, and Walter F. George Lake. Each of the individual storage reservoirs consists of four Zones. These Zones are determined by the operational guide curve for

[1] The term "exceptional" is used to distinguish these drought operations from those in the existing IOP. The term is not intended to adopt the permutations of the same term used by the National Weather Service.

each project. The Composite Storage utilizes the four Zone concept as well; i.e., Zone 1 of the Composite Storage represents the combined storage available in Zone 1 for each of the three storage reservoirs. Figure 1 illustrates the acre-feet of storage available for Composite Zones 1-4 throughout the year; as well as, the current Composite Storage. The EDO is "triggered" whenever the Composite Storage falls below the bottom of Zone 3 into Zone 4. At that time the provisions of the IOP are suspended and management decisions are based on the provisions of the EDO. The provisions of the EDO remain in place until conditions improve such that the Composite Storage reaches a level above the top of Zone 3 (i.e., within Zone 2). At that time, the temporary EDO provisions are suspended, and the provisions of the IOP are re-instated.

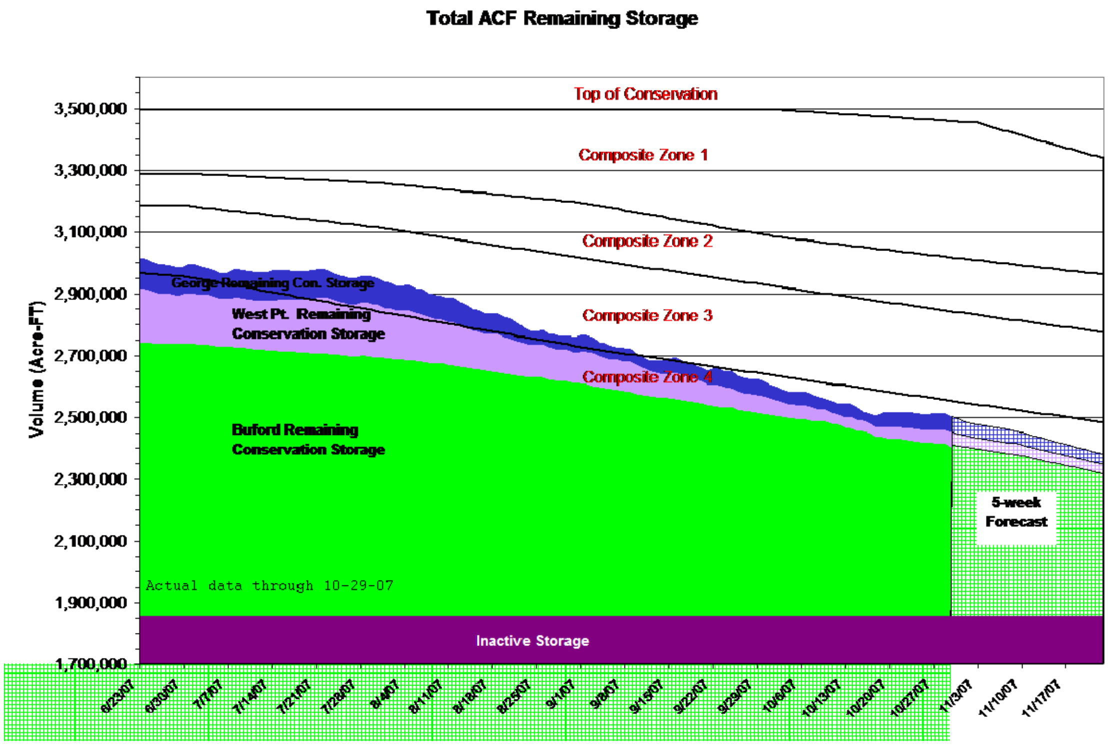

Figure 1. Composite Storage and Associated Zones in Acre-Feet

The EDO includes the following provisions and triggers:

- Immediate suspension of all existing IOP provisions including seasonal storage limitations, maximum fall rate schedule, minimum flow thresholds, and volumetric balancing accounting whenever the Composite Storage falls below the bottom of Zone 3 into Zone 4 (fall rates would be managed to match the fall rate of the basin inflow);

- Immediate reduction of the 5,000 cfs minimum flow requirement in the Apalachicola River, as measured at the Chattahoochee gage, to a 4,150 cfs minimum flow requirement (the reduction to this minimum flow would be implemented gradually, consistent with the IOP maximum fall rate schedule);

- Implementation of a monthly monitoring plan that tracks Composite Storage in order to determine water management operations (the first day of each month will represent a decision point) and whether EDO triggers are applied;

- Re-instatement of the 5,000 cfs minimum flow requirement, but none of the other IOP provisions once conditions improve such that the Composite Storage reaches a level above the top of Zone 4 (i.e., within Zone 3); and

- Suspension of all EDO provisions and re-instatement of the existing IOP provisions once conditions improve such that the Composite Storage reaches a level above the top of Zone 3 (i.e., within Zone 2).

The Chattahoochee gage (USGS number 02358000) is the point at which Jim Woodruff Dam releases are measured under the proposed action. Composite Zone 4 was selected as the trigger for implementation of the EDO based on a review of the HEC-5 IOP simulated reservoir conditions for the period of record (1939-2001). The simulated conditions were developed by applying the provisions of the IOP to the unimpaired flow daily time series data for the 63 year period and modeling the resultant reservoir and river conditions. By analyzing the Composite Storage simulated for each year during this period, we were able to identify a Composite Storage trigger that coincided with exceptional drought conditions such as those currently being experienced in the ACF basin. Composite Zone 4 indicates that all federal storage reservoirs have reached a critical storage level. The most conservative operation is enacted when in Composite Zone 4 and releases are only made for water supply and water quality. Navigation is not supported and hydropower demands will be met at minimum levels incidental to releases for water supply and water quality. Additional generation, solely to meet system hydropower demands will not be made. Composite Storage is currently within Zone 4. For the 63 year simulated period, there was only two other years (1986 and 2000) that resulted in Composite Storage below Zone 3. As described above, the year 2000 represented exceptional drought conditions and served as the critical period during the IOP analysis. It should be noted that the period of record simulated included severe droughts in 1941, 1954-55, 1981, 1986-89, 1999-2001. Based on this analysis, Composite Storage Zone 4 appears to be an appropriate indicator of exceptional drought conditions. Therefore, the EDO would be triggered immediately since the Composite Storage of the system is currently within Zone 4.

ALTERNATIVES CONSIDERED

A. <u>"No Action"</u> - Based on the nature of the proposed action, "no action" represents "no change" from the current management direction or level of management intensity. This alternative would represent the current water control operations at Jim Woodruff Dam (i.e., implementing the provisions of the IOP as described in the 23 March 2007 letter to USFWS). This alternative is not feasible given the intensity of the drought and the forecast for worsening conditions. Based on our modeling of the no action alternative under an extreme drought hydrology, the Composite Conservation Storage of the system would be depleted thus "breaking" the system in the event of a multi-year drought which has a reasonable chance of occurring given current meteorological forecasts. The Effects Analysis section includes a detailed description of this. Therefore, additional alternatives were considered.

B. Suspend Down Ramping Requirement Until 1 March 2008 – This alternative represents the IOP operations at Jim Woodruff Dam since 19 October 2007. At that time the Corps requested and the USFWS approved a temporary modification of the IOP consisting of an immediate suspension of the maximum fall rate schedule (Table 2) until 1 March 2008. Under this temporary modification, fall rates would be managed to match the fall rate of the basin inflow. As described in the request letter, elimination of the down ramping provision would improve our ability to conserve storage to the maximum extent practicable. However, it was noted that additional temporary modifications to the IOP would likely be required in order to avoid depletion of the composite storage in the system. The suspension of the down-ramping requirements would address the situation when increased flows in the system begin to decline and ramp-down occurs. However, this alternative does not address the situation when adequate rainfall does not occur and there is not significant increase in flows to the point that water can be stored in the system. If this does not occur, there may not be many opportunities to take advantage of the suspension in down ramping. Based on the modeling results for the no action alternative, it is apparent that suspension of the down ramping provision alone fails to avoid depletion or near depletion of the composite storage in the system. Therefore, additional modifications were considered.

C. Maintain 5,000 cfs Minimum Release at Jim Woodruff Dam and Eliminate All Other Provisions of IOP Until Composite Storage Enters Zone 2. The period of June through December is the most critical period during a dry year. This generally represents the period where significant amounts of storage are required to augment the basin inflow to meet the 5,000 cfs minimum flow. Our analysis indicates this period provides the maximum opportunity to conserve storage (not refill) during a drought of the current severity. An opportunity to reduce flow below the 5,000 cfs minimum during this time is necessary. This alternative did not provide sufficient opportunity to conserve storage until basin inflows increase to a level where storage recovery can begin. Furthermore, extended periods with Composite Storage in Zone 4 (the current level) and especially those with Composite Storage levels significantly lower than the top of Zone 4 greatly limit our ability to respond to drought conditions as severe as and more severe than are currently occurring. This alternative was deemed not a fair balance between providing more opportunities to conserve storage for future augmentation flows and continued flow support to threatened and endangered species and the multiple project purposes in the basin. Therefore, additional alternatives were considered.

D. Maintain 5,000 cfs Minimum Release at Jim Woodruff Dam and Eliminate All Other Provisions of IOP Until Composite Storage Enters Zone 2; On 1 June 2008 See if Trigger to 4,150 cfs Flow is Met. Although this alternative is very similar to the two previous alternatives, the minimum flow reduction decision is delayed until next summer. As described above, immediate consideration to lowering the minimum flow must be taken due to the continued need to use storage to augment the basin inflow to meet the 5,000 cfs minimum flow over the next few months and to optimize storage conservation and the likelihood of reservoir refill. Reservoir refill to Composite Storage levels above Zone 4 is critical to our ability to manage the system during an extended drought period and delaying the decision until 1 June, 2008 would also miss the opportunity for supplementing storage during the normally wetter periods (January – April), that occur prior to June. This alternative was deemed not a fair balance between providing more opportunities to conserve storage for future augmentation flows and continued flow support to threatened and endangered species and the multiple project purposes in the basin. Under this operation, more preference was given to immediate support to threatened and endangered species than reservoir refill. Therefore, additional alternatives were considered.

E. Maintain 4,150 cfs Minimum Release at Jim Woodruff Dam and Eliminate All Other Provisions of IOP Until Composite Storage Enters Zone 2. This alternative provided great benefit to storage conservation and reservoir refill. However, model results indicate prolonged periods of flows equal to 4,150 cfs would occur under this operation. This alternative was deemed not a fair balance between providing more opportunities to conserve storage for future augmentation flows and continued flow support to threatened and endangered species and the multiple project purposes in the basin. More preference was given to storage conservation and reservoir refill than to support to threatened and endangered species. Therefore, additional alternatives were considered.

F. Georgia Environmental Protection Division (GAEPD) Recommendation – By letter dated 12 October 2007, the GAEPD requested a temporary modification of the IOP. A copy of the letter is provided in Appendix C. The GAEPD recommends that these modifications remain in place until 1 March 2008 at which time additional modifications would likely be required. The GAEPD recommended plan consisted of temporary modifications of the IOP that include changes to two parameters applicable to the daily releases from Jim Woodruff Dam: a minimum discharge in relation to average basin inflows and a maximum fall rate. The recommended changes include:

- Immediate suspension of 5,000 cfs minimum release requirement at Jim Woodruff Dam. Minimum releases from the dam would match basin inflow while basin inflow values are less 5,000 cfs.

- If basin inflow values are 5,000 cfs or higher, then the maximum release from Jim Woodruff Dam would be 5,000 cfs.

- Immediate suspension of maximum fall rate schedule.

GAEPD subsequently revised the proposed modifications in a Motion for Preliminary Injunction filed in the United States District Court Middle District of Florida Jacksonville Division on 19 October 2007. A copy of this document is provided in Appendix D. GAEPD states in the motion that these emergency changes to the IOP would remain in effect until the earlier of: 1) 1 March 2008; 2) a decision on the merits of Georgia II; or 3) further order of this Court, with the understanding that motions for modification of this relief may be appropriate in the event that conditions improve and the threat of depletion of reservoir system conservation storage is materially reduced. The revised temporary modifications include:

- Immediate suspension of 5,000 cfs minimum release requirement at Jim Woodruff Dam. Minimum releases from the dam would match the adjusted basin inflow while the adjusted basin inflow values are less 5,000 cfs, as measured at the Chattahoochee gage.

- If the adjusted basin inflow values are 5,000 cfs or higher, then the maximum release from Jim Woodruff Dam would be that required to maintain a 5,000 cfs flow measured at the Chattahoochee gage.

- Immediate suspension of maximum fall rate schedule.

As defined in the motion, “Adjusted Basin Inflow” is “the amount of water that would flow by Jim Woodruff Dam during a given time period if all of the Corps' reservoirs maintained a constant water surface elevation during that period, plus Georgia's municipal and industrial consumptive demands from the Chattahoochee River and Lake Lanier (which are deemed for purposes of this order to be 457 cfs during October, 369 cfs during November, 352 cfs during December, 302 cfs during January, and 345 cfs during February)”. Due to the similarity of the proposed modifications, we address the most recent recommendation in this alternative discussion.

We have incorporated aspects of the Georgia proposal into the proposed action, such as the suspension of maximum fall rate schedule; the storage of all basin inflows above 5,000 cfs; and the reduction of the 5,000 cfs flow if certain triggers are reached. The immediate suspension of the 5,000 cfs flow to match the adjusted basin inflows was not incorporated because it may not provide the benefits to Lake Lanier that are key to maintaining storage in the system. It could be beneficial to the lower project but could present a problem with holding the additional storage in the lower projects if they exceed the top of conservation or even a designated level within the flood zone. The provision to match minimum releases to basin inflows when flows are below 5,000 cfs would be more detrimental to the species than the reduction designated in the proposed action. The proposed action provides a reduction in flow if certain triggers are reached but does not reduce the flows to a level that could occur under this proposal.

G. ARC Recommendation– By letter dated 25 October 2007, the Atlanta Regional Commission (ARC) provided a three-phase Reservoir Recovery Plan that included an Emergency Operations Plan as phase 1. The other two phases include actions that would require additional consultation apart from the intent of the current consultation and therefore are not included in this alternative description. A copy of the letter is provided in Appendix E. The ARC recommends that the Emergency Operations Plan remain in place until 1) composite storage within the system is recovered; 2) a new IOP and/or updated Water Control Plan are completed; or 3) composite storage within the system is in Zone 4 on 1 February 2008 (at which time additional modifications would be required). The Emergency Operations Plan consists of temporary modifications of the IOP that include changes to two parameters applicable to the daily releases from Jim Woodruff Dam: a minimum discharge in relation to average basin inflows and a maximum fall rate. In addition, the Emergency Operations Plan includes a temporary waiver of the seasonal drawdown at the West Point and Walter F. George projects (for 2007-2008 only). The recommended minimum discharge changes include:

During the non-spawning season (June-February):

- When Basin Inflow is greater than 5,000 cfs, all flows in excess of those required to meet the 2,000 cfs minimum flow target at Farley Nuclear Plant should be stored in the Chattahoochee reservoirs to the extent possible.

