IN REPLY REFER TO:

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September 22, 2006

Col. Peter Taylor, District Engineer
Mobile District, Corps of Engineers
Department of the Army
P.O. Box 2288
Mobile, Alabama 36628-0001

Dear Col. Taylor:

By this letter, I am sending you a corrected copy (CD and hard copy enclosed) of our 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. We inadvertently omitted Tables 5.1.A and 5.1.B from the earlier copy.

This version also corrects some inconsistencies and omissions from the Table of Contents, such as an entry for the first page (Service letterhead page) of the document and the "Determinations" section within the Conclusion. Each entry in the Table of Contents is also now "bookmarked" for navigation within the digital copy. Otherwise, this version is unchanged from the September 5 version.

I apologize for any inconvenience our omission may have caused. We will post the corrected copy on our website in the next week, and I will ask our counsel to notify the parties to the legal proceedings related to the opinion about its availability.

Sincerely yours,

Gail A. Carmody
Field Supervisor

Enclosures

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

Prepared by:
U.S. Fish and Wildlife Service
Panama City Field Office, Florida
September 5, 2006

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List of Acronyms

ACF	Apalachicola-Chattahoochee-Flint Basin
Act	Endangered Species Act
BO	Biological Opinion
cfs	Cubic feet per second
CPUE	catch per unit effort
DNR	Department of Natural Resources
DO	dissolved oxygen
EPD	Environmental Protection Division
FDEP	Florida Department of Environmental Protection
FFWCC	Florida Fish and Wildlife Conservation Commission
HEC-5	Hydrologic Engineering Center – model 5
IOP	Interim Operation Procedures
NPDES	National Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service (same as NOAA-Fisheries)
NOAA	National Oceanic and Atmospheric Administration
NWFWMD	Northwest Florida Water Management District
PCEs	Primary Constituent Elements
RM	River mile
RoR	“Run-of-River” operations
Service	U.S. Fish and Wildlife Service
TL	Total length
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCP	Water Control Plan
YOY	Young-of-the-year

ERRATA for September 22, 2006, Version

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Otherwise, this version is unchanged from the September 5 version.

United States Department of the Interior

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September 5, 2006

Col. Peter Taylor, District Engineer
Mobile District, Corps of Engineers
Department of the Army
P.O. Box 2288
Mobile, Alabama 36628-0001

Dear Col. Taylor:

This document represents the Fish and Wildlife Service's (Service) biological opinion and conference report based on our review of the Interim Operating Plan (IOP) for the Mobile District water management operations at Jim Woodruff Dam, and the associated releases to the Apalachicola River, and its effects on the threatened Gulf sturgeon (*Acipenser oxyrinchus desotoi*), endangered fat threeridge mussel (*Amblema neislerii*), threatened purple bankclimber mussel (*Elliptoideus sloatianus*) and threatened Chipola slabshell (*Eliptio chipolaensis*) and habitat designated and proposed as critical habitat for the Gulf sturgeon and the mussels, respectively, per section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.).

This biological opinion and conference report does not rely on the regulatory definition of destruction or adverse modification of critical habitat at 50 Code of Federal Regulations [C.F.R.] 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

This biological opinion and conference report is also based on numerous coordination and clarifying conference calls between the Corps and the Service, unpublished data in Service files, the experience of Service biologists and an extensive literature search on the fat threeridge, purple bankclimber, Chipola slabshell and Gulf sturgeon. A complete administrative record is on file in the Panama City Field Office, Florida.

A total of 37 federally listed species are known to occur within the ACF Basin, but effects of the proposed action are limited to those that depend primarily on riverine habitat. Operations under the IOP will be conducted within the boundaries of the existing water control plans for the upstream reservoir projects, and will not change the top of the flood control pools, conservation pools, or the rule curves of the upstream projects. Therefore, the proposed action will have no effect or an insignificant effect (*i.e.*, any impacts should never reach the scale where take occurs) on all but the riverine- and estuarine-dependent species. Two species of sea turtles and the West Indian manatee may sometimes occur in Apalachicola Bay or the lower Apalachicola River; however, any effects of the proposed action to these species would be insignificant also, due to their low numbers and only occasional seasonal residence in the river and bay. Three of the 37 ACF listed species are fresh water mussels that do not occur in areas downstream of the Corps' ACF projects: the shiny-rayed pocketbook, Gulf moccasinshell, and oval pigtoe. The proposed action will have no effect on these. Altogether, the proposed action will have either no effect or an insignificant effect on the species listed in Table 1 and these are not further discussed in this biological opinion.

Table 1. Species and critical habitat evaluated for effects from the proposed action but not further discussed in this biological opinion.

SPECIES OR CRITICAL HABITAT
Flatwoods salamander (*Ambystoma cingulatum*)
Loggerhead turtle (*Caretta caretta caretta*)
Eastern indigo snake (*Drymarchon corais couperi*)
Atlantic ridley (*Lepidochelys kempi*)
Piping plover (*Charadrius melodus*)
Bald eagle (*Haliaeetus leucocephalus*)
Wood stork (*Mycteria Americana*)
Gray bat (*Myotis grisescens*)
Indiana bat (*Myotis sodalis*)
West Indian manatee (*Trichechus manatus*)
Shiny-rayed pocketbook (*Lampsilis subangulata*)
Gulf moccasinshell (*Medionidus penicillatus*)
Oval pigtoe (*Pleurobema pyriforme*)
Little amphianthus (*Amphianthus pusillus*)
Apalachicola rosemary (*Conradina glabra*)
Telephus spurge (*Euphorbia telephioides*)
Harper's beauty (*Harperocallis flava*)
Black-spored quillwort (*Isoetes melanospora*)
Pondberry (*Lindera melissifolia*)
White birds-in-a-nest (*Macbridea alba*)
Canby's dropwort (*Oxypolis canbyi*)
Godfrey's butterwort (*Pinguicula ionantha*)
Harperella (*Ptilimnium nodosum)*
Chapman's rhododendron (*Rhododendron chapmanii*)
Michaux's sumac (*Rhus michauxii*)
Green pitcherplant (*Sarracenia oreophila*)
American chaffseed (*Schwalbea Americana*)
Florida skullcap (*Scutellaria floridana*)
Fringed campion (*Silene polypetala*)
Gentian pinkroot (*Spigelia gentianoides*)
Cooley meadowrue (*Thalictrum cooleyi*)
Florida torreya (*Torreya taxifolia*)
Relict trillium (*Trillium reliquum*)

CONSULTATION HISTORY

Consultation History	
Date	**Description**
1991-1997	Informal consultation developing information for the Tri-State Comprehensive Study.
1998-2003	Informal consultation on Corps operations of the reservoir system relative to ACF Compact water allocation discussions.
28-Apr-00	Letter from Service to Corps expressing concern for ACF reservoir operations and listed species and therefore requesting a meeting.
13-Jun-00	Letter from Corps, to Service, responding to 28-Apr-00 letter agreeing to a meeting to discuss the possibility of a formal or informal consultation.
7-Aug-00	Corps memo summarizing 2-Aug-00 field inspection by Corps, Service, and USGS of several sloughs of the Apalachicola River and potential effects to listed mussels.
10-Aug-00	Letter from Service to Corps expressing concern about listed mussel species at flows less than 5000 cfs and explaining the necessary step to begin a formal consultation.
26-Sep-00	Corps meeting with Service and state fishery management agencies from Georgia and Florida to discuss impacts of navigation windows and potential conflicts between water management in support of upstream reservoir fish spawn activities.
12-Oct-00	Letter from Service to Corps summarizing the meeting on 26-Sep-06.
17-Nov-00	Letter from Corps to Service, responding to the Service's concern for listed species and reduced flows.
30-Mar-01	Corps Regulation issued regarding project operations and lake regulation and coordination for fish management purposes. (Division Regulation DR 1130-2-16)
11-Jun-02	Letter from Service to Corps, requesting a meeting to discuss ACF consultation responsibilities relative to reservoir operations.
12-Aug-02	Corps' MFR regarding meeting amongst the Service, the Corps, and FWCC discussing ACF water control operations and consideration of Apalachicola river and bay aquatic resources.
31-Oct-02	Corps MFR by Joanne Brandt about initiating Gulf Sturgeon spawning habitat survey and mapping on the Apalachicola River on 22-23-Oct-02.
3-Mar-03	Corps MFR concerning interagency meeting held on 20-Feb-03 about proposed revision/update to SAM SOP 1130-2-9, lake regulation and coordination for fish management purposes.
19-Apr-03	Service and NOAA Fisheries jointly designate Gulf sturgeon critical habitat (68 FR 13370).
11-Feb-04	Corps memo about the continuation of the Gulf Sturgeon spawning habitat survey and mapping on the Apalachicola River.
15-Feb-04	Annual coordination meeting of Corps, Service, and state fishery management agencies to discuss reservoir water management operations in support of fish management.
March 2004 to May 2004	Regular interagency teleconferences to discuss reservoir water management to minimize effects to both reservoir fish spawning and Apalachicola river floodplain fish spawning.

Consultation History	
Date	**Description**
05-Feb-05	Draft SOP 1130-2-9 on project operations and coordination related to fish management presented at annual Fish Management and Coordination Meeting.
15-Feb-05	Annual coordination meeting of Corps, Service, and state fishery management agencies to discuss reservoir water management operations in support of fish management.
11-May-05	Corps memo documenting telephone conference between Corps, Service, and Florida Fish and Wildlife Conservation about fish spawning coordination and low flow.
12-May-05	Email from Corps to Service, responding to an update on Gulf Sturgeon spawning.
17-May-05	Email from Corps to Service, responding to an update on Gulf Sturgeon spawning and confirming "run of the river" flow releases.
10-Jun-05	Email from Service to Corps and others about the preliminary summary results from the Apalachicola River Gulf Sturgeon spawning study.
18-Jan-06	Letter from Corps to Service, requesting review and comment of the draft report "Distribution of the Fat Threeridge During Low Flows on the Apalachicola River, Florida" by the Corps.
7-Feb-06	Annual coordination meeting of Corps, Service, and state fishery management agencies to discuss reservoir water management operations in support of fish management.
7-Mar-06	Letter from Corps to Service, requesting the initiation of a formal consultation pursuant to Section 7 of the ACF).
9-Mar-06	Letter from Service to Corps, acknowledging receipt of formal consultation request.
15-Mar-06	Memorandum documenting phone conversation between Service and Corps discussing development of information and schedule for the BO.
21-Mar-06	Memorandum documenting phone conversation between Service and Corps discussing migration of existing ACF HEC5 model to new software ResSym.
30-Mar-06	Email from Corps to Service, requesting a telephone conference about modeling and planning.
26-Apr-06	Memorandum documenting telephone conference between the Corps and Service discussing the status of water management operations to implement the IOP,
5-May-05	Letter from Georgia EPD to Corps expressing concern regarding IOP and providing additional model analysis.
5-May-06	Email from Corps to Service, requesting the report on gulf sturgeon spring spawning and to confirm previous telephone conference discussion about proposed ramping rates for releases to the Apalachicola.
15-May-06	Letter from Corps to Georgia EPD regarding data to be used in consultation.
16-May-06	Meeting between Corps and Service to share and “truth” STELLA modeling data in preparation for technical modeling workshop
17-19-May-06	Email correspondence between Corps and Service about pre- and post-dam construction ramping rates.
18-May-06	Email from Corps to Service about present and post-consultation ramping rates.
19-May-06	Letter from Corps to Georgia EPD concerning the use of different modeling techniques for the ACF.
24/25-May-06	Workshop held on the Jim Woodruff Dam existing water management operations, section 7 consultation and hydrological modeling. Representatives included the Corps, the Service, Alabama Office of Water Resources, Georgia DNR, Florida Department of

Consultation History	
Date	**Description**
	Environmental Protection (FDEP), Northwest Florida Water Management District (NWFWMD), and Florida Fish and Wildlife Conservation Commission (FFWCC).
6-Jun-06	Service proposes critical habitat for the fat threeridege, purple bankclimber, and Chipola slabshell (71 FR 32746).
2-Jun-06	Letter from Georgia EPD to Corps and Service, requesting that the Corps reconsider the IOP and providing additional modeling information.
11-Jun-06	Email from Corps to Service discussing IOP flow discharges.
12-Jun-06	Letter from Corps to Service, concerning adjustments made to the IOP, after dealing with several "lessons learned." Letter also concludes that IOP is not likely to alter or destroy primary constituent elements of critical habitat for listed mussels and requests that a conference report be included in the biological opinion.
12-Jun-06	Corps memorandum documenting 24-25-May-06 technical workshop on the Jim Woodruff dam existing water management operations, Section 7 consultation, and hydrological modeling.
13-Jun-06	Letter from Service to Corps, requesting 45 day consultation extension in order to review and analyze information to be provided by the State of Florida.
19-Jun-06	Email from Corps to Service providing HEC-5 model representing the IOP and model settings
20- 28-June 06	Service field inspections of freshwater mussels in the middle Apalachicola River and lower Chipola river. Accompanied by staff of EnviroScience, Inc. and FFWC on several days.
21-Jun-06	Email from Corps to Service providing data from previous mussel surveys showing mussel depths by waypoint location.
22-Jun-06	Letter from Service to Corps recommending that the Corps not deviate from the IOP until the BO is completed.
28-Jun-06	Letter from Corps to Service confirming BO extension and review of changes in the current IOP.
10-Jul-06	Email from Corps to Service providing additional HEC-5 model runs for various minimum flows (8,000 and 6,600 cfs).
12-Jul-06	Hydrological Modeling Technical Workshop held at the Columbus Convention and Trade Center including representatives of AL, FL, GA, the Atlanta Regional Commission, Alabama Power, Service, and Corps.
July 06 – August 06	Weekly discussions between the Service and the Corps regarding interpretations of HEC-5 and STELLA model input variables and output, flow in Swift Slough and controlling sill depths, stage-discharge relationships, drought scenarios, and new data on listed mussels.
20-Jul-06	Email from Corps to Service providing additional HEC-5 model runs for period of record for minimum flows of 5,000 and 6,600 cfs.
21-Jul-06	Email from Corps to Service providing scanned hydrographic surveys (1959-1960)-post construction surveys
24-Jul-06	Email from Corps consultant (Ecol. Applications/Drew Miller) to Service providing mussel length data for RM 41.7 (Chipola Cutoff) associated with Miller (2005).
26-27-Jul-06	Emails from the Corps to the Service providing additional modeling output data on possible “worst case scenarios”
26-Jul-06	Service requests Florida DEP provide a digital copy of data contracted mussel study.
26 July 06	Service provides Corps draft of proposed action section of BO.
27-July-06	Email from Corps to Service providing copy of Design Memorandum No. 1 for Apalachicola River navigation project including 1938 pre-construction surveys.
28 July 06	Corps provides comments and several suggested edits to the Service’s draft of the

Consultation History	
Date	**Description**
	proposed action.
28-July-06	Corps email providing comments on Swift Slough draft memo of 07-25-06 site visit and data on diversion of flow into the Chipola Cutoff.
31-July-06	Email from Corps to Service providing comments from Corps consultant (Ecol. Applications/Drew Miller) to Service regarding mussel habitat requirements and Swift Slough.
1 August 06	FFWC provides draft of Gulf sturgeon report for review relative to Service data contained therein.
3 August 06	Corps provides data on water surface and bed elevations relative to Swift Slough on August 2, 2006.
9 August 06	Service provides Corps rough draft of possible conservation measures and measures to minimize harm. Teleconference between Service and Crops to discuss measures.
9 August 06	Gregg Zimmerman, EnviroScience, Inc. provides an estimate of the fat threeridge population in Swift Slough.
10 August 06	Service provides FFWCC additional data for the Brothers River site.
10-Aug-06	Email from Corps to Service providing Corps consultant (Ecol. Applications/Drew Miller) comments on Greg Zimmerman data on proportion of mussels relative to river depth.
10-Aug-06	Email from Corps to Service providing basin inflow time series used for HEC-5 model
10-Aug-06	Email from Corps to Service providing estimates of ACF basin water demands in terms of cfs flow.
14 August 06	Corps provides review on conservation measures and measures to minimize harm.
14 August 06	Additional Swift Slough data and analysis provided via email by Gregg Zimmerman, EnviroScience, Inc.
15 August 06	FFWCC submits final Gulf sturgeon report and supporting data. (Error in figure corrected on 16 August).
15-Aug-06	Email from Corps to Service providing comments from ERDC/Payne regarding hydraulic movement of mussels with sediment/flood flows and recruitment.
17 August 06	Received information on Georgia's Water Conservation Education Campaign from Carol Couch, Director, Georgia Environmental Protection Division.
18-Aug-06	Florida DEP letter to Service summarizing voluminous biological and related data submitted to Service in August.
20-Aug-06	Service updates Corps on status of consultation, missing information, and possible measures to minimize harm.
22-Aug-06	Service discusses with Corps possible measures to avoid and minimize harm.
23-Aug-06	Florida DEP provides a digital copy of data contracted mussel study.
23-Aug-06	Service discusses with Corps possible measures to avoid and minimize harm.
25-Aug-06	Corps provides Service revised model output correcting basin inflow time series.
25-Aug-06	Corps provides Service HEC-5 model output for IOP with 2010 demands data.
26-Aug-06	Corps provides Service additional model output and summary of demands data.
27-Aug-06	Service provides Corps draft biological opinion.
27-Aug-06 to 2-Sep-06	Daily discussions of Corps and Service regarding draft BO.
2-Sep-06	Service provides revised draft BO to Corps.
4-Sep-06	Corps provides Service comments on revised draft BO and Incidental Take Statement.

BIOLOGICAL OPINION

1 DESCRIPTION OF PROPOSED ACTION

The action evaluated in this consultation is the Corps' Interim Operations Plan (IOP) for Jim Woodruff Dam, which describes releases from the dam to the Apalachicola River. The IOP was formulated specifically to address endangered and threatened species and critical habitat in the Apalachicola River. The Corps described the IOP in its letter dated March 7, 2006, to the Service, which requested the initiation of formal consultation. By letter dated June 12, 2006, the Corps revised and clarified some elements of the IOP, and it is this revised plan that we address in this Biological Opinion (BO). It is our understanding that the IOP is effective until it is revised or until Apalachicola-Chattahoochee-Flint Basin (ACF) water control plans are formally updated, at which time the Corps would reinitiate consultation. The IOP is not a new water control plan for Woodruff Dam; it is a definition of ACF operations that is within the limits established by the existing ACF water control plan. This opinion considers the operations of the ACF system including composite upstream reservoir storage and specific discharges from Jim Woodruff dam as described by the IOP.

The Corps operates five dams in the ACF River Basin: (in downstream order) Buford, West Point, Walter F. George, George W. Andrews, and Jim Woodruff (Figure 1). All are located wholly on the Chattahoochee River arm of the basin except the downstream-most dam, Woodruff, which is located at the confluence of the Chattahoochee and Flint rivers and marks the upstream extent of the Apalachicola River. Andrews is a lock and dam without any appreciable water storage behind it and Lake Seminole has very limited storage capacity, and both are essentially operated as run-of-river reservoirs. The impoundments of Buford, West Point, and Walter F. George dams, however, provide for combined conservation storage of approximately 1.6 million acre-feet, relative to the top of each reservoir's full summer pool and the bottom of the conservation pool, which is potentially available to support water management operations. For about half of its length, the Chattahoochee River forms the boundary between Georgia and Alabama. Lake Seminole straddles the boundary between Florida and the southwest corner of Georgia.

The Corps operates the ACF reservoirs as a system, and releases from Woodruff Dam reflect the downstream end-result of system-wide operations. The IOP addresses specific parameters of the daily releases from Woodruff Dam into the Apalachicola River. The IOP does not address operational specifics at the four federal reservoirs upstream of Woodruff or all aspects of the operations at Woodruff. The IOP specifies two parameters applicable to the daily releases from Woodruff: a minimum discharge 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]). For purposes of this BO, we use data for both parameters that are collected by the USGS at gage number 02358000, "Apalachicola River at Chattahoochee, FL," which is located 0.6 mi downstream of Woodruff Dam. We refer to this flow measurement point throughout the BO simply as the "Chattahoochee gage".

1.1 Action Area

Service regulations define "action area" as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). Although the IOP specifically addresses the releases from Woodruff Dam, the downstream-most project among the Corps' ACF reservoirs, these releases are accomplished through the collective operations of all of the Corps' ACF reservoirs. Therefore, the action area includes all aquatic habitats that are downstream of the Corps' upstream-most ACF project, Lake Lanier/Buford Dam, ending with and including Apalachicola Bay (Figure 1.A). However, the only aquatic listed species that is known to occur in this action area upstream of Woodruff Dam is a single purple bankclimber found in Goat Rock Reservoir in 2000 (C. Stringfellow, Columbus State University, pers. comm., 2000). The proposed action is not anticipated to result in any physical changes to the environment of this individual animal. Therefore, while the action area includes all aquatic habitats that are downstream of the Corps' upstream-most ACF project, Lake Lanier/Buford Dam, ending with and including Apalachicola Bay, the effects of the action are limited to the aquatic habitats downstream of Woodruff Dam ending with and including Apalachicola Bay. This portion of the action area, which we address in the remainder of this BO, is shown in Figure 1.1.A. Hereafter, our use of the term "action area" refers to this limited portion of the broader action area. We refer to locations in the action area by river mile (RM), which is distance from the mouth of the river as noted on USGS 7.5-minute topographic maps.

1.2 Minimum Discharge

Table 1.2.A shows the minimum releases from Woodruff Dam prescribed by the IOP. These minimum releases vary by basin inflow and by month. Basin inflow is defined for the IOP as the amount of water that would flow by Woodruff Dam during a given time period if all of the Corps' reservoirs maintained a constant water surface elevation during that period. The Corps estimates basin inflow daily from a combination of river and reservoir level measurements, mathematical stage/volume/discharge relationships, and operating characteristics of the various water release structures of the dams. The Corps is using a 7-day moving average of daily basin inflow calculations for its daily release decisions under the IOP, which is a revision to the IOP documented in its June 12, 2006, letter to the Service. Basin inflow is not the natural or "unimpaired" flow of the basin at the site of Woodruff Dam, because it reflects the influences of reservoir evaporative losses, inter-basin water transfers, and consumptive water uses, such as municipal and industrial water supply and agricultural irrigation. Basin inflow represents the total amount of water that is available to add to storage in the Corps' reservoirs during a given time period, although the Corps never captures 100% of basin inflow in storage due to minimum release requirements at each of the dams and storage capacity limitations. In the context of this consultation, "no action" on the part of the Corps is the constant release of daily basin inflow from Woodruff Dam.

The IOP defines high, mid, and low ranges of basin inflow for operational decisions. In the high range, the Corps releases at least the minimum discharge listed in Table 1.2.A and may store any amount of basin inflow in excess of the minimum. In the mid range, the Corps releases at least 70% of basin inflow, but not less than the low-range threshold, and may store up to 30% of basin inflow. In the low range, the Corps releases at least 100% of basin inflow, but not less than 5,000 cfs.

The basin inflow threshold levels that separate the high, mid, and low ranges vary by season. The IOP operations during March through May are intended to support Gulf sturgeon spawning activities. The March through May threshold between high and mid basin inflow is 37,400 cfs, and the threshold between mid and low basin inflow is 20,400 cfs. The IOP operations during June through February are intended to support the protected mussels, host fish for mussels, and young sturgeon. The June through February threshold between high and mid basin inflow is 23,000 cfs, with a minimum release of 16,000 cfs, and the threshold between mid and low basin inflow is 8,000 cfs.

The Corps describes the flow rates included in Table 1.2.A as minimum, and not target, releases for Woodruff Dam. During a given month and basin inflow rate, releases greater than the Table 1.2.A minimum releases may occur consistent with the maximum fall rate schedule, described below, or as needed to achieve other project purposes, such as hydropower or flood control. During wet periods, releases may substantially exceed the Table 1.2.A values, but during dry periods, releases will more closely match the Table 1.2.A values, as the Corps operates to conserve reservoir storage for authorized project purposes and future endangered and threatened species needs.

1.3 Maximum Fall Rate

The IOP prescribes maximum fall rates for the releases from Woodruff Dam (Table 1.3.A). Fall rate, also called down-ramping rate, is the vertical drop in river stage (water surface elevation) that occurs over a given period. IOP fall rates are expressed in units of feet per day (ft/day), and are measured at the Chattahoochee gage as the difference between the daily average river stage of consecutive calendar days. Rise rates (*e.g.*, today's average river stage is higher than No effectterday's) are not addressed in the IOP, only fall rates. Maximum fall rates under the IOP vary according to the flow released from Woodruff. Lower flows are assigned more gradual fall rates, and higher flows are assigned more rapid fall rates. The intent of the IOP maximum fall rate schedule is to limit the potential for stranding aquatic organisms, including listed species and host fish for listed mussels, in areas that become exposed or become disconnected from the main channel during periods of declining flow.

Managing fall rates to conform to Table 1.3.A is a difficult undertaking at Woodruff Dam when flow rates exceed the release capacity of the powerhouse, which is about 16,000 cfs. Releases of greater than 16,000 cfs require the use of spillway gates in addition to the turbines, and require an operator to open or close the gates using a rail-mounted crane on the crest of the dam. The water discharge openings of the gates are not fully adjustable, and inclement weather, floating debris from the reservoir, and other factors often complicate the procedure of opening and closing the gates. Fall rates are relatively more manageable when releases are less than 16,000 cfs and controlled by the powerhouse, but this control is not yet a precise operation. Neither turbine nor gate operations provide for precise flow measurement. For these reasons, a lower and an upper maximum fall rate is given in Table 1.3.A for each release range specified, and the Corps has indicated that when conditions allow, they will generally operate towards the more gradual (lower) rate in each range, consistent with safety requirements, flood control purposes, and equipment capabilities.

Under the June 12, 2006, IOP revisions, the Corps is using a 7-day moving average basin inflow calculation to determine the minimum daily release from Woodruff, as described under “Minimum Discharge” above. A 7-day moving average dampens daily fluctuations in basin inflow more than the 3-day moving average basin inflow that was originally proposed for the IOP, and results in less extreme day-to-day changes in the required minimum release from Woodruff. This dampening should generally, but not always, yield a required minimum release under Table 1.2.A that is also consistent with the Table 1.3.A ramping rate schedule without the release of additional water from storage. To prevent a substantial drawdown of storage due to gradual down ramping while following declining basin inflow, the Corps is tracking the volume of basin inflow and releases. When the volume of releases exceeds the volume of basin inflow during a given period by more than 5%, the Corps will adjust subsequent releases to replenish the storage that was used for down ramping. The adjustment will involve delaying and/or reducing an increase in releases during the next period of rising basin inflow. Similarly, if an inadvertent under-release occurs, the Corps will over-release that amount thereafter to re-establish consistency with Table 1.2.A (July 20, 2006, phone conversation between J. Ziewitz, USFWS, and M. Vaughan, C. Hrabovsky, and J. Brandt, Corps).

When daily average releases are less than the combined capacity of the powerhouse turbines at Woodruff, about 16,000 cfs, the Corps typically increases the discharge for a few hours each day to near the full capacity of one or more of the turbines. Figure 1.3.A shows an example of this practice for six days, July 14 to July 20, 2006. These “spikes” in the hydrograph, known as hydropower peaking, deliver extra power during hours of peak demand for electricity, and is included in the daily average discharge computations for minimum flow requirements under Table 1.2.A. The estimated average daily discharge from 7/14 to 7/20 shown in Figure 1.3.A ranged from 5,978 to 6,073 cfs, although instantaneous releases were as high as 10,100 cfs during the peaking, and as low as 5580 cfs between the peaks. The peaks are also included in the stage computations for ramping rate requirements under Table 1.3.A; however, Table 1.3.A addresses the difference between the average river stages of consecutive calendar days, not the shorter-term differences that result from peaking operations within a calendar day. In Figure 1.3.A, the average daily stage computed from the 96 readings (every 15 minutes over 24 hours) for 7/19 and for 7/20 is 39.74 ft and 39.68 ft, respectively, which is a drop in stage of 0.04 ft and which complies with the Table 1.3.A ramping rates. The drop in stage from the peak to the base release during these two dates was about 2.5 ft. The relative drop in stage from the peak to the base release will vary with different flows, but becomes more pronounced as flows decline. As average daily releases approach 5,000 cfs, the Corps will temporarily discontinue the daily peaking operation in order to maintain instantaneous releases greater than or equal to 5,000 cfs.

1.4 Conservation Measures

Conservation measures are actions that benefit or promote the recovery of a listed species that a Federal agency includes as an integral part of its proposed action and that are intended to minimize or compensate for potential adverse effects of the action on the listed species. The IOP was formulated in large part to avoid and minimize impacts to listed species while achieving other authorized project purposes. Minimum flow and maximum fall rates are set based upon the current basin inflow, which limits most project-induced alterations of the flow regime to higher flow rates. At lower flow rates, *e.g.*, basin inflow less than 8,000 cfs during June through February, the Corps releases a minimum of not less than basin inflow and controls declining river stages to rates less than 0.25 ft/day. When basin inflow is less than 5,000 cfs, which did not occur in the pre-Lanier flow record of the Chattahoochee gage (1929 through 1955), the Corps augments basin inflow, which offsets to some degree the impact of the evaporative losses, non-project related consumptive water uses, and drought conditions more severe than previously observed in the Basin.

1.5 Tables and Figures for Section 1

Table 1.2.A. IOP minimum discharge from Woodruff Dam by month and by basin inflow (BI) rates.