- When Basin Inflow is less than 5,000 cfs, (or whatever alternative minimum flow FWS determines to be appropriate) storage should be released from the Chattahoochee reservoirs to meet the minimum flow.

During the spawning season (March-May):

- When Basin Inflow is greater than 11,000 cfs, all flows in excess of those required to meet the 2,000 cfs minimum flow target at Farley Nuclear Plant should be stored in the Chattahoochee reservoirs to the extent possible.

- When Basin Inflow is between 5,000 cfs and 11,000 cfs, Woodruff Outflow should equal Basin Inflow.

- When Basin Inflow is less than 5,000 cfs, (or whatever alternative minimum flow FWS determines to be appropriate) storage should be released from the Chattahoochee reservoirs to meet the minimum flow.

The ARC Emergency Operation Plan includes a modification of the IOP maximum fall rate schedule that determines maximum fall rate based on (1) the Basin Inflow fall rate; or (2) the IOP maximum fall rate schedule. The recommendation is that the maximum fall rate schedule should follow the higher of these two fall rates.

We have incorporated aspects of the ARC proposal such as storing basin inflow; maintaining the 5,000 cfs minimum flow if certain triggers do not call for a reduction in the minimum flow; storing basin inflow while meeting the minimum target flow for Farley Nuclear Plant and adjustments to the maximum fall rate. The condition in the ARC proposal to provide releases equal to basin inflow when Basin Inflow is between 5,000 cfs and 11,000 cfs was not incorporated into the proposed action because it does not provide enough opportunities to store water during the periods that fall into that range. This may occur more frequently during a dry winter and spring and would represent opportunities missed to supplement storage.

STATUS OF THE SPECIES/CRITICAL HABITAT

Please refer to the STATUS OF THE SPECIES/CRITICAL HABITAT section (Section 2) of the September 5, 2006 Biological Opinion and Conference Report on the U.S. Army Corps of Engineers, Mobile District, Interim Operating Plan for Jim Woodruff Dam and the Associated Releases to the Apalachicola River (USFWS 2006). The detailed information provided in Section 2 represents the best scientific information available on the listed species occurring in the action area and provided the basis for determining the flow regime characteristics identified as relevant to the listed species and their habitats during development of the IOP. Additional studies pertaining to listed mussel species in the Apalachicola River have occurred since the BO was signed. The findings of these studies are summarized in the Environmental Baseline section below.

ENVIRONMENTAL BASELINE

As described in the BO, the environmental baseline is a "snapshot" of a species' health at a specified point in time. It does not include the effects of the proposed action, but rather provides an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area. Section 3 of the BO provides a description of the environmental baseline prior to implementation of the IOP. This detailed information represents the best scientific information available at that time regarding the listed species occurring in the action area. However, the environmental baseline for the proposed action must also consider the effects of operating under the IOP for the past 12 months. Some of the factors contributing to the environmental baseline, such as the general description of the action area, have not changed significantly since the time the BO was written and we incorporate this information by reference to Section 3 of the BO. The following discussion will focus on new information relevant to the three principal components of the species' environment in the action area: channel morphology, flow regime, and water quality; as well as new information regarding the status of the species/critical habitat within the action area. This information is considered supplemental to that previously described in the BO.

CHANNEL MORPHOLOGY ALTERATIONS

As described in the BO, in 2006 Light et al. determined that the Apalachicola River has not followed the normal pattern of lateral migration in which erosion and deposition are balanced so that the channel maintains a relatively constant width and bed elevation. This determination was based on studies that suggest that in the past 50 years, many portions of the Apalachicola River have substantially declined in elevation (incised) and/or become substantially wider.

In accordance with RPM4 of the BO, the Corps conducted an evaluation of the sediment dynamics and channel morphology trends on the Apalachicola River in order to improve our understanding of dynamic conditions and monitor the zone at which take may occur, and to identify possible alternatives to minimize effects to listed mussels in vulnerable locations. By letter dated 30 August 2007, the Corps provided the findings of this evaluation to the USFWS. A copy of this letter and the accompanying enclosures is provided in Appendix F. The RPM4 Terms and Conditions described in the BO specify that Mobile District and USFWS will consult with experts, jointly identified by both agencies, to assist in identifying 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 is to be based on available information and tools and best professional judgment. The USFWS and Corps mutually identified specialists with specific river sediment transport and morphology expertise and malacologists with extensive experience regarding freshwater mussels in the Apalachicola River and other large river systems to assist in the evaluation.

Based on review of existing information, the reconnaissance field trip, presentations and discussions at the technical workshop, and the summary of findings reports prepared by the river specialists and malacologist, the Corps determined that the current version of the IOP adequately met the intended goal of minimizing or avoiding adverse impacts or providing support to listed species occurring in the Apalachicola River. As documented in the BO, the flow regime in the Apalachicola River has not been changed significantly between the pre- and post- dam periods. The river appears to be in a relatively stable dynamic equilibrium. The morphology of the river could have been impacted over time by land use changes, upstream impoundments and consumptive use of water, and tectonic movement, as well as channel alterations, meander cutoffs, and channel dredging and snagging operations. Obvious channel degradation impacts were noted below Jim Woodruff Lock and Dam immediately after construction. However, these impacts appear to be reduced through time. Data from the Blountstown and Wewahitchka gages downstream of the dam indicate that there was a small change in low flow water surface elevations at those sites in response to Jim Woodruff construction, but the changes appear to have stabilized. Field observations and data analysis by the river specialists suggests that the river is not continuing to degrade and that it may have attained a state of relative equilibrium. This is consistent with the findings of Light et al. (2006) who concluded that channel conditions had been relatively stable for the a ten year period (1995-2004). Although a large portion of the middle river (Nautical Mile (NM) 78 to NM 35) is very sinuous and actively meandering, maximum erosion rates on the outside of the bends in this reach are extremely low compared to other large alluvial rivers and appear to be part of the natural down-valley meander migration which is common to most meandering streams. This does not appear to be the result of continuing post-dam system-wide adjustment such as degradation, aggradation, or channel widening. It appears unlikely that erosion rates will increase over time unless there are significant changes of the flow regime or reduction in sediment supply, which do not appear likely to occur under the provisions of the IOP. This evaluation did not include analysis of Apalachicola River flows less than 5,000 cfs. However, generally channel morphology alterations are more closely associated with increased duration and frequency of high flow events rather than low flow events as have occurred throughout this year.

FLOW REGIME ALTERATIONS

The proposed action is an operational plan that prescribes the flow of the river. Therefore, as described in the BO, the habitat characteristic of greatest relevance to this analysis is the flow regime of the river, which is highly variable over time, due to fluctuations in magnitude, seasonality, duration, frequency, and rate of change. In the BO, the USFWS describes the environmental baseline as a “snapshot” of a species health and habitat within the action area. However, in order to capture the intra- and inter-annual variability, the flow regime of the environmental baseline is necessarily a “video” of river flow that begins at an appropriate date in the past and concludes at the present (USFWS 2006). Therefore, this analysis provides an update of the “video” incorporating the conditions experienced over the last year since the BO was completed. Determining effects to the species and their habitat in the baseline flow regime is an evaluation of the degree to which the natural flow regime in the action area has been altered to date by all anthropogenic factors, including past and current IOP operations of the Corps’ ACF projects. Determining effects of the proposed action is an evaluation of the degree to which the baseline flow regime may be further altered by operations under the proposed action.

As noted in the “Description of Proposed Action” section, the Chattahoochee gage (USGS number 02358000) is the point at which Jim Woodruff Dam releases under the proposed action are measured. This gage is also the source of data for describing the baseline flow regime. Although the IOP attempts to mimic a natural flow regime, the flow of the Apalachicola River has been altered to some degree during the implementation period by provisions for storage of basin inflow, augmentation to maintain the 5,000 cfs minimum flow, and consumptive water uses which affect the basin inflow calculation. These alterations contribute to the environmental baseline.

As described above, the environmental baseline for the proposed action must also consider the effects of operating under the IOP for the past 12 months. Table 3 illustrates the average annual discharge statistics from the BO for the pre-Lanier and post-West Point periods and the calculated average annual discharge for the September 2006-September 2007 period. Since the last column only includes one year of data, the mean value is the only statistic provided. The average annual discharge value for the September 2006-September 2007 period is approximately half that observed in the other periods. This is a reflection of the severe drought conditions experienced during much of the past year. The USGS Apalachicola River discharge data (Chattahoochee gage) used to calculate the average annual discharge for the past year is considered provisional and is subject to change and final approval.

Average Annual Discharge Statistics

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Sep. 2006 - Sep. 2007*
Mean	21287.8	21677.3	10793.0
Median	20130.1	22283.0	
Standard Deviation	7387.5	6375.5	
Minimum	11223.2	9341.0	
Maximum	39579.6	35344.4	

Table 3. Average annual discharge statistics for the pre-Lanier (1922-1955), post-West Point (1975-2005), and September 2006-September 2007 periods.

As described in the BO, "The discharge generally associated with the greatest volume of sediment movement over time is the bankfull discharge, which is typically the annual peak flow event that occurs an average of two out of three years (1.5-year recurrence interval) (Dunne and Leopold 1978). Bankfull discharge tends to occur almost annually in the coastal plain portions of Alabama, north Florida, and Georgia (Metcalf 2004). Although higher flow rates than the 1.0- to 1.5-year recurrence peaks move more sediment per unit time, these more frequent events move the greatest sediment volume over time. Using 85 years of annual instantaneous peak flow data from the Chattahoochee gage, the 1.0- and 1.5-year recurrence peak flows for the Apalachicola River are 23,400 cfs and 72,100 cfs" (USFWS 2006). During the September 2006-September 2007 period, the maximum discharge value recorded was approximately 37,000 cfs.

Tables 4 - 6 compare the distribution of monthly average flow in the pre-Lanier, post-West Point, and September 2006-September 2007 periods. The average monthly discharge values for the September 2006-September 2007 period are considerably lower than observed in the other periods. This is a reflection of the severe drought conditions experienced during much of the past year. The average monthly discharge values for the September 2006-September 2007 period would have been significantly lower if conservation storage had not been available to augment basin inflow to meet the 5,000 cfs minimum flow at Jim Woodruff Dam.

Table 7 compares the total annual precipitation (inches) for the pre-Lanier, post-West Point, and September 2006-September 2007 periods. The total annual precipitation for the September 2006-September 2007 period is approximately 10 inches less than the average observed in the other periods. This further supports the severity of the drought conditions experienced during much of the past year.

Average Monthly Discharge Statistics

January

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Jan. 2007*
Mean	27136.5	26115.5	21307.3
Median	23432.3	21103.2	
Standard Deviation	13929.1	12772.9	
Minimum	10748.4	9035.8	
Maximum	62467.7	50896.8	

February

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Feb. 2007*
Mean	29599.1	34350.5	18930.8
Median	28658.6	33196.4	
Standard Deviation	13097.0	13916.8	
Minimum	11233.6	10423.2	
Maximum	64917.2	67314.3	

March

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Mar. 2007*
Mean	40474.2	40827.4	19452.2
Median	32764.5	44600.0	
Standard Deviation	29883.5	18693.5	
Minimum	12780.6	14573.2	
Maximum	171632.3	90332.3	

April

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Apr. 2007*
Mean	34332.5	31342.2	13525.9
Median	31423.3	27553.3	
Standard Deviation	16434.1	16694.8	
Minimum	16750.0	10884.7	
Maximum	80703.3	71786.7	

Table 4. Average monthly discharge statistics (January-April) for the pre-Lanier, post-West Point, and September 2006-September 2007 periods.

Average Monthly Discharge Statistics

May

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*May-07*
Mean	22921.6	20204.7	6855.9
Median	19938.7	17093.5	
Standard Deviation	9990.5	9890.8	
Minimum	9840.3	8325.8	
Maximum	44977.4	43038.7	

June

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Jun. 2007*
Mean	15918.6	16303.0	5148.7
Median	15633.3	14626.7	
Standard Deviation	5403.0	7079.8	
Minimum	7147.7	4825.7	
Maximum	27670.0	37116.7	

July

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Jul. 2007*
Mean	16959.1	18453.0	5350.3
Median	15587.1	12740.0	
Standard Deviation	7060.2	16550.7	
Minimum	9009.7	5116.8	
Maximum	37854.8	87780.6	

August

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Aug. 2007*
Mean	15660.5	14807.5	5138.3
Median	14977.4	12138.7	
Standard Deviation	5569.7	7844.1	
Minimum	8129.0	4750.0	
Maximum	29254.8	32348.4	

Table 5. Average monthly discharge statistics (May-August) for the pre-Lanier, post-West Point, and September 2006-September 2007 periods.

Average Monthly Discharge Statistics

September

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Sep. 2006*
Mean	12174.7	12390.1	6996.5
Median	12003.3	11605.7	
Standard Deviation	3669.0	4958.4	
Minimum	6092.0	5888.7	
Maximum	19716.7	28414.0	

October

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Oct. 2006*
Mean	11787.9	12346.1	6165.6
Median	10574.2	11325.8	
Standard Deviation	6540.8	5749.8	
Minimum	5319.4	5658.7	
Maximum	37509.7	30367.7	

November

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Nov. 2006*
Mean	12696.8	14214.2	12103.9
Median	9960.0	12723.3	
Standard Deviation	7129.3	6371.1	
Minimum	5524.0	5613.7	
Maximum	28990.0	31790.0	

December

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Dec. 2006*
Mean	19450.6	20585.6	9153.9
Median	14870.0	16793.5	
Standard Deviation	13794.5	12570.3	
Minimum	7990.6	7336.8	
Maximum	70393.5	51664.5	

Table 6. Average monthly discharge statistics (September-December) for the pre-Lanier, post-West Point, and September 2006-September 2007 periods.

Total Annual Precipitation (Inches)

	Pre Lanier (1922-1955)	*Post West Point (1975-2005)*	*Sep. 2006 - Sep. 2007*
Mean	51.6	52.9	42.9
Median	49.3	52.9	
Standard Deviation	9.2	7.4	
Minimum	31.2	41.3	
Maximum	72.4	68.2	

Table 7. Total annual precipitation (inches) statistics for the pre-Lanier, post-West Point, and September 2006-September 2007 periods.

WATER QUALITY

As described in the BO, although the State standards adopted consistent with the U.S. Environmental Protection Agency (EPA) criteria generally represent levels that are safe for sturgeon and mussels, these standards are sometimes violated. Point and non-point source pollution have contributed to impaired water quality in the Apalachicola and Chipola rivers resulting in several segments of the rivers within the action area failing to fully serve the designated uses. The impairments identified include turbidity, coliforms, total suspended solids, dissolved oxygen (DO), biology, and unionized ammonia (FDEP 1998 and 2003). Elevated coliform bacteria counts are not known to harm Gulf sturgeon or freshwater mussels; however, elevated unionized ammonia and low DO are associated with adverse effects to fish and mussels (USFWS 2006). In addition, the 5-Year Review for seven listed mussel species (including the three occurring in the action area) published by the USFWS this summer states that recent studies have demonstrated early life stages of mussels are generally more sensitive to copper and ammonia than other organisms and that current EPA criteria for copper and ammonia are not protective of mussels (USFWS 2007). The 5-Year Review also notes that these early life stages may be particularly sensitive to pesticides and herbicides such as glyphosate and atrazine (USFWS 2007). We lack sufficient information to determine if implementation of the IOP has altered the baseline water quality of the action area. However, we recognize that the extraordinary drought conditions experienced during much of the IOP implementation period, have resulted in salinity changes in Apalachicola Bay and increased water temperatures and associated localized dissolved oxygen changes due to extended periods of low flow (approximately 5,000 cfs).