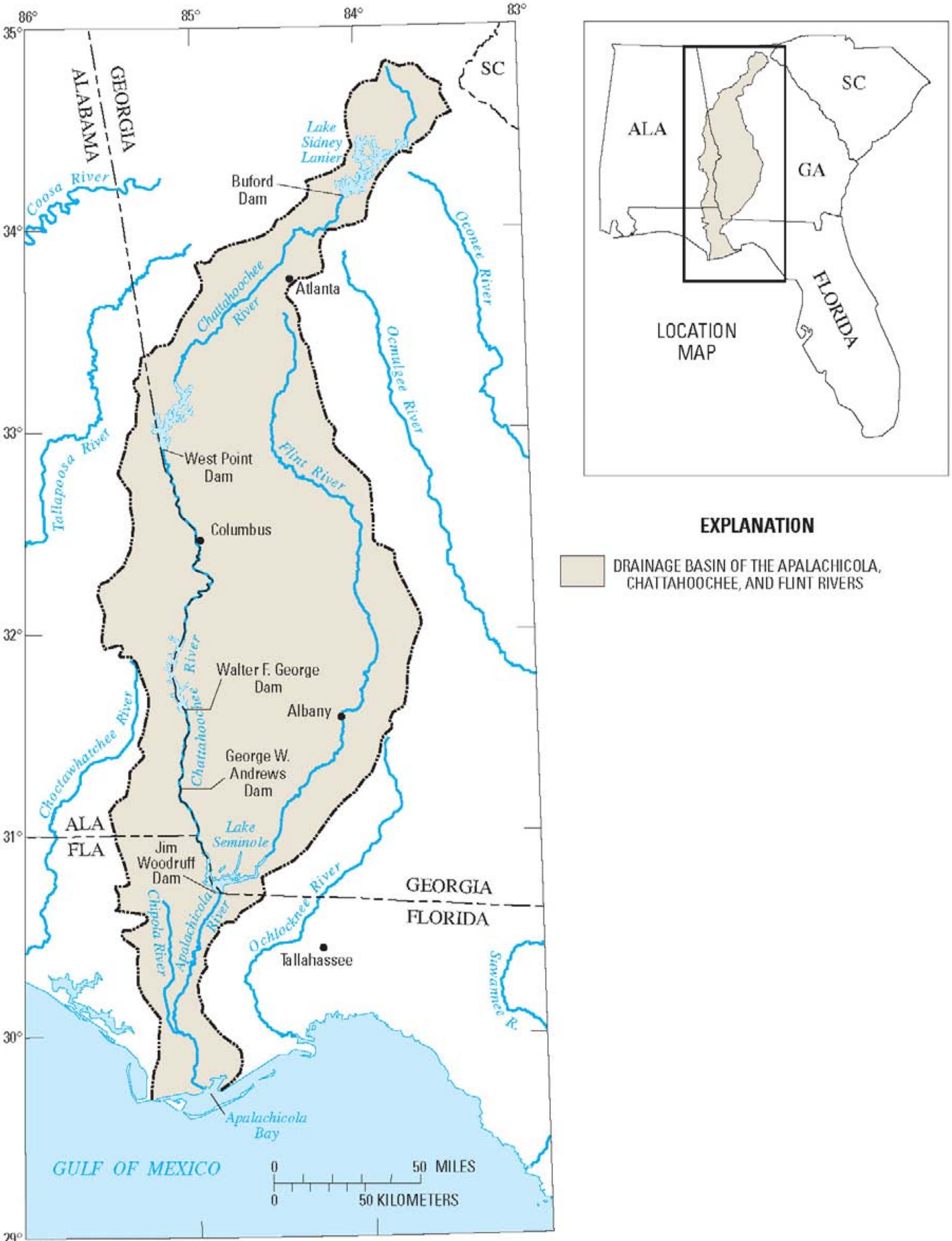
Months	Basin Inflow (cfs)[a]		Releases from Woodruff Dam (cfs)
March - May	High	>= 37,400	not less than 37,400
	Mid	>= 20,400 and < 37,400	>= 70% BI; not less than 20,400
	Low	< 20,400	>= BI; not less than 5,000
June - February	High	>= 23,000	not less than 16,000
	Mid	>= 8,000 and < 23,000	>= 70% BI; not less than 8,000
	Low	< 8,000	>= BI; not less than 5,000

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

Table 1.3.A. IOP maximum fall rate for discharge from Woodruff Dam by release range.

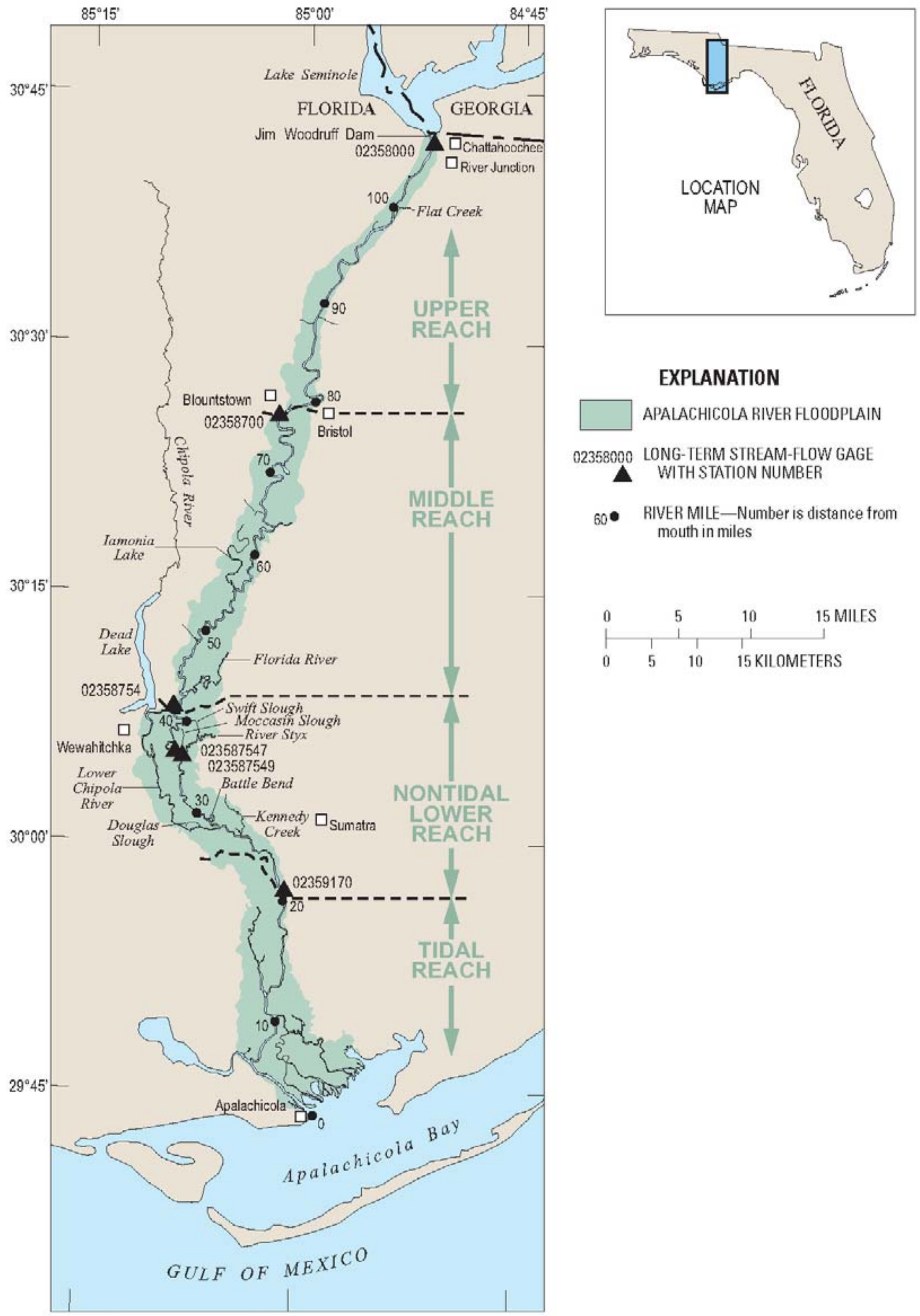
Release Range (cfs)	Maximum Fall Rate (ft/day)[a]
≥ 30,000	Fall rate is not limited.
≥ 20,000 and < 30,000	1.0 to 2.0
> 16,000 and < 20,000	0.5 to 1.0
> 8,000 and ≤ 16,000	0.25 to 0.5
≤ 8,000	0.25 or less

[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.



Base from U.S. Geological Survey digital data, 1972
Albers Equal-Area Conic projection
Standard Parallels 29°30' and 45°30', central meridian -83°00'

Figure 1.A. Map of the ACF Basin showing location of the Corps' dams (source: Light *et al.* 2006)



Base from U.S. Geological Survey digital data, 1972
Albers Equal-Area Conic projection
Standard Parallels 29°30' and 45°30', central meridian -83°00'

Figure 1.1.A. Map showing the Apalachicola River and Bay portion of action area (source: Light *et al.* 2006).

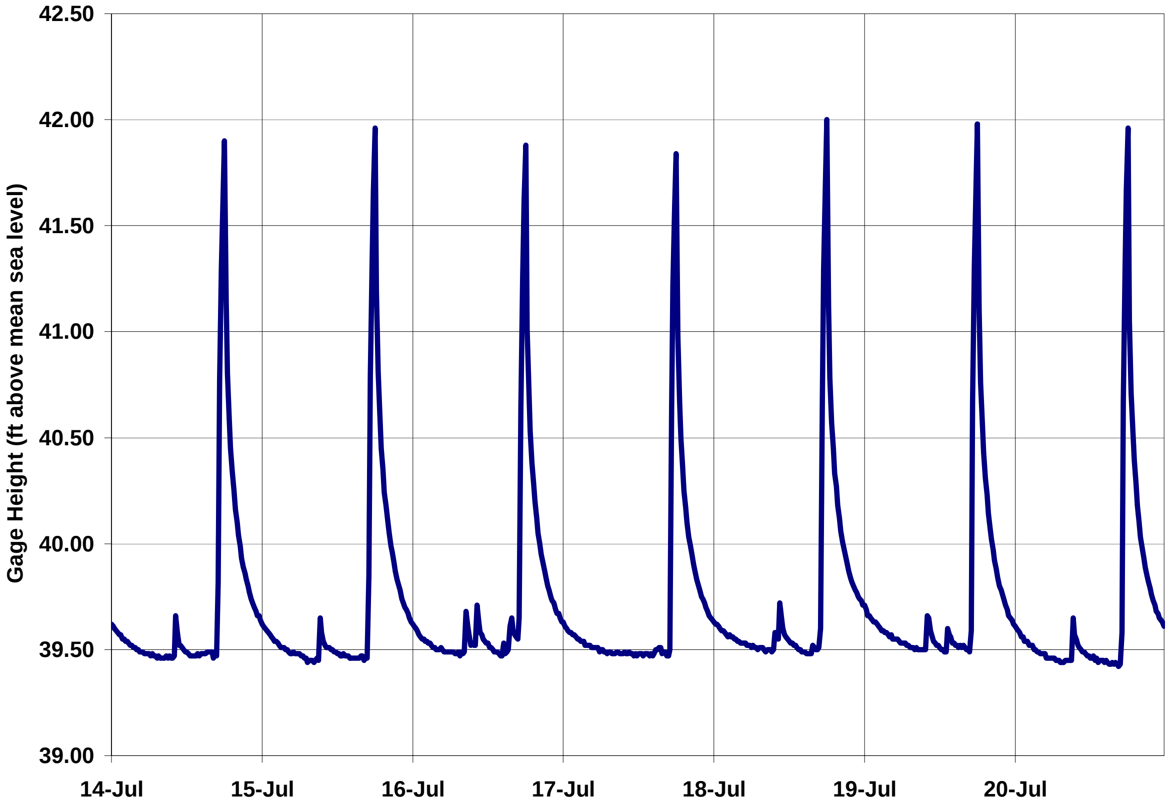


Figure 1.3.A. Stage of the Apalachicola River at Chattahoochee, FL, July 14 to July 20, 2006, recorded every 15 minutes on USGS gage number 02358000.

2 STATUS OF THE SPECIES/CRITICAL HABITAT

2.1 Gulf Sturgeon

2.1.1 Species Description

The Gulf sturgeon (*Acipenser oxyrinchus* (=*oxyrhynchus*) *desotoi*), also known as the Gulf of Mexico sturgeon, is an anadromous fish (breeding in freshwater after migrating up rivers from marine and estuarine environments), inhabiting coastal rivers from Louisiana to Florida during the warmer months and over wintering in estuaries, bays, and the Gulf of Mexico. It is a nearly cylindrical primitive fish embedded with bony plates or scutes. The head ends in a hard, extended snout; the mouth is inferior and protrusible and is preceded by four conspicuous barbels. The caudal fin (tail) is heterocercal (upper lobe is longer than the lower lobe). Adults range from 1.2 to 2.4 m (4 to 8 ft) in length, with adult females larger than males. The Gulf sturgeon is distinguished from the geographically disjunct Atlantic coast subspecies (*A. o. oxyrinchus*) by its longer head, pectoral fins, and spleen (Vladykov 1955; Wooley 1985). King *et al*. (2001) have documented substantial divergence between *A. o. oxyrinchus* and *A. o. desotoi* using microsatellite DNA testing.

2.1.2 Critical Habitat Description

The Service and NOAA Fisheries jointly designated Gulf sturgeon critical habitat on April 18, 2003 (68 FR 13370, March 19, 2003). Gulf sturgeon critical habitat includes areas within the major river systems that support the seven currently reproducing subpopulations and associated estuarine and marine habitats. Gulf sturgeon use rivers for spawning, larval and juvenile feeding, adult resting and staging, and moving between the areas that support these life history components. Gulf sturgeon use the lower riverine, estuarine, and marine environment during winter months primarily for feeding and, more rarely, for inter-river movements.

Fourteen areas (units) are designated as Gulf sturgeon critical habitat. Critical habitat units encompass approximately 2,783 km (1,729 mi) of riverine habitats and 6,042 km^2 (2,333 mi^2) of estuarine and marine habitats, and include portions of the following Gulf of Mexico rivers, tributaries, estuarine and marine areas:

Unit 1	Pearl and Bogue Chitto Rivers in Louisiana and Mississippi;
Unit 2	Pascagoula, Leaf, Bowie, Big Black Creek and Chickasawhay Rivers in Mississippi;
Unit 3	Escambia, Conecuh, and Sepulga Rivers in Alabama and Florida;
Unit 4	Yellow, Blackwater, and Shoal Rivers in Alabama and Florida;
Unit 5	Choctawhatchee and Pea Rivers in Florida and Alabama;
Unit 6	Apalachicola and Brothers Rivers in Florida;
Unit 7	Suwannee and Withlacoochee River in Florida;
Unit 8	Lake Pontchartrain (east of causeway), Lake Catherine, Little Lake, the Rigolets, Lake Borgne, Pascagoula Bay and Mississippi Sound systems in Louisiana and Mississippi, and sections of the state waters within the Gulf of Mexico;
Unit 9	Pensacola Bay system in Florida;

Unit 10	Santa Rosa Sound in Florida;
Unit 11	Nearshore Gulf of Mexico in Florida;
Unit 12	Choctawhatchee Bay system in Florida;
Unit 13	Apalachicola Bay system in Florida; and
Unit 14	Suwannee Sound in Florida.

Critical habitat determinations focus on those physical and biological features (primary constituent elements [PCEs]) that are essential to the conservation of the species (50 CFR 424.12). Federal agencies must insure that their activities are not likely to result in the destruction or adverse modification of designated critical habitats. Therefore, proposed actions that may affect designated critical habitat require an analysis of potential impacts to the PCEs. The PCEs of Gulf sturgeon critical habitat are:

- Abundant food items, such as detritus, aquatic insects, worms, and/or mollusks, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, mollusks and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages.
- Riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone, or hard clay;
- Riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during fresh water residency and possibly for osmoregulatory functions;
- A flow regime (*i.e.*, the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, and staging, and for maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larval staging;
- Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages;
- Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and
- Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (*e.g.*, an unobstructed river or a dammed river that still allows for passage).

2.1.3 Life History

In a report on the early life history of the Gulf sturgeon in the Suwannee River, Sulak *et al.* (2004) described the evolution and life history of sturgeons generally, which we quote below as a preface to our description of the Gulf sturgeon's unique biology.

> “Sturgeons and their fossil relatives comprise a distinct lineage of fishes that originated in the late Paleozoic Era over 300 million years ago. Modern sturgeons evolved as specialized large benthic suction feeders during the age of the dinosaurs about 100 million years ago. Body form, exquisitely adapted for hydrodynamic benthic position holding and bottom feeding in large, swift rivers, has remained virtually unchanged. Advanced adaptations for bottom feeding on tiny arthropod prey include the evolutionary loss of teeth, the development of a highly protrusile tubular mouth, and the elaboration of a long sensory snout provided with multiple senses (touch, taste and electroreception). Rapid growth to large size together with an armored body confer a anti-predator advantage enabling sturgeons to exist on open sand substrate, a biotope exploited by few other fish species. The world's 25 species of sturgeons, together with two paddlefishes, are the only living representatives of the unique chondrostean lineage. All other chondrostean fishes (bony fishes with flexible, de-ossified skeletons) have become extinct. In this respect, sturgeons are sometimes considered "living fossils". However, in evolving a lifestyle that has enabled them to thrive for 100,000 millennia, they should more appropriately be viewed as one of the most progressive and successful of living fish lineages. Although they retain a primitive body plan (heterocercal tail, pelvic fins set far back, pectoral fins nearly immobile and set low, spiral valve intestine), they are perhaps the earliest group of fishes to evolve protrusile jaws, a distinguishing hallmark of all advanced groups of fishes.”

Sturgeons were originally fresh-water species, and some, including the Gulf sturgeon, evolved an anadromous life history, probably to exploit the richer benthic food resources of estuarine and marine habitats as adults, but still required a fresh water for reproduction and early life stages. Among the world’s 25 sturgeon species, the Gulf sturgeon has the southern-most distribution, and has a unique life history as the only anadromous sturgeon that displays an extended period of fresh-water residency following spawning during which it does not feed.

2.1.3.1 Feeding Habits

The Gulf sturgeon is a benthic (bottom dwelling) suction feeder. Its hydrodynamic body form is adapted for holding position on the bottom where it feeds mostly upon small invertebrates in the substrate using its highly protrusible tubular mouth. The type of invertebrates ingested vary by habitat, which ranges from riverine to estuarine to marine waters of the Gulf, but are mostly soft-bodied animals that occur in sandy substrates.

Young-of-the-year (YOY) Gulf sturgeon remain in freshwater feeding on aquatic invertebrates, mostly insect larvae, and detritus approximately 10 to 12 months after spawning occurs (Mason and Clugston 1993; Sulak and Clugston 1999). Juveniles (less than 5 kg (11 lbs), ages 1 to 6 years) are believed to forage extensively and exploit scarce food resources throughout the river, including aquatic insects (*e.g.*, mayflies and caddisflies), worms (oligochaetes), and bivalve mollusks (Huff 1975; Mason and Clugston 1993). Juvenile sturgeon collected in the Suwannee River are trophically active (foraging) near the river mouth at the estuary, but trophically dormant (not foraging) in summer holding areas upriver; however, a portion of the juvenile population reside and feed year round near the river mouth (K. Sulak, U.S. Geological Survey [USGS], pers. comm. 2002). In the Choctawhatchee River, juvenile Gulf sturgeon did not remain near the estuary at the river mouth for the entire year; instead, they were located during winter months in Choctawhatchee Bay and moved to riverine aggregation areas in the spring (F. Parauka, USFWS, pers. comm. 2002). Subadult (age six to sexual maturity) and adult (sexually mature) Gulf sturgeon do not feed in freshwater (Wooley and Crateau 1985; Mason and Clugston 1993).

Many reports indicate that adult and subadult Gulf sturgeon lose a substantial percentage of their body weight while in freshwater (Wooley and Crateau 1985; Mason and Clugston 1993; Clugston *et al.* 1995) and then compensate the loss during winter-feeding in the estuarine and marine environments (Wooley and Crateau 1985; Clugston *et al*. 1995). Gu *et al*. (2001) tested the hypothesis that subadult and adult Gulf sturgeon do not feed significantly during their annual residence in freshwater by comparing stable carbon isotope ratios of tissue samples from subadult and adult Suwannee River Gulf sturgeon with their potential freshwater and marine food sources. A large difference in isotope ratios between freshwater food sources and fish muscle tissue suggests that subadult and adult Gulf sturgeon do not feed significantly in freshwater. The isotope similarity between Gulf sturgeon and marine food resources strongly indicates that this species relies almost entirely on the marine food web for its growth (Gu *et al*. 2001).

Having spent at least 6 months in the river fasting, we presume that adult and subadult sturgeon begin feeding immediately upon leaving the river of summer residency. If so, the lakes and bays at the mouths of the river systems where Gulf sturgeon occur are especially important because they offer the first opportunity for feeding. To regain the weight they lose while in the river system and to maintain positive growth on a yearly basis, adults and subadults need to consume sufficient quantities of prey while in estuarine and marine waters. Reproductively active Gulf sturgeon require yet additional food resources (Fox *et al.* 2002; D. Murie and D. Parkyn, University of Florida [UF], pers. comm. 2002).

Adult and subadult Gulf sturgeon, while in marine and estuarine habitat, are thought to forage opportunistically (Huff 1975), primarily on benthic invertebrates. Gut content analyses have indicated that the Gulf sturgeon's diet is predominantly amphipods, lancelets, polychaetes, gastropod mollusks, shrimp, isopods, bivalve mollusks, and crustaceans (Huff 1975; Mason and Clugston 1993; Carr *et al.* 1996b; Fox *et al.* 2000; Fox *et al.* 2002). Ghost shrimp (*Lepidophthalmus louisianensis*) and haustoriid amphipods (*e.g., Lepidactylus* spp.) are strongly suspected to be important prey for adult Gulf sturgeon over 1 m (3.3 ft) (Heard *et al.* 2000; Fox *et al.* 2002). Harris *et al.* (2005) reported that the Gulf sturgeon's major prey resources in the Suwannee River, Florida consisted of brachiopods, amphipods, and brittle stars. They found that distribution of Gulf sturgeon in the spring and fall appear to be associated with sandy areas on which brachiopods settle.

2.1.3.2 Reproduction

Gulf sturgeon are long-lived, with some individuals reaching at least 42 years in age (Huff 1975). Age at sexual maturity for females ranges from eight to 17 years, and for males from seven to 21 years (Huff 1975). Adult Gulf sturgeon spawn in the upper reaches of rivers, at least 100 km (62 miles) upstream of the river mouth Sulak *et al.* (2004). Gulf sturgeon eggs are demersal (they are heavy and sink to the bottom), adhesive, and vary in color from gray to brown to black (Vladykov and Greeley 1963; Huff 1975; Parauka *et al.* 1991). Chapman *et al.* (1993) estimated that mature female Gulf sturgeon weighing between 29 and 51 kg (64 and 112 lb) produce an average of 400,000 eggs.

Habitat at egg collection sites consists of one or more of the following: limestone bluffs and outcroppings, cobble, limestone bedrock covered with gravel and small cobble, gravel, and sand (Marchant and Shutters 1996; Sulak and Clugston 1999; Heise *et al.* 1999a; Fox *et al.* 2000; Craft *et al.* 2001; USFWS unpub. data 2005; Pine *et al.* 2006). On the Suwannee River, Sulak and Clugston (1999) suggest a dense matrix of gravel or cobble is likely essential for Gulf sturgeon egg adhesion and the sheltering of the yolk sac larvae, and is a habitat spawning adults apparently select. Other substrates identified as possible spawning habitat include marl (clay with substantial calcium carbonate), soapstone, or hard clay (W. Slack, Mississippi Museum of Natural Science [MMNS], pers. comm. 2002; F. Parauka, USFWS, pers. comm. 2002). Water depths at egg collection sites ranged from 1.4 to 7.9 m (4.6 to 26 ft), with temperatures ranging from 18.2 to 25.3 degrees Celsius (^{o}C) (64.8 to 75.0 degrees Fahrenheit (^{o}F)) (Fox *et al.* 2000; Ross *et al.* 2000; Craft *et al.* 2001; USFWS unpub. data 2005; Pine *et al.* 2006).

Laboratory experiments indicated optimal water temperature for survival of Gulf sturgeon larvae is between 15 and 20^{o}C (59 and 68^{o}F), with low tolerance to temperatures above 25^{o}C (77^{o}F) (Chapman and Carr 1995). Sulak and Clugston (1999) suggested that sturgeon spawning activity in the Suwannee River is related to the phase of the moon, but only after the water temperature has risen to 17^{o}C (62.6^{o}F). Other researchers however, have found little evidence of spawning associated with lunar cycles (Slack *et al.* 1999; Fox *et al.* 2000). Spawning in the Suwannee River occurs during the general period of spring high water, when ionic conductivity and calcium ion concentration are most favorable for egg development and adhesion (Sulak and Clugston 1999). Fox *et al.* (2002) found no clear pattern between timing of Gulf sturgeon entering the river and flow patterns on the Choctawhatchee River. Ross *et al.* (2001b) surmised that high flows in early March were a cue for sturgeon to begin their upstream movement in the Pascagoula River.

Atlantic sturgeon (*A. oxyrinchus oxyrinchus*) exhibit a long inter-spawning period, with females spawning at intervals ranging from every 3 to 5 years, and males every 1 to 5 years (Smith 1985). Researchers believe that Gulf sturgeon exhibit similar spawning periodicity, with male Gulf sturgeon capable of annual spawning, but females requiring more than one year between spawning events (Huff 1975; Fox *et al.* 2000).

The age structure evident from mark/recapture studies of the Apalachicola sturgeon population suggests variable recruitment over time (Pine and Allen 2005), but the factors influencing this variability have not yet been investigated. Randall (2003) examined variable recruitment in the Suwannee and suggested that it may be due to flow in fall and amount of estuarine habitat of moderate salinity.

2.1.3.3 Freshwater Habitat

During early life history stages, sturgeon require bedrock and clean gravel or cobble as a substrate for egg adhesion and a shelter for developing larvae (Sulak and Clugston 1999). In the Suwannee river, YOY disperse widely downstream of spawning sites, using extensive portions of the river as nursery habitat. They are typically found in open sand-bottom habitat away from the shoreline and vegetated habitat. The wide dispersal of YOY fish in the river may be an adaptation to exploit scarce food resources in these sandy habitat types (Randall and Sulak 1999). Clugston *et al.* (1995) reported that young Gulf sturgeon in the Suwannee River, weighing between 0.3 and 2.4 kg (0.7 and 5.3 lb), remained in the vicinity of the river mouth and estuary during the winter and spring. Sulak *et al.* (2004) noted that the apparent preference of juvenile sturgeon for sandy main channel habitats enable sturgeon to exploit a unique niche with little competition.

In the Pascagoula River and Apalachicola River, some adult and subadult Gulf sturgeon remain near the spawning grounds throughout the summer months (Wooley and Crateau 1985; Ross *et al.* 2001b), but the majority move downstream to areas referred to as summer resting or holding areas. In these two systems, however, confirmed spawning habitats are located within a relatively short distance downstream of impediments to further upstream migration. In other rivers, most Gulf sturgeon spawn and move downstream to summer resting or holding areas. A few Gulf sturgeon have been documented remaining at or near their spawning grounds throughout the winter (Wooley and Crateau 1985; Slack *et al.* 1999; Heise *et al.* 1999a). Adults and subadults are not distributed uniformly throughout the river, but show a preference for these discrete areas usually located in lower and middle river reaches (Hightower *et al.* 2002). Often, these resting areas are located near natural springs throughout the warmest months of the year, but are not located within a spring or thermal plume emanating from a spring (Clugston *et al.* 1995; Foster and Clugston 1997; Hightower *et al.* 2002). These resting areas are often located in deep holes, and sometimes shallow areas, along straight-aways ranging from 2 to 19 m (6.6 to 62.3 ft) deep (Wooley and Crateau 1985; Morrow *et al.* 1998; Ross *et al.* 2001a and b; Craft *et al.* 2001; Hightower *et al.* 2002). The substrates consisted of mixtures of limestone and sand (Clugston *et al.* 1995), sand and gravel (Wooley and Crateau 1985; Morrow *et al.* 1998), or just sandy substrate (Hightower *et al.* 2002).

River flow may serve as an environmental cue that governs both sturgeon migration and spawning (Chapman and Carr 1995; Ross *et al.* 2001b). If the flow rate is too high, sturgeon in several life-history stages can be adversely affected. Data describing the sturgeon’s swimming ability in the Suwannee River strongly indicates that they cannot continually swim against prevailing currents of greater than 1 to 2 m per second (3.2 to 6.6 ft per second) (K. Sulak, USGS, pers. comm. cited in Wakeford 2001). If the flow is too strong, eggs might not be able to settle on and adhere to suitable substrate (Wooley and Crateau 1985). Flows that are too low can cause clumping of eggs, which leads to increased mortality from asphyxiation and fungal infection (Wooley and Crateau 1985). Flow velocity requirements for YOY sturgeon may vary depending on substrate type. Chan *et al.* (1997) found that YOY Gulf sturgeon under laboratory conditions exposed to water velocities over 12 cm/s (0.4 ft/s) preferred a cobble substrate, but favored water velocities under 12 cm/s (0.4 ft/s), and then used a variety of substrates (sand, gravel, and cobble).

Gulf sturgeon require large areas of diverse habitat that have natural variations in water flow, velocity, temperature, and turbidity (USFWS and GSMFC 1995; Wakeford 2001). Laboratory experiments indicate that Gulf sturgeon eggs, embryos, and larvae have the highest survival rates when temperatures are between 15 and 20°C (59 and 68°F). Mortality rates of Gulf sturgeon gametes and embryos are highest when temperatures are 25°C (77°F) and above (Chapman and Carr 1995) (see section 2.1.3.2 for more details). Researchers have documented temperature ranges at Gulf sturgeon resting areas between 15.3 and 33.7°C (59.5 and 92.7°F) with dissolved oxygen levels between 5.6 and 9.1 milligrams per liter (mg/l) (Morrow *et al.* 1998; Hightower *et al.* 2002). Compared to other fish species, sturgeon have a limited behavioral and physiological capacity to respond to hypoxia (insufficient oxygen levels) (Secor and Niklitschek 2001). Basal metabolism, growth, consumption, and survival are sensitive to changes in oxygen levels (Secor and Niklitschek 2001). In laboratory experiments, young shortnose sturgeon (*A. brevirostrum*) (less than 77 days old) died at oxygen levels of 3.0 mg/l and all sturgeon died at oxygen levels of 2.0 mg/l (Jenkins *et al.* 1993). Data concerning the temperature, oxygen, and current velocity requirements of cultured sturgeon are being collected. Researchers plan to use information gained from these laboratory experiments on hatchery-reared sturgeon to develop detailed information on water flow requirements of wild sturgeon throughout different phases of their freshwater residence (Wakeford 2001).

2.1.3.4 Estuarine and Marine Habitat

Most subadult and adult Gulf sturgeon spend cool months (October or November through March or April) in estuarine areas, bays, or in the Gulf of Mexico (Odenkirk 1991; Foster 1993; Clugston *et al.* 1995; Fox *et al.* 2002). Studies of subadult Gulf sturgeon (ages 4 to 7) in Choctawhatchee Bay found that 78% of tagged fish remained in the bay the entire winter, while 13% ventured into a connecting bay. Possibly the remaining 9% overwintered in the Gulf of Mexico (USFWS 1998). Adult Gulf sturgeon are more likely to overwinter in the Gulf of Mexico, with 45% of the tagged adults presumed to have left Choctawhatchee Bay and spent extended periods of time in the Gulf of Mexico (Fox and Hightower 1998; Fox *et al.* 2002). In contrast, Gulf sturgeon from the Suwannee River subpopulation are known to migrate into the nearshore waters, where they remain for up to two months and then depart to unknown feeding locations in the open Gulf of Mexico (Carr *et al.* 1996b; Edwards *et al.* 2003).

Research in Choctawhatchee Bay indicates that subadult Gulf sturgeon show a preference for sandy shoreline habitats with water depths less than 3.5 m (11.5 ft) and salinity less than 6.3 parts per thousand (Parauka *et al.* 2002). Fox and Hightower (1998) found that adult Gulf sturgeon monitored in Choctawhatchee Bay use some of the same habitats as subadults. The majority of tagged fish have been located in areas lacking seagrass (Fox *et al.* 2002; Parauka *et al.* 2001). Craft *et al.* (2001) found that Gulf sturgeon in Pensacola Bay appear to prefer shallow shoals 1.5 to 2.1 m (5 to 7 ft) and deep holes near passes. Estuary and bay unvegetated habitats with sandy substrate support a variety of burrowing crustaceans, such as ghost shrimp and small crabs, amphipods, polychaete worms, and small bivalve mollusks (Menzel 1971; Abele and Kim

1986; American Fisheries Society 1989). Gulf sturgeon are often located in these areas, and because their known prey items are present, it is assumed that Gulf sturgeon are foraging.

Telemetered Gulf sturgeon tracked in Mississippi Sound were frequently located over sandy substrates at the passes between barrier islands (Ross *et al.* 2001a). Bottom samples at these sites all contained lancelets (*Branchiostoma*), a documented prey item of Gulf sturgeon. Nearshore areas of the Gulf of Mexico (less than 1.6 km [1 mi] from land) with unconsolidated, fine-to-medium-grain sand substrates, typically support crustaceans such as mole crabs, sand fleas, various amphipod species, and lancelets (Menzel 1971; Abele and Kim 1986; American Fisheries Society 1989), all of which are sturgeon prey items.

Sulak and Clugston (1999) describe two hypotheses regarding adult Gulf sturgeon winter habitat: 1) Nearshore -- adults move along the coast in waters less than 10 m (33 ft) deep; and 2) Offshore -- adults migrate far offshore to the broad sedimentary plateau in deep water (40 to 100 m [131 to 328 ft]) west of the Florida Middle Grounds, where over twenty species of bottom-feeding fish congregate in the winter (Darnell and Kleypas 1987). Telemetry data collected to date support the first hypothesis. Gulf sturgeon from the Pearl River and Pascagoula River subpopulations migrate from their natal river systems to Mississippi Sound and move along the barrier islands, where they are relocated most often at the passes between islands (Ross *et al.* 2001a; Rogillio *et al.* 2002). Gulf sturgeon from the Choctawhatchee River, Yellow River, and Apalachicola River have been documented migrating in the nearshore Gulf of Mexico waters between Pensacola and Apalachicola Bays (Fox *et al.* 2002; F. Parauka, pers. comm. 2002). Telemetered fish are usually located in areas less than 6 m (19.8 ft) deep (Ross *et al.*, 2001a; Fox *et al.* 2002; Rogillio *et al.* 2002; F. Parauka, pers. comm. 2002).

2.1.3.5 Migration

In the spring (March to May), most adult and subadult Gulf sturgeon return to their natal river, where sexually mature sturgeon spawn, and then stay until October or November (6 to 8 months) in freshwater (Odenkirk 1991; Foster 1993; Clugston *et al.* 1995; Fox *et al.* 2000). Fox *et al.* (2000) found that some individuals of the Choctawhatchee River subpopulation do not enter the river until the summer months.

Migratory behavior of the Gulf sturgeon seems influenced by sex, reproductive status, water temperature, and possibly river flow. Carr *et al.* (1996b) reported that male Gulf sturgeon initiate migration to the river earlier in spring than females. Fox *et al.* (2000) found no significant difference in the timing of river entry due to sex, but reported that males migrate further upstream than females and that ripe (in reproductive condition) males and females enter the river earlier than nonripe fish (Fox *et al.* 2000). Change in temperature is thought to be an important factor in initiating sturgeon migration (Wooley and Crateau 1985; Chapman and Carr 1995; Foster and Clugston 1997). Most adults and subadults begin moving from estuarine and marine waters into the coastal rivers in early spring (*i.e.*, March through May) when river water temperatures range from 16.0 to 23.0^{o}C (60.8 to 73.4^{o}C) (Huff 1975; Wooley and Crateau 1985; Odenkirk 1991; Clugston *et al.* 1995; Foster and Clugston 1997; Fox and Hightower 1998; Sulak and Clugston 1999; Fox *et al.* 2000), while others may enter the rivers during summer months (Fox *et al.* 2000). Some research supports the theory that spring migration coincides with the general period of spring high water (Chapman and Carr 1995; Sulak and Clugston 1999; Ross *et al.* 2001b), however, observations on the Choctawhatchee River have not found a clear relationship between the timing of river entrance and flow patterns (Fox *et al.* 2002).

Downstream migration from fresh to saltwater begins in September (at about 23^{o}C [73^{o}F]) and continues through November (Huff 1975; Wooley and Crateau 1985; Foster and Clugston 1997). During the fall migration from fresh to saltwater, Gulf sturgeon may require a period of physiological acclimation to changing salinity levels, referred to as osmoregulation or staging (Wooley and Crateau 1985). This period may be short (Fox *et al.*, 2002) as sturgeon develop an active mechanism for osmoregulation and ionic balance by age 1 (Altinok *et al.* 1998). On some river systems, timing of the fall migration appears to be associated with pulses of higher river discharge (Heise *et al.* 1999a and b; Ross *et al.* 2000 and 2001b; Parauka *et al.* 2001).

Sturgeon, ages 1 through 6, remain in the mouth of the Suwannee River over winter. In late January through early February, YOY Gulf sturgeon migrate down river for the first time (Sulak and Clugston 1999). Huff (1975) noted that juvenile Gulf sturgeon in the Suwannee River most likely participated in pre- and post-spawning migrations, along with the adults.

Parauka *et al.* (2001) noted that most telemetered sub adult Gulf sturgeon relocated while overwintering in Choctawhatchee Bay were associated with the lower salinity (6.3 ppt) found in the eastern portion of the bay. Fox *et al* (2002) reported that most male Gulf sturgeons (60%) overwintered exclusively in Choctawhatchee Bay while most females (60%) were found in adjacent bays, the Gulf of Mexico, or were not located.

Findeis (1997) described sturgeon (Acipenseridae) as exhibiting evolutionary traits adapted for benthic cruising. Tracking observations by Sulak and Clugston (1999), Fox *et al.* (2002), and Edwards *et al.* (in prep.) support the idea that individual fish travel until they encounter suitable prey type and density, at which time they forage in that area for extended periods of time. Individual fish often remained in localized areas (less than 1 km^{2} [0.4 mi^{2}]) for extended periods of time (greater than 2 weeks), and then moved rapidly to another area where localized movements occurred again (Fox *et al.* 2002). It is unknown precisely how much benthic area is needed to sustain Gulf sturgeon health and growth, but Gulf sturgeon are known to travel long distances (greater than 161 km [100 mi]) during the winter, which suggests that significant resources must be necessary.

When temperature drops associated with major winter cold fronts occur, researchers of the Escambia, Yellow, and Suwannee Rivers subpopulations have been unable to locate adult Gulf sturgeon within the bays (Craft *et al.* 2001; Edwards *et al.* 2003). They hypothesize that the sudden drop in water temperature disperses sturgeon to more distant foraging grounds. It is currently unknown whether Gulf sturgeon undertake extensive offshore migrations, and further study is needed to determine whether important winter-feeding habitat occurs offshore.

2.1.3.6 River-Specific Fidelity

Stabile *et al.* (1996) analyzed tissue from Gulf sturgeon in eight drainages along the Gulf of Mexico for genetic diversity. They noted significant differences among Gulf sturgeon stocks and suggested that they displayed region-specific affinities and may exhibit river-specific fidelity. Stabile *et al.* (1996) identified five regional or river-specific stocks (from west to east): (1) Lake Pontchartrain and Pearl River, (2) Pascagoula River, (3) Escambia and Yellow Rivers, (4) Choctawhatchee River, and (5) Apalachicola, Ochlockonee, and Suwannee Rivers.

Tagging studies suggest that Gulf sturgeon exhibit a high degree of river fidelity (USFWS and GSMFC 1995). From 1981 to 1993, 4,100 fish were tagged in the Apalachicola and Suwannee Rivers. Of these, 868 total fish were recaptured. Of the recaptured fish, 860 fish (99%) were recaptured in the river of their initial collection. Eight fish moved between river systems and represented less than 1% (0.009) of the 868 total fish recaptured. We have no information that would verify Gulf sturgeon spawning in non-natal rivers. Foster and Clugston (1997) noted that telemetered Gulf sturgeon in the Suwannee River returned to the same areas as the previous summer, and suggested that chemical cuing may influence distribution.

As of June 2005, biologists have documented a total of 35 Gulf sturgeon making inter-river movements. Tallman and Healey (1994) noted that observed straying rates between rivers were not the same as actual gene flow rates, *i.e.,* inter-stock movement does not equate to interstock reproduction. The gene flow is low in Gulf sturgeon stocks, with each stock exchanging less than one mature female per generation (Waldman and Wirgin 1998).

2.1.4 Status and Distribution

Historically, the Gulf sturgeon occurred from the Mississippi River east to Tampa Bay. Its present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic occurrences have been recorded as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay (Wooley and Crateau 1985; Reynolds 1993).

In the late 19th century and early 20th century, the Gulf sturgeon supported an important commercial fishery, providing eggs for caviar, flesh for smoked fish, and swim bladders for isinglass, which is a gelatin used in food products and glues (Huff 1975; Carr 1983). Gulf sturgeon numbers declined due to overfishing throughout most of the 20th century. The decline was exacerbated by habitat loss associated with the construction of dams and sills (low dams), mostly after 1950. In several rivers throughout the species' range, dams and sills have severely restricted sturgeon access to historic migration routes and spawning areas (Wooley and Crateau 1985; McDowall 1988).

On September 30, 1991, the Service and the National Marine Fisheries Service (NMFS) listed the Gulf sturgeon as a threatened species under the Act (56 FR 49653). Threats and potential threats identified in the listing rule included: construction of dams, modifications to habitat associated with dredging, dredged material disposal, de-snagging (removal of trees and their roots) and other navigation maintenance activities; incidental take by commercial fishermen; poor water quality associated with contamination by pesticides, heavy metals, and industrial contaminants; aquaculture and incidental or accidental introductions; and the Gulf sturgeon's long maturation and limited ability to recolonize areas from which it is extirpated.

These threats persist to varying degrees in different portions of the species range. In recent years, dredging for channel maintenance and beach nourishment has resulted in death and injury of a few Gulf sturgeon in the marine environment. Collisions with boats traveling at high speeds through areas where sturgeon jump out of the water have occurred on numerous occasions in the Suwannee and Choctawhatchee rivers, which support the two largest sturgeon populations. These collisions have seriously injured several people as well as the sturgeon. A sudden drop in dissolved oxygen content of the waters in the lower Escambia River of Florida following Hurricane Ivan in 2004 resulted in the death of at least 10 Gulf sturgeon.

Currently, seven rivers are known to support reproducing subpopulations of Gulf sturgeon. Table 2.1.4.A lists these rivers and most-recent estimates of subpopulation size. At this time, the Service characterizes the status of the species as stable. Identifying specific limiting factors to the species' recovery is difficult due to its long life span, large range, and utilization of diverse riverine, estuarine, and marine habitats.

2.2 Mussels

2.2.1 Species Description

2.2.1.1 Fat three ridge

The fat threeridge (*Amblema neislerii*) is a medium-sized to large, subquadrate, inflated, solid, and heavy-shelled mussel that reaches a length of 4.0 inches (in) (10.2 centimeters (cm)). Large specimens are so inflated that their width approximates their height. The umbos (bulge or beak that protrudes near the hinge of a mussel) are in the anterior quarter of the shell. The dark brown to black shell is strongly sculptured with seven to eight prominent horizontal parallel plications (ridges). As is typical of the genus, no sexual dimorphism is displayed in shell characters. Internally, there are two subequal pseudocardinal teeth in the left valve (shell half) and typically one large and one small tooth in the right valve. The lateral teeth are heavy, long, and slightly arcuate (curved like a bow), with two in the left valve and one in the right valve. The inside surface of the shell (nacre) is bluish white to light purplish and iridescent.

This taxon was originally described as *Unio neislerii* Lea, 1858, and was assigned to the genera *Quadrula* and *Crenodonta* by Simpson (1914) and Clench and Turner (1956), respectively. Subsequent investigators (*e.g.*, Mulvey *et al*. 1997; Turgeon *et al*. 1998) have placed the fat threeridge in the genus *Amblema*.

2.2.1.2 Purple bankclimber

The purple bankclimber (*Elliptoideus sloatianus*) is a large, heavy-shelled, strongly-sculptured mussel reaching lengths of 8.0 in (20.5 cm). A well-developed posterior ridge extends from the umbo to the posterior ventral margin of the shell. The posterior slope and the disk just anterior to the posterior ridge are sculptured by several irregular plications that vary greatly in development. The umbos are low, extending just above the dorsal margin of the shell. No sexual dimorphism is displayed in purple bankclimber shell characters. Internally, there is one pseudocardinal tooth in the right valve and two in the left valve. The lateral teeth are thick and slightly curved, with one in the right valve and two in the left valve. Nacre color is whitish near the center of the shell becoming deep purple towards the margin, and iridescent posteriorly. Fuller and Bereza (1973) described aspects of its soft anatomy, and characterized *Elliptoideus* as being an “extremely primitive” genus.

This taxon was originally described as *Unio sloatianus* Lea, 1840, and was included in the genus *Elliptio* until Frierson (1927) erected the subgenus *Elliptoideus*. The new subgenus designation was based on the presence of glochidia in all four gills instead of two gills, a characteristic of the genus *Elliptio* (Ortmann 1912). Clench and Turner (1956) overlooked the work of Frierson (1927), placing the species under *Elliptio*. Subsequent investigators (*e.g.*, Turgeon *et al.* 1998) have elevated the subgenus, creating the monotypic genus *Elliptoideus.* More recent genetic evaluation indicates a close relationship between *E. sloatianus* and the bankclimber, *Plectomerus dombeyanus* (Valenciennes 1827) (Serb *et al.* 2003). Additional anatomical analysis of the purple bankclimber is warranted to determine proper generic placement (Williams, USGS; A.E. Bogan, North Carolina State Museum of Natural Sciences; J.T. Garner, Alabama Division of Wildlife and Freshwater Fisheries [ADWFF], all pers. comm., 2003). The Service currently follows Turgeon *et al.* (1998) and recognizes the purple bankclimber as *Elliptoideus sloatianus* with the following names considered synonyms: *Unio atromarginatus* Lea, 1840, *Unio aratus* Conrad, 1849, and *Unio plectophorus* Conrad, 1850.

2.2.1.3 Chipola slabshell

The Chipola slabshell (*Elliptio chipolaensis)* is a medium-sized species reaching a length of about 3.3 in (8.4 cm). The shell is ovate to subelliptical, somewhat inflated, with the posterior ridge starting out rounded but flattening to form a prominent biangulate margin. The periostracum is smooth and chestnut colored. Dark brown coloration may appear in the umbo region and the remaining surface may exhibit alternating light and dark bands. The umbos are prominent, well above the hingeline. As is typical of all *Elliptio* mussels, no sexual dimorphism is displayed in shell characters. Internally, the umbo cavity is rather deep. The lateral teeth are long, slender, and slightly curved, with two in the left and one in the right valve. The pseudocardinal teeth are compressed and crenulate, with two in the left and one in the right valve. Nacre color is salmon, becoming more intense dorsally and somewhat iridescent posteriorly. This taxon was originally described as *Unio chipolaensis* Walker, 1905, and was subsequently moved to the genus *Elliptio* by Frierson (1927).

2.2.2 Critical Habitat Description

On June 6, 2006, the Service proposed to designate 11 stream segments (units) as critical habitat for the endangered fat threeridge, shinyrayed pocketbook, Gulf moccasinshell, Ochlockonee moccasinshell, and oval pigtoe, and the threatened Chipola slabshell and purple bankclimber (collectively referred to as the seven mussels) pursuant to the Endangered Species Act of 1973, as amended (71 FR 32746, June 6, 2006). These units comprise portions of the Econfina Creek (Florida), ACF (Alabama, Florida, and Georgia), Ochlockonee (Florida and Georgia), and Suwannee (Florida portion only) river basins.

2.2.2.1 Fat threeridge

Two units are proposed as Fat threeridge critical habitat (Table 2.2.2.1.A). Proposed critical habitat units encompass approximately 345.4 kilometers (214.7 miles) of river in the Chipola River Basin in Alabama and Florida and the Apalachicola River in Florida.

2.2.2.2 Purple bankclimber

Six units are proposed as purple bankclimber critical habitat (Table 2.2.2.1.A). Proposed critical habitat units encompass approximately 1,487.2 kilometers (924.4 miles) of river in the Flint River Basin in Georgia, Apalachicola River Basin in Florida and the Ochlockonee River Basin in Florida and Georgia.

2.2.2.3 Chipola slabshell

One unit is proposed as Chipola slabshell critical habitat (Table 2.2.2.1.A). Proposed critical habitat units encompass approximately 190.0 kilometers (118.1 miles) of river in the Chipola River Basin in Alabama and Florida.

Each of the proposed critical habitat units for these three listed mussels contains one or more of the primary constituent elements (PCEs) that the Service describes as essential to the conservation of the species, and which may require special management considerations or protection. The PCEs of fat threeridge, purple bankclimber, and Chipola slabshell proposed critical habitat are:

- A geomorphically stable stream channel (a channel that maintains its lateral dimensions, longitudinal profile, and spatial pattern over time without an aggrading or degrading bed elevation);
- A predominantly sand, gravel, and/or cobble stream substrate;
- Permanently flowing water;
- Water quality (including temperature, turbidity, dissolved oxygen, and chemical constituents) that meets or exceed the current aquatic life criteria established under the Clean Water Act (33 U.S.C. 1251-1387); and
- Fish hosts (such as largemouth bass, sailfin shiner, and brown darter) that support larval life stages of the mussels.

2.2.3 Life History

The fat threeridge, purple bankclimber and Chipola slabshell- mussels are bivalve mollusks (clams) of the family Unionidae. Unionid mussels generally live embedded in the bottom of rivers, streams, and other bodies of water. They siphon water into their shells and across four gills that are specialized for respiration and food collection. Known food items include detritus (disintegrated organic debris), diatoms, phytoplankton, zooplankton, and other microorganisms (Coker *et al.* 1921; Churchill and Lewis 1924; Fuller 1974). Adults are filter feeders and generally orient themselves on or near the substrate surface to take food and oxygen from the water above them (Kraemer 1979). Juveniles typically burrow completely beneath the substrate surface and are pedal (foot) feeders (bringing food particles inside the shell for ingestion that adhere to the foot while it is extended outside the shell) until the structures for filter feeding are more fully developed (Gatenby *et al.* 1996; Yeager *et al.* 1994).

Sexes in unionid mussels are usually separate. Males release sperm into the water, which females take in through their siphons during feeding and respiration. Eggs are fertilized and retained in the gills of the female until the larvae (glochidia) fully develop. The glochidia of most unionid species, including the fat threeridge, purple bankclimber and Chipola slabshell, require a parasitic stage on the fins, gills, or skin of a fish to transform into juvenile mussels. Females release glochidia either separately or in masses termed conglutinates, depending on the mussel species. The duration of the parasitic stage varies by mussel species, water temperature, and perhaps host fish species. When the transformation is complete, juvenile mussels normally detach from their fish host and sink to the stream bottom where, given suitable conditions, they grow and mature to the adult form.

2.2.3.1 Feeding Habits

Adult freshwater mussels are filter-feeders, orienting themselves in the substrate to facilitate siphoning of the water column for oxygen and food (Kraemer 1979). Mussels have been reported to consume detritus, diatoms, phytoplankton, zooplankton, and other microorganisms (Coker *et al.* 1921; Churchill and Lewis 1924; Fuller 1974). According to Ukeles (1971), phytoplankton are the principal food of bivalves, although other food sources (*e.g.*, bacteria, organic detritus, assimilated organic material, phagotrophic protozoans) may also comprise an important portion of their diet (Neves *et al.* 1996). Churchill (1916) concluded that mussels could absorb various sources of fat, protein, and starch dissolved in the water. According to Baldwin and Newell (1991), bivalves feed on an entire array of naturally available particles (*e.g.*, heterotrophic bacteria, phagotrophic protozoans, phytoplankton). Based on the findings of studies such as Baldwin and Newell (1991) and Neves *et al.* (1996), an omnivorous opportunistic diet allows mussels to take advantage of whatever food type happens to be abundant.

Juvenile mussels employ foot (pedal) feeding and are suspension feeders (Yeager *et al.* 1994). Video observations of rainbow mussel (*Villosa iris* [Lea, 1829]) by Yeager *et al.* (1994) revealed juveniles occupy the top 0.4 in (1.0 cm) of sediment and employed two types of feeding mechanisms: 1) collecting organic and inorganic particles that adhere to the foot and conveying them to the pedal valve gape with sweeping motions; and 2) extending the foot anteriorly pulling themselves along while picking up organic and inorganic particles on the foot. These methods of suspension feeding have been termed pedal sweep feeding and pedal locomotory feeding, respectively (Reid *et al.* 1992).

Foods of juveniles up to two weeks old include bacteria, algae, and diatoms with amounts of detrital and inorganic colloidal particles (Yeager *et al.* 1994). In juvenile freshwater mussel feeding experiments, Neves *et al.* (1996) found that algae was a suitable food and Gatenby *et al.* (1997) determined that a tri-algal (three algae species) diet high in lipids mixed with fine sediment resulted in better growth. Silt provided some nutritional value, which was also observed by Hudson and Isom (1984), but bacteria in riverine sediments was not essential to growth and survival (Neves *et al.* 1996).

2.2.3.2 Growth and Longevity

Growth in freshwater mussels tends to be relatively rapid for the first few years (Chamberlain 1931, Scruggs 1960, Negus 1966), then slows appreciably (Bruenderman and Neves 1993, Hove and Neves 1994). The abrupt slowing in growth rate occurs at sexual maturity, probably due to the diversion of energy to gamete production. Growth rates vary among species; heavy-shelled species grow slowly relative to thin-shelled species (Coon *et al.* 1977; Hove and Neves 1994). Under shoal habitat conditions, where high water velocities in river shallows are characterized by increased oxygen levels and food availability per unit time, growth rates are probably higher (Bruenderman and Neves 1993).

As a group, mussels are extremely long-lived, with maximum life spans of 100 to 200 years for certain species (Neves and Moyer 1988; Bauer 1992, Mutvei *et al.* 1994). Heavy-shelled species, which include many riverine forms, tend to reach higher maximum ages (Stansbery 1961). Some Virginia subpopulations of Cumberland moccasinshell, *Medionidus conradicus* (Lea, 1834) and Tennessee clubshell, *Pleurobema oviforme* (Conrad, 1834) were found to have individuals up to 24 and 56 years old, respectively (Moyer and Neves 1984).

Because no population demographic information was available for the fat threeridge, the Service collected fresh-dead shells for age and growth analysis in June of 2006. We collected eight shells of various sizes from a main channel site at RM 44.3 and sent them to Virginia Tech (J. Jones, USFWS) for aging via examination of internal annuli by shell thin-sectioning (Neves and Moyer 1988; Kennish 1980; McCuaig and Green 1983; Tevesz and Carter 1980). Ages of the eight shells ranged from 3 years old (42 mm total length) to 32 years old (82 mm total length). A von Bertalanffy growth curve for these known length-at-age data (Anthony *et al.* 2001; San Migel *et al.* 2004; Neves and Moyer 1988) was statistically significant ($R^2 = 0.98$; $p < 0.0001$; Figure 2.2.3.2.A) and predicted ages up to 98 years old (total length = 83.6 mm). The Service has collected fat threeridge as large as 100 mm total length (USFWS unpubl. data 2006).

For populations with relatively stable age-structure (*e.g.,* constant recruitment and survival and equal survival among year classes), estimates of total annual mortality and survival can be computed from age structure data using catch curve analysis (van den Ayvle and Hayward 1999; Slipke and Maceina 2001). Catch curves are computed by regressing the natural log of the number of individuals at each age (dependent variable) against age or year class (Ricker 1975). Using the length-at-age relationship, the fat threeridge has a relatively stable age-structure illustrated by the typical exponential decline between year classes (Figure 2.2.3.2.B) (data is from qualitative sampling on the Apalachicola, Chipola, Swift Slough combined; USFWS 2006 and EnviroScience 2006a). Year classes after 1999 are under-represented in these data because smaller individuals are not as detectable in qualitative sampling, and juvenile mussels are more likely burrowed beneath the substrate. For this reason, the youngest year classes that are not yet as susceptible to the sampling methodology are generally excluded from further analysis (van den Ayvle and Hayward 1999; Slipke and Maceina 2001).

We computed weighted catch curves for the number-at-age data for all locations combined and for specific locations of the middle Apalachicola River, the Chipola River and Cut, and Swift Slough (Figures 2.2.3.2.C – 2.2.3.2.F). Results indicate that the overall (all locations combined) annual mortality rate is about 18%, *i.e.*, about 82% of each age-class survives from year to year. The mortality rates vary only slightly by location. Mortality in the main channel of the Apalachicola River is lower than in the Chipola River and Swift Slough. Values above and below the catch curve regression line represent above- and below-average year class survival in fish populations (Maceina 1997). We consider observed values above and below the 95% confidence belts to represent strong and weak year class production, respectively (Figures 2.2.3.2.C – 2.2.3.2.F). These results suggest that year class strength is variable by year and by location; however, no obvious patterns are discernable. All locations combined, strong year classes are apparent for 1994, 1989, 1984, 1977, and 1975. Weak year classes are apparent for 1997, 1987, 1986, and 1983. The number of strong and weak year classes are about the same between animals observed in the middle reach of the Apalachicola River, the Chipola River and Chipola Cutoff, and Swift Slough.

2.2.3.3 Reproduction

Following is a summary of freshwater mussel reproduction (see Watters [1994] for an annotated bibliography of mussel reproduction). Freshwater mussels generally have separate sexes, although hermaphroditism is known for some species (van der Schalie 1970, Downing *et al.* 1989). The age of sexual maturity for mussels is variable, usually requiring from 3 (Zale and Neves 1982) to 9 (Smith 1979) years, and may be sex dependent (Smith 1979). Males expel clouds of sperm into the water column, although some species expel spermatozeugmata (sperm balls), which are comprised of thousands of sperm (Barnhart and Roberts 1997). Females draw in sperm with the incurrent water flow. Fertilization takes place in the suprabranchial chamber of the female, and the resulting zygotes develop into specialized parasitic larvae, termed glochidia, in water tubes of the gills.