Livingston (1984) noted that the salinity distribution in the Apalachicola Bay system at any given time is affected primarily by river flow, local rainfall, basin configuration, wind speed and direction, and water currents. Low bay salinities coincide with high river flows generally experienced during winter, spring, and tropical storm events in the summer. The bay system can generally be divided into two main provinces 1) the relatively high salinity open Gulf waters of eastern St. George Sound and Alligator Harbor (greater than 30 parts per thousand (ppt) most of the year); and 2) the brackish (river-diluted) portions of western St. George Sound, Apalachicola Bay, St. Vincent Sound (varying from 5-18 ppt to 18-30 ppt), and East Bay (0.5-5 ppt most of the year). The Florida Department of Environmental Protection (FDEP) has been monitoring salinity levels at several locations in the Apalachicola bay system throughout the year. Preliminary data provided by USFWS (J. Ziewitz, pers. comm.) provides some insight into the impact of this year's extended low river flow on salinity levels in the bay. Dataloggers located at Cat Point (an oyster bar on the western end of St. George Sound), Dry Bar (an oyster bar on the eastern end of St. Vincent Sound), and Upper East Bay (the northeastern end of East Bay) continuously (15 minute intervals) collected data throughout the summer. All of these locations occur in areas Livingston (1984) characterized as brackish. Preliminary data indicates that all three locations experienced relatively high salinity levels throughout the recording period (July – September). The Cat Point data indicates salinity levels generally in the range of 23-33 ppt; the Dry Bar data indicated salinity levels generally in the range of 24-35 ppt; and the Upper East Bay data indicated salinity levels generally in the range of 14-23 ppt. This data is consistent with anecdotal information provided by the Shellfish Group at the Florida Department of Agriculture, which observed significant oyster mortality, beginning in late March, in the western portions of the bay and spread eastward throughout the summer to areas closer to the mouth of the river (Cat Point). They attribute this mortality to dermo (disease) and predation which is exacerbated by the high salinities and high water temperatures which are also attributed to the lack of fresh water flows from the river that cool down the bay (J. Ziewitz, pers. comm.). The high salinity levels experienced in Apalachicola Bay this summer may impact juvenile and adult Gulf sturgeon entering the bay this fall/winter. A discussion of salinity alterations on sturgeon is provided in the Status of the Species section below.

Although we do not have water temperature or DO data from this year, it is reasonable to assume that the maintenance of an approximately 5,000 cfs flow in the Apalachicola River for an unprecedented duration (generally from late May to present) during the hottest months of the year has resulted in increased water temperature and localized declines in DO. These alterations could be particularly damaging to the mussels species since their movement capabilities are slow and limited. The most extreme examples of this would occur in shallow backwater areas with little or no connection to the main channel of the river and in shallow isolated pool habitat occurring in distributaries that no longer have a hydrological connection to the main channel of the river (eg., Swift Slough). Generally, mussels occurring in habitats along the margins of the main channel where flowing water is present do not experience temperature and DO changes at a significant impact level. However, observations made by USFWS field personnel this summer, indicate that mussels found in isolated pools or shallow slack water habitats are showing signs of stress or mortality likely due to high temperatures and low DO (J. Ziewitz, pers. comm.). It should be noted that the exceptional drought conditions would have resulted in "natural flows" less than 5,000 cfs if the storage from the upstream reservoirs had not been used to augment basin inflow in order to maintain the 5,000 cfs minimum flow. Significant reductions in river flow below 5,000 cfs would likely exacerbate the temperature and DO conditions observed this year; as well as substantially increase in the risk of stranding aquatic organisms.

STATUS OF THE SPECIES/CRITICAL HABITAT WITHIN THE ACTION AREA

This portion of the environmental baseline section focuses on new information relative to each listed species' spatial distribution, population status, and trends within the action area, as well as, any new information relative to designated and proposed critical habitats.

GULF STURGEON

Very little new sturgeon data is available since the time the IOP BO was signed. In spring 2007, Dr. Bill Pine collected Gulf sturgeon migration data in conjunction with an FWCC funded research study on fish movement and spawning patterns in the Battle Bend region of the Apalachicola River. The study included monitoring an array of several passive receivers located at strategic positions along the river to document movement patterns of 13 sturgeon with known viable acoustic tags. Preliminary data from the study indicates that several of the tagged sturgeon migrated up to the documented spawning habitat near NM 105 and at least one of the tagged sturgeon migrated up to the documented spawning habitat near Torreya State Park (B. Pine, pers. comm.). A full analysis of the data has not been completed yet and funding is required to complete the effort. This preliminary data indicates that although March flows this year were lower (maximum approximately 37,000 cfs) than the average observed post-West Point March flows (approximately 45,000 cfs) described in the BO (reference Figure 3.3.3A), flows were still of a sufficient magnitude to trigger migratory movements. This represents between 4 and 9 acres of suitable spawning habitat at the rock ledge site at NM 105, and between 5 and 19 acres of suitable spawning habitat at the combined two known spawning sites (NM 105 and NM 99.5). However, there is no data available regarding whether or not spawning occurred or if it was successful.

The U.S. Geological Survey (USGS) also conducted a study during October 2006-May 2007 tracking the movement of juvenile sturgeon within the East Bay-Apalachicola Bay area. Similar to the methods described above, USGS deployed an array of 14 passive receivers and tracked the movement of four juvenile sturgeon (age 1-2 fish) in the size range of 350-750 mm total length (TL). Of the tagged sturgeon, three (429-680 mm TL) reported back numerous times to individual receivers; no reports were obtained for the fourth fish. Additionally, the receivers collected data on larger adult Gulf sturgeon with viable tags from separate studies. A detailed report on this data has not been completed. However, the preliminary data indicates that these juvenile sturgeon remained very close to shore (within 1-3 km), and mostly in the East Bay area. After October 2006, no data was collected from receivers within the Apalachicola River proper or East River proper (until late March, when the fish were moving in). Over the whole monitoring period, no data was obtained from 3 receivers deployed further offshore in the bay. This suggests that early juveniles appear to be utilizing primarily very shallow, nearshore areas as winter feeding grounds. Based on NOAA benthos data, these same areas have high densities of polychaetes and amphipods (important prey items), relative to lower values in deeper bay waters. The USGS also noted that based on the juvenile sturgeon tracking data and the adult sturgeon tracking data, it appears that the really small juveniles stay very close to shore, and are heavily using the East Bay area, while the larger sturgeon are using the same areas, but also additional areas farther out into the bay proper. This further supports the importance of the East Bay area to juvenile sturgeon as it appears that other areas provide suitable foraging habitat as well, but are not being utilized. The USGS study information was provided by USFWS based on discussions with Ken Sulak (USGS).

As described in the BO, juvenile sturgeon develop a tolerance to higher salinity gradually during the first year of life, and thereafter exhibit optimum growth at a salinity level of about 9 ppt. Estuarine and later marine habitats provide the primary feeding areas for the species at some point during the first year hatching; therefore, the salinity regime of Apalachicola Bay is likely an important factor in defining juvenile feeding habitat (USFWS 2006). The high salinity levels observed in Apalachicola Bay (especially the East Bay area) throughout the summer of 2007 likely continued through October. FDEP reported that the East Bay surface datalogger had not recorded salinity values below 12 ppt since July of this year (J. Ziewitz, pers. comm.). Given the apparent importance of the East Bay area to sturgeon (particularly juveniles) and the continuing high salinities, it is possible that juvenile and to some extent adult sturgeon could be impacted by both delayed entry to the feeding areas of the bay and potential reduction in productivity of these normally rich feeding areas. This could result in poor growth and/or lower survival of juvenile sturgeon. Adult sturgeon appear to be better adapted to the higher salinity levels and may be able to exploit other feeding areas in the bay and the Gulf. As noted above, portions of the bay appear to provide high value feeding habitat to juvenile and adult sturgeon. Since the sturgeon do not feed while in the riverine spawning and holding areas, these foraging areas are of particular importance as they provide the first opportunity for feeding when exiting the river. In her dissertation, Putland (2005) analyzed the ecology of phytoplankton and microzooplankton in Apalachicola Bay relative to changes in salinity. The analysis indicated that higher salinity levels in the bay, associated with low river discharge periods, resulted in decreased ingestion and production of microzooplankton. Because microzooplankton are key constituents of the estuarine food web in Apalachicola Bay, the analysis suggests that lower discharges in the river that result in lower nutrients and higher salinity (>20 psu, which is roughly equivalent to 20 ppt) in the bay could reduce higher trophic level productivity as a consequence of reduced microzooplankton production (Putland 2005).

FAT THREERIDGE

In the 5-Year Review for the seven mussels (USFWS 2007) concluded the status of the fat threeridge is considered declining. This determination is based in part on the significant drought-induced mortality that occurred in 2006 (USFWS 2007). In addition, they also describe fat threeridge as a species with a high degree of threat and low recovery potential.

By letter dated 30 March 2007, the USFWS granted an extension of the RPM4 and RPM5 completion date to 30 August 2007 and requested that the Corps conduct mussel sampling surveys this summer in order to evaluate the potential risk of exposure to listed mussels located in vulnerable microhabitats should basin inflows fall below 10,000 cfs. Therefore, with USFWS guidance, the Corps obtained the services of Dr. Drew Miller (malacologist formerly employed by the Corps Engineering Research Development Center) to conduct a mussel survey to collect information on density and relative species abundance of *A. neislerii* at sites that appeared to provide appropriate water depth, velocity, and substratum. The survey was conducted on 7-11 July 2007 at 25 locations between NM 40 and 50 on the Apalachicola River. No divers were used; all collecting was done by wading. Survey design and sampling stations were developed based on discussions with representatives of the Mobile District, US Fish and Wildlife Service (USFWS), and the Florida Game and Freshwater Fish Commission (FWCC), as described below.

A reconnaissance field trip was conducted by representatives of the Corps, USFWS, and FWCC in late May. Following the field trip, personnel of the USFWS identified 25 study areas between NM 40 and 50 along the Apalachicola River which either supported, or appeared likely to support *A. neislerii*. The USFWS randomly selected 10 sites for detailed study. Detailed field studies were conducted at the 10 sites and partial studies were conducted at most remaining sites (23). In addition, one new site (DS01) was added at a disposal area of interest. This site was added because of a desire to obtain sediment and elevation data at a disposal area that appeared to have little or no value to mussels. 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, and 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. Eddies, which are swirling and reverse currents in rivers, are created when water flows past upstream obstacles such as point bars. These eddies create favorable conditions for mussel assemblages since they encourage deposition of fine particulate matter and glochidia larvae.

A detailed description of the survey methods and results is provided in the mussel report enclosure to the RPM4 and RPM5 submittal letter in Appendix F. At the 10 areas where detailed studies were conducted, six evenly spaced transects were established perpendicular to shore. Mussels were collected with a 0.25 m^2 quadrat at three sites along each transect moving from near- to far-shore. The three sampling sites along each transect generally corresponded to depths of 1, 2, and 3 feet. A theodolite was used to obtain distance and elevation data along each transect and a sediment sample was taken at the midshore location along each transect. A total of 18 quantitative samples were obtained at each of the 10 areas; therefore, 180 quantitative samples were taken. Additionally, a 10- or 20-minute timed search for mussels was conducted between two of the transect lines in the center of each area. At the remaining 15 areas only two transect lines were established perpendicular to shore. Sediment samples were collected, and elevation and distance measures were obtained along each transect. Mussels were collected for 10 minutes in the area bounded by transects in order to calculate Catch per Unit Effort (CPUE) values for these qualitatively sampled areas.

Based upon qualitative sampling, *A. neislerii* was found at 23 of the 25 areas between NM 40 and 50 including all 10 areas surveyed using quantitative methods. CPUE for all mussels at the 25 sites ranged from 0 to 1,080 (average = 312), and CPUE for *A. neislerii* ranged from 0.0 to 774 (average = 162). The qualitative and quantitative data were used to predict density of *A. neislerii* from CPUE using a regression equation (Y = 0.28X – 0.77; R^2 = 0.59) for the 15 sites where only CPUE data were obtained. Mean *A. neislerii* density ranged from 0.2 to 12.7 individuals/m^2 (average = 3.7, standard deviation = 3.7) and total unionid density ranged from 2.4 to 36.0 (average = 11.9, standard deviation = 11.2). Total shell length for *A. neislerii* ranged from 11.7 to 76.4 mm, and there was evidence of strong recruitment with cohorts centered at 17.5 and 42.5 mm.

The pooled within site density data for the 10 quantitatively sampled areas was evaluated to determine if within site density distribution exhibited significant differences moving upriver to downriver or near to far shore. Only minor differences were observed. Although the mid-shore sample sites did have slightly higher mean densities than the near- and far-shore sample sites. The 2003 study data also noted higher mean densities at the mid-shore sample sites. Results of both surveys suggest that *A. neislerii* (and most other mussel species in this river) generally inhabit a fairly narrow band along the shore in reaches with suitable water velocity and substrate. Assuming only a 1meter wide 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; this data indicates that the total population size at all 25 sites would be 19,000 individuals. However, it should be noted that density estimates based on this type of qualitative data could considerably over- or under-estimate the actual population density. Additionally, it is likely that the mussel "bed" or strip is wider than 1 meter and extends further into deeper water. In fact the data at some of the sites suggests that the band of mussels may extend into more far-shore, deeper habitat (DM16). Results of a study conducted in 2003 indicated that while maximum densities were at 1.2 m, *A. neislerii* could be found up to 2.7 m deep (river flows at the time of the study were considerably higher than those observed in 2007). This is an additional 1.5 m of depth beyond that which was sampled during the present survey. Therefore, the total population of *A. neislerii* at these 25 locations probably exceeds 19,000 individuals. In addition, this estimation does not include other sites both in and outside the study reach (NM 40-50) that also support *A. neislerii*.

These recent mussel surveys indicate that the main channel habitats favored by the fat threeridge are moderately depositional areas generally associated with eddies. Eddies shift location over time through the process of lateral channel migration. When the shift is abrupt, mussels may be stranded in areas that are later exposed. It is possible the mortality event observed in 2006 was partially a result of this phenomenon. The surveys conducted in 2007 suggest that the stranding sites are becoming terrestrial habitat and mussels are found in high numbers in the existing eddy habitat downstream. It is important to note that this system is dynamic and mussels are adapted to some degree of habitat change. However, additional analysis is needed to determine if the observed rate of change is consistent with a natural process or if it is accelerated by other activities (USFWS 2007).