Three subfamilies are generally recognized within the family Unionidae and can be separated based on the number or portions of the gills used as marsupia (brood chambers) (Ortmann 1919; Parmalee and Bogan 1998): Ambleminae (*e.g., Amblema*, *Elliptio*, *Elliptoideus*, *Pleurobema*); Anodontinae (*e.g., Alasmidonta*, *Pyganodon*); and Lampsilinae (*e.g., Lampsilis*, *Medionidus*). Depending upon the subfamily, all four gills (Ambleminae), the entire outer pair of gills (Anodontinae, some Ambleminae), or discreet portions of the outer pair of gills (Lampsilinae), are used as marsupia, although Heard and Guckert (1970) argue that some amblemines (*e.g., Elliptio*, *Pleurobema*) that use only the outer gills as marsupia may warrant a fourth subfamily, the Pleurobeminae. Spawning appears to be temperature dependent (Zale and Neves 1982; Bruenderman and Neves 1993), but may also be influenced by stream discharge (Hove and Neves 1994). Fertilization rates are dependent on spatial aggregation of reproductive adults (Downing *et al.* 1993).

After a variable incubation period, mature glochidia, which may number in the tens of thousands to several million (Surber 1912; Coker *et al.* 1921; Yeager and Neves 1986), are expelled into the water column. The temporal release of glochidia is thought to be behavioral rather than developmental (Gordon and Layzer 1993). Glochidia must come into contact with specific species of fish whose gills and fins they temporarily parasitize, although two species have been shown to possibly utilize amphibian hosts (Howard 1915; 1951; Watters 1997a). Some mussel species, such as the green floater (*Lasmigona subviridis* [Conrad, 1835]), creeper (*Strophitus undulatus* [Say, 1817]), and paper pondshell (*Utterbackia imbecillis* [Say, 1829]) may not require a host fish to complete their life cycle (Lefevre and Curtis 1912; Howard 1914; G.T. Watters, Ohio Biological Survey, pers. comm., 1998). Glochidia failing to come into contact with a suitable host will drift through the water column, surviving for only a few days at most (Sylvester *et al.* 1984; Neves and Widlak 1988; Jansen 1990; O'Brien and Williams 2002).

Glochidia are generally released individually in net-like mucoid strands that entangles fish (Haag and Warren 1997), or as discreet packets termed conglutinates, which represent all the glochidial contents (and sometimes eggs) of a single water tube packaged in a mucilaginous capsule (Ortmann 1910; 1911). A newly described method, termed a "superconglutinate" by Williams and Butler (1994), involves the expulsion of the sum of the conglutinates from discreet portions of both outer gills that are packaged in a single glochidial mass (Haag *et al.* 1995; Hartfield and Butler 1997; O'Brien and Brim Box 1999; Roe and Hartfield 2005).

Each of the three basic methods of glochidial expulsion and glochidial shape facilitates attachment to specific host fish and to specific fish structures (fin vs. gill), respectively (Lefevre and Curtis 1910; 1912). Although supported by field observations (Lefevre and Curtis 1912; Neves and Widlak 1988), the fish structure parasitized may in some cases be due to fish behavior rather than morphology (Gordon and Layzer 1989).

As few as 1 to as many as 25 fish species are known to serve as suitable hosts for particular species of mussels (Fuller 1974; Trodan and Hoeh 1982; Gordon and Layzer 1989; Hoggarth 1992). Host specificity appears to be common in mussels (Neves 1993), with most species utilizing only a few host fishes (Lefevre and Curtis 1912; Zale and Neves 1982; Yeager and Saylor 1995).

The parasitic stage generally lasts a few weeks (Neves *et al.* 1985, O'Brien and Williams 2002) but possibly much longer (Yeager and Saylor 1995; Haag and Warren 1997), and is temperature dependent (Watters and O'Dee 2000). After dropping from fish hosts, newly metamorphosed juveniles passively drift with currents and ultimately settle in depositional areas with other suspended solids (Neves and Widlak 1987; Yeager *et al.* 1994). Juveniles must, however, come into contact with suitable habitat to begin their free-living existence (Howard 1922). Survival rates for a glochidium to metamorphosis ranges from 0.000001 to 0.0001%, not factoring in predation after metamorphosis (Watters and Dunn 1993-94).

Glochidial parasitism serves two purposes: nutrition for larval development and dispersal. Substances within the blood serum of the host fish are necessary for the transformation of a glochidium into a juvenile mussel (Isom and Hudson 1982). Parasitism also serves as a means of dispersal for this relatively sedentary faunal group (Neves 1993). The intimate relationship between mussels and their host fish has therefore played a major role in mussel distributions on both a landscape (Watters 1992) and community (Haag and Warren 1998) scale. Haag and Warren (1998) determined that mussel community composition was more a function of fish community pattern variability than of microhabitat variability, and that the type of strategy used by mussels for infecting host fishes was the determining factor. The distribution of host-generalist mussels without elaborate host-attracting mechanisms (*e.g.*, anodontines) and host-specialized mussels with elaborate host-attracting mechanisms (*e.g.*, lampsilines) was independent of host-fish densities. Conversely, the distribution of host-specialist mussels without elaborate host-attractant mechanisms (*e.g.*, amblemines) was dependent on densities of host fishes. Host fish density appears to be a factor in determining where amblemines, which include the three listed mussels addressed in this BO, may persist.

Knowledge about the reproductive biology of many freshwater mussels remains incomplete (Jansen 1990). For example, according to Watters (1994), host fish for only 25% of the 300 mussel species in North America have been identified, although subsequent studies are gradually expanding that number (*e.g.*, Luo 1993; Weiss and Layzer 1995; Yeager and Saylor 1995; Haag and Warren 1997; Howells 1997; Keller and Ruessler 1997; Roe and Hartfield 1997; O'Dee and Watters 2000). Host fish information is lacking most in the Southeast where over 90% of the freshwater mussel species occur (Neves *et al.* 1997).

Villella *et al.* (2004) summarized the general unionid life history strategy:

> Unionids are unique among freshwater invertebrates both in their longevity and their high and constant adult survival. This life history strategy is instead similar to large mammals and some freshwater vertebrates such as hellbenders and some fish species. Their life history strategy can be considered a hybrid between an r and K-strategist. Unionids share some qualities of K-strategists (longevity and high adult survival) and they also share some of the qualities of r-strategists (high output of glochidia, lower survival of young, no parental care). It is possible that continuous (though low) reproduction during a long adult life span can be beneficial for unionids and may be an evolutionary strategy in response to uncertain larval and juvenile survival.

2.2.3.3.1 Fat threeridge

O'Brien and Williams (2002) studied various aspects of the life history of the fat threeridge, determining that it is likely a short-term summer brooder of its glochidia. Females appear to be gravid in Florida when water temperatures reached 75.2°F, in late May and June, suggesting that the species expels glochidia in the summer. Fat threeridge glochidia are released in a white, sticky, web-like mass, which expands and wraps around a fish, thus facilitating attachment. The glochidia are viable for 2 days after release.

The fat threeridge lacks mantle modifications or other morphological specializations that would serve to attract host fishes and appears to be a host-fish generalist that may infect fishes of at least three different fish families. Five potential host fishes were identified: weed shiner (*Notropis texanus*), bluegill (*Lepomis macrochirus*), redear sunfish (*L. microlophus*), largemouth bass (*Micropterus salmoides*), and blackbanded darter (*Percina nigrofasciata*). Transformation of the glochidia on host fishes required 10 to 14 days at 73.4 ± 2.7°F (O'Brien and Williams 2002).

2.2.3.3.2 Purple bankclimber

Females of the purple bankclimber with viable glochidia were found in the Ochlockonee River from February through April when water temperatures ranged from 46.4 to 59.0°F (O'Brien and Williams 2002). The species may or may not brood glochidia over the winter, depending on when fertilization occurs, but most likely expels glochidia in late winter to early spring,. Females expel narrow lanceolate-shaped conglutinates (0.4 to 0.6 in (1.0 to 1.5 cm) long) that are viable for 3 days after release. The white structures, which are two-glochidia thick, are generally released singly, although some are attached to each other at one end and released in pairs (O'Brien and Williams 2002). Prematurely released conglutinates (containing only unfertilized eggs) are rigid, but conglutinates with mature glochidia easily disintegrate, presumably facilitating host infection.

The eastern mosquitofish, blackbanded darter, guppy and greater jumprock transformed glochidia of the purple bankclimber during laboratory infections (O'Brien and Williams 2002; P.D. Johnson, Tennessee Aquatic Research Institute [TNARI], pers. comm. 2003). Only the eastern mosquitofish was effective at transforming glochidia (100% transformation rate), with the percentages for the blackbanded darter and guppy being under 33%. Transformation on eastern mosquitofish occurred in 17 to 21 days at temperatures of 68.9 ± 5.4°F (O'Brien and Williams 2002). Only one glochidium was successfully transformed on the greater jumprock during preliminary trials and occurred after 52 days (Johnson, TNARI, pers. comm. 2003). The eastern mosquitofish occupies stream margins in slower (or slack) currents (Lee *et al.* 1980), and is considered a secondary host fish since the purple bankclimber is more of a main-channel species (Williams and Butler 1994). The primary host species for this mussel remains unknown (O'Brien and Williams 2002).

2.2.3.3.3 Chipola slabshell

Little is known about the life history of the Chipola slabshell. A unionine, it is suspected that this species expels conglutinates and is a tachytictic summer releaser. Southeastern congeners of the Chipola slabshell have been documented to use centrarchids (sunfishes) as host fish (Keller and Ruessler 1997), although a relationship between cyprinids and tachytictic brooders has been documented (Bruenderman and Neves 1993).

2.2.3.4 Habitat

Adult mussels are generally found in localized patches (beds) in streams and almost completely burrowed in the substrate with only the area around the siphons exposed (Balfour and Smock 1995). The composition and abundance of mussels are directly linked to bed sediment distributions (Neves and Widlak 1987; Leff *et al.* 1990). Physical qualities of the sediments (*e.g.,* texture, particle size) may be important in allowing the mussels to firmly burrow in the substrate (Lewis and Riebel 1984). These and other aspects of substrate composition, including bulk density (mass/volume), porosity (ratio of void space to volume), sediment sorting, and the percentage of fine sediments, may also influence mussel densities (Brim Box 1999, Brim Box and Mossa 1999). Water velocity may be a better predictor than substrate for determining where certain mussel species are found in streams (Huehner 1987). In general, heavy-shelled species occur in stream channels with currents, while thin-shelled species occur in more backwater areas.

Stream geomorphic and substrate stability is especially crucial for the maintenance of diverse, viable mussel beds (Vannote and Minshall 1982; Hartfield 1993; Di Maio and Corkum 1995). Where substrates are unstable, conditions are generally poor for mussel habitation. Although several studies have related adult habitat selection with substrate composition, most species tend to be habitat generalists (Tevesz and McCall 1979; Strayer 1981; Hove and Neves 1994; Strayer and Ralley 1993), with few exceptions (Stansbery 1966).

Habitat and stream parameter preferences for juveniles are largely unknown (Neves and Widlak 1987). This is possibly due to a prevalent lack of evidence of recruitment, inadequate sampling methods, or reproductive failure (Coon *et al.* 1977; Strayer 1981; Moore 1995; McMurray *et al.* 1999a, b). Isley (1911) stated that juveniles may prefer habitats that have sufficient oxygen, are frequented by fish, and are free of shifting sand and silt accumulation. Neves and Widlak (1987) suggested that juveniles inhabit depositional areas with low flow, where they can feed pedally (see “Food Habits”) and siphon water from interstitial spaces among substrate particles (Yeager *et al.* 1994). Juvenile mussels of certain species stabilize themselves by attaching to rocks and other hard substrates with abyssal (protein threads) (Frierson 1905; Isley 1911; Howard 1922). Strayer (1999a) demonstrated in field trials that mussels in streams occur chiefly in flow refuges, or relatively stable areas that displayed little movement of particles during flood events. Flow refuges conceivably allow relatively immobile mussels to remain in the same general location throughout their entire lives. He thought that features commonly used in the past to explain the spatial patchiness of mussels (*e.g.,* water depth, current speed, sediment grain size) were poor predictors of where mussels actually occur in streams.

Neves and Widlak (1987) summarized juvenile mussel associations with substrate, current velocity, and presence of other bivalves. Most of the youngest juveniles they found were clumped in runs and riffles on the downstream side of boulders, and were significantly correlated with fingernail clam presence. They observed that the habitat of older juveniles (*i.e.,* ages 2 to 3 years) was similar to that of adults, but did not conclude whether juveniles of most species experience differential survival rates in different habitat types, remain in the habitat of the host fish, or exhibit any specific habitat preference (Neves and Widlak 1987).

Mussels may be particularly susceptible to exposure by low flows during the spawning season, which, for the fat threeridge, occurs in the late spring and early summer. Once the water warms and the days become longer, mature mussels move vertically to the substrate surface (Balfour and Smock 1995; Amyot & Downing 1998; Watters et. al 2001; Perles et al 2003). Watters *et al.* (2001) studied eight freshwater mussel species and found that all of the species surfaced during the spring to spawn. Studies of *Elliptio complanata* showed that 80% of the population migrate vertically to the sediment surface to spawn (Balfour and Smock 1995; Perles et al 2003). Mussels also aggregate via horizontal movement to enhance recruitment (Amyot & Downing 1998). Spawning itself requires a substantial energy expenditure for female mussels (Russell-Hunter 1979; Amyot & Downing 1998), and because of the energy cost associated with movement (Trueman 1983), females may move less than males during the reproductive season

(Amyot and Downing 1998). For this reason, females may be relatively more susceptible than males to exposure-induced mortality.

Williams and Butler (1994) discussed the habitat features associated with the listed mussels addressed in this BO, including stream size, substrate, and current velocity. Brim Box and Williams (2000) and Blalock-Herod (2000) also provided habitat information, particularly substrate associations. Following is a summary of this information.

2.2.3.4.1 Fat threeridge

The fat threeridge inhabits the main channel of small to large rivers in slow to moderate current. Substrate used by this mussel varies from gravel to cobble to a mixture of sand and sandy mud (Williams and Butler 1994). Brim Box and Williams (2000) found 60% of the specimens were located in a sandy silt substrate.

2.2.3.4.2 Purple bankclimber

The purple bankclimber inhabits small to large river channels in slow to moderate current over sand or sand mixed with mud or gravel substrates (Williams and Butler 1994). Over 80% of the specimens located during the ACF Basin portion of the status survey were found at sites with a substrate of sand/limestone (Brim Box and Williams 2000). ACF Basin collections were often in waters over 10 feet in depth.

2.2.3.4.3 Chipola slabshell

The Chipola slabshell inhabits silty sand substrates of large creeks and the main channel of the Chipola River in slow to moderate current (Williams and Butler 1994). Specimens are generally found in sloping bank habitats. Nearly 70% of the specimens found during the status survey were associated with a sandy substrate (Brim Box and Williams 2000).

2.2.4 Status and Distribution

2.2.4.1 Fat threeridge

The type locality of the fat threeridge is the Flint River, Macon County, Georgia. Records for this species are limited to main channels of the Apalachicola, Flint, and Chipola rivers, and a few tributaries/distributaries of the Apalachicola, all in north Florida and southwest Georgia (Clench and Turner 1956; Williams and Butler 1994) and all below the Fall Line (Brim Box and Williams 2000). We have no records of the species in the Chattahoochee Basin. Two historical records from the Escambia River (van der Schalie 1940; Heard 1979) are considered erroneous (Williams and Butler 1994). Brim Box and Williams (2000) reported 56 historical museum collections from 21 sites in the ACF Basin.

The fat threeridge was added to a list of regionally rare mussels compiled in 1971 (Stansbery 1971). The Service (1989) made it a candidate for Federal listing in 1989 and listed it as a endangered species in 1998. In two separate reports, Williams *et al.* (1993) assigned the fat threeridge mussel a status of endangered rangewide, while Williams and Butler (1994) assigned it a status of threatened in Florida.

Until recently, the Service believed that the fat threeridge was extirpated from the Flint River Basin; however, several live adult animals were found this summer (2006) in the main channel of the Flint where it forms the border between Baker and Mitchell counties, Georgia (C. Stringfellow, personal communication). Elsewhere in its extant range, the fat threeridge is documented in recent collections from several main channel sites on the Apalachicola River and in the lower Chipola River in Florida, both upstream and downstream of Dead Lake (Figure 2.2.4.1.A).

Concerning its historical abundance, van der Schalie (1940) reported only 17 fat threeridge specimens from 2 of 25 Chipola River system sites collected from 1915 to 1918. The majority of the sampling sites he reported were in the upper half of the system where this species has never been reported. Van Hyning (1925) considered it "rare," having spent some money sent by L.S. Frierson to acquire specimens in 1918 "several times over since then in the endeavor to locate them." It took several years of effort on his part before a "nice little lot" of fat threeridge was secured from the lower Chipola River. Clench and Turner (1956) described it as being a "rather rare species [but]. . . locally abundant." They reported it common from an Apalachicola River site (56 specimens collected in 1954) now submerged in the reservoir created by Jim Woodruff Lock and Dam (Brim Box and Williams 2000).

Clench and Turner (1956) documented an exceptional subpopulation of fat threeridge, reported at densities of 0.9 to 1.4 specimens per square foot along a 600+ foot stretch of shoreline, from Dead Lake, a natural flow-through, lake-like section of the lower Chipola River. Several museum lots containing a total of 102 specimens dated September 3, 1954, probably refer to their collection from this subpopulation. Dead Lake was impounded in 1960 by a low-head dam (Brim Box and Williams 2000). Although the dam was removed in 1987, Dead Lake has aggraded with sediment, which may have contributed to the localized extirpation of the fat threeridge. Though only a few locations within the Apalachicola and Chipola rivers were examined, Heard (1975) considered this species rare throughout its range and in danger of extinction. He also noted the decline of this species in the Apalachicola River (likely at US Highway 90, Butler, pers. comm. 2003) from abundant to rare over a seven-year period. Eight of 21 historical collections contained 10 or more fat threeridge specimens (Brim Box and Williams 2000).

A status survey (USFWS 1998) produced an average of 6.4 live specimens of the fat threeridge from six sites of occurrence in the ACF Basin. Brim Box and Williams (2000) reported a subpopulation of approximately 100 specimens located on the Chipola River below Dead Lake in 1988. Relatively large subpopulations are currently known in the lower Apalachicola River, where scores of specimens could be found in the mid-1990s (J. Brim Box, USGS, pers. comm., 1994); and a distributary (a side channel whose origin is the river main stem), Swift Slough. Limited quadrat sampling at one main stem site (six 2.7-square feet samples) conducted by Richardson and Yokley (1996) determined the fat threeridge to be the second most abundant of four species encountered (25% relative abundance).

The Corps has completed mussel surveys at potential dredged material disposal sites, slough locations, and other main channel areas within the Apalachicola and Chipola rivers (Miller 1998; Miller 2000; Miller, US Army Engineer Research and Development Center [ERDC] pers. comm. 2003). During these surveys, approximately 100 sites were examined over 30 river miles. The fat threeridge was detected at 22 locations and recruitment was documented at several of these locations. At the Chipola River cutoff (river mile 41.6) a “dense band” of mussels was located, with more than 60% being fat threeridge. At this same location 10% of the fat threeridge were less than 30 mm in total shell length, representing recent recruitment (Miller, ERDC, pers. comm. 2003).

Based on the above data, we categorized the fat threeridge population as “stable” in our 2005 annual reporting. Survey results from the fall of 2005, provided to the Service in the spring of 2006 (EnviroScience 2006), and our own surveys during the summer of 2006, demonstrated that the fat threeridge was more abundant than we previously believed. The areas of highest density were also the areas subject to high mortality as water levels dropped in June and July 2006. Mussels located in the main channel appeared to move in response to declining flows, but large numbers were located in side channels and in at least one distributary, Swift Slough, from which movement to deeper areas was not possible. We believe that large numbers of mussels were moved from the main channel into these side-channels and sloughs during high flow either in the spring of 2005 or following Hurricane Dennis in July 2005 (see section 3.5.2). These mussels display a normal age distribution, and many would have been present in the river before and during the last period of sustained low flows associated with drought conditions (1999-2002) that were comparable to flows in the summer of 2006. The mortality observed during 2006 represents a significant impact to the population; however, we believe that sufficient numbers for recovery likely persist in reaches that were not so strongly affected by the hurricane and subsequent sustained low flows. Additional studies of channel morphology are needed to assess habitat and population responses following significant disturbance events.

2.2.4.2 Purple bankclimber

The type locality of the purple bankclimber was the Chattahoochee River, Columbus, Georgia, by Clench and Turner (1956). This large-bodied species is known from the main channels of the ACF Basin, and the Ochlockonee Basin in Florida and Georgia (Clench and Turner 1956; Williams and Butler 1994; Brim Box and Williams 2000) (Figure 2.2.4.2.A). Generally distributed in the Flint, Apalachicola, and Ochlockonee Rivers, it was also known from the lower halves of the Chattahoochee and Chipola Rivers, and from two tributaries in the Flint River system. Heard (1979) erroneously reported it from the Escambia River system (Williams and Butler 1994). Brim Box and Williams (2000) located 68 historical museum collections from 25 sites in the ACF Basin alone. Fossil material is also known from the Suwannee River main stem and the Hillsborough Bay system in peninsular Florida (Brim Box and Williams 2000; Bogan and Portell 1995). The latter site has been dated from the early Pleistocene (Bogan and Portell 1995).

The purple bankclimber was recognized in lists of rare species published in the early 1970s (Athearn 1970; Stansbery 1971). Williams *et al.* (1993) assigned this species a status of threatened rangewide, while Williams and Butler (1994) assigned it a status of threatened in Florida. The Service listed the purple bankclimber as a threatened species in 1998.

Subpopulations from the Chattahoochee River have apparently been extirpated save for a single live specimen found in 2000 (C. Stringfellow, Columbus State University, pers. comm., 2000). In addition, it is no longer known from Line and Ichawaynochaway Creeks, and has not been seen live in the Chipola River since 1988. Within portions of the Flint and Ochlockonee Rivers, the purple bankclimber occurs more sporadically than it did historically. Most occurrences in the Ochlockonee River are upstream of Talquin Reservoir. An anomalous small stream occurrence (a single specimen from an unnamed tributary of Mill Creek, Flint River system) was discovered during our status survey in the early 1990s (USFWS 1998). A survey of five sites in the main channel of the Flint River between Warwick Dam and Lake Worth found that the purple bankclimber was the most abundant among nine species collected, but very few small individuals were observed (McCann 2005).

van der Schalie (1940) did not record the purple bankclimber from the Chipola River, but the 1915-18 surveys upon which he based his findings searched the upper portion of the system more thoroughly than the lower main stem. The purple bankclimber was noted as being a "relatively rare species" by Clench and Turner (1956). Heard (1975) considered this species to be common in the Apalachicola River in the 1960s, but that population sizes by the mid-1970s, particularly below Jim Woodruff Lock and Dam, had been "drastically reduced." Based on museum records, however, this species was relatively common in the lower Flint, upper Apalachicola, and upper Ochlockonee Rivers (Brim Box and Williams 2000; J.D. Williams, USGS, unpub. data). The largest museum collections with the same localities and dates were from the upper Apalachicola River (36 specimens collected in 1954) and lower Flint River (17, 1954). Museum collections may under-represent its abundance at certain sites where it was common, however, due to the difficulty of processing and storing substantial numbers of this large species.

An average of 54 specimens of the purple bankclimber were recorded from 41 sites rangewide during our status survey of the early 1990s; 30 sites in the ACF Basin and 11 in the Ochlockonee Basin (USFWS 1998; Brim Box and Williams 2000). The Corps has periodically surveyed for mussels at designated dredged material disposal sites and other sites in the Apalachicola River and the lower Chipola River (Miller 1998; Miller 2000; Miller, ERDC pers. comm. 2003). The purple bankclimber was found at 10 of these sites, including several that represented new locations for the species.

Richardson and Yokley (1996) used sieves to quantitatively sample substrates in the Apalachicola River downstream of Woodruff Dam, measuring purple bankclimber densities of about one animal per ft^2. Bankclimber density in four hand-picked (not sieved) substrate samples taken in the Ochlockonee River in 1993 averaged 0.34 animal per ft^2 (J. Brim Box, USGS, unpub. data).

Although the purple banckclimber is one of the largest animals in the regional mussel fauna, its preference for deeper habitats in the main channels of the ACF and Ochlockonee basins likely make it generally less detectable than other species in most mussel surveys. Based on its relative abundance at some locations (*e.g.,* the middle Flint), and finding it in small numbers fairly regularly at new locations elsewhere within its extant range, the Service believes at this time that the purple banckclimber population is stable; however, we make this assessment with less confidence than we would like. It is rare to find juvenile bankclimbers, which may mean only that they are even less detectable than adults, but it may signal a widespread reproductive failure. Studies to verify recruitment, by an age structure analysis of the adult population and by detecting juveniles in the field, are particularly necessary to adequately assess the bankclimber's status.

2.2.4.3 Chipola slabshell

The type locality of the Chipola slabshell is the Chipola River, Marianna, Jackson County, Florida. The Chipola slabshell was thought to be endemic to the Chipola River system (van der Schalie 1940; Clench and Turner 1956; Burch 1975; Heard 1979; Williams and Butler 1994) until Brim Box and Williams (2000) located a museum lot (single specimen) from Howards Mill Creek, a Chattahoochee River tributary in southeastern Alabama. The historical range of this ACF Basin endemic is centered throughout much of the Chipola River main stem and several of its headwater tributaries (Figure 2.2.4.3.A). The Chipola slabshell is one of the most narrowly distributed species in the drainages of the northeast Gulf of Mexico. Brim Box and Williams (2000) located 37 historical museum collections from 17 sites. Williams *et al.* (1993) assigned the Chipola slabshell a status of threatened rangewide. Williams and Butler (1994), who considered it a Florida endemic, also assigned it a status of threatened. In 1998, the Service listed it as a threatened species.

The Chipola slabshell is no longer known from Howards Mill Creek in Alabama. Likewise, this species is probably extirpated from Dead Lake on the lower main stem of the Chipola in Florida, and from two Chipola River tributaries, Cowarts and Spring creeks in Alabama, and if so, the species is extirpated from Alabama (Lydeard *et al.* 1999). Sites supporting the Chipola slabshell area in Marshall and Dry creeks, and in the upper two-thirds of the Chipola River main stem. EnviroScience (2006a) found a single live individual in the Chipola River downstream of Dead Lake. The largest remaining subpopulation appears to be on the Chipola River main stem upstream of (but not in) Dead Lake, where the species remains relatively common (J.D. Williams, USGS, unpub. data).

Relative abundance of this species has always been low for the Chipola slabshell. Clench and Turner (1956) considered it to be "rather rare, though it does occur throughout most of the length of the river proper and its smaller tributaries." van der Schalie (1940) reported 31 specimens of this species from 6 of 25 sites (average of 5.2 per site of occurrence). The largest museum collections with the same localities and dates were from Cowarts Creek, Houston County, Alabama (28 specimens collected in 1916) and Chipola River (22 specimens collected in 1954). The former record represents the only occurrence of the Chipola slabshell from the Alabama portion of the Chipola River system (Brim Box and Williams 2000), and was apparently overlooked by van der Schalie (1940). Heard (1975) reported this species as being relatively uncommon but that it could be locally abundant. We found an average of 3.7 Chipola slabshell specimens per site of occurrence (3 sites) during our status survey of the early 1990s (USFWS 1998).

A new status survey of the mussel fauna of the Chipola River, focusing on the slabshell, is currently underway. Pending the results of this survey, the Service considers the status of the Chipola slabshell unknown.

2.3 Analysis of the Species/Critical Habitat Likely to be Affected

This BO addresses effects of the Corps' water management operations under the Woodruff Dam IOP and the associated releases to the Apalachicola River on the Gulf sturgeon, fat threeridge, purple bankclimber, and Chipola slabshell and their designated or proposed critical habitats. These listed species are found in the Apalachicola River and distributaries downstream of Woodruff Dam, which is the downstream-most Federal reservoir within the ACF system.

The Apalachicola River is one of seven rivers currently known to support a reproducing subpopulation of Gulf sturgeon. The critical habitat in the Apalachicola system is included in Unit 6 (the Apalachicola River mainstem, downstream to its discharge at Apalachicola Bay, and all Apalachicola River distributaries [channels flowing out of the mainstem]). Critical habitat for Gulf sturgeon is also found in Apalachicola Bay included in Unit 13 (the main body of Apalachicola Bay and its adjacent sounds, bays, and the nearshore waters of the Gulf of Mexico). Unit 13 provides winter feeding migration habitat for the Apalachicola River Gulf sturgeon subpopulation. Corps operations affect freshwater flow into the bay, which affects salinity regimes and habitat conditions for Gulf sturgeon and their estuarine feeding habitats. Therefore, we limit our analysis of effects to Gulf sturgeon in this BO to the Apalachicola River subpopulation of the species in critical habitat Units 6 and 13.

The Apalachicola River is proposed as critical habitat for the fat threeridge and purple bankclimber. It is included as Unit 8 of 11 units proposed (71 FR 32746). Unit 8 includes the main stem of the Apalachicola River and two distributaries: the Chipola Cutoff downstream to its confluence with the Chipola River, and Swift Slough downstream to its confluence with the River Styx. The Chipola River and several of its tributaries are proposed as critical habitat for the fat threeridge and Chipola slabshell, including the portion of the Chipola River that is within the action area: the Chipola River downstream of its confluence with the Chipola Cutoff. The Chipola slabshell was recently found in this reach (EnviroScience 2006a), where the fat threeridge was already known to occur. Therefore, we limit our analysis of effects to the fat threeridge and purple bankclimber in Unit 8 and to the fat threeridge and Chipola slabshell in Unit 2.

2.4 Tables and Figures for Section 2

Table 2.1.4.A. Estimated size of known reproducing subpopulations of Gulf sturgeon.

River	States	Estimated Gulf Sturgeon Subpopulation Size[1]	Source
Pearl	**LA, MS**	**300**	**Rogillio *et al.* 2002**
Pascagoula	**MS**	**162-216**	**Heise *et al.* 1999a; Ross *et al.* 2001b**
Escambia	**AL, FL**	**506-687**	**F. Parauka, USFWS, pers. comm. 2005**
Yellow	**AL, FL**	**500-911**	**Berg *et al.* 2004**
Choctawhatchee	**AL, FL**	**2000-3000**	**F. Parauka, USFWS, pers. comm. 2005**
Apalachicola	**FL**	**270-321**	**USFWS 1998; USFWS 1999**
Suwannee	**FL**	**5500-7650**	**Sulak and Clugston 1999; Pine and Allen 2001**

[1] All estimates listed apply to the portion of the subpopulation exceeding a minimum size, which varies between researchers according to the sampling methods used.

Table 2.2.2.1.A. Proposed critical habitat for the fat threeridge, purple bankclimber, and Chipola slabshell.

Species, Critical Habitat Unit, and State(s)	Miles
fat threeridge	
2. Chipola River, AL, FL	**118.1**
8. Apalachicola River, FL	**96.6**
Total	**214.7**
purple bankclimber	
5. Upper Flint River, GA	**236.4**
6. Middle Flint River, GA	**187.8**
7. Lower Flint River, GA	**246.5**
8. Apalachicola River, FL	**96.6**
9. Upper Ochlockonee River, FL, GA	**110.2**
10. Lower Ochlockonee River, FL	**46.9**
Total	**924.4**
Chipola slabshell	
2. Chipola River, AL, FL	**118.1**
Total	**118.1**

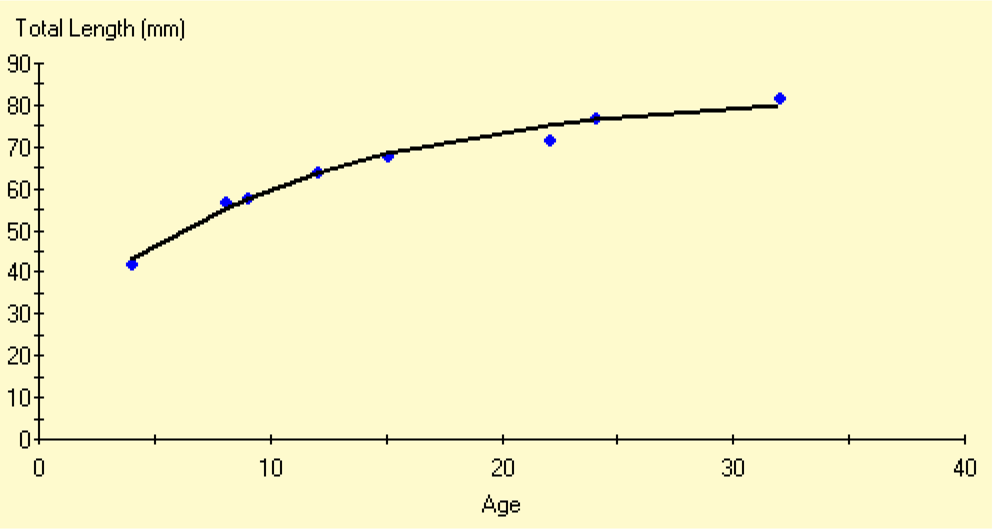


Figure 2.2.3.2.A. The von Bertalanffy growth relationship for the fat threeridge collected in the main channel of the Apalachicola River at RM 44.3.

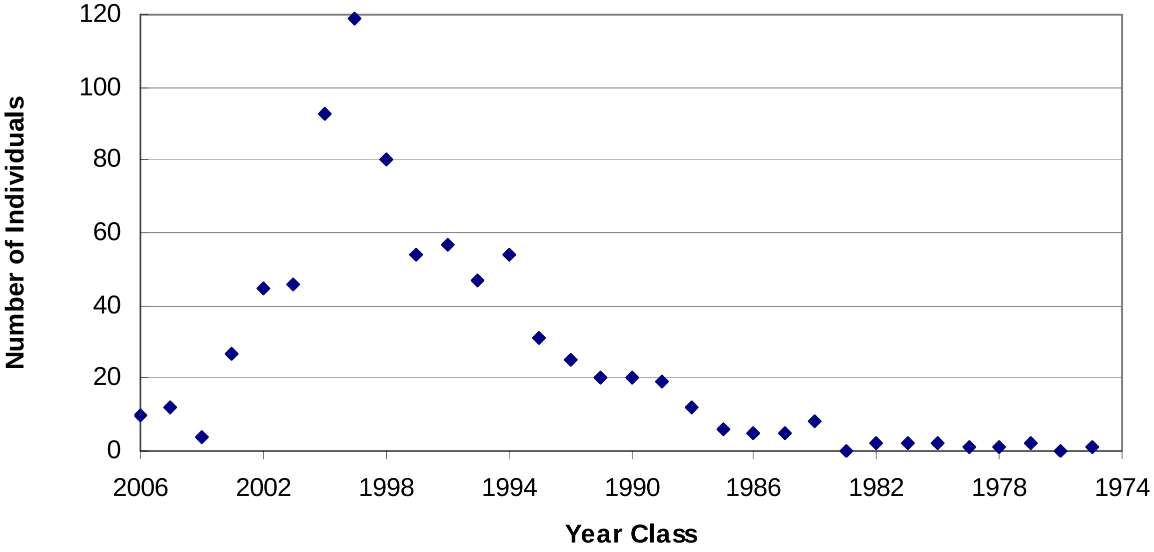


Figure 2.2.3.2.B. Age-class (year class) structure of fat threeridge in the Apalachicola River, Chipola River and Cut, and Swift Slough sampled by qualitative methods in 2005 and 2006 (USFWS unpubl. data 2006; EnviroScience 2006). Year classes prior to 1999 are under-represented because they are not fully recruited to the sample methodology.

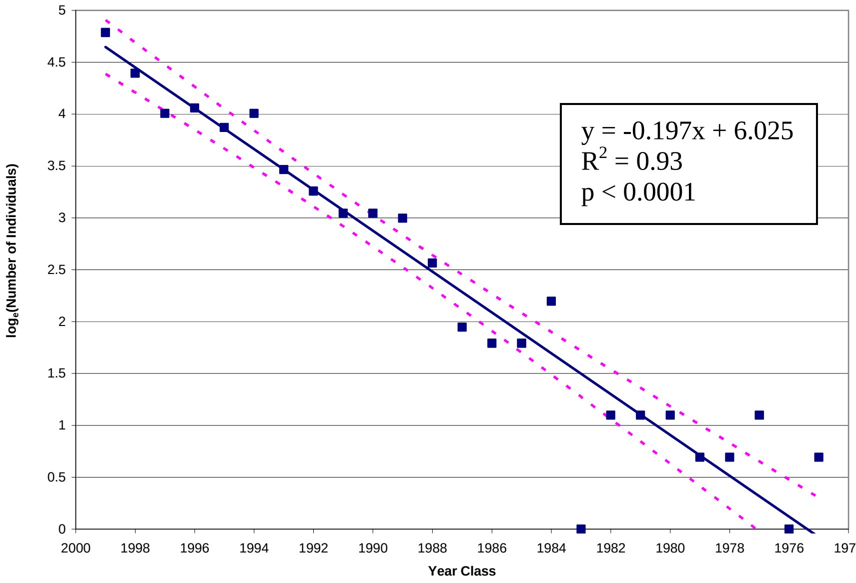


Figure 2.2.3.2.C. Catch curve analysis (natural log of number-at-age vs. age or year class) for fat three ridge collected from qualitative sampling conducted in the middle reach of the Apalachicola River, Swift Slough, and the Chipola River and Cut from October 2005 through June 2006. Dashed lines represent 95% confidence belts of the regression. Observed values above and below the 95% confidence belts represent strong and weak year class production, respectively.

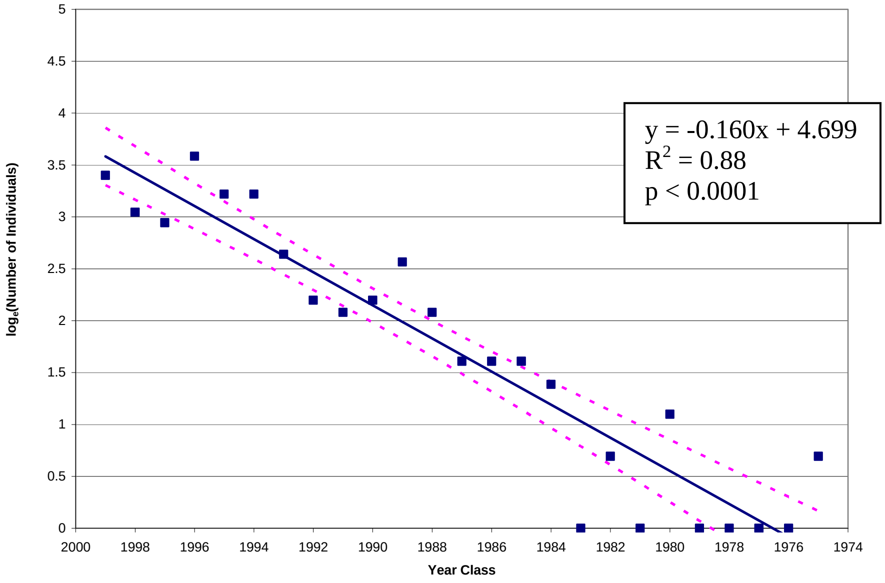


Figure 2.2.3.2.D. Catch curve analysis (natural log of number-at-age vs. age or year class) for fat three ridge collected from qualitative sampling conducted in the middle reach of the Apalachicola River from October 2005 through June 2006. Dashed lines represent 95% confidence belts of the regression. Observed values above and below the 95% confidence belts represent strong and weak year class production, respectively.

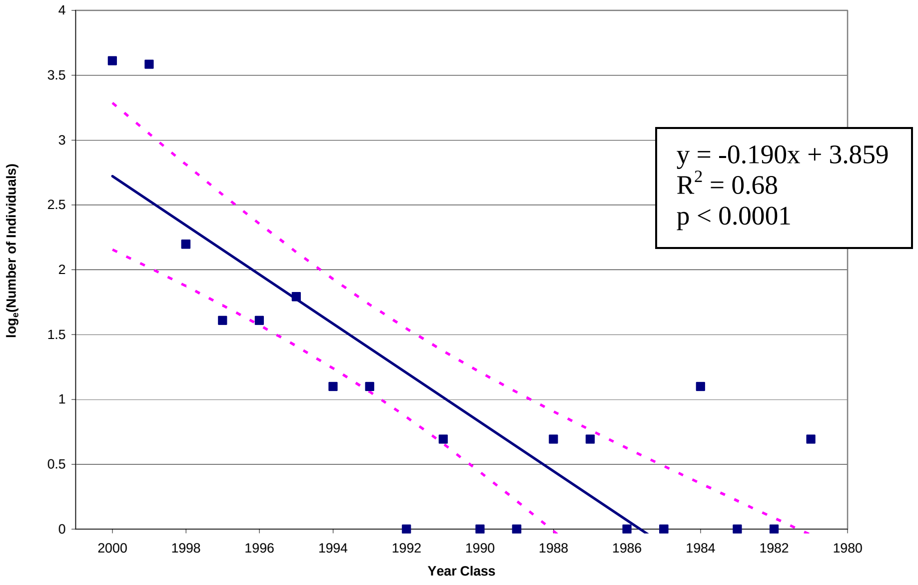


Figure 2.2.3.2.E. Catch curve analysis (natural log of number-at-age vs. age or year class) for fat three ridge collected from qualitative sampling conducted in Swift Slough from October 2005 through June 2006. Dashed lines represent 95% confidence belts of the regression. Observed values above and below the 95% confidence belts represent strong and weak year class production, respectively.

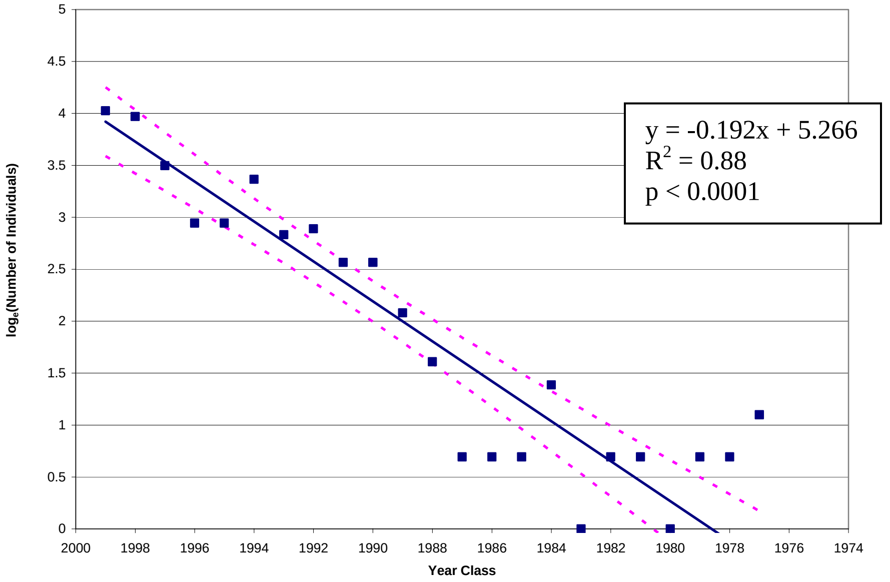


Figure 2.2.3.2.F. Catch curve analysis (natural log of number-at-age vs. age or year class) for fat three ridge collected from qualitative sampling conducted in the Chipola River and Cut from October 2005 through June 2006. Dashed lines represent 95% confidence belts of the regression. Observed values above and below the 95% confidence belts represent strong and weak year class production, respectively.

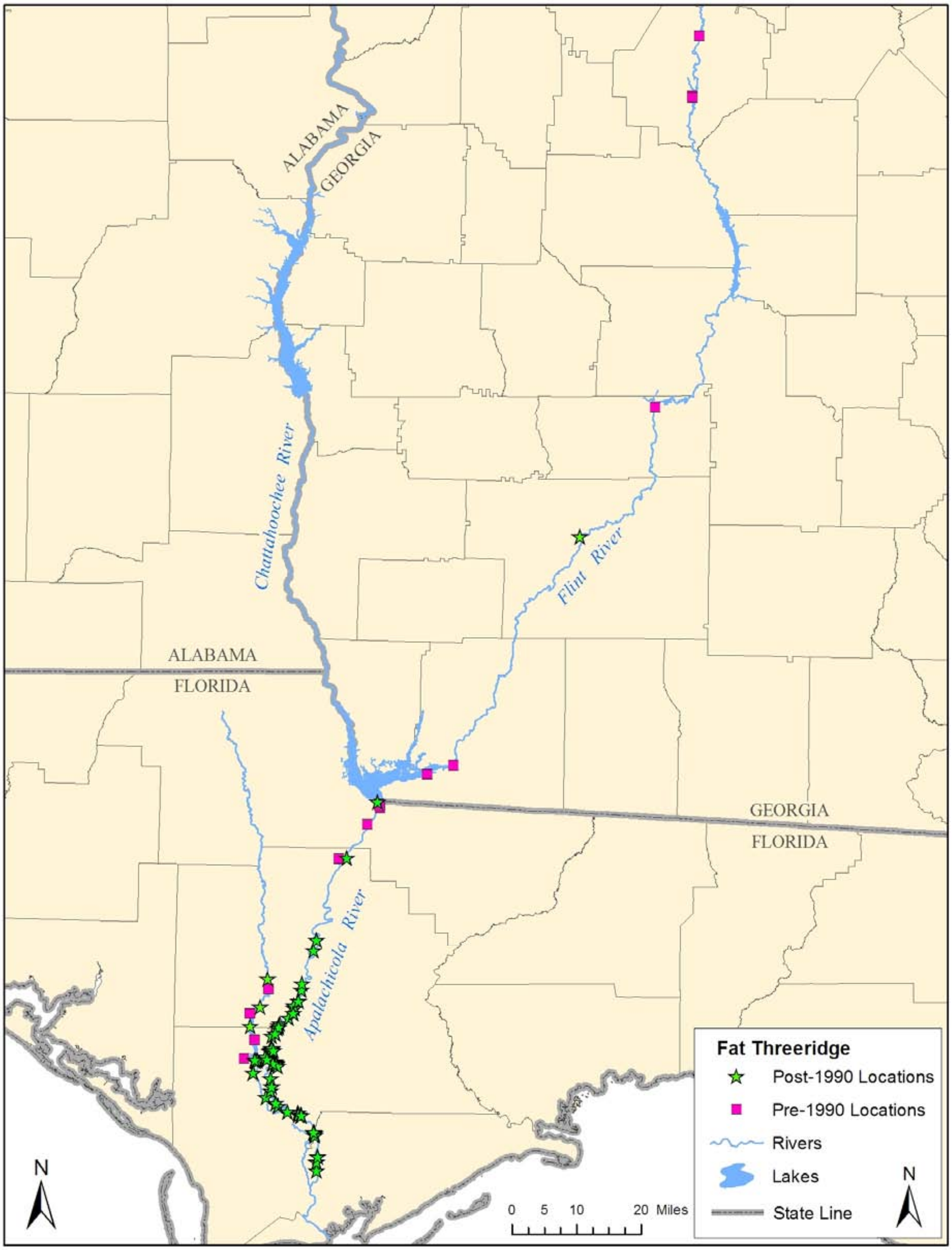


Figure 2.2.4.1.A. Known historical and present occurances of the fat threeridge.

Figure 2.2.4.2.A. Known historical and present occurances of the purple bankclimber.

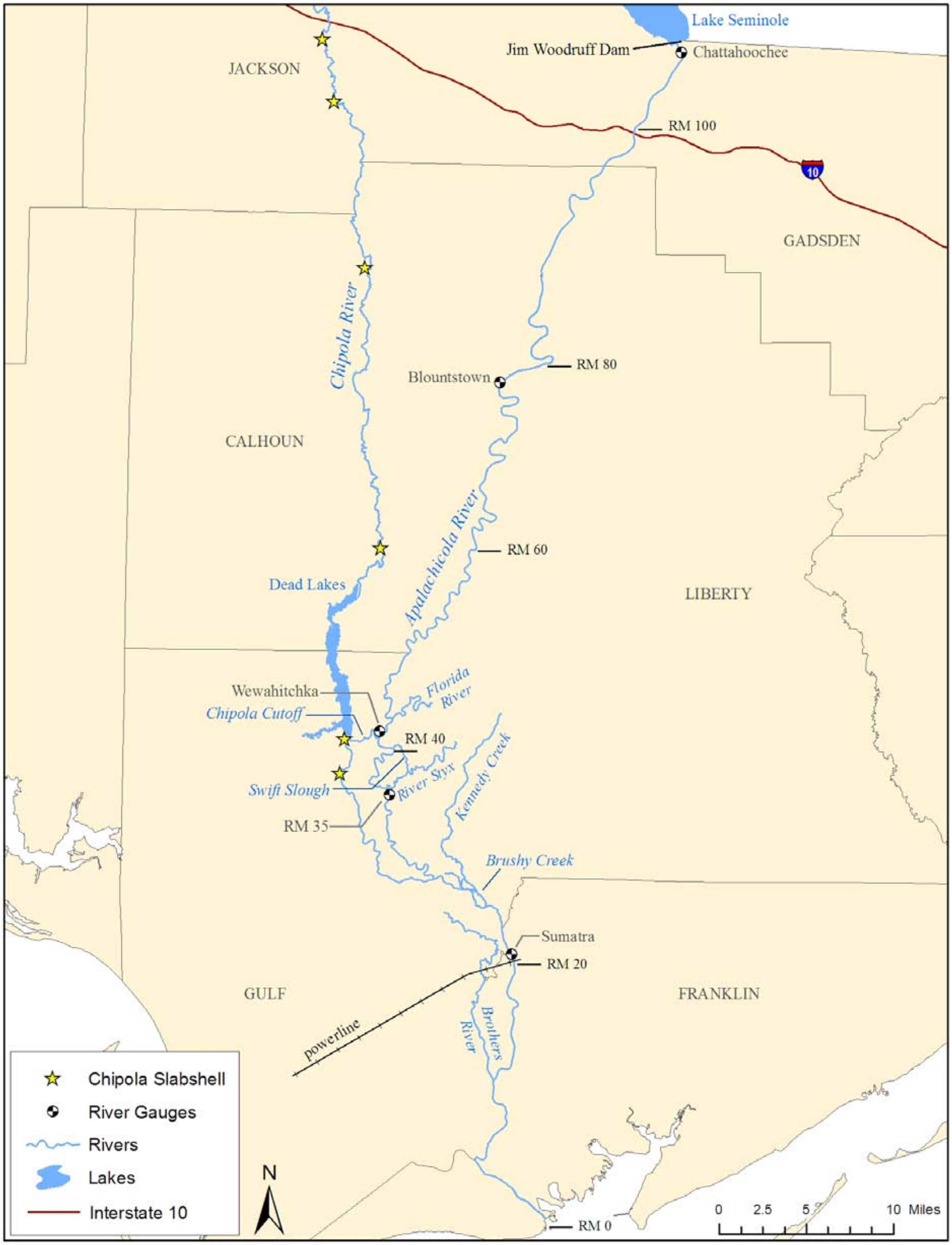


Figure 2.2.4.3.A. Known historical and present occurances of the Chipola slabshell.

3 ENVIRONMENTAL BASELINE

This section is 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. The environmental baseline is a "snapshot" of a species' health at a specified point in time. It does not include the effects of the action under review in the consultation. The action under review is the Corps' IOP for the releases from Woodruff Dam. In the case of an ongoing water project, such as Woodruff Dam, the total effects of all past activities, including the effects of its construction and past operation, current non-Federal activities, and Federal projects with completed section 7 consultations, form the environmental baseline (USFWS 1998b).

Within the action area, various Federal, State, and private actions affect the Apalachicola River ecosystem and the listed species considered in this opinion, which we discuss in this section. Not all Federal actions in the ACF basin have undergone consultation with the Service regarding potential effects to listed species. In particular, the construction of the Corps' dams, which preceded the Act and the listing actions for the sturgeon and mussels, continue to affect the Apalachicola River by trapping sediment in reservoirs that would otherwise move as bed load through the system. The interruption of this bed load movement is a major factor contributing to altered channel morphology, which we address in this section. However, no present discretionary Federal action, *per se*, perpetuates sediment trapping that would prompt a consultation, and as stated above, we include the effects of project construction in the baseline. Consultations regarding water supply storage contracts, hydropower contracts, and the water control master operations manual are expected in the future.

3.1 General Description of the Action Area

See Section 1.1 for a definition of the action area. The Apalachicola River has the highest annual discharge of any river in Florida. It is the fifth-largest river in the continental United States, as measured by annual discharge to the sea (Leopold 1994). Together with the Chattahoochee and Flint rivers, its two largest tributaries, the Apalachicola drains an area of 19,800 square miles in parts of southeastern Alabama (15%), northwestern Florida (11%), and central and western Georgia (74%). The basin extends approximately 385 miles from the Blue Ridge Mountains to the Gulf of Mexico, and has an average width of 50 miles. The ACF Basin spans 50 counties in Georgia, 8 in Florida, and 10 in Alabama.

The Apalachicola River is entirely within the State of Florida and flows from Woodruff Dam about 107 miles to the Apalachicola Bay. Tidal influences on the river extend about 25 miles upstream from the bay. Within Florida, it receives flow from several tributaries, the largest of which is the spring-fed Chipola River. Lidstone and Anderson, Inc., (1989) described general morphological features of the Apalachicola River, which we summarize here. Almost the entire floodplain is forested and averages 1-2 miles in width in the upper river, 2-3 miles in the middle river, and 2.5 to 4.5 miles in the lower river. Limestone outcrops are found within the channel from river mile RM 86 to RM 105, where slope averages 0.424 ft per mile, and channel width averages 670 ft. The middle river has a slope of 0.495 ft per mile, is about 600 ft wide, and includes several abandoned river channels and oxbow lakes. In the lower river, both tidal and nontidal portions, slope is 0.334 ft per mile with an average width of 533 ft.

As a sand-bed alluvial river, the Apalachicola is a dynamic system constantly changing by ongoing processes of erosion and sedimentation. Historically, the river included large meanders and tree-lined banks. The river banks were dominated by cohesive sediments that include large quantities of silt and clay (Lidstone and Anderson, Inc., 1989). Winter floods deposited tons of tree limbs, trunks, and stumps in the main channel. It was noted that the extensive tree growth in the subtropical environment required constant trimming to reduce hazards to steamboats that plied the river in the 1800s (Jeanne 2002).

The flow of the Apalachicola is carried by a complex of channels that includes the main channel and various distributaries. The upstream-most distributary is a "loop stream" called The Bayou, which departs the main channel at RM 86 and returns to the main channel at RM 78. Loop streams like this become increasingly more common downstream, particularly downstream of the river gage near Wewahitchka, FL (~RM 42). These loop streams carry a substantial portion of the total flow of the river at medium and high flows (Light *et al.* 2006). Distributaries that do not loop back to the main channel and instead carry water directly to Apalachicola Bay begin at RM 14.

3.2 Channel Morphology Alterations

The Apalachicola River is a large, meandering, alluvial river that migrates across the floodplain (Hupp 2000). However, the Apalachicola 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 (Light *et al.* 2006). In the past 50 years, many portions of the Apalachicola have substantially declined in elevation (incised) and/or become substantially wider. Unless otherwise noted, the source for our summary of these changes in this section is Light *et al.* (2006), and our use of the terms upper, middle, and lower river refer to the delineation provided in Figure 1.1.A.

Mean bed elevation declined to some degree from 1960 to 2001 at 42 of 51 cross sections measured by the Corps throughout the nontidal portion of the Apalachicola River (Price *et al.* 2006). This decline is greatest in the upper river. During the period 1954 to 1980, mean bed elevation at the Chattahoochee gage declined 9 ft and the stage equivalent to 10,000 cfs declined 4.8 ft. During the period 1960 to 2001, in the upper 41 miles of the river, mean bed elevation declined an average of 2.2 ft at 24 of 26 cross sections measured in this reach. The probable cause of the bed degradation is sediment sequestration in Lake Seminole following construction of Woodruff Dam. The data suggest that dam-induced bed degradation continues to migrate downstream. In the lower nontidal river (RM 22.1 at Owl Creek to RM 34.5 at River Styx), the bed has also degraded an average of 3.2 ft. The probable cause of this degradation was the construction of five cutoffs and bend easings between 1957 and 1969 that shortened the reach by 1.8 miles, increasing its slope.

Channel width, measured as the distance between the treeline of opposite banks on aerial photography, has significantly increased since 1941. The mean increase in width of the nontidal river has been 82 ft, using 2004 aerial photography as the most recent measure. Relative increases were greater going downstream. Most of the widening occurred between 1959 and 1979, and appears to have stabilized between 1979 and 1999, with the exception of some minor widening in the middle and non-tidal lower reaches that continued between 1999 and 2004, which warrants continued monitoring. Channel widening is in part responsible for the declining elevation associated with a given discharge over time, as the same amount of water spreads over a larger area. The current widening in the middle and lower nontidal reaches may slow or even reverse itself somewhat in the future as riparian vegetation stabilizes point bars and other depositional areas on the channel margins. This process is apparently already at work in portions of the upper river, where trees colonized depositional areas during 1999 to 2004 within dike fields that were previously constructed for the navigation channel, which resulted in minor channel narrowing.

Channel incising (declining mean bed elevation) and channel widening both contributed to reduced connectivity between the main channel and its distributaries and its floodplain. We examine the effects of reduced connectivity on the baseline specifically in section 3.3.2, and again when considering the effects of the proposed action in section 4.2.6

In the middle reach of the Apalachicola River, some unusual geomorphic features, which Light *et al.* (2006) coined “hooks and bays”, have formed at 10 locations in reaches that have experienced some of the most extreme channel widening. A hook and bay is a relatively large backwater area (the “bay”) along the bank, usually on the outside of a bend in the channel, which is partially separated from the main channel by a large hook-shaped depositional area. The surface area in these bays has increased more than ten-fold since 1941, with the most rapid increase occurring between 1979 to 1999. Most are associated with dredged-material disposal sites used since 1977. However, large disposal sites in other areas of the river do not have these formations.