In early October 2007, Dr. Miller conducted additional analysis on the mussel depth distribution data collected during the 2003 and 2007 studies (Appendix G). The following summarizes this analysis and unless otherwise noted is attributable to the 15 October 2007 report he authored. Essentially the same sampling strategy was used in 2003 and 2007. Since mussels were collected at 1-foot (ft) depth increments, results (density or relative abundance) could be expressed in terms of water depth or elevation. At each collecting site, water elevation data were converted to discharge by Corps personnel based on recent ratings data provided by the USGS in order to estimate the number of *A. neislerii* that could be exposed to the atmosphere if water level and discharge declined. It should be noted that mussels exposed to the atmosphere during low flow will not necessarily be killed; an unknown number will likely move into deeper water if flows decline slowly enough to facilitate movement. In addition, studies suggest that some exposed mussels could survive for days or weeks if they are shaded and partially buried in moist sediment. However, mussels exposed or located in extremely shallow water would likely experience more stress due to low water quality and high temperature and would be more susceptible to predation and mortality.

A. neislerii density estimates were higher in 2007 than in 2003 in the same river reach. The maximum estimated density in 2003 was 2.0 individuals/m^2, recorded at NM 41.5, at a depth of 4 ft. In 2007 the maximum estimated density was 22.7 individuals / m^2, recorded at NM 43.9 at a depth of 2 ft. Since none of the sites studied in 2003 were re-surveyed in 2007, a direct comparison between study years cannot be done. It is possible that the areas surveyed in 2007 were located in better habitat than those studied in 2003 and therefore supported more mussels. However, it is also possible that the higher densities recorded in 2007 could have been the result of a large number of mussels moving to lower elevations in response to lower flows.

The 2007 survey data indicated similar densities of *A. neislerii* could be exposed to the atmosphere if water level and discharge declined at the 10 quantitatively sampled and 15 qualitatively sampled survey locations. The results of the depth distribution analysis for the 15 qualitative sites indicated that a 1-ft loss in water level, below a discharge of 5,150 cfs, to an equivalent flow of approximately 4,150 cfs, could expose approximately 20 percent of the *A. neislerii*. A 2-ft decline in water level at these same sites, corresponding to a flow of 3,200 cfs, could expose approximately 65 percent of the *A. neislerii* (Figure 2). The results of the depth distribution analysis for the 10 quantitative sites indicated that a 1-ft loss in water level, below a discharge of 5,150 cfs, to an equivalent flow of approximately 4,150 cfs, could expose approximately 20 percent of the *A. neislerii*. A 2-ft decline in water level at these same sites, corresponding to a flow of 3,200 cfs, could expose approximately 65 percent of the *A. neislerii* (Figure 3). As stated above, all exposed mussels would not necessarily be killed by reductions in water level; some could move into deeper water and survive, and as long as water levels remained low, these mussels would likely do well in these previously unoccupied areas. However, it is uncertain if habitat conditions in the deeper water areas would provide suitable habitat under higher flow conditions due to potential differing geomorphic conditions. In the future when water discharge and velocity increase, some of the mussels located in the deeper water could be vulnerable to sheer stress far in excess of what they can tolerate, resulting in mussels being eroded out of the substratum and being displaced downriver. It is possible that some of these individuals could be carried to suitable areas and survive, although others (potentially significant numbers) could be deposited in the main channel or other unsuitable habitat and be killed.

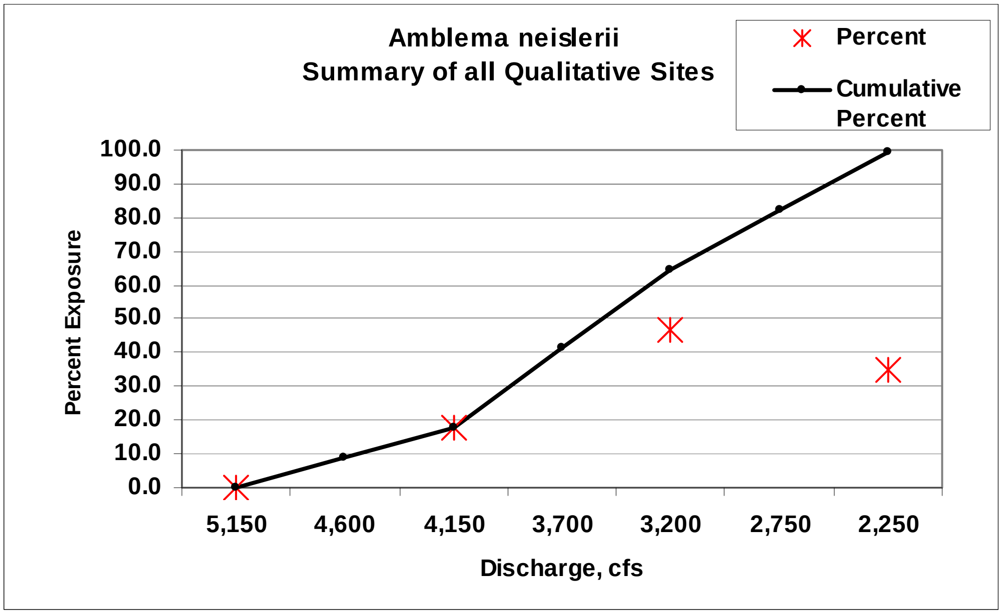

Figure 2. Percent Exposure Potential for Incremental Flows at the Qualitative Sampled Sties

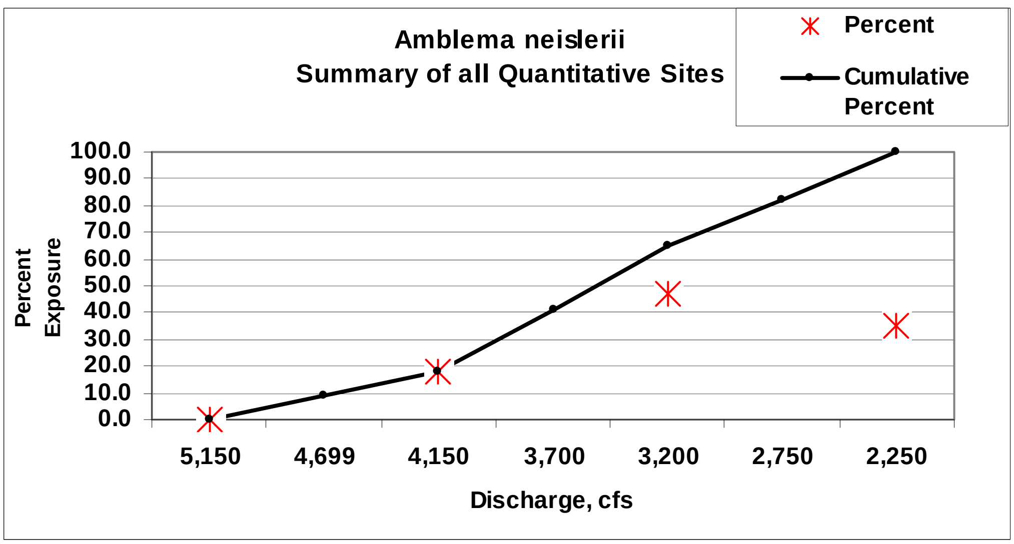

Figure 3. Percent Exposure Potential for Incremental Flows at the Quantitative Sampled Sties

PURPLE BANKCLIMBER

There is very little new data relative to purple bankclimber mussels. In the 5-Year Review for the seven mussels (USFWS 2007) the USFWS concluded the status of the purple bankclimber is considered stable based on persisting populations. However, they also describe purple bankclimber as a species with a moderate degree of threat and low recovery potential.

As described in the BO, the purple bankclimber is characterized as a species preferring the deeper portions of main channels (often at depths greater than 3 m) in the larger rivers within its range. Although portions of the Apalachicola River contain deep-water habitat in relatively stable condition, these areas have been inadequately sampled for listed mussels. The Corps is unaware of any additional sampling in deep-water habitat than what was described in the BO. However, the USFWS did observe several purple bankclimber mussels approximately six inches below the water surface elevation at the limestone rock outcrop (NM 105) below the dam earlier this summer (J. Ziewitz, pers. comm.).

CHIPOLA SLABSHELL

There is very little new data relative to Chipola slabshell mussels. In the 5-Year Review for the seven mussels (USFWS 2007) the USFWS concluded the status of the Chipola slabshell is considered unknown due to lack of new data. However, they also describe Chipola slabshell as a species with a moderate degree of threat and low recovery potential. USFWS is currently funding a mussel survey to determine the status and distribution of Chipola slabshell and other species in the Chipola Basin. Thus far over 300 individual mussels from ten new subpopulations and six previously documented subpopulations have been collected (USFWS 2007).

HOST FISH FOR THE MUSSEL SPECIES

As described in the BO, lab-confirmed host fish species for the fat threeridge include the weed shiner, bluegill, redear sunfish, largemouth bass, and blackbanded darter. No host fish species have been confirmed for the purple bankclimber (USFWS 2006). Recently, researchers also confirmed that bluegill can serve as a host fish species for Chipola slabshell (USFWS 2007).

Monitoring data from FWCC indicates that some species of native shiners, redbreast sunfish, madtoms, and bullhead catfish have declined in catch and percent abundance numbers. Some species have become increasingly rare in several river basins within Florida. Preliminary information also indicates that largemouth bass, bluegill, redear sunfish, spotted suckers, and redbreast sunfish year-class and abundance numbers are affected by flow regime in the Apalachicola River (USFWS 2007).

EFFECTS ANALYSIS

This section is an analysis of the effects of the proposed action on the species and critical habitat. The previous "Environmental Baseline" section described the effects of the IOP over the past year. This section addresses the future direct and indirect effects of the proposed action.

FACTORS CONSIDERED

In the "ENVIRONMENTAL BASELINE" section, we described three principal components of the species' environment in the action area: channel morphology, flow regime, and water quality. We lack sufficient information to determine if implementation of the IOP has altered the baseline water quality of the action area described in the BO. However, we recognize that the extraordinary drought conditions experienced during much of the IOP implementation period, and perhaps the IOP itself, have resulted in salinity changes in the bay and localized dissolved oxygen changes due to extended periods of low flow (approximately 5,000 cfs). As described in the BO, physical habitat conditions for the listed species in the action area are largely determined by flow regime, and channel morphology sets the context for the flow regime. As described above, based on the evaluation of the sediment dynamics and channel morphology trends on the Apalachicola River conducted this summer, the Corps determined that the river appears to be in a relatively stable dynamic equilibrium, and that the current version of the IOP adequately met the intended goal of minimizing or avoiding adverse impacts or providing support to listed species occurring in the Apalachicola River. We have no ability at this time to predict specific effects on channel morphology due to the influence of the proposed action on the flow regime. However, generally channel morphology alterations are more closely associated with increased duration and frequency of high flow events rather than low flow events as have occurred throughout this year. The IOP and the proposed action define limits on the extent to which the Corps alters basin inflow into the Apalachicola River via operations of the ACF dams and reservoirs; therefore, the primary focus of this analysis is the flow regime of the Apalachicola River with and without the proposed action. Consistent with the BO for the IOP, our analysis of flow regime alteration relative to the listed species and critical habitats considers the following factors.

Proximity of the action: The proposed action will affect habitat occupied by all life stages of Gulf sturgeon in both the Apalachicola River and Bay, which are designated as critical habitat. The proposed action will also affect habitat known to be occupied by the purple bankclimber, Chipola slabshell, and fat threeridge mussels. These mussel species spend their entire lives within the action area, all of which is proposed as critical habitat for the mussels. The proposed action is implemented through releases from Jim Woodruff Dam and affects some of the species' life history stages and habitat features from as close as immediately below the dam to more than 100 miles downstream.

Distribution: The proposed action could alter flows in the Apalachicola River and its distributaries downstream of the dam, and alter freshwater inflow to Apalachicola Bay. The Gulf sturgeon may occur throughout the river and bay in suitable habitats, and occasionally in the Chipola River downstream of Dead Lake. Most of the known range of the fat threeridge is included within the action area on the Apalachicola and Chipola Rivers. The purple bankclimber is known to occur within the Apalachicola River, while only one individual Chipola slabshell is known from the Chipola River downstream of the confluence with the Chipola cutoff within the action area. This analysis examines how the proposed action may variously affect different portions of the action area according to the distribution of the species and important habitat features in the action area.

Nature of the effect: The proposed action will reduce flows in the Apalachicola River when increasing composite storage in the ACF reservoirs and increase flows when decreasing composite reservoir storage. Three of the Gulf sturgeon primary constituent elements of designated critical habitat may be affected by the action: riverine spawning sites, flow regime, and water quality. Permanently flowing water and water quality are also two of the five primary constituent elements of proposed critical habitat for the fat threeridge, purple bankclimber, and Chipola slabshell. The proposed action may also affect a third element of proposed critical habitat for the mussels: host fish. We examine how the proposed action may affect the listed species and critical habitat elements through specific analyses focused on relevant habitat features, such as spawning substrate, floodplain inundation, and vulnerability to exposure by low flows.

Duration: This proposed action is a temporary modification to the IOP applicable until revised or until the drought is over (composite storage returns to zone 2) and the nature of its effects is such that none are permanent. Reservoir operations may conceivably be altered at any time; therefore, flow alterations that may result from the proposed action will not result in permanent impacts to the habitat of any of the listed species. However, we examine how the proposed action may alter, while it is implemented, the duration of high flows and low flows that are relevant to the listed species and critical habitats.

Disturbance frequency: The proposed action is applicable year round; therefore, changes to the flow regime and water quality parameters may occur at any time and/or continuously until such time as it is revised or until the drought is over (composite storage returns to zone 2). However, we examine how the proposed action may alter, while it is implemented, the frequency of high flows and low flows that are relevant to the listed species and critical habitats.

Disturbance intensity and severity: The proposed action provides for potentially substantial discretionary alteration of the flow regime when basin inflow is greater than 4,150 cfs, but maintains a minimum flow of 4,150 cfs from Jim Woodruff Dam. We examine how the proposed action affects the magnitude of flow events relative to the baseline or no action condition.

ANALYSIS FOR EFFECTS OF THE ACTION

To determine the future effect of project operations as prescribed by the proposed action, we must compare the environmental conditions expected to occur under the EDO to the environmental baseline. As described above, the principal factor examined in determining effects for the alternative operations is the flow regime of the Apalachicola River and how the flow regime affects habitat conditions for the listed species.

In the BO for the IOP, the flow regime of the environmental baseline was described using post-1975 flow records, because this period represented the complete hydrology of the current configuration of the ACF federal reservoir projects. The USFWS compared the flow regime expected under the IOP to this historic flow record to identify changes in flows that were relevant to the listed species and their habitats. To isolate the effects of the present level of consumptive water use on the flow regime in the foreseeable future from the effects of implementing the IOP, the USFWS also examined environmental conditions that would result if project operations were not continued, *i.e.*, the effects of no action on the part of the Corps. This flow regime was termed the run-of-river (RoR) regime. By comparing all three flow regimes, baseline, IOP, and RoR, the USFWS identified effects relative to the Baseline attributable to the IOP apart from effects attributable to an increase in depletions due to consumptive losses in the basin since 1975.