Light *et al.* (2006) considered, but dismissed, the possibility that these observed changes in morphology are part of a decadal or multi-decadal cycle of stream dynamics, observed in some other rivers, wherein the river becomes wider and shallower following large flood events and becomes narrower and deeper in the absence of floods. Flow data for the Apalachicola does not show such an alternating pattern. They also considered the possibility of systematic change over century-long time frames, wherein deep incision is followed by substantial widening and slow aggradation, which is a pattern triggered by a disturbance event such as flood or drought. Although this pattern occurs in some streams similar to the Apalachicola, none have been observed to both incise and widen simultaneously. Finally, they considered how rivers normally change shape in response to a decrease in discharge by narrowing and becoming more shallow to accommodate the decreased runoff. Conversely, when more water is delivered in a watershed, the channel will widen and deepen in response to the increased runoff. This also has not been the case for the Apalachicola, as the period of greatest widening and deepening (1954-1979) does not coincide with the largest flood events or any sustained increase in peak discharges.

The combination of deeper and wider river conditions of the Apalachicola is not consistent with natural geomorphic processes observed on other rivers. A combination of anthropogenic factors is more likely driving channel instability on the Apalachicola, including reduced sediment supply following dam construction, and various actions associated with construction and maintenance of the federal navigation channel (dredging, disposal, woody debris removal, and training dikes). The overall effect of channel changes is a generally lower stage (elevation of the water surface) for the same amount of flow on the order of 2-5 ft throughout most of the 86-miles of the nontidal river. Relative to a reference discharge of 10,000 cfs, the declines in stage are 4.8 ft, 2.2 ft, 1.9 ft, and <0.5 ft at the Chattahoochee, Blountstown, Wewahitchka, and Sumatra gages, respectively. Most of this decline in stage associated with a 10,000 cfs discharge occurred in the 18 years after Woodruff Dam was completed.

It appears that bed degradation is continuing to extend downstream beyond RM 65, perhaps at a rate of about 0.7 mi per year (Light *et al.* 2006). This reach may also narrow slightly due to deposition of eroded material at the river training structures. Some additional widening and aggradation may occur in the middle reach before narrowing begins. The Corps did not dredge the navigation channel in 2000, conducted limited dredging in 2001, and none since then. Although the federal navigation project is still authorized, the State of Florida has denied project certification under its delegated authority in section 401 of the Clean Water Act. At this time, channel maintenance are deferred indefinitely.

3.3 Flow Regime Alterations

Because the proposed action is an operational plan that prescribes the flow of the river, the habitat characteristic of greatest relevance to this consultation is the flow of the river, which is highly variable over time. A river's flow varies in its magnitude, seasonality, duration, frequency, and rate of change, and collectively, this variability is called its flow regime. The environmental baseline is a "snapshot" of a species health and habitat within the action area (USFWS 1998b), but to capture intra- and interannual 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. 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 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 IOP.

As noted in the "Description of Proposed Action" section, USGS stream gage number 02358000 at Chattahoochee, FL, which is located 0.6 mi downstream of Woodruff Dam, is the point at which Woodruff releases and ramping rates under the IOP are measured. We use this gage also as the source of data for describing the baseline flow regime and for estimating characteristics of the natural flow regime of the river. The continuous discharge record of this gage begins in 1928, with 1929 as the first complete calendar year of record. The flow of the Apalachicola River has been altered over time to some degree by land use changes, reservoirs, and various consumptive water uses, and these alterations contribute to the environmental baseline.

The first dam/reservoir completed among the Corps' ACF projects was Buford Dam/Lake Lanier, which began operations in 1956. Although several other ACF mainstem dams were built before Buford, only Bartlett's Ferry Reservoir on the Chattahoochee River has appreciable storage capacity. The capacity of Bartlett's Ferry is less than 10% of Lanier's capacity, and less than 5% of the total capacity of the Corps' ACF projects. We therefore use the 27-year pre-Lanier flow record of the Apalachicola River's Chattahoochee gage from 1929 to 1955 to characterize the pre-impoundment flow regime. The Corps' full complement of ACF projects was not completed until October 1974, when operations of West Point Reservoir began. Although we could use all 50 post-Lanier years as the flow baseline, we use only the post-West Point years, 1975 to 2005 (31 years), because this period is the full history of the present configuration of the Corps' ACF projects.

The Corps' operations have changed incrementally over the post-West Point period. These changes were documented in a draft water control plan in 1989. Additional incremental changes in water control operations have occurred since 1989, and are reflected in the current operations and the IOP. Except in very general terms, it is not possible to describe a single set of reservoir operations that apply to the entire post-West Point period.

3.3.1 Annual Flow

To compare the flow regimes of the pre-Lanier period and the post-West Point periods, we use several of the measures identified in the Service's instream flow guidelines for the ACF Basin (USFWS and USEPA 1999), as well as other measures appropriate to this consultation. We begin with a general comparison of the two periods. Figure 3.3.1.A shows the distribution of annual average discharge for the Apalachicola River in the 1929-1955 pre-Lanier period and the 1975-2005 post-West Point period. Although the median annual discharge is slightly higher in the post-West Point period, two lowest-flow years (2000 and 2002) and six of the 10 lowest-flow years belong to the baseline period. The occurrence of these lowest-flow years in the baseline period may be due to differences in precipitation patterns.

An obvious climatic basis for annual discharge differences between these two periods; however, is not apparent in an examination of readily available historical precipitation data (http://www.ncdc.noaa.gov/oa/climate/onlineprod/drought/xmgr.html#ds) for the Chattahoochee and Flint Basins. Figure 3.3.1.B shows annual precipitation during the two periods compiled for Alabama climate zones 5, 6, and 7, and Georgia climate zones 1, 2, 3, 4, 5, 7, and 8. The climate zone boundaries do not coincide with the ACF Basin boundaries; therefore, we computed annual precipitation data as an average of the annual inches reported for these ten climate zones weighted by the area of each zone within the ACF Basin. These data suggest that, despite the occurrence of the lowest-flow years in the post-West Point period, it was generally wetter than the pre-Lanier period (median 52.93 inches vs. 49.27 inches). The pre-Lanier period contains the two driest years according to this precipitation data (1954 and 1931) and seven of the 10 driest years.

Figure 3.3.1.C shows the relationship between annual precipitation in the ACF basin upstream of Woodruff Dam, estimated as described above, and annual discharge of Apalachicola River at the Chattahoochee gage for the two periods. The addition of 3.7 million acre ft of reservoir storage (including "dead" storage) during the post-West Point period does not appear to have altered the overall relationship between precipitation in the Chattahoochee and Flint Basins and discharge into the Apalachicola Basin. The trend lines (linear model best fit) for the two periods are almost identical; however, the distribution of data points around the trend lines is noticeably different in

the lowest-flow years. Both periods contain 6 years with annual discharge less than 15,000 cfs, but total rainfall during the six post-West Point years exceeded total rainfall in the six pre-Lanier years by 19.11 inches. An outlier in this subset of the data is the year 2002, second-lowest flow year of the two periods, with annual rainfall of 53.18 inches, which exceeds the median annual rainfall of either period. The year 2002 marked the end of a period of below-normal rainfall in the basin that began in 1998-1999, but it did not yet mark the end of below-normal flow in the river. The delayed response of river flow to increased rainfall was due in part to refilling reservoir storage. Between January 1 and December 31, 2002, storage in three largest federal reservoirs increased by about 402,000 acre ft.

Figure 3.3.1.D is a flow frequency chart for the two periods taken from an analysis that combines all daily discharge values in each period, sorts the data in ascending order, and computes the percentage of the period containing values that exceed each unique value in the sorted list. This kind of flow frequency analysis shows the distribution of discharge magnitude in a period of record as a whole and is useful in characterizing overall differences between two periods of record. The frequency plots of the two periods are remarkably similar, as all differences in frequency at a given discharge level are less than 3.51%. The two plots cross each other at a discharge of 21,900 cfs, showing that flow rates less than this amount occur more often in the pre-Lanier period and flow rates greater than this amount occur more often in the post-West Point period. The two plots cross each other again at several higher flow rates, but differences in flow frequency in the range greater than 50,000 cfs are all less than 1.72%. Figure 3.3.1.D is truncated at 50,000 cfs to allow for greater clarity in the range less than 50,000 cfs.

3.3.2 High Flow

High flows perform many functions that are vital to the maintenance of riverine and estuarine ecological integrity, including (USFWS and USEPA 1999):

- the maintenance of channel and floodplain features by transporting sediment;
- the export of organic matter, nutrients, and organisms from the floodplain to the main channel and the estuary;
- removing and transporting fine sediments, clearing interstitial spaces in gravel bars used for fish spawning;
- importing woody debris into the channel, creating new high-quality habitat for fish and invertebrates;
- scouring floodplain soils, which rejuvenates habitat for early-successional plant species;
- reducing estuarine salinity, which provides nursery habitat for many marine species with early life stages that are intolerant of high salinity, and prevents the permanent intrusion of marine predators, such as oyster drills, that are intolerant of low salinity;
- connecting the main channel to the floodplain, providing access to spawning habitats, nursery areas, and food sources; and
- maintaining flood-resistant, disturbance-adapted communities.

Higher-flow events move more sediment per unit time than lower-flow events and, therefore, exert the greatest influence on channel morphology (Leopold and Wolman 1957). Although the analysis referenced in the previous section did not show appreciable differences in the overall frequency of the highest flow rates between the pre-Lanier and post West Point, this kind of analysis does not necessarily detect a change in the inter-annual recurrence of flow events, which could affect channel-forming processes. 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.

Figure 3.3.2.A shows a comparison of the annual duration of high flow in the pre-Lanier and post-West Point periods using a threshold of 50,000 cfs, which is about mid-way between the 1.0-to 1.5-year peak flow values. Flow did not exceed 50,000 cfs in about 10% of the years in both periods, however, the median number of days greater than 50,000 cfs is almost doubled in the post-West Point period (28 days vs. 15 days). This shift in the inter-annual duration of high flows suggests a relatively greater potential for sediment transport in the baseline period, which may have exacerbated the process of bed degradation and channel widening set in motion following the construction of Woodruff Dam (see section 3.2).

One effect of bed degradation and channel widening has been to reduce the amount of floodplain inundation associated with a given discharge (Figure 3.3.2.B) (pre and post total acres v. flow chart) (Light *et al.* 1998; Light *et al.* 2006). For example, the amount of floodplain habitat inundated by a flow of 30,000 cfs was about 46,500 acres in the pre-Lanier period and about 35,000 acres in the post-West Point period, a 25% reduction. Floodplain inundation during the growing season (generally April through October) is critical to the reproduction of many fish species, including some identified host species for the listed mussels. Figure 3.3.2.C shows the frequency and areal extent of growing-season (April through October) floodplain inundation in the pre-Lanier and post-West Point periods, which is computed by transforming the daily flow records to daily acres inundated in each period using the applicable area versus discharge relationship shown in Figure 3.3.2.B. Despite an increase during the post-West Point period in the annual duration of flows greater than 50,000 cfs, discussed in the previous paragraph, the frequency and extent of floodplain inundation during the post-West Point period is decreased relative to the pre-Lanier period, largely due to altered channel morphology. For example, 20,000 floodplain acres were inundated for 32% of the growing-season days in the pre-Lanier period, but for only 19% of the growing-season days in the post-West Point period.

Figure 3.3.2.C is an analysis of the pre-Lanier and post-West Point periods as a whole, and does not assess the inter-annual frequency or magnitude of floodplain inundation. Inter-annual patterns are important in interpreting effects to riverine and estuarine biota, because the year-to-year variability in habitat conditions influences reproductive success and other population characteristics. In the case of fish spawning in floodplain habitats, it is further important to consider continuous days of inundation within a year, because utilization of these floodplain habitats requires time for movement from the main channel into the floodplain, courtship and spawning behaviors, egg incubation, and juvenile growth to a size capable of moving to and surviving in the main channel when water levels recede. We analyzed the growing-season

floodplain inundation during the pre-Lanier and post-West Point periods using a 30-day moving minimum to represent this aspect of habitat availability, identifying the maximum acreage inundated for at least 30 days each year in both periods. Figure 3.3.2.D shows the results of this analysis, and again, habitat availability during the post-West Point period is substantially less than the pre-Lanier period. In 50% of the pre-Lanier years, more than about 23,500 floodplain acres were inundated for at least 30 continuous growing-season days. The median for the post-West Point period is less than half this amount, about 11,000 acres.

3.3.3 Seasonality

Many riverine organisms have life history features that are adapted to seasonal patterns of river flow (Poff *et al.* 1997). As noted in sections 3.1.3.3 and 2.1.3.5, Gulf sturgeon migratory movements are likely prompted by a combination of temperature and flow cues. Freshwater flow into Apalachicola Bay regulates its salinity and likely influences the amount of feeding habitat available to young sturgeon, which move towards the bay in the fall and winter and have not yet developed a tolerance for high salinity (Altinok *et al.* 1998). Seasonal flow adaptations of the mussels have not been investigated, but due to their limited mobility, it is likely that any such adaptations would serve to enhance fertilization of gametes and infection of fish hosts with glochidia. The habits of many fish species, some of which may serve as hosts for the listed species, are seasonal and flow dependent (Angermeir 1987; Schlosser 1985). We discussed the importance of floodplain inundation as spawning and rearing habitat for fishes in the previous section. Although many riparian plant species thrive under frequently inundated conditions, most require exposed substrate at some time of year for seed germination. In estuaries, plants and animals also are adapted to seasonally dynamic flows delivered by rivers. High spring flows deliver nutrients and extend the area of freshwater out toward the sea. Low flows in late summer and autumn permit salt water to move inland, sustaining marshland vegetation and allowing saltwater fishes and invertebrates opportunities to feed in the productive estuarine habitats. A seasonally variable flow regime is for many reasons vital to the health of the riverine and estuarine ecosystem. In this section, we examine the possibility of seasonal shifts in the baseline flow regime.

Figures 3.3.3.A and 3.3.3.B compare the distribution of monthly average flow in the pre-Lanier and post-West Point periods. The distributions of monthly flow for January, June, September, October, and December, are similar. In February and March, the median monthly flow is appreciably higher in the post-West Point period, which is probably not the result of reservoir project operations. The ACF federal reservoirs' are generally drawn down in the fall from summer to winter pool levels, and this drawdown is completed before February. The fall drawdown is a likely explanation for a higher distribution of monthly flow for November in the post-West Point period. The Corps generally begins refilling West Point reservoir to its summer pool level sometime in February, which reduces, not increases, flow to the Apalachicola River. Higher flow during February and March, therefore, suggests possible climatic differences between the two periods, but since the average annual flow of the two periods is comparable (Figure 3.3.3.A), the post-West Point period must necessarily also contain months with lower flow than the pre-Lanier period. These months appear to be April, May, July, and August, which show a generally lower distribution of monthly flow. Lower flow in April and May may be attributed to some degree to the Corps' project operations, since the system is generally operated to fill the reservoirs to summer pool levels by the end of May, and this necessarily reduces flow to the Apalachicola. Lower flow in July and August is likely a combination of climatic differences in the two periods, higher consumptive uses, as well as reservoir operations.

3.3.4 Low Flow

Extreme low flows are likely among the most stressful natural events faced by riverine biota. Cushman (1985) and Kingsolving and Bain (1993) described the some of the effects of low flows. During low flow, available habitat constricts and portions of the channel become dry. Aquatic animals perish that are unable to move to remaining pools or burrow into the moisture of the streambed itself. Others become concentrated in pools, where small-bodied species are more vulnerable to aquatic predators and large-bodied species are more vulnerable to terrestrial predators, particularly birds and raccoons. During warm months, extreme low water levels are accompanied by higher-than-normal water temperatures and low dissolved oxygen levels, further stressing river biota. Because of the physical and biological harshness of extreme low-flow conditions, decreasing the magnitude, increasing the duration, or increasing the inter-annual frequency of low-flow events is likely to have detrimental effects on native riverine biota, including the listed species.

Figures 3.3.4.A and 3.3.4.B show the distribution of monthly 1-day minimum flow in the pre-Lanier and post-West Point periods. The medians of the two periods are about the same in the months of January, February, July, August, October, and November. The distribution of monthly 1-day minimum flow is shifted to generally higher levels in the post-West Point period in the months of September and December, and to lower levels during the months of March through June. In the month of May, for example, flows less than 10,000 cfs occur in about twice as many years in the post-West Point period, although flows less than 10,000 cfs occur at some time during the year in about 85% of the years of both periods. The shift in the seasonal occurrence of low-flow rates into the March through June time frame is significant to the listed species and to many other riverine species, as these are the months of concentrated reproductive activity and early life stage development.

The duration of low-flow events in the two periods is shown in Figures 3.3.4.D and 3.3.4.E, which shows the maximum number of days per year and the maximum number of consecutive days per year that flow rates were less than 5,000 to 10,000 cfs. It is appropriate to focus on the maximum duration, because the mortality or reproductive failure associated with a severe episode of extended low flow may adversely affect a population for many years. For all rates between 5,000 and 10,000 cfs, the post-West Point period has a greater maximum event duration, expressed as both total days per year and consecutive days. The difference is most extreme at the 7,000 cfs level, at which the baseline period shows a doubling of the duration.

3.3.5 Rate of Change

Riverine rate of change is the rise and fall of river stage over time. Rapid changes in river stage may wash out or strand aquatic species (Cushman 1985; Petts 1984). By capturing high flows in storage, reservoirs typically accelerate the drop in stage compared to pre-reservoir conditions by closing spillway gates during flood recession, which may reduce germination and survival of riparian tree seedlings that colonize banks and sandbars by drying these areas out too fast (Rood *et al.* 1995). Successful regeneration of riparian vegetation is essential in the balance of erosion and deposition to maintain channel stability.

The IOP prescribes daily minimum releases and daily maximum fall rates from Woodruff Dam; therefore, we address rate of change in this BO in an average daily context; *i.e.*, change in river stage from one day to the next. We further focus on fall rates, and not rise rates, in this analysis due to the possible effect of stranding listed species and host fishes for the mussels in higher portions of the stream channel or floodplain when river stages decline too rapidly. Figure 3.3.5.A shows fall rates in the pre-Lanier and post-West Point periods, using the same intervals of fall rates that define this measure under the proposed action, which range from less than 0.25 ft/day to greater than 2.00 ft/day. The most extreme fall rates, 1.00 to 2.00 ft/day and > 2.00 ft/day, are the least common in both periods, but the frequency of these events is more than doubled in the post-West Point period (10.3% vs. 4.4%). This increase represents a substantial increase in the risk of stranding aquatic organisms due primarily to how the system of reservoirs was operated in this period.

3.4 Water Quality

Although the State standards adopted consistent with the US Environmental Protection Agency (USEPA) criteria generally represent levels that are safe for sturgeon and mussels, these standards are sometimes violated. Several segments of the Apalachicola and Chipola rivers that are within the action area are included on the 1998 303(d) list of water bodies that fail to fully serve the designated uses (FDEP 1998). The impairments included turbidity, coliforms, total suspended solids, and DO. The 2001 Impaired Surface Waters Rule analysis identifies potential impairments in the same segments for biology, coliforms, dissolved oxygen (DO), and unionized ammonia (FDEP 2003). Mercury-based fish advisories apply to one or more segments of both watersheds, and organochlorine pesticides were found at levels in ACF Basin streams that often exceeded chronic exposure criteria for the protection of aquatic life (FDEP 2002; Frick *et al.* 1998). Point and non-point source pollution have contributed to impaired water quality in the Apalachicola and Chipola rivers.

The Apalachicola River receives effluent from 15 surface water discharge facilities, including 6 domestic and 8 industrial waste facilities and 1 concrete batch plant. The major domestic waste facilities are the city of Blountstown (discharge (Q) = 1.5 million gallons per day (mgd)), the city of Chattahoochee (Q = 0.5 mgd), Florida State Hospital (Q = 1.3 mgd), and the town of Sneads (Q = 0.495 mgd). The only major industrial waste facility is the Gulf Power Scholz Steam Plant (Q = 129.6 mgd). Of these facilities, bioassays were completed for Blountstown, Chattahoochee, and the Florida State Hospital (adjacent to the town of Chattahoochee). The bioassay for Blountstown (3 September 1997) noted that the discharge to Sutton Creek had unionized ammonia (0.079 mg/L) and silver (0.27 µg/L) greatly exceeding the freshwater criterion of 0.07 µg/L (FDEP 2002). The bioassay for Chattahoochee (October 1998) noted no toxicity, no organic pollutants or metals, and no algal growth impacts to Mosquito Creek (FDEP 2002). The bioassay for the hospital (May 2000) noted no effluent toxicity and little impact on taxa richness to a tributary to North Mosquito Creek (FDEP 2002).

Predominant land uses in the drainage area of the Apalachicola River in Florida include upland forests (53.5%), wetlands (30.5%), agriculture (8.4%), and urban/built-up (2.1%); however, most of the drainage area of the basin as a whole is upstream of Florida in Alabama and Georgia. The NWFWMD recently completed a study of 12 watersheds in the Apalachicola drainage basin to determine relationships between land use and water quality (Thorpe *et al.* 1998). Very few water quality differences were noted between silviculture-dominated and naturally forested watersheds. Agriculture-dominated watersheds showed higher loading than natural and silviculture rates for a number of nutrients, such as unionized ammonia, nitrate-nitrogen, total nitrogen, and total phosphorus (Thorpe *et al.* 1998). The USGS has estimated nonpoint loadings for the Apalachicola River (Frick *et al.* 1996). The total nitrogen loads (tons/yr) are point sources (11), animal manure (210), fertilizer (1500), and atmospheric deposition (1300). For total phosphorus, the loads are point sources (5), animal manure (64), and fertilizer (680). The USGS has also estimated loadings for the Chipola River (Frick *et al.* 1996). The total nitrogen loads (in tons/yr) are point sources (28), animal manure (1700), fertilizer (6100), and atmospheric deposition (1500). For total phosphorus, the loads are point sources (6), animal manure (480), and fertilizer (1700).

The sources of these nutrient loadings are likely related to the violations of the water quality standards observed for coliforms, dissolved oxygen (DO), and unionized ammonia (FDEP 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 (Dahlberg *et al.* 1968; Fuller 1974; Sparks and Strayer 1998; Johnson 2001; Augspurger *et al.* 2003).

USGS has recorded water temperature intermittently at the USGS Apalachicola River gage near Chattahoochee, FL. Records were available from 1974-1978 and 1996-1997; however, water temperatures were not available for all of the days in each year. We calculated the mean daily temperature from the available data for each calendar date to plot a seasonal average water temperature profile for the river (Figure 3.4.A).

3.5 Status of the Species within the Action Area

This portion of the environmental baseline section focuses on each listed species, describing what we know about its spatial distribution, population status, and trends within the action area.

3.5.1 Gulf sturgeon

3.5.1.1 Current Distribution in the Action Area

Completed in 1957, Woodruff Dam blocks the upstream migration of Gulf sturgeon to historical riverine habitat in the Chattahoochee and Flint Basins (USFWS and GSMFC 1995). Prior to completion of Woodruff Dam, sturgeon were known to migrate to the Flint (Swift *et al.* 1977; Yerger 1977) and Chattahoochee rivers to spawn (USACE 1978). The Service has monitored the Gulf sturgeon subpopulation in the Apalachicola River since 1978. We have documented the Gulf sturgeon in the main channel of the Apalachicola River from the Woodruff Dam downstream to its mouth, in Apalachicola Bay, and in various tributaries and distributaries to the main channel, such as the Brothers River. Service personnel have since 1978 captured and tagged 1,515 Gulf sturgeon in the river, mostly in two areas: in the tailrace of Woodruff Dam (965 fish) and in the Brothers River (550 fish) (Wooley and Crateau 1985; Zehfuss *et al* 1999; Pine and Allen 2005).

In recent years, we have captured and tagged Gulf sturgeon during the summer months in the Brothers River upstream of its confluence with the Brickyard Cutoff, a distributary that leaves the main channel at RM 21 (USFWS Annual Report 1999, 2001 through 2005). The area is located about 10 km upstream of the river mouth and about 7 km upstream of the fall staging area described by Wooley and Crateau (1985) and Odenkirk (1991). The substrate consists of sand, mud, clay and detritus with depths ranging from 7 to 14 m. We believe that the upper portion of the Brothers River is an important summer resting area for Gulf sturgeon.

The Apalachicola Bay is a highly productive lagoon-and-barrier-island complex that encompasses 54,910 hectares, including East Bay, St. George’s Sound, Indian Lagoon, and St. Vincent Sound (Seaman 1988). We have very little data on Gulf sturgeon movements and habitat use in this enormous complex. We summarize here our observations to date.

In 1987 and 1990, we fitted a small number of adult Gulf sturgeon captured at Woodruff Dam with sonic tags specifically for tracking movements in the estuarine and marine environment following their fall downstream migration. In November 1987, one of these fish entered the bay, which we tracked for several hours before loosing contact in the middle of the bay (USFWS Annual Report 1988). We again tracked a tagged fish in December 1990 for several hours in the bay before loosing contact. This fish was moving parallel to the navigation channel between the river mouth and Sikes Cut in a meandering fashion. Upon reaching mid bay, the fish turned northward and continued in that direction for about 2 km and then turned to the west before contact with the fish was lost (USFWS Annual Report 1990).

In November 1989, we equipped an adult Gulf sturgeon that was collected in a shrimp trawl in Apalachicola Bay with a sonic tag, released it at the capture location in mid bay, and monitored its movements for four days. The fish moved north after its release and into the Apalachicola River, traveling about 5 km upstream before returning to the bay. The fish remained in the vicinity of the river mouth for about a day, and then spent a day east of the navigation channel headed mid bay. The fish turned westward, and we lost contact at East Pass (USFWS Annual Report 1989).

In 1999, we again captured and tagged several fish in the Apalachicola and Brothers rivers for tracking in the bay, October 1999 through April 2000. Most detections of these fish were 2 to 3 km south and west of the river mouth. The substrate at this location was a mixture of mud and sand and the average water depth was 2.5 m. One fish was located on the north side of St. George Sound in 2 m of water and about 56 km east of the river mouth. A data logger installed at Indian Pass detected two adult sturgeon, possibly leaving the bay for the Gulf (USFWS Annual Report 2000).

3.5.1.2 Population Status and Trends in the Action Area

Gulf sturgeon catch in the Apalachicola River in the early 1900s ranged from about 9,000 to 27,000 kg/year (U.S. Commission of Fish and Fisheries 1902; Huff 1975). The fishery declined to minimal levels by 1970 (Barkuloo 1987), and in 1984, the State of Florida prohibited all Gulf sturgeon fishing (Rule 46-15.01, Florida Marine Fisheries Commission). The Services (USFWS and NOAA) listed the species as threatened in 1991.

Studies to estimate the size of the Gulf sturgeon population below Woodruff Dam have been conducted periodically since 1982. Researchers noted that Gulf sturgeon congregated in the area immediately downstream of Woodruff Dam during the summer months, with little movement out of area during their residency, which provided an opportunity for relatively unbiased population estimates using capture/recapture methods. Population sizes from these studies have ranged from a low of 62 fish in 1989 to 350 fish in 2004 (Wooley and Crateau 1985; Zehfuss *et al* 1999; USFWS Annual Report 1983-2005). Our attempts to repeat these estimates in 2005 and 2006 were not successful due to low capture rates.

Gulf sturgeon radio tagged in 2004 were located below the dam during the spring of 2005 and 2006 during studies to locate spawning sites. However, most of these fish did not remain near the dam for the summer period. For reasons unknown at this time, sturgeon are selecting alternate summer habitats elsewhere in the system, such as the Brothers River. A number of telemetered sturgeon did not migrate upstream to Woodruff Dam in the spring of 2005, and instead entered the Brothers River, remaining there until the fall downstream migration.

The Gulf sturgeon population in the Apalachicola River appears to be slowly increasing relative to levels observed in the 1980’s and early 1990’s (Pine and Allen 2005). The majority of sampling in the Apalachicola River has occurred below Woodruff Dam which is one of several known population aggregation areas within the Apalachicola River system (Wooley and Crateau 1985, Zehfuss 2000). Since 2001, we have captured and tagged 440 sturgeon in the Brothers River (USFWS Annual Reports 2001 through 2005; F. Parauka, USFWS, personal communication 2006). Pine and Allen (2005) suggest that a monitoring program for the Apalachicola Gulf sturgeon population should rely upon a sampling scheme that includes sites, such as the Brothers River, as well as the established site at Woodruff Dam.

3.5.2 Fat threeridge

3.5.2.1 Current Distribution in the Action Area

Eighty-four percent of the currently occupied range of the fat threeridge (111.2 out of 132.5 river miles) falls within the action area of this consultation. The range outside the action area was believed to be entirely within the Chipola River upstream of Dead Lake; however, the Service recently received reports of live specimens collected in the Flint River. Known locations of fat threeridge in the action area are displayed in Figure 3.5.2.1.A. Brim Box and Williams (2000), Miller (2005), and EnviroScience (2006) have surveyed the river for freshwater mussels, but due to the nature of mussel surveys, it is not possible to search all areas that may support mussels.

The fat threeridge has been recently collected near the tailrace of Woodruff Dam (RM 106) and at various locations downstream to RM 15.3 on the south end of Bloody Bluff Island (USFWS unpubl. data 2006). Most detections of the species are between RM 60 and RM 21 (Figure 3.5.2.1.A). Results of extensive sampling in the Apalachicola system in 2005 confirm that the fat threeridge is locally common in the Apalachicola River from RM 44 to 26, the Chipola River and Chipola Cutoff, and Swift Slough (EnviroScience 2006a). It was also detected in Kennedy Creek and in the inflow of Brushy Creek Feeder B (EnviroScience 2006a; FFWCC 2006). Of note, the fat threeridge was once abundant at the shoal located near RM 105; however, live specimens have not been collected there since 1981 (USFWS unpubl.data 2006).