Because the proposed action is a temporary response to extraordinary drought conditions, it is not appropriate to compare the flow-regime effects of the EDO to a longer-term historical baseline, as included in the BO for the IOP. For the proposed action, the current IOP, as described in the 23 March 2007 letter to USFWS, represents the environmental baseline condition, and the impact we must evaluate is how a short-term proposed change to the IOP may affect listed species and designated critical habitat. Because the proposed action applies only until the drought is over (composite storage returns to zone 2), isolating the effects of increasing consumptive uses in the basin over time from the effects of the proposed action is not necessary in this analysis as it was for evaluating the IOP. The current level of consumptive uses is part of the baseline and will be part of the proposed action also. Whereas the effects analysis in the IOP BO compared 27 years of historic flows with 27 years of simulated IOP flows and 27 years of simulated run-of-river (no action) flows, this effects analysis compares only two operational schemes, the IOP and the proposed action, over the course of approximately two years. However, we simulate that two year period at two possible levels of drought conditions in the basin. Therefore, the environmental baseline is the suite of environmental conditions expected if the Corps would continue operating according to the IOP for the next two years. For the purposes of this analysis, we assume that drought conditions will continue for the next two years and have synthesized two flow regime scenarios to represent a range of possible conditions that could be experienced under the proposed action and the baseline. It should be noted that these synthesized flow regimes are based on continuing drought conditions and thus the hydrological data input into the model represents reasonable “worst case scenario” hydrological conditions. A detailed description of how this hydrological input data for the model was developed is provided in the model description section below.

MODEL DESCRIPTION

A simulation of ACF project operations under the proposed action and the baseline using the HEC-5 hydrologic simulation software is provided. This version of the HEC-5 model represents the EDO operations (described in the “Description of Proposed Action” section above) and the baseline (current IOP, as described in the 23 March 2007 letter to USFWS or “no action”).

As described in the BO, basin inflow is the amount of water that would flow by Jim Woodruff Dam during a given time period if all of the Corps reservoirs maintained a constant water surface elevation during that period, such that the reservoirs would only release the net inflow into the dam. Basin inflow is not the natural flow of the basin at the site of Jim Woodruff Dam, because it reflects the influences of reservoir evaporative losses, inter-basin water transfers, and consumptive water uses, such as municipal water supply and agricultural irrigation. The baseline and EDO scenarios include these influences, and use the same estimates of reservoir evaporation and current water demands; therefore, the difference between these scenarios is the net effect of continued operation under each scenario including the effect of influences that are unrelated to project operations.

The consumptive water demands used in the models represent an estimate of year 2000 levels of the net depletion due to municipal, industrial, and agricultural water uses and evaporative losses from the four largest reservoirs, Lanier, George, West Point, and Seminole. These depletions vary by month and in the case of agricultural demands and reservoir evaporation, also by year (wet, normal, dry). These consumptive demand estimates and the other model settings and techniques are consistent with those utilized during the development of the IOP.

To provide a potential range of flows that might be experienced under continuing drought conditions while the proposed action is in effect, we have synthesized two flow scenarios. The HEC-5 model simulates river flow and reservoir levels using a daily time series of synthesized flow data for a certain period of record. For the purposes of this analysis we selected hydrological conditions that represent 1) an unprecedented, exceptional drought applied across the entire ACF basin and continuing without relief for a two year period (referred to as the 10 percent hydrology); and 2) an exceptional drought that reflects differences in precipitation within the basin but is still more severe (20 percent reduction) than observed during the critical period prior to the current drought (referred to as the 1999-2001 20 percent reduced hydrology).

The unimpaired flow data set is a product of the Tri-State Comprehensive Study, and has been extended to include water years through 2001. Whereas basin inflow is computed to remove the effects of reservoir operations from observed flow, unimpaired flow is computed to remove the effects of both reservoir operations and consumptive demands from observed flow.

The model simulation period is October 8, 2007 to December 31, 2009 (26 months). The observed elevation for October 7, 2007 is used as the initial elevation for the four ACF reservoirs; Lake Lanier, West Point Lake, Walter F. George Lake and Lake Seminole. The HEC-5 reservoir simulation model uses unimpaired local flow at 25 control points (nodes) as the flow data input for the ACF Model. The Corps' HEC-DSS Vue tool is used to compute the daily 10th percentile local flows at every control point. This synthetic flow data set assumes a uniform distribution of flow throughout the basin based on the local percentile flow. In other words the daily local 10th percentile flow occurs at every location on the same day. The result is a one-year daily time series of the local

10th percentile flows. The one year flow series is repeated for each year during the simulation period. The 1999 to 2001 period represents the driest consecutive 3 year period in the unimpaired flow data set. To increase the drought severity to represent exceptional drought conditions, these flows were further reduced by 20 percent. This reduction was selected to capture an intermediate condition between the 10th percentile and the driest single year in 2000. The annual basin inflow for the “10th percentile” flow and the year 2000 basin inflow is 5,322 cfs and 8,853 cfs respectively. The resulting 20 percent reduction in the 2000 basin inflow is 7,082 cfs and captures an intermediate hydrology. It is unlikely that the actual hydrology occurring over the next two years will match closely these simulated hydrological conditions. However, with the growing threat of LaNina conditions this fall and winter and the resultant continuing exceptional drought conditions, it is likely that whatever hydrology occurs could result in a continuation of significant depletion of Composite Storage within the system.

The HEC-5 model imposes reservoir operations and consumptive demands onto the synthesized flow-time series to simulate flows and levels under those operations and demands. As described above, the minimum flow for the EDO is 4,150 cfs and the minimum flow for the IOP is 5,000 cfs. However, in order to more closely represent the actual operations for releases from Jim Woodruff Dam, we impose slightly higher minimum flow rules in the model. For the EDO we use 4,200 cfs as the minimum flow rule and for the no action we use 5,130 cfs as the minimum flow rule in the model. These values are based on what the operators actually release in order to avoid violating minimum flow floors, and reflect the physical operational constraints and limitations of the dam and powerhouse.

GENERAL EFFECTS ON THE FLOW REGIME

Consistent with the analysis conducted in the BO, the effects of the proposed action on the flow regime is evaluated by comparing the Apalachicola River flow frequencies for the various conditions. The no action simulation represents the Baseline condition, or the simulated flow of the river under the operational rules of the IOP. EDO is the simulated flow of the river under the operational rules of the proposed action. The Baseline and EDO frequencies represent those simulated by the HEC-5 model for the 10 percent and 1999-2001 reduced hydrological conditions over the next two years.

Table 8 displays the maximum, minimum, and average Apalachicola River discharge for the four flow regimes. Generally, the EDO and no action flow regimes are similar regarding maximum daily flow and average daily flow under the two hydrological flow scenarios. The no action regime generally has the highest flow associated with the lowest exceedance frequencies, and the lowest flow associated with the highest exceedance frequencies. However, the minimum flow values under the no action flow regimes are significantly lower than those of the EDO.

	10% EDO	10% No Action	20% Reduction No Action	20% Reduction EDO
Max	10536	12595	64404	64404
Min	4200	2104	3370	4200
Avg	5440	5669	9867	9378

Table 8. Simulated maximum, minimum, and average daily discharge of the Apalachicola River at the Chattahoochee gage for the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

Figure 4 displays in greater detail the frequency analysis of the various flow regimes. By focusing on the lowest flows (flows that are exceeded at least 65 percent of the time), we can compare the low-flow differences between the four regimes. These low flow events represent the most severe flow conditions for the aquatic biota in the river. The no action flow regime results in higher frequencies of flows less than 4,150 cfs than the EDO flow regimes. This is due to maintenance of the 5,000 cfs minimum flow in the river until conservation storage is depleted; at which time, this minimum flow can no longer be met and the Apalachicola River flow is essentially limited to the basin inflow when basin inflows are less than 5,000 cfs.

The fat threeridge depth distribution data, described in the Environmental Baseline section above, suggests that a significant percentage of mussels could be exposed at river flows less than 4,150 cfs. We recognize that listed mussel (purple bankclimber and fat threeridge) mortality could and likely would result when river flows are reduced below 5,000 cfs. The depth distribution data suggests that approximately 20 percent of the fat threeridge mussels occurring at the sites sampled this summer would be in areas exposed at flows of 4,150 cfs. However, this data also suggests that flows of 3,200 cfs would expose approximately 65 percent of the fat threeridge mussels. Flows as low as 2,000 cfs would expose 100 percent of the fat threeridge mussels at these same sites. USFWS is currently conducting additional analysis at these sites regarding mussel densities and percent exposure. However this data is not completed and therefore could not be used in this effects analysis. As stated above, all exposed mussels would not necessarily be killed by reductions in water level; some could move into deeper water and survive, and as long as water levels remained low, these mussels would likely do well in these previously unoccupied areas. However, it is uncertain if habitat conditions in the deeper water areas would provide suitable habitat under higher flow conditions due to potential differing geomorphic conditions. In the future when water discharge and velocity increase, these mussels could be vulnerable to sheer stress far in excess of what they can tolerate, resulting in mussels being eroded out of the substratum and being displaced downriver. It is possible that some individuals could be carried to suitable areas and survive, although others (potentially significant numbers) could be deposited in the main channel or other unsuitable habitat and be killed. Modeling shows that with no action, flows could be reduced to 2,000 cfs if conservation storage is depleted and augmentation flows could no longer be provided. The potential adverse biological effect of a flow as low as 2,000 cfs versus a flow of 4,150 cfs or greater during an extended drought period is substantial. Therefore, we have determined that the overall effect of the proposed action is beneficial with respect to the no action conditions for this measure of a flow-dependent habitat feature.

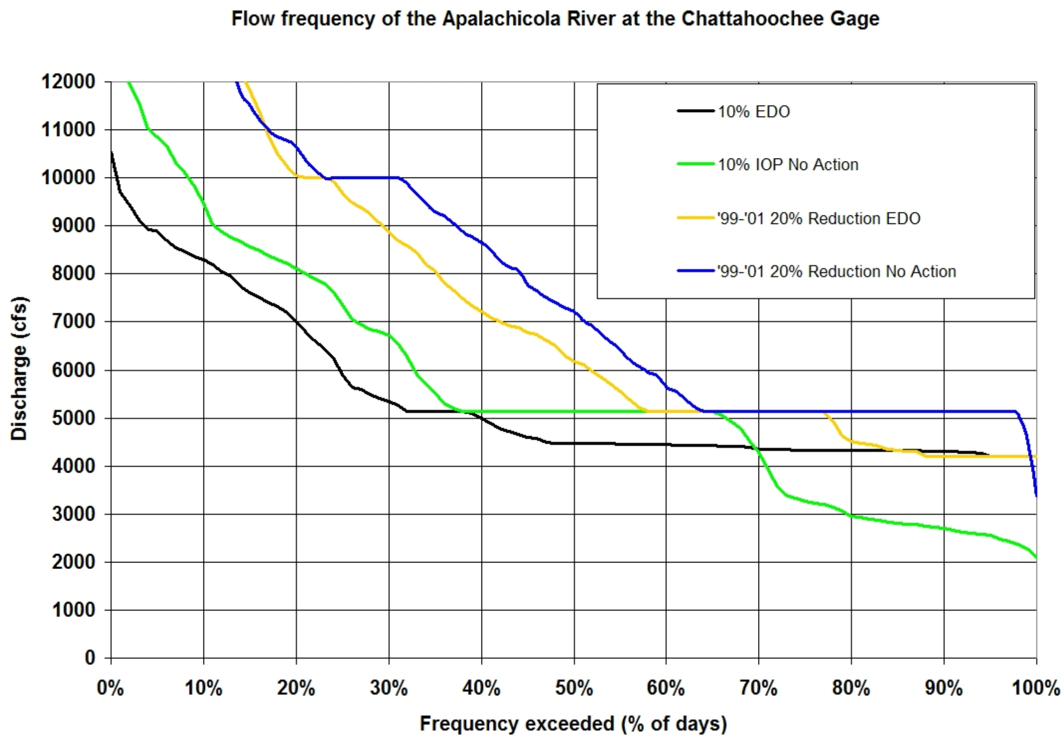

Figure 4. Flow frequency (% of days flow exceeded) of the Apalachicola River at the Chattahoochee gage for the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

SUBMERGED HARD BOTTOM

As described in the BO, the principal analysis for effects of the proposed action on sturgeon consists of comparing the amount of potential spawning habitat available under the various operational scenarios. This is accomplished by combining hard bottom area versus discharge relationship with the time series of daily flow values from the four flow regimes to obtain time series of available habitat area. A frequency analysis of these habitat availability time series for the two known Apalachicola River spawning sites, located at NM 105 and NM 99, is shown in Figure 5. This figure represents how much hard-bottom habitat was inundated to depths of 8.5 to 17.8 feet (the range of 80 percent of sturgeon egg collections in 2005 and 2006) during the months of March, April, and May, under each of the flow time series. Although the four curves cross each other multiple times over the full range of 0 to about 20 acres, habitat availability under the no action flow regimes is generally greater (median daily habitat availability of approximately 13 to 15 acres) than habitat availability under the EDO (median daily habitat availability of approximately 12 acres). A reduction in habitat availability of 1-2 acres (10 percent reduction) may not represent a biologically significant effect.

Spawning habitat availability has not been identified as a limiting factor to Gulf sturgeon recovery and the population is currently considered stable to increasing. Spring flows providing similar habitat availability values have occurred in the past (less than 12 acres of habitat availability occurred during 15 percent of the observed flow record 1975-2001; reference Figure 4.2.3.A of the BO). In order to determine the effect of only 12 acres or less of habitat availability, strength of year class data is needed for the years this occurs. This data is not available. Therefore, we have determined that the proposed action results in an adverse effect on Gulf sturgeon with regards to this flow-dependent habitat feature as compared to the no action.