The fat threeridge is generally found at water depths less than 5 ft in the Apalachicola River (Miller 2005; EnviroScience 2006a; EnviroScience unpubl data 2006). Miller (2005) found that it was most abundant at depths ranging from 3 to 5 ft (highest abundance at 4 ft). It was much less common in waters deeper than 5 ft and shallower than 3 ft. EnviroScience (2006a) found most fat threeridge within 5 m of the shoreline at depths less than 5 ft. Both of these surveys (Miller 2005; EnviroScience 2006a) were conducted at discharges generally greater than 9,000 cfs; however, similar patterns of fat threeridge distribution depths are also observed when flows are much lower (about 5800-6000 cfs). EnviroScience sampled a main channel location (RM 46.8) on 7 August 2006, finding a majority of the fat threeridge at about 3 ft deep and 99% at depths of less than 4 ft (EnviroScience unpubl data 2006). Because the fat threeridge was found at similar depths at various flows, it likely prefers depths of less than 4-5 ft, and moves to maintain these depths in response to changing river stage.

As noted above, the fat threeridge is most abundant in the middle and lower non-tidal reaches of the Apalachicola from about RM 44 to 26, including the Chipola Cutoff and Swift Slough distributaries. This reach has been undergoing substantial morphological changes in recent years (see section 3.2). In the summer of 2006, thousands of fat threeridge were exposed in portions of this reach during low flows, which resulted in a die-off on a scale never before observed on the Apalachicola River.

We conducted a limited survey of listed mussels in the middle and lower non-tidal reaches of the Apalachicola River system from 14 June 2006 to 28 June 2006. The purpose was to document mussel mortality and strandings in areas with relatively large numbers of fat threeridge. We inspected four sites in the mainstem of the Apalachicola River, three sites in Swift Slough, and two sites in the Chipola Cutoff, respectively (Table 3.5.2.1.A). We measured the elevation of all mussels found relative to the current water surface elevation, noted the daily average gage height on the nearest gage to each site, and estimated the Chattahoochee gage flow equivalent to these elevations using stage/discharge relationships in Light *et al.* (2006). We found mussels at stages equivalent to less than 4,500 cfs (the lowest flow given in these relationships) to as high as about 10,000 cfs.

At one main channel location (site Z142; RM 43.7; Table 3.5.2.1.A), we ovserved thousands of fat threeridge in very hot and shallow water (5 to 10 cm). A clear sign of stress, many had recently expelled glochidia onto the substrate, and we observed several expel glochidia while we were there. Many were exposed on the shore, and those in the water were in a backwater situation with no flow. Concerned about their survival, we moved a total of 841 fat threeridge in 50 minutes of direct effort (CPUE = 1009.2; Table 3.5.2.1.A) about about 40 m upstream where the water was deeper and cooler. On this day, mean daily stage at the Wewahitchka gage (RM 42) was 12.51 ft (equivalent to Chattahoochee discharge of about 6400 cfs) (Light *et al.* 2006). Returning this site a few weeks later, measured water temperature was over 40°C (see Section 3.6.2.4 for more information on temperature and potential mortality and this location). We later observed female fat threeridge with expelled glochidia that were either exposed or in extremely hot and/or shallow water at two additional sites, one in the Chipola Cutoff (C156) and one in Swift Slough (Z203) (Table 3.5.2.1.A). We did not survey any locations outside the RM 50 to RM 40 reach for mussel strandings, except for the large rock shoal at RM 105, where we observed a few purple bankclimbers on low, but exposed portions of the shoal. No other areas of listed mussel strandings were reported to us.

Total length (TL) data taken during the USFWS survey indicated the mean total length of dead fat threeridge (61mm, about age-10) was significantly greater (Mann Whitney U; $p<0.0001$) than the mean TL of live fat threeridge (53mm, about age-7). The mean TL of exposed fat threeridge (62mm, about age-11) was significantly greater (Mann Whitney U; $p<0.0001$) than the mean TL of inundated fat threeridge (52mm about age-7). Haag and Staton (2003) reported that fecundity increases exponentially with size for a congener of the fat threeridge, *Amblema plicata,* which makes larger individuals particularly important for population maintenance.

Most of the mussel mortality due to low flow we observed was in the RM 50 to RM 40 reach of the river, and it was either in elevated side channels along the main channel of the river and Chipola Cutoff, or in Swift Slough. We considered several possibilities to explain why we observed so many fat threeridge, and other species, exposed or stranded in these areas during 2006. First, we considered whether these particular areas were sites of extraordinary recruitment during the past few years. Flows during the summer of 2006 were no lower than occurred only a few years ago from 1998 through 2002, at which time we did not observe a mussel die-off. The age-at-length data we aquired (see section 2.2.3.2), however, demonstrated that these side channel areas and Swift Slough were populated by a full range of ages, and that most would have been spawned before 2002.

Second, we considered the possibility of substantial mussel movement into these side channels and Swift Slough. The depth distribution data discussed earlier in this section strongly suggest that the fat threeridge moves in response to changing river stage, as it is found generally at depths of about 3 ft regardless of the stage at the time of the survey. River flows have not been less than 8,000 cfs except for very brief periods since the fall of 2002. Sustained higher flows for several years could account for a net movement of mussels from deeper portions of the main river into the elevated side channel areas along the main river and Chipola Cutoff, but would probably not account for the large numbers of mussels in the upstream-most mile of Swift Slough.

The third, and we belive most plausible explanation for the unprecedented mussel exposure in 2006 is the movement of a large amount of sediment in the main channel, and along with it, large numbers of mussels, during either of two extended periods of very high flow during 2005. The first event, in late March through early May, 2005, exceeded 50,000 cfs for 18 days, reaching a daily average discharge peak of 158,000 cfs. The second event, in July, 2005, exceeded 50,000 cfs for 15 days, reaching a daily average discharge peak of 112,000 cfs. Although the first event peaked higher than the second did, it may be more likely that large numbers of fat threeridge were moved onto higher portions of the streambed during the second event in July. The fat threeridge is reproductively active in the late spring and early summer (see section 2.2.3.3.1). Sexually mature animals necessarily come to the streambed surface to reproduce in late May and June, and we observed many at the surface in July 2006. di Maio and Corkum (1995) suggested that freshwater mussels withstand the scouring action of floods by burrowing deeper into the substrate. It is relatively more likely that the July 2005 flood moved the fat threeridge, as they would have already been near or at the surface for reproduction.

Our hypothesis is consistent with several observations:

1) In August of 2000 during low flow (< 6,000 cfs), the Service actively searched the RM 50 to RM 40 reach of the river for evidence of listed mussel exposure and stranding. We found none on the main channel and only a few dead fat threeridge and purple bankclimber in various tributaries and distributaries (USFWS letter to the Corps dated August 10, 2000).
2) In the same time frame, two experienced USGS mussel surveyors, assisted by personnel from the Service, Corps, and FFWCC, thoroughly searched the upstream-most 100 m of Swift Slough finding a total of 17 live fat threeridge.
3) Several thousand fat threeridge were found exposed in the same areas searched under 1) and 2) above in the summer of 2006 during comparable low flow conditions. These animals were readily apparent to anyone venturing into Swift Slough or along the stream margins of the main channel between RM 50 and RM 40. Estimated age of animals in these areas ranged from 1 to 98 years (see section 2.2.3.2), ruling out an alternative hypothesis that fat threeridge in the exposed areas represented recruitment following the last extended period of low flow during 2002.
4) Swift Slough and nearly all of the other locations on the margins of the main channel where mussels were exposed in this reach appear to have substantially aggraded (filled) with sediment in the period since flows were last as low as 6,000 cfs (2002). Swift Slough was connected to main channel at a flow of about 5,000 cfs during 2000, and is now disconnected from the main channel at a flow of about 5,600 cfs.

We found listed mussels exposed in 2006 at elevations associated with a Chattahoochee gage flow of as high as about 10,000 cfs. Some of these animals have survived in these areas by burrowing and by movement into local thermal refugia. Estimates of mortality varied by site and date of survey (range: 8 to 70%, USFWS unpublished data; EnviroScience unpublished data). We may expect further mortality among the survivors in the foreseeable future when flows are less than 10,000 cfs, especially if these flows occur during the warmer months of reproductive activity. If our hypothesis is correct about how these mussels came to be in areas that are so regularly vulnerable to exposure (flows less than 10,000 cfs occur in almost all years of the Chattahoochee gage record and flows less than 8,000 occur about 1 out of every 2 years), future high flow events could move yet more animals from the unstable main channel into shallow water habitats vulnerable to being exposed at low flows.

3.5.2.2 Population Status and Trends in the Action Area

At this time, we lack the data necessary for a population estimate of the fat threeridge in the entire action area. Much of the sampling in the Apalachicola River system has been qualitative and only catch per unit effort (CPUE) data is available. Surveys of the Apalachicola River system summarized in the Status of the Species Section (*e.g.*, USFWS 1998; Brim Box pers. comm. 1994; Williams pers. comm. 2000; Brim Box and Williams 2000; Richardson and Yokley 1996; Miller 1998; and Miller 2000), generally suggest that the fat threeridge occurs in a limited range, but within that range, is locally abundant. All recent surveys have reported evidence of recruitment in the main channel of the Apalachicola River (RM 44.3 and 46.8; USFWS unpubl. data 2006), Swift Slough (Williams pers. comm. 2000; EnviroScience 2006a; USFWS unpubl. data 2006), and the Chipola River and Cut (Miller 2005; EnviroScience 2006a; USFWS unpubl. data 2006).

The Corps surveyed areas in the vicinity of dredge disposal sites on the main channel from 1996-2002 and found that the fat threeridge was the fourth-most common species, representing 10% of the total individual mussels collected (mean CPUE/hr = 2.2) (Miller 2005). In surveys of sites selected specifically to find fat threeridge within the main channel during 2003, the fat threeridge was the most abundant species overall, representing about 36% of the total number of individual mussels collected (mean CPUE/hr = 13.6) (Miller 2005).

In 2005, a survey of listed mussels was commissioned by the Florida Department of Environmental Protection (EnviroScience 2006a). During qualitative surveys of over 160 sites in the Apalachicola and Chipola River system, the fat threeridge was also the fourth most common species detected (CPUE/hr = 6.5), comprising 25% of the total live individuals in both qualitative and quantitative samples. The greatest numbers of fat threeridge were found in relatively shallow habitats along channel margins, secondary channels, and the upstream-most segment of Swift Slough (28/m^2) (EnviroScience 2006a). In the Chipola River and Chipola Cutoff, fat threeridge were also found in deeper, but stable mid-channel habitats.

In June of 2006, the Service surveyed four main channel sites located between RM 48.3 and RM 43.7, three sites in Swift Slough, and two sites in the Chipola Cutoff. We found a total of 1284 fat threeridge (live and fresh dead) (mean CPUE/hr = 179.1) (USFWS unpubl. data 2006). Catch rates were generally highest in the main channel locations, where the mean CPUE/hr was 328.7. Catch rates were similar in Swift Slough and the Chipola Cutoff (mean CPUE/hr = 59.6 and 60.8, respectively). The upper portion of Swift Slough had higher CPUE than the locations further downstream (CPUE = 144.0 vs. 18.7 and 13.3, respectively; Table 3.5.2.1.A). This supports the theory that the mussels were deposited by high water, since most were deposited in the upstream-most areas and become less dense as you get deeper into the slough (D. Miller, pers. comm.).

By email sent August 8, 2006, EnviroScience (2006b) provided the Service a population estimate for the fat threeridge in Swift Slough based on data collected August 3 to August 7, 2006. The estimate applies to the upstream-most mile of the stream and not to the next half mile in which EnviroScience (2006a) found much lower numbers of fat threeridge during their previous survey in 2005. The population estimate methods followed Strayer and Smith (2003). The upper portion of Swift Slough was divided into 35 stream reaches of equal length (50m), from which 6 reaches (sites) were randomly selected. Four of the sites were sampled using quantitative systematic sampling with three random starts. The researchers could not apply systematic sampling at the other two sites, because suitable mussel habitat was limited to a narrow bank of habitat in deep (about 4 ft) pools. They applied semi-quantitative sampling at these sites and excluded these data from the population estimate. The four quantitative sample sites were each 50m by 9m = 450 m^2. The full channel area beneath bankfull elevation was not sampled, because most mussels occurred at elevations beneath the toe of the banks, which they estimate is inundated by flows of approximately 6000-6300 cfs (EnviroScience 2006b).

The density estimates for the fat threeridge at 4 sites on Swift Slough are presented in Table 3.5.2.2.B. The estimated abundance per sampled reach was used to calculate an average abundance estimate of 787 (462-1473 90% CI) fat threeridge per 50m reach. This abundance estimate was then multiplied by the 23 50-m reaches representing the upstream-most segment of Swift Slough for a population estimate of 18,101 (10,626 – 33,879 90% CI). This estimate excludes pool habitats, areas occupied outside of the upstream segment, and bed elevations above the stage associated with 6300 cfs at the Chattahoochee gage. All of these excluded areas contain some fat threeridge; therefore, the total number of fat threeridge in Swift Slough is likely greater than 18,101.

We recognize the high density of fat threeridge in Swift Slough. However, we believe that this is an anomaly related to a substantial export of individuals from the main channel of the Apalachicola during high-flow events that occurred between 2002 and the fall of 2005, most likely during July of 2005 (see section 3.5.2.1). The fat threeridge was present in Swift Slough during August 2000, the same time of year as the EnviroScience population estimate, but in low numbers. We found 17 animals in the upstream-most 100 m of the stream during a thorough search supervised by experienced mussel surveyors. This same segment now contains over 1,000 fat threeridge according to the EnviroScience estimates, with densities diminishing going downstream.

Our surveys in 2006, plus those of EnviroScience (2006) in 2005 and 2006, indicate that the fat threeridge is locally abundant, even more so than the Corps' surveys from 1998 through 2003 suggested (Miller 2005). If our hypothesis is correct that large numbers of the species were deposited in side channels and in Swift Slough by one or more high flow events during 2005 (section 3.5.2.1), these animals came from other portions of the main channel, portions that likely still support substantial numbers of the species. Even so, the mortality sustained in 2006 in the side channels and in Swift Slough exceeds the estimated 18% natural annual mortality that is evident from our catch-curve analysis of animal age-at-length data collected from these areas (section 2.2.3.2). At this time, therefore, we believe the current population trend for the fat threeridge is declining. Although the 2006 impact is substantial, we believe the species will survive it. We described in the section 2 of this BO how most recent surveys of this species have detected evidence of recent recruitment, and how our analysis of shell lengths suggests a relatively normal age structure and annual survival rate leading up to 2006. These observations, plus the large portion of its extant range that is not so severely affected by the combination of low flow and channel instability, suggest to us that the fat threeridge will be able to recover from this impact. Unless the circumstantces leading to the 2006 die-off are repeated soon, we believe the species could return to a stable or increasing trend in the foreseeable future.

3.5.3 Purple bankclimber

3.5.3.1 Current Distribution in the Action Area

About 23% of the currently occupied range of the purple bankclimber (104.6 river miles) falls within the action area of this consultation. Known locations of the purple bankclimber are displayed in Figure 3.5.2.1.A. It has been recently collected in the main channel of the Apalachicola River from the Woodruff Dam (RM 106) downstream to about RM 17.7. It has also been collected in Swift Slough, River Styx, a distributary that flows into Brushy Creek, and the Chipola Cutoff, but not in the Chipola River proper (USFWS, unpubl. data 2006; EnviroScience 2006a; FFWCC 2006).

3.5.3.2 Population Status and Trends in the Action Area

We do not have population estimates for the purple bankclimber in the action area or a length-at-age relationship from which to infer population structure, annual survival rates, or year class strength. Like the fat threeridge, most of the sampling has been qualitative and only catch per unit effort (CPUE) data is available. In addition to the surveys of the Apalachicola River system summarized in the Status of the Species Section (*e.g.,* Heard 1975; Brim Box and Williams 2000; USFWS 1998; Miller 1998, Miller 2000; Richardson and Yokley 1996), recent survey data suggest it is perhaps the rarest member of the Apalachicola River mussel fauna. It represented less than 2% of the Corps' survey findings from 1996 to 2002 (Miller 2005), and 1% of the EnviroScience (2006a) survey findings in 2005, half of which were detected at a single location. The species represented much less than 1% of our survey in 2006 (USFWS unpubl data 2006).

While recent surveys have documented fat threeridge recruitment, we are aware of only one report of a relatively small (size class 75-96 mm) purple bankclimber collected recently in the action area (in the Chipola Cutoff, EnviroScience 2006a), which suggests either poor reproductive success or sampling methods that are not suited to detecting juveniles of this species. 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 (Brim Box and Williams 2000; EnviroScience 2006a), which are more difficult to sample. EnviroScience (2006a) expressed the view that deep-water habitat with stable substrate is rare in the Apalachicola River. We analysed records provided by the Corps that list dredged volumes by navigation mile each year from 1957 to 2001 as a possible means to substantiate this view. Areas that do not require maintenance have at least a 9- to 11-ft by 100-ft wide central channel (the dimensions of the authorized navigation channel) relative to the reference flow used for dredging purposes. The Corps' records show that since 1992, 84.1 miles of the 105.4 miles between Woodruff Dam and RM 1.0 received no dredging. It is our view that portions of the river contain deep-water habitat in relatively stable condition, but that these areas have been inadequately sampled for listed mussels.

3.5.4 Chipola slabshell

3.5.4.1 Current Distribution in the Action Area

Researchers have only recently documented this species in the action area (Figure 3.5.2.1.A). In 2005, one individual was collected in the Chipola River about 2.3 river miles downstream of its junction with the Chipola Cutoff (EnviroScience 2006a). Eight individuals were collected immediately downstream of Dead Lake (outside of the action area) in 1991 (Brim Box and Williams 2000), but before that, the Chipola slabshell was known only upstream of Dead Lake in the Chipola River Basin. The Service is presently funding a mussel survey to determine the current status and distribution of the Chipola slabshell (and other species) in the Chipola Basin. If we assume that its range may include the full length of the Chipola River that is downstream of Dead Lake, the portion within the action area (13.8 river miles) would represent 14% of the total range of the Chipola slabshell.

3.5.4.2 Population Status and Trends in the Action Area

Only one individual Chipola slabshell has ever been collected in the action area (EnviroScience 2006a). Lacking any evidence whatsoever of other animals or of reproduction in the action area, the species is at best stable in the action area.

3.6 Status of the Critical Habitat within the Action Area

This portion of the environmental baseline section focuses on the designated and proposed critical habitats for the listed species, describing what we know about the physical and biological features that are essential to the species' conservation within the action area.

3.6.1 Gulf sturgeon

The Apalachicola is one of seven rivers known to support a reproducing subpopulation of the Gulf sturgeon (see "Status of the Species/Critical Habitat" section). The species has been reported in several other rivers that are not known to support reproduction, such as the Mobile River in Alabama and the Ochlockonee River in Florida, but among the seven spawning rivers, the Apalachicola is the largest, as measured by average annual discharge and by basin drainage area. The seven spawning rivers have been designated critical habitat for the Gulf sturgeon. The Apalachicola River critical habitat unit encompasses 173.65 river miles entirely within the action area of this consultation, which accounts for 10% of the river miles included in all seven riverine critical habitat units.

Most Gulf sturgeon of the Apalachicola subpopulation age 1 and older likely feed during some part of the year in Apalachicola Bay, which is also designated critical habitat for the species. The Apalachicola Bay estuarine unit encompasses 168,708 acres. Because the ecology of the bay is strongly influenced by freshwater inflow from the river, we include all portions of the estuarine unit in the action area. The Apalachicola Bay unit represents 12% of the estuarine acres designated as critical habitat for the species.

Because the action area includes both riverine and estuarine critical habitat, it may contain all of the principal constituent elements (PCEs) that we determined are features essential to the species' conservation. The following is a summary of what is known about the status of these PCEs in the action area.

3.6.1.1 Food items

> *Abundant food items, such as detritus, aquatic insects, worms, and/or mollusks, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, mollusks and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages.*

The status of food items for the Gulf sturgeon in both the river and bay is important. The Gulf sturgeon is a benthic (bottom dwelling) suction feeder. The type of invertebrates ingested vary by age and by habitat, which ranges from riverine to estuarine to marine waters of the Gulf. As described in Section 2.1.3.1, the following food resources are important to the Gulf sturgeon in the Apalachicola River and Bay: a) riverine freshwater insect larvae and detritus by young-of-the-year (YOY), b) aquatic insects (*e.g.,* mayflies and caddisflies), worms (oligochaetes), and bivalve mollusks by juveniles at the mouth of the estuary and suitable areas of the Bay, c) amphipods, lancelets, polychaetes, gastropod mollusks, shrimp, isopods, bivalve mollusks, and crustaceans by adult sturgeon when in marine and estuarine waters.

Age 1 fish and older most likely feed primarily near the mouth of the river and in the bay. Apalachicola Bay is shallow, averaging 1.8 to 2.7 m in depth. Soft muddy substrates comprise about 78% of the open water zone with the remainder divided between oyster reefs and sandy sediments with submerged aquatic vegetation (Livingston 1984). Livingston (1983) reported that the polychaete worm was the most abundant infaunal species found in the sediments of the Apalachicola Bay estuary during the winter months.

The Florida Department of Environmental Protection (FDEP) (2000) conducted a benthic mapping study of Apalachicola Bay in 1999, finding that that polychaetes, bivalves, gastropods and amphipods dominated the total abundance. All of these organisms may serve as food items for Gulf sturgeon. This study noted that salinity was negatively correlated with average abundance and biomass of infaunal organisms, but positively correlated with average richness of infaunal organisms. Silty bottom areas had the lowest species richness, diversity, biomass and abundance. The study developed a benthic habitat quality (BHQ) index based on infaunal successional stages, with values greater than or equal to 5 indicating high-quality habitat. The BHQ for silt and sand (infauna subclass) were calculated at 6.0 and 6.9, respectively (FDEP *et al.* 2000).

The food resources for Gulf sturgeon in Apalachicola River (Unit 6) and Bay (Unit 13) appear to be adequate to support the population at this time. An investigation of juvenile sturgeon of the Apalachicola system is underway that will provide some additional information about prey for this life stage. There have been no studies to determine if the diversity, abundance, or distribution of benthos is affected by changes in salinity regime due to changes in the riverine flow characteristics.

3.6.1.2 Riverine spawning sites

> *Riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone, or hard clay;*

Two sites are known to support Gulf sturgeon spawning in the action area in the upstream-most 7 miles of the Apalachicola River; a rough limestone outcrop at RM 105 and a smooth consolidated clay outcrop at RM 99. The Service cooperated with the Corps to characterize habitat conditions at these two sites and eight others that contain substrate potentially suitable for spawning, which we collectively refer to as “hard bottom”. Figure 3.6.1.2.A is a map of the river showing the locations of the ten “hard bottom” sites, which all occur between Woodruff Dam and the State Highway 20 Bridge near Blountstown and Bristol, FL. Collectively, these ten sites contain about 117 acres of potentially suitable sturgeon spawning substrate, including an area of about 30 acres within which Gulf sturgeon eggs have been collected (Pine *et al.* 2006; USFWS unpublished data 2005). Depending on the site, the hard-bottom substrate spans a range of channel elevations from near the thalweg (deepest point on the cross section) to near the crest of the bank, and is generally located on one side of the channel only. The availability, and likely the suitability, of hard-bottom areas for spawning varies with flow, *i.e.*, more of the hard-bottom habitat is inundated at higher flow and less at lower flow. We discuss the role of flow in providing spawning habitat in greater detail below under “Flow Regime”.

The status of this constituent element is stable. A portion of the historic hard bottom habitat was removed to improve the navigation channel. No additional removal is planned. The limestone habitat is affected by sedimentation at medium to low flows, but is generally swept clean again following high flows. At this time, we are unaware of specific spawning habitat alterations in Unit 6 that may limit the ability of the designated critical habitat to function for the conservation of the species.

3.6.1.3 Riverine aggregation areas

> *Riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during fresh water residency and possibly for osmoregulatory functions.*

Wooley and Crateau (1985) reported that Gulf sturgeon occupied the area immediately downstream of Woodruff Dam during the summer months. This area was the deepest available in the upstream-most 15.5 mi of the river, with a mean depth of 27.6 ft. They monitored movements of 15 radio-tagged Gulf sturgeon in this reach from May through September, 1983, finding that all remained within 0.5 mi of the dam. Whether this site, at the confluence of the Flint and Chattahoochee Rivers, was a summer aggregation area before dam construction in the 1950s is unknown. Odenkirk (1991) also found that radio-tagged sturgeon showed a strong tendency to remain immediately downstream of the dam during the summer. Zehfuss *et al.* (1999) reported temporary emigration from the area near the dam of about 25% of the radio-tagged sturgeon.

Recently, use of the summer aggregation site near the dam has decreased and use of a site about 10 km upstream on the Brothers River has increased (F. Parauka, pers. comm., Pine *et al.* 2006). The substrate at this site consists of sand, mud, clay, and detritus with depth ranging from seven to 14 m.

The Brothers River is also an important fall pre-migration Gulf sturgeon "staging area". Gulf sturgeon captured at the dam and fitted with radio tags were tracked to the Brothers River during the fall downstream migration, where they remained for up to 24 days before moving further downstream (Wooley and Crateau 1985; Odenkirk 1991). Congregation areas in the Brothers River had a sand and clay substrate and average depth of 36 ft. (Wooley and Crateau 1985).

It is unknown if some factor has caused the reduced use of the summer aggregation area at the dam. Habitat in this area changes significantly following significant flood events such as occurred in May and July 2005. A shallow bar downstream of the dam is formed and degraded regularly. These changes in channel morphology could affect the extent of use of the site as summer habitat for the sturgeon. Little is known about the historic conditions of the Brothers River sites, but these sites are thought to be relatively stable. At this time, we are unaware of specific alterations to riverine aggregation areas in Unit 6 that may limit the ability of the designated critical habitat to function for the conservation of the species.

3.6.1.4 Flow regime

> *A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, and staging, and for maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larval staging;*

At this time, our ability to quantify the relationship between flow and these life history requirements in the Apalachicola River is limited to spawning habitat availability. We rely upon information from other systems and qualitative information about the role of the flow regime to infer possible effects of flow regime changes to other sturgeon life history requirements.

To review the status of the flow regime relative to Gulf sturgeon spawning habitat, we evaluated depths at the known spawning locations at various discharges. The range of depths at which eggs have been collected on the Apalachicola River was 7.5 to 20.1 ft (median 11.4 ft) in 2005 (USFWS unpublished data); and 5.9 to 21.3 ft in 2006 (median 11.8 ft) (Pine *et al.* 2006) (Figure 3.6.1.4.A). The similarity in these two years of Apalachicola depth data is remarkable, considering that the median daily river stage during the 2005 egg collection period was 6.5 ft higher than during the 2006 egg collection period. River flow from the date of first to the date of last egg collection in these two studies barely overlapped (range: 20,400 to 37,400 cfs in 2005, and 12,700 to 22,400 cfs in 2006).

Most of the Apalachicola River sturgeon spawning data (110 out of 117 egg collection events) come from one site, a large limestone outcrop located within sight of Woodruff Dam at RM 105. A second site at RM 99, downstream and within sight of the Highway I-10 bridge, was sampled in both 2005 and 2006, but eggs were collected only in 2006 (Pine *et al.* 2006). Because sturgeon spawned at the same site at comparable depths during 2005 and 2006 under very different flow conditions, they were necessarily using different portions of the river cross section at that site. Figure 3.6.1.4.B shows one of the Corps/USFWS cross sections at the RM 105 spawning site (transect 7 of 10). This cross section is one of three that is within 250 ft of multiple egg collection locations in both 2005 and 2006 (USFWS unpublished data 2005; Pine *et al.* 2006). This cross section is fully inundated at a flow of approximately 15,000 cfs. Figure 3.6.1.4.B notes the range of bed elevations at which eggs were collected within 250 ft of this cross section in the two years. The location and depth of these egg collections indicates that sturgeon used higher portions of the rock shoal in 2005 when flow was higher, and lower portions in 2006 when flow was lower. No eggs were collected in areas that were less than 7.5 ft deep in 2005 and less than 5.9 ft deep in 2006. Egg sampling pads deployed to capture eggs spawned in areas shallower than these depths captured fine sediments instead. No eggs were collected in 2005 in the lowest/deepest portions of the two areas sampled (RM 105 and RM 99), where egg sampling pads were repeatedly carried away by the strong mid-channel current, despite the use of large grapnel-type anchors.

Water velocity was not systematically measured at egg collection locations during 2005, but was during 2006. The range of velocities reported was 0.8 ft/sec to 3.5 ft/sec (median 2.5 ft/sec) (Pine *et al.* 2006). Water velocity is likely an important variable that influences substrate suitability for spawning, and higher flows preceding spawning may remove accumulated fine sediments on hard-bottom substrates that could smother eggs. A hydraulic simulation capability for the sturgeon spawning sites is not available to the Service at present to describe spawning habitat availability over a range of flows as a function of velocity, depth, and substrate. At this time, we must use depth and substrate only for that purpose.