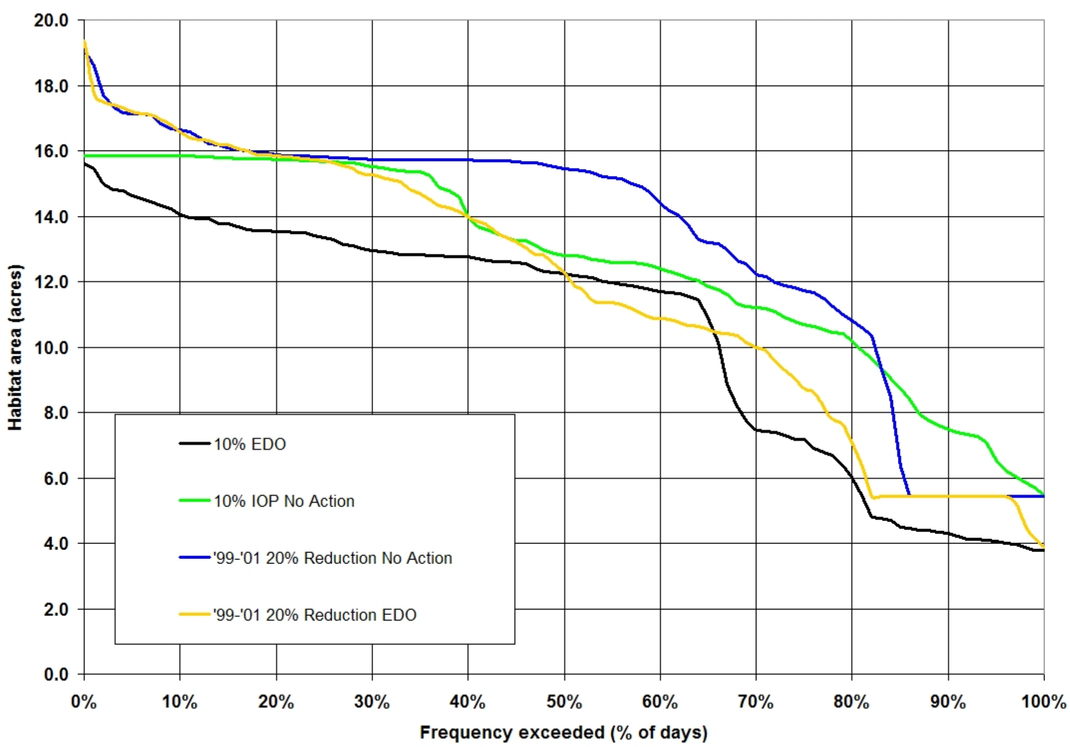

Figure 5. Frequency (% of days) of Gulf sturgeon spawning habitat availability (acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet), on each day March 1 through May 31, at the two sites known to support spawning, under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

The analysis shown in Figure 5 above, combines data from the two years of each time series into a single pool for frequency computations and does not examine differences between years or the pattern of habitat availability within a year. However, as described in the BO, it is also important to ascertain whether the proposed action would produce exceptionally low and high habitat availability between years or within a year. Since the simulated flow regimes only extend out two years, it is not appropriate to draw conclusions regarding habitat availability between years. However, the simulated flow conditions can provide insight into the amount of habitat inundated to the 8.5 to 17.8 ft depth range for at least 30 consecutive days each year, March through May, under the four flow time series. This flow-dependent habitat feature is important based on the limited sturgeon spawning data recorded in the river. As described in the BO, studies indicate that Gulf sturgeon spawning generally begins when water temperature reaches about 17°C and is concluded by the time temperature reaches about 25 °C. Based on available data from the Chattahoochee gage, the mean dates for these events in the Apalachicola River are March 26 and May 23, respectively, a span of 58 days. Sturgeon egg collections during 2005 and 2006 spanned a period of 17 and 27 days, respectively. Hatching requires at least 2 days in this temperature range, and several more days are required for larvae to develop a free-swimming ability (USFWS 2006). Based on this phenomenon, we further analyze the effect of the proposed action on Gulf sturgeon spawning success by comparing the average spawning habitat availability (maximum amount of habitat inundated to the 8.5 to 17.8 ft depth range for at least 30 consecutive days each year), March through May, under the four flow time series (Table 9).

	Habitat Acres			
YEAR	10% EDO	10% IOP No Action	20% Reduction No Action	20% Reduction EDO
2008	12.7	15.6	15.7	8.1
2009	11.6	12.1	13.1	13.8
AVG	**12.2**	**13.8**	**14.4**	**11.0**

Table 9. Average Gulf sturgeon spawning habitat availability (maximum acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet for at least 30 consecutive days each year), March 1 through May 31, at the two known spawning sites, under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

Generally the no action flow regimes provide for more acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet for at least 30 consecutive days each year), during the spawning season, at the two known spawning sites than the two EDO flow regimes. Therefore, we have determined that the proposed action results in an adverse effect on Gulf sturgeon with regards to this flow-dependent habitat feature as compared to the no action.

During coordination and development of the proposed action, the Corps and USFWS recognized that trade offs of the quantity and intensity of direct adverse effects to listed species would likely be required in order to facilitate the intent of the EDO, which is to minimize adverse impacts to listed species in the Apalachicola River while making allowances for increased storage opportunities and/or reductions in the demand of storage in order to provide continued support to project purposes and minimize impacts to other water users during a severe multi-year drought. Generally, reproductive adults represent the most critical individuals relative to management decisions for species with small populations and limited distribution. The effects described above should not result in the direct mortality of reproductive adult Gulf sturgeon. Therefore, we acknowledge that Gulf sturgeon may be directly or indirectly adversely affected to some extent by the proposed action as we attempt to avoid or minimize the loss of reproductive age fat threeridge and purple bankclimber mussels.

CHANGES IN SALINITY AND INVERTEBRATE POPULATIONS IN APALACHICIOLA BAY

Very little is known about Gulf sturgeon feeding behavior and habitat selection in Apalachicola Bay. However, Gulf sturgeon studies in other systems, known life history patterns, and other studies of the role of freshwater inflow in estuarine ecology can be used to evaluate the possibility of effects of the proposed action on Gulf sturgeon in Apalachicola Bay (see discussion in the Water Quality section of the Environmental Baseline section above).

Studies indicate that most adult and sub-adult sturgeon limit feeding almost exclusively to estuarine and marine environments upon departing the river and do not feed much, if at all, during the months of riverine residency. Juvenile Gulf sturgeon studies have also established that direct transition from fresh water into salinities greater than 30 ppt is lethal, and gradual acclimation to seawater with higher salinities (34 ppt) is required. Juvenile growth rates are highest at 9 ppt salinity (USFWS 2006). The 2006 observed flow regime included significant periods of approximately 5,000 cfs discharge, which as described above, preliminary data indicates has resulted in significantly higher salinity values in the Apalachicola Bay than normally observed.

Since Apalachicola Bay is the first estuarine habitat that both juvenile fish and older fish encounter upon departing the river, substantial alteration of flow regime features may directly relate to sturgeon and sturgeon critical habitat elements in the bay and should be minimized or avoided. Based on the analysis in the BO, adverse impacts to ecological processes in the bay critical to sturgeon can be evaluated by comparing the number of consecutive days per year that flows less than 16,000 cfs occurred for the various flow time series. Figure 6 illustrates this comparison and indicates that the EDO does not significantly alter the number of consecutive days per year of flows less than 16,000 cfs from that of the no action for the 10 percent hydrology, and provides fewer number of consecutive days per year of flows less than 16,000 cfs than the no action for the 1999-2001 20 percent reduced hydrology. Therefore, we have determined that the proposed action is not likely to have an appreciable effect on sturgeon estuarine habitat and may have a beneficial effect as compared to the no action alternative. It should be noted that all the simulated flow regimes result in considerably high numbers of consecutive days of flows less than 16,000 cfs and this would likely result in bay salinity levels similar to those experienced this summer. These high salinity levels could impact juvenile, and to some extent adult sturgeon, by both delayed entry to the feeding areas of the bay and potential reduction in productivity of these normally rich feeding areas. This could result in poor growth and/or lower survival of juvenile sturgeon. However, due to the similarity of the flow regime data relevant to this measure it is deemed that this impact is attributable to a projection of continuing extreme drought conditions and not discretionary actions on the part of the Corps. Also, since the proposed action (and no action until storage is depleted) supports minimum discharges that are higher than basin inflow during significant portions of the simulated period, the proposed action may benefit ecological processes within the bay.

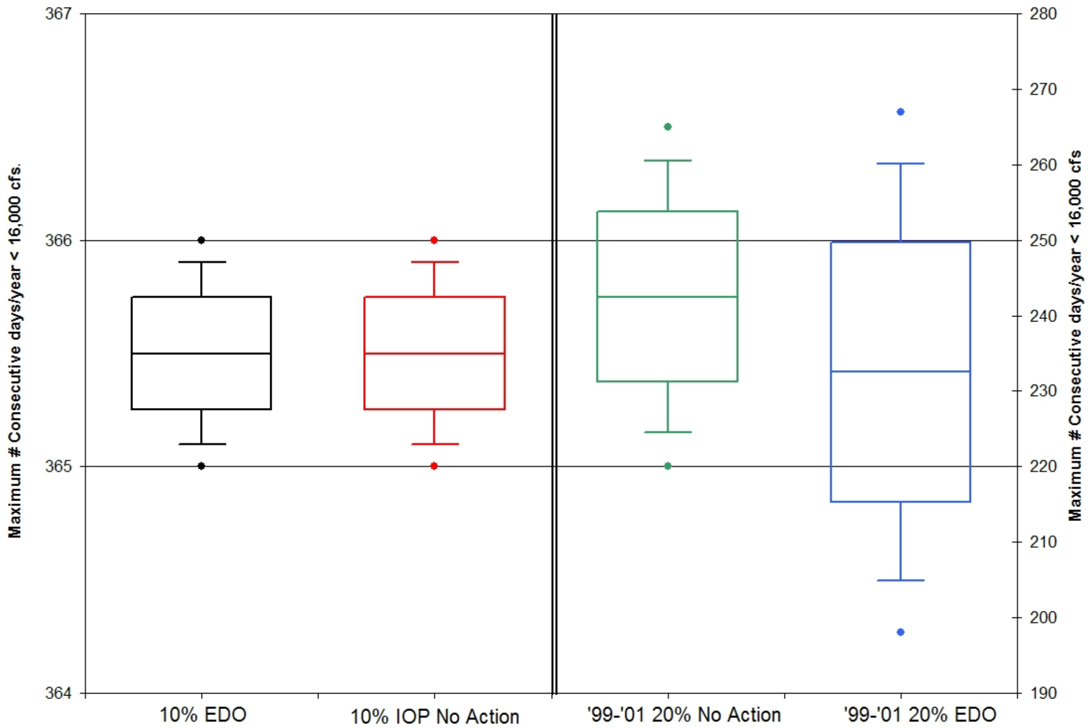

Figure 6. Maximum number of consecutive days/year of flow less than 16,000 cfs under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

SUBMERGED HABITAT BELOW 10,000 CFS

This section focuses on direct effects to listed mussels by exposure during low-flow conditions. During the summer of 2006, listed mussels were found exposed and stranded at elevations up to approximately 10,000 cfs. Therefore, consistent with the BO, impacts to listed mussel species will be evaluated by analyzing the differences between the no action and EDO flow regimes in the range of flow less than 10,000 cfs. During the summer of 2007 Apalachicola River flows remained at approximately 5,000 cfs from late May to present. It is unlikely that many live mussels exist at elevations higher than 5,000 cfs. Therefore this analysis will focus primarily on simulated flows of 5,000 cfs or less as these are the most relevant to assessing impacts to listed mussel species.

An analysis of the inter-annual frequency of flow rates between 1,000 and 10,000 cfs in the no action and EDO flow regimes is not included. Since the simulated flow regimes only extend out two years, it is not appropriate to draw conclusions regarding habitat availability between years.

We use the maximum number of days per year with flows less than 1,000 to 10,000 cfs as a measure of the most severe year for aquatic biota under each flow scenario (Figure 7). The 10 percent hydrology simulated flow regimes for the no action and EDO generally provide for the highest maximum number of days per year with flows less than 5,000 cfs; which is expected since this hydrology represents an unprecedented exceptional drought extending over a two year period. However, the EDO includes no days with flows less than 4,150 cfs compared to the no action flow regime which includes approximately 175 days with flows less than 4,150 cfs per year and has days with flows as low as approximately 2,000 cfs. In this respect, the EDO provides a beneficial effect as compared to the no action flow regime. As described above, the fat threeridge depth distribution analysis conducted earlier this year indicates that significant exposure occurs at flows less than 4,150 cfs and flows of 2,000 cfs would result in exposure and likely mortality of all fat threeridge mussels occurring at the sites sampled. An impact of this nature would seriously impair the likelihood of recovery of this species. The 1999-2001 20 percent reduced hydrology simulated flow regimes for the no action and EDO do not include days with flows less than 4,150 cfs. However, the no action simulated flow regime eliminates days with flows less than 5,000 cfs by maintaining this minimum flow throughout the two year period. The EDO simulated flow regime under this hydrology includes approximately 250 days per year with flows between 4,150 and 5,000 cfs by maintaining the lower minimum flow (4,150 cfs) throughout the two year period. In this respect, the EDO results in an adverse effect as compared to the no action flow regime. As described above, the fat threeridge depth distribution analysis conducted earlier this year indicates that up to approximately 20 percent of the fat threeridge mussels occurring at the sites sampled would be exposed at flows between 4,150 and 5,000 cfs.

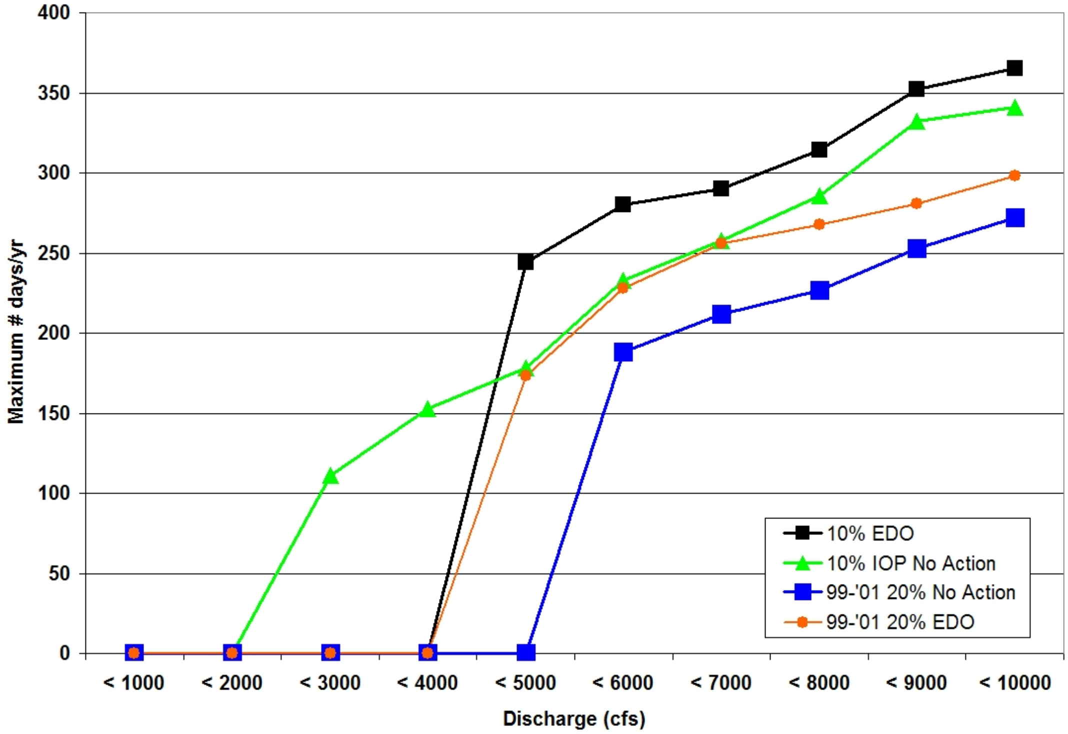

Figure 7. Maximum number of days per year of discharge less than 1,000 to 10,000 cfs under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

As observed in 2006, some mussels may survive brief periods of exposure by closing their shells tightly or burrowing into the substrate. Therefore, unless water temperature is extreme, the stress of exposure is most likely a function of exposure duration (USFWS 2006). Figure 8 illustrates a most-severe event analysis by computing the maximum number of consecutive days of flow less than the 1,000 to 10,000 cfs. The results of this analysis are consistent with the maximum number of days per year of discharge less than 1,000 to 10,000 cfs analysis. The 10 percent hydrology simulated flow regimes for the no action and EDO generally provide for the highest maximum number of consecutive days per year with flows less than 5,000 cfs. However, the EDO includes no consecutive days with flows less than 4,150 cfs compared to the no action flow regime which includes approximately 150 consecutive days with flows less than 4,150 cfs per year and has days with flows as low as approximately 2,000 cfs. In this respect, the EDO provides a beneficial effect as compared to the no action flow regime. The 1999-2001 20 percent reduced hydrology simulated flow regimes for the no action and EDO do not include consecutive days with flows less than 4,150 cfs. However, the no action simulated flow regime eliminates consecutive days with flows less than 5,000 cfs by maintaining this minimum flow throughout the two year period. The EDO simulated flow regime under this hydrology includes approximately 175 consecutive days per year with flows between 4,150 and 5,000 cfs by maintaining the lower minimum flow (4,150 cfs) throughout the two year period. In this respect, the EDO results in an adverse effect as compared to the no action flow regime.

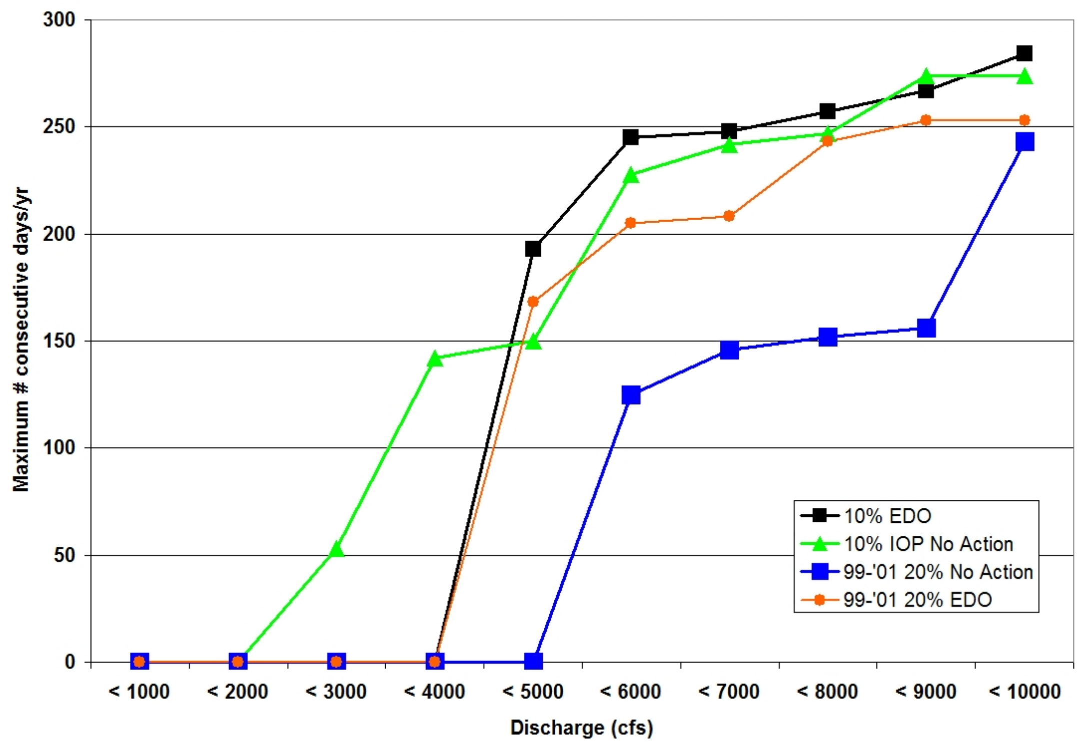

Figure 8. Maximum number of consecutive days per year of discharge less than 1,000 to 10,000 cfs under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

"Because moderately low flows, not just the most extreme events, constrict aquatic habitat availability and are generally stressful to mussels and other aquatic biota, it is appropriate to also consider the more common low-flow condition, *i.e.*, the magnitude and duration of low flows that occur in half the years of the flow regime. If the common low-flow conditions become even more common or more severe, it would reduce the amount of habitat available to mussels and would increase their vulnerability to exposure-related mortality, including increased predation by terrestrial predators" (USFWS 2006). Figure 9 displays the median number of days per year less than the thresholds of 1,000 to 10,000 cfs. The results of this analysis are also consistent with those of the other two flow parameters considered. The EDO provides a beneficial effect as compared to the no action flow regime under the 10 percent hydrology simulations by eliminating days of flows less than 4,150 cfs. The EDO results in an adverse effect as compared to the no action flow regime under the 1999-2001 20 percent reduced hydrology simulations by including days of flows less than 5,000 cfs.

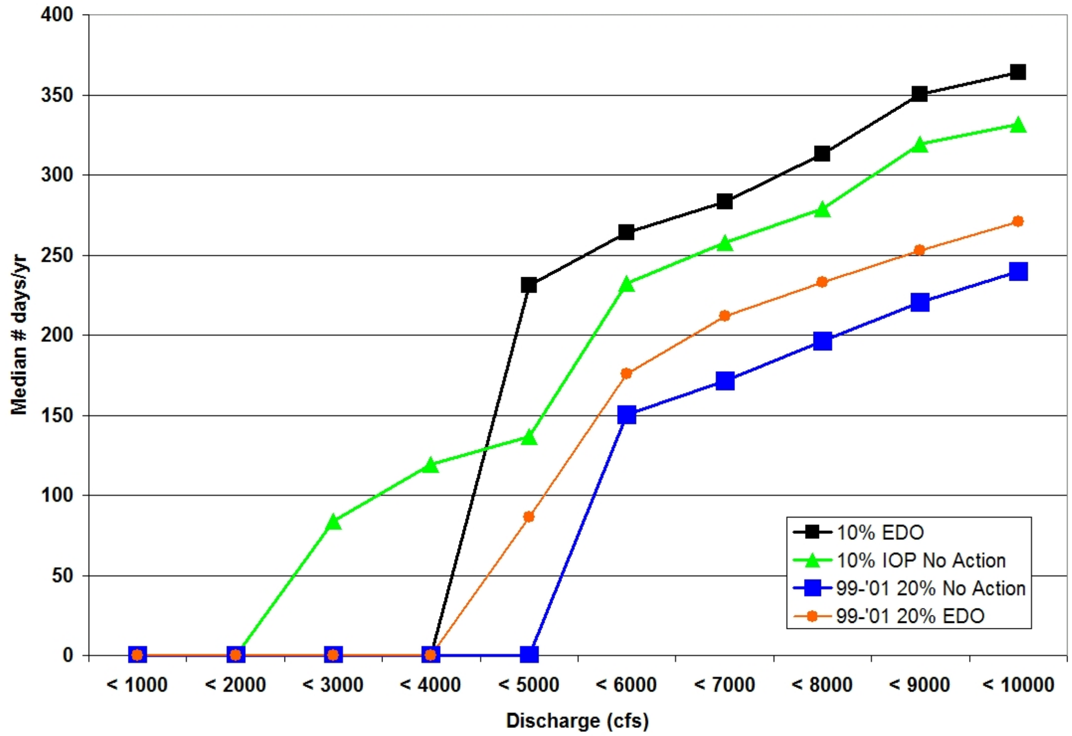

Figure 9. Median number of days per year of discharge less than 1,000 to 10,000 cfs under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

The no action (IOP) plan utilizes a maximum fall rate schedule (Table 2). The schedule limits operations to more gradual fall rates as flow declines to the river stages where listed mussels may occur in order to facilitate, as much as possible, the movement of mussels and other aquatic biota from higher to lower elevation habitats. The general intent of the schedule is to avoid extreme daily declines in river stage and thereby lessen the potential for exposing or stranding listed mussels, their host fish, and other aquatic biota. The EDO does not include a maximum fall rate schedule, but includes the provision that fall rates would be managed to match the fall rate of the basin inflow.

To analyze effects due to elimination of the maximum fall rate schedule for the modeled flow regimes, we used the Chattahoochee gage rating curve that characterizes the stage/discharge relationship during recent years (Light *et al.* 2006) to compute the gage heights associated with simulated daily flows, and then computed change rates as the difference between each pair of consecutive daily values (previous day gage height minus current day gage height = change rate associated with current day).

Figure 10 is a frequency histogram of the rate of change results, which lumps all stable or rising days into one category and uses the ranges that correspond to the maximum fall rate schedule as categories for the falling days (<=0.25 ft/day, > 0.25 to <= 0.50 ft/day, > 0.50 to <= 1.00 ft/day, > 1.00 to <= 2.00 ft/day, and > 2.00 ft day). As described above, since essentially all live mussels occur in habitats inundated at an approximately 5,000 cfs flow due to an extended period of flows at this level, that still persist, the most critical fall rate category is the 0.25 or less ft/day category which corresponds to the maximum fall rate provision for flows ≤ 8,000 cfs. Among the falling days, rates less than 0.25 ft day are the most common occurrence in the four simulated flow regimes which is generally beneficial to listed mussels and other aquatic biota. However, the EDO flow regimes have a higher percentage of days in the 0.25 to 0.50 ft/day category than the no action flow regimes. Collectively, the EDO flow regime has a very slightly higher percentage of days in the fall rate categories of greater than 0.25 ft/day than the no action (20.0 percent versus 19.9 percent respectively). This shift increases the relative risk of stranding and exposure of aquatic organisms over the no action; however, most of the shift is confined to the 0.25-0.50 ft/day category and not the more extreme categories. Based on the very minor difference in frequency of fall rate categories of greater than 0.25 ft/day between the two actions, and this difference being mainly attributable to the less extreme 0.25-0.50 ft/day category, we have determined that the EDO has no effect on listed mussels with regards to this flow-dependent habitat parameter as compared to the no action plan.

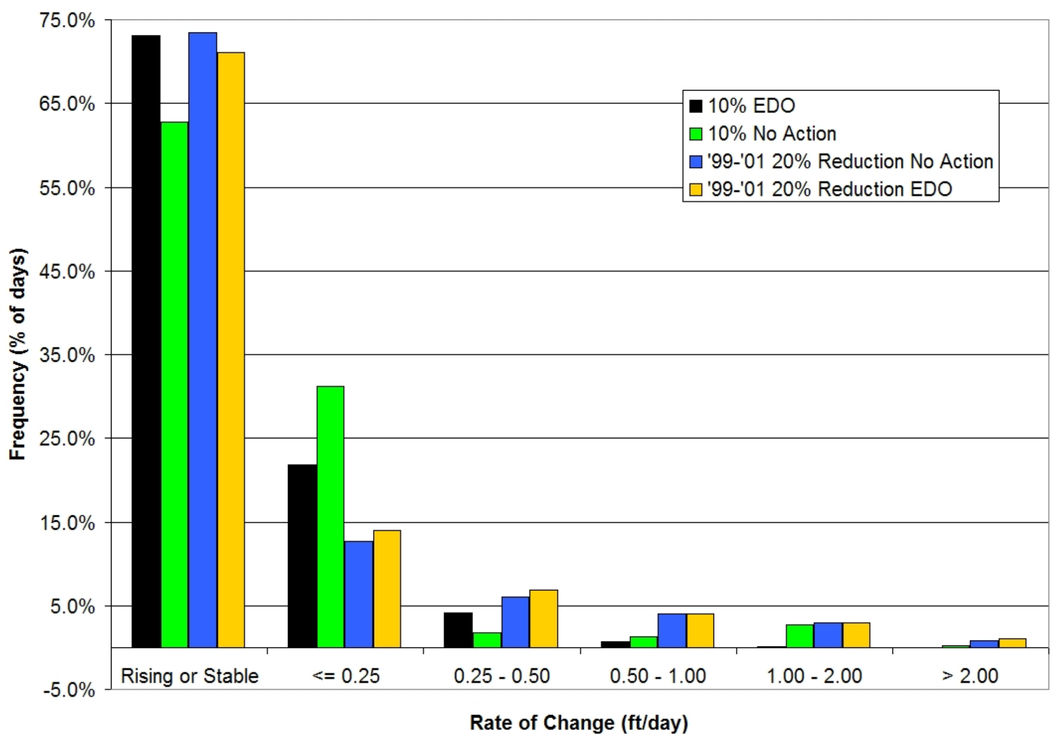

Figure 10. Frequency (percent of days) of daily stage changes (ft/day) under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

As noted in the BO, the USFWS observed mussels exposed at stages as high as about 10,000 cfs during the summer of 2006 (USFWS 2006). Therefore, listed mussels could potentially be directly impacted by increases in the percentage of days that fall rates greater than 0.25 ft/day occur and flows are less than 10,000 cfs. Figure 11 shows a count of days in the various rate-of-change categories when flow was less than 10,000 cfs. For this analysis, the flow associated with the rate of change on a given day is the flow of the previous day. A count of days is utilized here for the vertical scale of this figure instead of a percentage of days as in Figure 10, because each flow regime has a different number of days less than 10,000 cfs, and this difference is relevant to the effects analysis. Similar to the previous analysis, the numbers of days of daily stage changes for fall rates greater than 0.25 ft/day under the four simulated flow regimes are generally similar within each category. Among the falling days, rates less than 0.25 ft/day are the most common occurrence in the four simulated flow regimes. The collective number of days in the greater than 0.25 ft/day categories for the EDO flow regime is 98, slightly lower than the number in the no action flow regime (101). The EDO improves upon the no action with regards to this flow-dependent habitat parameter; however, since the difference between the two actions is so minor we have determined that the EDO has no effect on listed mussels with regards to this flow-dependent habitat parameter.

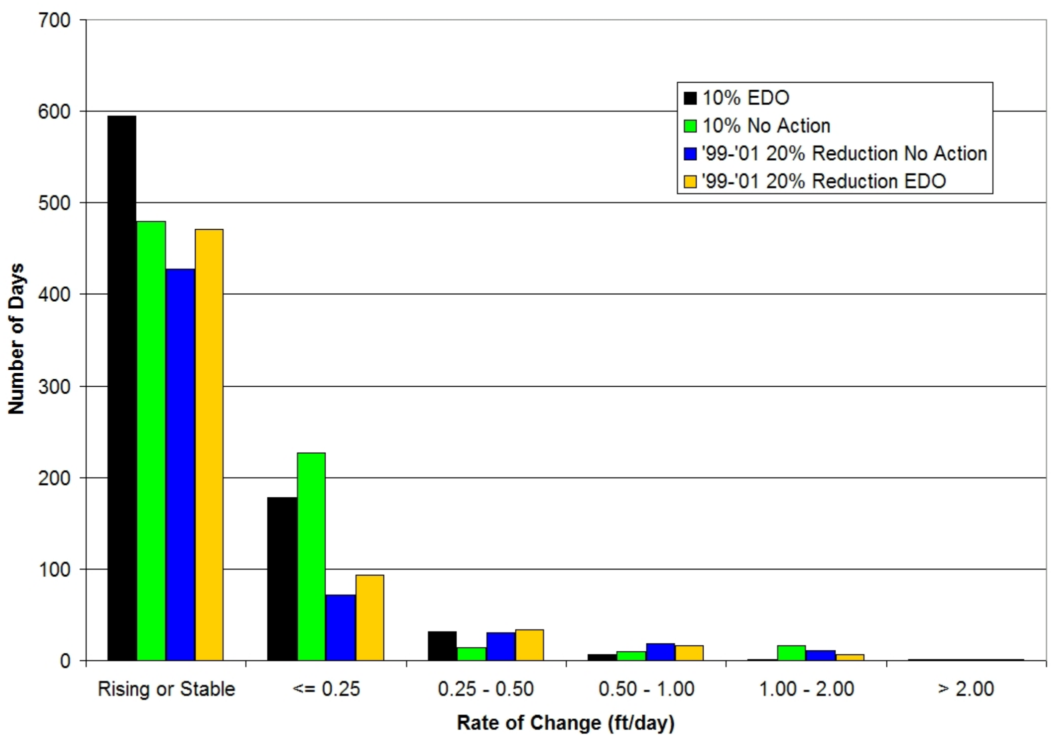

Figure 11. Frequency (number of days) of daily stage changes (ft/day) when releases from Woodruff Dam are less than 10,000 cfs under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

FLOODPLAIN CONNECTIVITY AND SYSTEM PRODUCTIVITY

Listed mussels and sturgeon can be indirectly affected by changes to the frequency, timing, and duration of floodplain habitat connectivity/inundation. The Apalachicola River floodplain is a highly productive area that likely provides spawning and rearing habitats for one or more of the host fishes of the purple bankclimber and fat threeridge. Floodplain inundation is also critical to the movement of organic matter and nutrients into the riverine feeding habitats of both the mussels and juvenile sturgeon, and into the estuarine feeding habitats of juvenile and adult sturgeon (USFWS 2006).

Therefore, we must compare the impact of the proposed action to the no action on the timing, and duration of floodplain habitat connectivity and inundation. As described in the BO, this is accomplished by utilizing the relationship documented by Light *et al.* (1998) between total area of non-tidal floodplain area inundated and discharge at the Chattahoochee gage (USFWS 2006). Figure 12 displays a frequency analysis of the results of transforming the four daily discharge time series during the growing season months (April – October) to connected floodplain area. The overall area/frequency pattern of the proposed action is similar for the median daily value as compared to the no action. However, the no action flow regime generally provides more acres of floodplain connectivity to the main channel than the EDO. This discrepancy between the EDO and no action flow regimes is due to operational provisions allowing for storage of all basin inflow above that required to meet the minimum flow discharge under the EDO and limitations to storage during the months of April and May under the no action (especially when basin inflow is less than 18,000 cfs which allows for no storage). Therefore, we have determined that the proposed action results in an adverse effect on listed species in the Apalachicola River with regards to this flow-dependent habitat feature as compared to no action.

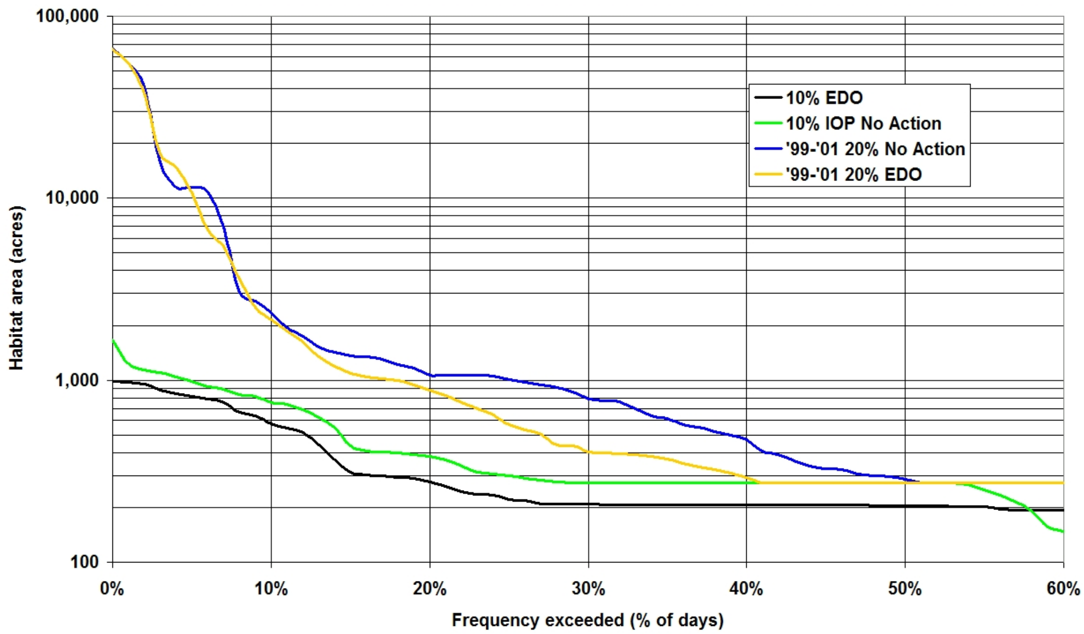

Figure 12. Frequency (percent of days) of growing-season (April-October) floodplain connectivity (acres) to the main channel under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

A period of continual inundation is required for successful spawning and rearing of host fishes of the listed mussel species. Therefore, we used a 30-day moving minimum to represent this aspect of habitat availability, identifying the maximum acreage inundated during the growing-season for at least 30 consecutive days each year. Table 10 illustrates the results of this analysis by comparing the maximum amount of growing season 30-day continuous connected floodplain habitat per year for the four flow regimes.

Maximum Acreage				
YEAR	10% EDO	10% No Action	20% Reduction No Action	20% Reduction EDO
2008	330	713	390	270
2009	405	552	1464	1003

Table 10. Maximum acreage of 30-day continuous floodplain connectivity to the main channel (per year) during the growing-season (April-October) under the no action (10% hydrology HEC-5 simulated flow), no action (1999-2001 20% reduction hydrology HEC-5 simulated flow), EDO (10% hydrology HEC-5 simulated flow), and EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

The EDO provides less maximum acreage of 30-day continuous connectivity per year than the no action under both hydrology simulations. Therefore we have determined that the EDO results in an adverse effect with regards to this flow-dependent habitat parameter as compared to the no action.

CONCLUSIONS

Generally, the analysis for determining adverse effects of the EDO compared to the no action (IOP) results in some adverse effects to listed species for the flow dependent habitat parameters considered. However, for several of the parameters considered (especially those relative to direct impacts to listed mussel species) it appears that an adverse effect determination is dependent on the severity of the hydrology input into the model. For the purposes of this analysis we selected hydrological conditions that represent 1) an unprecedented, exceptional drought applied across the entire ACF basin and continuing without relief for a two year period (10 percent hydrology); and 2) an exceptional drought that reflects differences in precipitation within the basin but is still more severe than observed during the critical period prior to the current drought (1999-2001 hydrology). It is unlikely that the actual hydrology occurring over the next two years will match closely these simulated hydrological conditions. It may be better than simulated or it may be worse than simulated. With the growing threat of LaNina conditions this fall and winter and the predicted resultant continuing exceptional drought conditions, it is likely that whatever hydrology occurs could result in significant reduction of Composite Storage within the system. If this reduction is severe and depletes the conservation storage in the system, the no action plan would result in extremely low flows on the Apalachicola River as the ability to augment flow above basin inflows would cease or be severely limited, and the river flow would essentially be limited to basin inflow. Therefore, in order to analyze the likelihood of this occurring, and determine if the adverse effects of the proposed action relative to the no action are justified, we have evaluated the Composite Storage values for the no action and EDO under the 1999-2001 20 percent reduced flow regimes. The 10 percent flow regime of the no action includes depletion of the Composite Conservation Storage within the system and therefore is not further considered. Since Composite Storage Zone 4 is the trigger for the EDO and represents a period when operations are the most conservative, we focus on the amount of storage available within this Zone and the duration spent in this Zone to illustrate the clear need for the proposed action. Figure 13 illustrates the simulated Composite Storage under the EDO flow regime. Figure 14 illustrates the simulated Composite Storage under the no action flow regime.

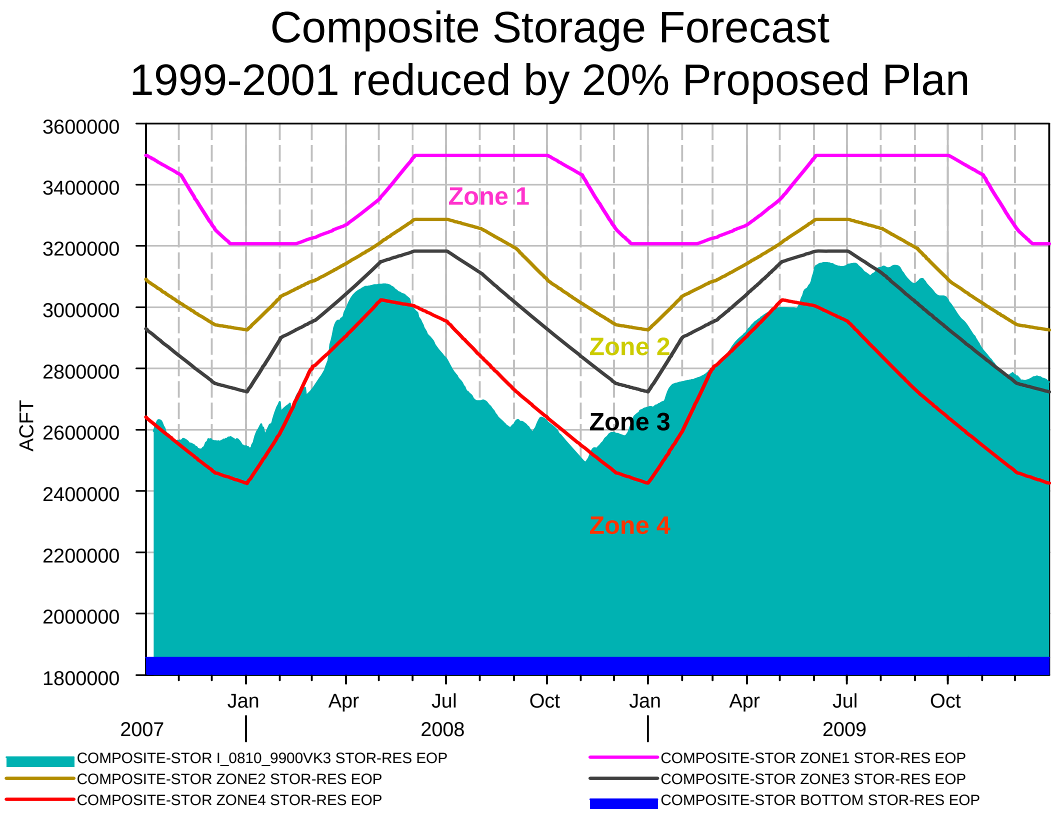

Figure 13. Composite Storage under the EDO (1999-2001 20% reduction hydrology HEC-5 simulated flow).

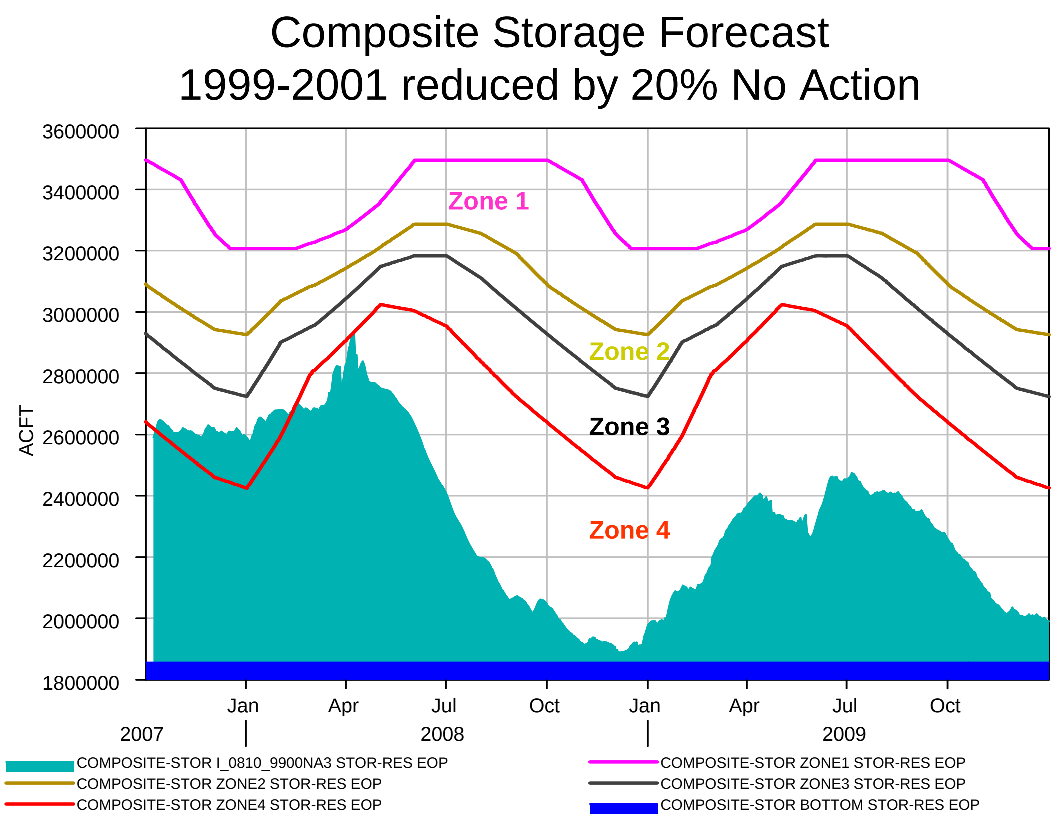

Figure 14. Composite Storage under the no action (1999-2001 20% reduction hydrology HEC-5 simulated flow).

Figure 14 clearly demonstrates the threat of continuing to operate under the IOP during this extended drought period. The no action flow regime under this hydrological condition very nearly results in depletion of Composite Conservation Storage within the system (as occurred in the 10 percent hydrology). Furthermore, the low level of Composite Conservation Storage that persists from summer 2008 through 2009 greatly limits our ability to respond to continued or repeated drought conditions more severe than those input into the model simulation. Given the current severity and projected prolongation of the existing drought conditions, we submit that responsible operation of the system cannot realistically be based on an expectation of any appreciable recovery in the near future. The EDO flow regime under this hydrological condition greatly reduces the severity of reductions in the Composite Conservation Storage within Zone 4 and the duration of time spent in Composite Zone 4, thus improving our ability to respond to drought conditions more severe than those input into the model simulation. Therefore, we have determined that although the EDO results in some immediate adverse effects to listed species (especially fat threeridge and purple bankclimber mussels), it is necessary (and beneficial) to prevent more severe adverse and long-lasting effects that have a high probability of occurring if we continue to operate under the IOP during the current exceptional drought.

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United States Fish and Wildlife Service (USFWS). 2007. Fat Threeridge (*Amblema neislerii*) Shinyrayed Pocketbook (*Lampsillis subangulata*) Gulf Monccasinshell (*Medionidus penicillatus*) Ochlockonee Moccasinshell (*Medionidus simpsonianus*) Oval Pigtoe (*Pleurobema pyriforme*) Chipola Slabshell (*Elliptio chipolaensis*) Purple Bankclimber (*Elliptoideus sloatianus*); 5-Year Review: Summary and Evaluation.