The range of depths at which Gulf sturgeon eggs were collected in the Apalachicola River was relatively broad (5.9 ft to 21.3 ft, Figure 3.6.1.4.A). The fish used higher elevations on the river bed for spawning under higher flows in 2005, and lower elevation areas under lower flows in 2006, but the median depth used in both years was about 11 ft. Excluding the deepest 10% and shallowest 10% of the egg collection depths as outliers, the range of spawning depths observed at the site used in both 2005 and 2006 (RM 105) combined (n = 110) is 8.5 to 18.0 ft (median = 11.8 ft).

We applied this depth range to bathymetric and substrate surveys of the ten potential spawning habitat sites shown in Figure 3.6.1.2.A in order to describe the relationship between flow and spawning habitat availability. In 2003 and 2004, the Service and the Corps cooperatively surveyed 3 to 12 cross sections at each of these sites, which included the sites at RM 105 and RM 99 that were later confirmed as spawning sites in 2005 and 2006. These cross sections, a total of 72 altogether, were placed about 300 ft apart so as to span the full longitudinal extent of the hard substrate at each site. We measured the bottom elevation every 3 to 10 ft and collected 3 to 6 bottom samples on each cross section to map the approximate depth and extent of the hard substrate on the cross section. We classified the substrate as potentially suitable for spawning if the sample contained only trace amounts of sand or finer material. Suitable substrates included clean limestone bedrock, cobble, gravel, and a consolidated hard clay-like material.

By attributing the depth and substrate characteristics on each cross section to half the distance upstream and downstream to the adjacent cross sections, we estimated the area of hard bottom at each site. We used the elevation vs. discharge relationships contained in Light *et al.* (2006) to estimate the area inundated at each site at flow rates of 4,500 to 50,000 cfs, in 500-cfs increments, and at higher flow rates in broader increments. Figure 3.6.1.4.C shows the acreage of hard-bottom habitat at the RM 105 and RM 99 spawning sites that is inundated by this depth range at flows from 4500 to 50,000 cfs. Figure 3.6.1.4.D shows the same relationships for the other eight sites surveyed. The documented spawning sites have a greater amount of hard bottom available at a larger range of flows than the other eight sites.

Gulf sturgeon migratory movements within and into/out of the Apalachicola River may be influenced by flow; however, we have no direct evidence that either extreme high-flow events or extreme low-flow events preclude migration. Flow may affect habitat availability or suitability for young-of-the-year (YOY) fish in the river; however, we have no data that would describe the relationship or a threshold flow below or above which adverse effects may occur. High flow could conceivably wash away eggs, larvae, and YOY of limited mobility; however, the extreme roughness of the limestone outcrop at the site (RM 105) that has been twice documented as a spawning site likely provides a refuge from high velocity within its many crevices and voids. For example, at one location where sturgeon eggs were collected from a depth of 14.1 ft on May 2, 2005, the water velocity 1 ft below the water surface was 3.8 ft/sec and was 0.4 ft/sec 1 ft above the river bed (USFWS unpublished data 2005). Hoover *et al.* (2005) observed that small pallid sturgeon could maintain position for prolonged periods in flume experiments against velocities of 0.98 to 1.87 ft/sec.

For hard-bottom sites to remain suitable as spawning habitat, especially the rough limestone-bed site at RM 105, periodic high-flow events are likely necessary to remove sediments that settle on the substrate during lower flow. Such high flows may or may not exceed the flows that sturgeon find suitable for spawning behavior. We have observed substantial vegetation growth on the limestone shoal at RM 105, for example, rooted in accumulated sediments on the exposed rocks in the summer time, and then observed the same areas devoid of vegetation the following spring, presumably scoured away during intervening high flows.

Changes in the flow regime are discussed in Section 3.3. As discussed above this variability is important to some aspects of the life history of the sturgeon. The documented spawning habitat is available to the species at a wide range of discharges that are common in the spring. At this time, we are unaware of specific flow regime alterations to Unit 6 or Unit 13 that may limit the ability of the designated critical habitat to function for the conservation of the species.

3.6.1.5 Water quality

> *Temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages*

We summarized under section 3.4 above the water quality data available to us that are pertinent to this element of Gulf sturgeon habitat in the action area. Reported water quality impairment in some reaches that may adversely affect sturgeon include low dissolved oxygen (DO) and excessive unionized ammonia. We do not expect low DO to affect the Gulf sturgeon in the action area, as reported incidences have been limited to certain creeks, distributaries, and backwater areas (FDEP 2002). Elevated unionized ammonia levels have adverse effects on fish species, including strugeon (Dahlberg *et al.* 1968; Isely and Tomasso, 1998). However, the observed violations of unionized ammonia levels in the action area are relatively minor exceedances of a State of Florida water quality standard for freshwater systems, one which closely approximates criteria recommended to the USEPA for protection of aquatic life (Augspurger *et al.* 2003).

As an anadromous fish, the Gulf sturgeon is adapted to life in both fresh and saline waters; however, juvenile fish 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 (Altinok *et al.* 1998). Estuarine and later marine habitats provide the primary feeding areas for the species at some point during the first year hatching (see section 2.1.3); therefore, the salinity regime of Apalachicola Bay is likely an important factor in defining juvenile feeding habitat. River flow, along with winds, tides, and local rainfall runoff, controls the salinity of Apalachicola Bay (Livingston 1984).

Using data collected in the bay during 1985 and 1986, two relatively low-flow years, Livingston *et al.* (2000) developed a spatially explicit hydrodynamic circulation model of the bay that predicts salinity, among other variables, as a function of freshwater inflow. Salinity at most locations in the bay measured and predicted exceeded 10 ppt most of the time, except when river discharge was at its highest levels during these low-flow years. Extended duration of high salinity in the estuarine environment is ecologically significant, because aquatic organisms widely differ in their salinity tolerance. More variable salinity favors those with the widest tolerance, and less variable salinity favors those with narrower tolerance.

Juvenile Gulf sturgeon, at least during their first year of life, are among the aquatic biota for whom periods of extended salinity less than about 10 ppt would likely limit feeding habitat availability. Examining the results of Livingston *et al.* (2000), it is apparent that periods of high salinity (>10 ppt) in 1985 and 1986 were generally associated with flows less than about 16,000 cfs at the Chattahoochee gage, a condition that persisted for most days of both years. To determine whether this condition is more or less common in the post-West Point period than the pre-Lanier period, we computed the annual maximum number of consecutive days less than 16,000 cfs (Figure 3.6.1.5.A). The post-West Point period shows a noticeable shift towards longer periods of uninterrupted low flow, with a median of 137 days, compared to 110 days during the pre-Lanier period, which is a 25% increase that has probably resulted in reduced availability of low-salinity bay habitat.

Water temperature is relevant to Gulf sturgeon migratory movements and particularly to spawning. Gulf sturgeon spawning in the Apalachicola occurs in the spring when water temperature rises to between about 17-25 °C. Using water temperature data from the

Chattahoochee gage summarized in section 3.4 (Figure 3.4.A), the mean date by which water temperature rises to 17°C is March 26 (range: January 23 to April 14) and to 25 °C is May 23 (range: May 12 to June 29). Based on the average dates, Gulf sturgeon spawning potentially encompasses a 58-day period.

At this time, the status of the water quality PCE of Gulf sturgeon critical habitat in Units 6 and 13 is not pristine, but we believe it does not likely limit the ability of the designated critical habitat to function for the conservation of the species. We are not aware of water quality impairments that have resulted in death, injury, or reduced growth and reproductive success to Gulf sturgeon in this system, and the Apalachicola population appears to be slowly increasing (see section 3.5.1.2).

3.6.1.6 Sediment quality

> *Texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages*

The sturgeon's riverine habitat in the action area is predominantly sandy, with some rock outcrops and gravel in the upper reaches of the river, becoming progressively finer materials (more silt and clay) in the lower reaches. The main channel of the river is mostly sand. Sediments covering most of the bottom of the bay (about 80% of the bay area) are characterized as soft mud; however, most adult and sub-adult Gulf sturgeon feeding activity appears to occur in sandy substrates, which are relatively uncommon in Apalachicola Bay. It is therefore quite possible that the species will exploit somewhat different habitat types in this system than in other systems. Sediment pollution in Apalachicola Bay is relatively low in comparison to other bay systems in the area (USDOC 1997). Since most pollutants attach to finer sediments, sediment quality in the predominantly sandy substrates of the river is probably high.

At this time, we are unaware of specific sediment quality alterations to Unit 6 or Unit 13 that may limit the ability of the designated critical habitat to function for the conservation of the species.

3.6.1.7 Safe and unobstructed migratory pathways

> *Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage)*

Pathways for Gulf sturgeon of the Apalachicola River are affected by activities in the river and bay and by Woodruff Dam. To avoid the possibility of sturgeon disturbance or entrainment in hydraulic dredge equipment, the Corps delayed the start of channel maintenance until after May 31 each year, when the sturgeon spawning season is most likely concluded. Dredging in the river has not occurred since 2001. The navigation channel leading from the mouth of the river to Sikes Cut (a man-made pass across St. George Island between the Bay and the Gulf) has been dredged several times in recent years. Another navigation channel within the Bay, the Two Mile project, which parallels the bay shore to the west of the town of Apalachicola, was dredged a few years ago. As yet, no sturgeon mortality or injury has been associated with the maintenance of these channels. The death of one juvenile sturgeon is attributed to use of the river navigation channel resulting from propeller injury by a passing barge tug boat in the lower river in 2004. Woodruff Dam limits the upstream movement of Gulf sturgeon to historic habitats. Studies of passage alternatives are ongoing.

At this time, we are unaware of any other ongoing hazards or obstructions that may limit migratory movements within the Units 6 and 13. Most activities in the river and bay can be scheduled to avoid affecting migration. We have determined that access to historic spawning habitats upstream of Woodruff Dam is not essential to the conservation of the species.

3.6.2 Mussels

The three species of freshwater mussels that we address in this BO were listed at the same time with four other species in 1998. The Service has likewise proposed critical habitat for these seven mussels in a single FR notice issued earlier this year (71 FR 32746). The entire length of the Apalachicola unit proposed as critical habitat for the fat threeridge and purple bankclimber is within the action area. The downstream-most 13.8 miles of the Chipola unit proposed as critical habitat for the fat threeridge, purple bankclimber, and Chipola slabshell is within the action area. The action area contains all of the Primary Constituent Elements (PCEs) that we described as features of occupied critical habitat that are essential to these species' conservation. The following is a summary of what is known about the status of these PCEs in the action area.

3.6.2.1 Channel Stability

> *A geomorphically stable stream channel (a channel that maintains its lateral dimensions, longitudinal profile, and spatial pattern over time without an aggrading or degrading bed elevation);*

Studies of freshwater mussels have found that mussel distributional patterns are influenced by river bed stability (e.g. Vannote and Minshall 1982; Strayer and Ralley 1993; di Maio and Corkum 1995). Generally, mussels can withstand some changes in the river bed due to floods by burrowing deeper into the bed (di Maio and Corkum 1995).

We summarized in section 3.2 observed channel morphology changes in the Apalachicola River. The overall amount of stable riverine habitat available for the listed mussels varies from year to year due to the dynamic nature of the river. Entrenchment following dam construction and various activities associated with the federal navigation channel, such as dredging, snagging and the construction of dike fields, changed channel stability, and probably reduced habitat availability for the fat threeridge, as it is now absent or rare in the upstream-most 30 miles of the river. In the RM 50 to RM 40 reach, including the Chipola Cutoff, and Swift Slough, channel instability most likely explains a substantial recent redistribution of sediments and mussels, which resulted in unprecedented mussel mortality during low flow in the summer of 2006. The long-term effects of the channel instability in this reach are unknown.

On the River Kerry in Scotland, Hastie *et al.* (2001) found that a large number of mussels were moved and killed following a flood of record. However, upon further inspection of previously surveyed sites, they found that most of the mussel population had survived, and that mortality was highest in geomorphically unstable portions of the river. Predicting what would happen to the population overall was not possible as fauna depleted by major floods often take many years to recover (Goldman and Horne 1983 as cited in Hastie *et al*. 2001).

We do not yet have data to determine the fraction of the total listed mussel populations in the action area were affected by exposure in 2006. We believe that the reach between RM 50 and RM 40 is still susceptible to a substantial redistribution of sediments and mussels during future high-flow events. However, most of the river does not likely share this characterization. The Corps' dredging records show that since 1992, 84.1 miles of the 105.4 miles between Woodruff Dam and RM 1.0 received no dredging, suggesting that these portions of the river transport the sediment they receive without substantial aggradation.

Many changes in the channel affect individual mussels, but conservation of the species depends on sufficient stable instream habitat. Strayer (1999) suggested that mussels might generally be found in areas that are stable at flows with 3 to 30 year recurrence intervals. Morales *et al.* (2006) developed a model to predict substrate stability that coincided with reported mussel locations. They noted that large areas that seemed stable under low flow conditions have active sediment motion at high and medium flows that would render the locations unsuitable for mussels. They hypothesized that annual peak flows most often limit the spatial distribution of freshwater mussel communities. We have noted previously that high flows during 2005 likely redistributed large numbers of the fat threeridge in the RM 50 to RM 40 reach of the river. Using the concepts developed by Morales *et al.* (2006) for a portion of the Upper Mississippi River suggests to us that some areas have remained stable on the Apalachicola following high flows and support mussels. We believe that the sites where we observed mussels not associated with the depositional side channels and hooks and bays are these more stable sites. We suspect that the observed changes in annual peak flows have reduced the available stable habitat, but the relative amount is unknown. Additional channel morphology and sediment transport studies of of the Apalachicola are needed to estimate the amount of stable habitat and how it changes with changes in flow regime.

The river channel in Unit 8 appears to be continuing to change (Light *et al*. 2006; Price *et al.* 2006) as the river seeks dynamic equilibrium. However, at this time, we are unable to quantify the amount of stable habitat or the rate of change that might change the status of the mussel beds found in the most stable instream areas of the river. Based on the species persistence in the river during past periods of instability affecting the entire river, we believe that sufficient stable instream habitat exists in the mainstem of Unit 8 for the conservation of the species. There is no specific information available for Unit 2; however, we are unaware of any factors that may change channel stability and limit the ability of the proposed critical habitat to function for the conservation of the species.

3.6.2.2 Substrate

A predominantly sand, gravel, and/or cobble stream substrate.

Substrate used by the fat threeridge varies from gravel to cobble to a mixture of sand and sandy mud (Williams and Butler 1994), and it is found mostly in depositional situations with slow to moderate current within the stream channel (Butler 1993). Brim Box and Williams (2000) found 60% of the specimens were located in a sandy silt substrate. It is possible that channel entrenchment in the upper river may have reduced the depositional areas favored by this species.

The purple bankclimber inhabits sand or sand mixed with mud or gravel substrates in portions of the channel with slow to moderate current (Williams and Butler 1994). Over 80% of the specimens located during the ACF Basin status survey were found at sites with a substrate of sand/limestone (Brim Box and Williams 2000). These collections were often in waters over 10 ft in depth.

The Chipola slabshell inhabits silty sand substrates in portions of the channel with slow to moderate current (Williams and Butler 1994). Specimens are generally found in sloping bank habitats. Nearly 70% of the specimens found during the status survey were associated with a sandy substrate (Brim Box and Williams 2000).

At this time, we are unaware of specific substrate alterations to Unit 8 or Unit 2 that may limit the ability of the designated critical habitat to function for the conservation of the species.

3.6.2.3 Permanently flowing water

Permanently flowing water.

The main channel of the Apalachicola River has consistently contained permanently flowing water, but loop streams, backwaters, tributaries, and distributaries require specific discharges to retain connectivity to the main channel. Flowing water is important because it transports food items to the sedentary juvenile and adult life stages, provides oxygen for mussel respiration, and with enough depth, it provides protection from terrestrial predators. Flowing water is also likely essential for reproduction through suspension of glochidia or conglutinates (O'Brien and Williams 2000). Above normal flows can affect overall recruitment and where juvenile mussels settle (Hardison and Layzar 2001). The magnitude and duration of flows can have a long-term effect on population dynamics (van Note and Minshall 1982; di Maio and Corkum 1995).

This constituent element is also necessary for host fishes that spawn in the floodplain. According to Light *et al.* (1998; 2006) and analyses presented in this Biological Opinion (see Section 3.3 Flow Regime Alterations), the frequency and duration of main channel-floodplain disconnections has increased over time, and these disconnections are exacerbated by low flows associated with droughts and controlled water releases (Walsh *et al.* 2006). During April and May, spawning there has been about a 25% reduction in floodplain available to spawning fish. See section 3.6.2.5 for additional analysis regarding abundance of host fish.

Because mussels inhabit the banks and are often found in shallower areas, permanently flowing water is also an issue in the main channel, especially when flows decline and there is an obstacle to movement such as in a shallow sand bar or within a shallow side channel. The elevations where mussels are found in any particular year, versus where they may have been found in previous years (*i.e.,* 2000 versus 2006) is likely dependent upon hydrological conditions prior to the survey. For example, in the year 2000, there had been prior conditions of sustained low flow beginning in May, and mussels may have been located at lower elevations during the fall surveys. In 2005, flows had been maintained above 10,000 cfs for most of the year, which may account for mussels being found at higher elevations in the fall of 2005 and into 2006. It is likely the mussels continue to move up and down the instream slope as waters recede or rise, provided rates of change accommodate such movement without significant mortality. Such movement can be significantly restricted in the side channel areas and in the several “hooks and bays” adjacent to the main channel.

An extended drought from 1999 to 2002 resulted in reduced flow, lower surface water elevation, and many disconnected loop streams, backwaters, tributaries, and distributaries in the Apalachicola River. Concern over the possibility of insufficient storage for flow augmentation prompted the Corps to initiate a study to determine the depth distribution of the fat threeridge in order to evaluate the effects of low water on its survival (Miller 2005). Estimates of water level elevations at discharges in 1000 cfs intervals from 3000 to 10000 cfs (changed form 6000) were made and used to estimate the percentage of the fat threeridge population that would be exposed at each discharge. Sites were grouped by location in the river. Group A included RM 30.0, group B included RM 41.5, 46.8, 48.4, and 49.0, and group C included RM 73.3. The percentage of fat threeridge that would be exposed at these locations (provided they did not move with receding water levels) can be found in Table 3.6.2.3.A. Results varied by location in the river, but a large percentage of the fat threeridge populations in groups B and C would be exposed at discharges less than 6000 cfs. At location B, 77% and 60% of the population would be exposed at flows of 5000 and 6000 cfs, respectively. Location C would fare better with about 46% and 34% of the population exposed at 5000 and 6000 cfs, respectively (Miller 2005). The locations in groups B and C have some of the most abundant populations of fat threeridge in the main channel (see Section 3.1.2.2). These results should be interpreted with care because the mussels likely move as the water level recedes.

Although mussels move in response to changing water levels, they sometimes are caught in areas too far from the receding shoreline or areas in which down-slope movement does not lead to deeper water. We found several such sites in the summer of 2006. As discharges from Woodruff Dam declined in June of 2006, the Service was notified of mussel strandings and mortalities. We investigated the reports and completed mussel surveys at each of the sites where we found mussels exposed or stranded.

Table 3.5.2.1.A provides a summary of the results of the sites surveyed. A total of 446 listed species (443 fat threeridge and 3 purple bankclimber) were found at the 8 sites, of which 30.5% were freshly dead and 32.1% were exposed but were not necessarily dead. Drought-induced mortality was also documented by EnviroScience (unpubl data 2006). Fat threeridge were tagged in areas where the mussels were exposed in the main channel (RM 44.3; Z141) and Swift

Slough. High mortality of tagged individuals was reported at RM 44.3 (ranged from 23-28% after 2 weeks to 69-70% after 4 weeks). Thirty-one percent mortality was estimated at Swift Slough from data collected during the population estimation. Catch curve analyses indicate that natural mortality of the population is about 18% (see Section 2.2.3.2). As described above, the loss of larger individuals, the potential loss of more females, and the high-localized mortality in the middle reaches of the Apalachicola may inhibit short-term reproductive success. Additional studies are needed to determine the relative effects of drought related mortalities.

The effect of this additional mortality as a proportion of the overall population is unknown. Hastie *et al*. (2001) found that 4-8% of the total population of the freshwater pearl mussel (*Margaritifera margaritifera*) were killed by a 100-year flood event. We believe that the effects of the 2005 floods were similar to the population of fat threeridge and that long-term survival and recovery have not been appreciably reduced. We base this conclusion on the fact that we observed mussels at several sites on the main stem and the Chipola River that were situated where they could retreat to deeper water and successfully reproduce. We do not believe that the flow levels of the summer of 2006 have permanently limited the ability of the proposed critical habitat to function for the conservation of the species in Unit 8 or Unit 2.

3.6.2.4 Water quality

> *Water quality (including temperature, turbidity, dissolved oxygen, and chemical constituents) that meets or exceed the current aquatic life criteria established under the Clean Water Act (33 U.S.C. 1251-1387).*

A wealth of evidence that supports the dependency of the mussels on good water quality. As animals with limited mobility, mussels must tolerate the full range of water quality parameters to persist in that stream. Most mussels are considered sensitive to low dissolved oxygen (DO) levels, high temperatures, and unionized ammmonia (Fuller 1974; Johnson 2001; Sparks and Strayer 1998; Augspurger *et al.* 2003). Various contaminants in point- and non-point-source discharges can degrade water and substrate quality and adversely affect mussel populations through direct mortality, reduced recruitment, or impaired physiological processes (Ahlstedt and Tuberville 1997; Chetty and Indira 1995; Fleming *et al.* 1995; Fuller 1974; Havlik and Marking 1987; Horne and McIntosh 1979; Jacobson *et al.* 1993; Keller and Lydy 1997; Keller and Zam 1991; McCann and Neves 1992; Moulton *et al.* 1996; Naimo 1995; Neves and Zale 1982; Yeager *et al.* 1994). In general, we believe the numeric standards for pollutants and water quality parameters that are adopted by the States under the Federal Clean Water Act represent levels that are essential to mussel conservation. Furthermore, the federal criteria and State standards are adaptive to new data developments and discoveries as a means to represent the most recent state of our understanding of protective water quality.

Several segments of the Apalachicola and Chipola rivers that are within the action area are included on the 1998 303(d) list of water bodies that fail to fully serve the designated uses (FDEP 1998). The impairments included turbidity, coliforms, total suspended solids, and DO. The 2001 Impaired Surface Waters Rule analysis identified potential impairments in the action area same segments for biology, coliforms, dissolved oxygen (DO), and unionized ammonia (FDEP 2003). These water quality impairments could influence the health of the aquatic community, including the freshwater mussels, to an undetermined extent (Dahlberg *et al.* 1968; Fuller 1974; Sparks and Strayer 1998; Johnson 2001; Augspurger *et al.* 2003). Violations of the unionized ammonia standard are relative to a State of Florida standard for freshwater systems, which closely approximates criteria recommended to the USEPA to protect freshwater mussel species (Augspurger *et al.* 2003).

Walsh *et al.* (2006) reported that the middle reach of the main channel of the Apalachicola River had relatively high values for both secchi depth (*e.g.*, low turbidity) and dissolved oxygen, and natural pH. Water quality in River Styx connectors (*e.g.*, Swift Slough, Hog Slough, and Moccasin Slough) was similar to the main channel when connected, but it was much more variable when disconnected (Walsh 2006). The authors also reported a negative relationship between DO and decreased flow and connectivity to the main river, and there was a significant difference (Sheffe post-hoc multiple pairwise comparison; $p<0.002$) in DO in each category of main channel connectivity (*e.g.*, flowing, connected backwater, isolated <6 weeks, and isolated > 6 weeks). The lowest yearly DO values occurred during mid- to late summer (July to September) when temperatures were highest and flows were lowest (Walsh *et al.* 2006).

DO level is affected by both flow and the abundance of detritus at the site. As Swift Slough became disconnected and consisted of a series of isolated pools (EnviroScience unpubl data 2006), DO values in all of the isolated pools were less than 5 mg/L, which is less than both the Florida state standard and the USEPA criterion for DO (Florida Administrative Code 2004; USEPA 1986). DO concentrations were less than 1 mg/L in over 62% of the isolated pools (Figure 3.6.2.4.A). When the Slough was reconnected several days later, DO levels rapidly increased to levels above the Florida state standard and USEPA criteria. A study conducted in the Flint River basin during the 1999-2002 drought found that there was accelerated mussel mortality as DO levels dropped below 5 mg/L, and DO levels between 0 and 3 mg/L resulted in variable mortality up to 76% (Johnson *et al.* 2001; Golladay et. al 2004). The above reported mortality in Swift Slough was likely due to a combination of low DO and exposure. Other shallow “hooks and bays” in this reach probably experienced DO levels less than 3 mg/L also.

Low DO concentrations during droughts may also be further reduced in response to the decay of soft organs of dead mussels. For instance, the invasive Asian clam (*Corbicula fluminea*) is intolerant to drought conditions and further exacerbates hypoxic conditions (McMahon 1979; Johnson *et al.* 2001). In the presence of the Asian clam, DO levels are lowered at an accelerated rate, and may contribute to increased competition amongst unionids for limited supplies of DO (Johnson *et al.* 2001). Many study sites along the Apalachicola have extremely high abundance of Asian clams, and low DO levels during drought conditions are likely to be exacerbated by mortality of Asian clams.

The fat threeridge spawning period begins when water temperatures are 23°C ± 1.5°C (Brim Box and Williams 2002). Using water temperature data from the Chattahoochee gage summarized in section 3.4 (Figure 3.4.A), the mean date by which water temperature rises to 21.5°C is May 1 (range: April 5 to May 14) and to 24.5°C is May 22 (range: April 14 to June 30). Some spawning in June 2006 was still underway when water temperatures in the very shallow areas exceeded 30°C, and likely resulted in reproductive failure in these individuals.

O'Brien and Williams (2002) found gravid female purple bankclimbers in the Ochlockonee River during late winter/early spring when water temperatures were 8 to 15°C. Average temperatures by calendar date (Figure 3.4.A) all exceed 8°C in the available Apalachicola River data. The mean date by which temperatures rise to 15°C is March 13 (range: January 1 to April 1). There are no known factors that would affect the normal temperature range during this period.

Water temperatures associated with Chipola slabshell reproductive activity have not been investigated.

We believe that fat threeridge mortality due to low DO and high temperature in the summer of 2006 was unusual due to a coincidental change in bed elevation, change in channel morphology, and low flows associated with an extended period of unusually low rainfall in the basin. We do not believe that these temporary changes in water quality have permanently limited the ability of the proposed critical habitat to function for the conservation of the species in Unit 8 or Unit 2. Some mussel spawning occurred prior to the low flows and several sites on the main channels of the Apalachicola and Chipola rivers supported mussels in areas where they could move to deeper water of adequate temperature and reproduce successfully. Some mussels in Swift Slough have survived in the shallow pools and others buried themselves in wet substrates with adequate DO and temperature.

3.6.2.5 Fish hosts

> *Fish hosts (such as largemouth bass, sailfin shiner, brown darter) that support larval life stages of the mussels.*

The distribution and diversity of unionids is strongly related to the distribution and diversity of fish species (Watters 1992; Haag and Warren 1998). Bogan (1993) identified the dependency of mussels on fish hosts as one of several contributing causes in the extinction of several unionid species worldwide. Host fish availability and density are significant factors influencing where certain mussel populations can persist (Haag and Warren 1998), and simulations of fish-mussel interactions indicate that mussel populations are extirpated if a threshold host fish density is not exceeded (Watters 1997). The importance of host fish to persistence of mussel populations is well documented. Riverine fish populations in the southeast have been adversely affected by the same habitat alterations that have contributed to the decline of the mussel fauna (Etnier 1997; Neves *et al.* 1997; Warren *et al.* 1997).

Of the three listed mussels considered in this BO, host fish species are only known for the fat threeridge (see sections 2.2.3.3.1 – 2.2.3.3.3). This species is considered a host-fish generalist for which the density of host fish species may be of particular importance. Watters (1997) found that generalists attained higher population sizes than specialists when host fish density was high, but declined when host fish density declined. However, Haag and Warren (1998) found that densities of host-generalist and host-specialist mussels with elaborate host-attracting mechanisms were independent of host-fish densities.

The Florida Fish and Wildlife Conservation Commission (FFWCC) monitored the fish assemblage in the main channel of the Apalachicola River at four fixed stations from 1984-1993 and 2000-2003. Data from these boat electrofishing surveys were taken from the summary provided by Walsh *et al.* (2006). Data from more recent surveys were not available for this BO. One of the four monitoring stations was in the middle reach of the Apalachicola River (RM 37.5 to 40.9). This is the general area of the river with the highest known abundance of the fat threeridge, and we have focused on data from this station for purposes of this BO.

Lab-confirmed host fish species for the fat threeridge include the weed shiner, bluegill, redear sunfish, largemouth bass, and blackbanded darter (see Section 2.2.3.3.1). All five host fish species were collected by the FFWCC in the middle reach of the Apalachicola River from 1984-1993 and 2000-2003. When data from all years are combined, the weed shiner was the most abundant species collected (28.2% of the total catch), and bluegill was the third most abundant species collected (10.4%). The other host fish did not rank as high in percent composition, but were still considered dominant species (*e.g.*, comprising at least 1% of the total catch). Redear sunfish comprised 1.9% of the total number of fish collected (ninth most abundant), and largemouth bass comprised 1.7% of the catch (tenth most abundant). The blackbanded darter was not considered a dominant species and was rarely encountered (0.7% composition). The percent composition of the dominant species varied slightly between the two general sampling periods (1984-1993 and 2000-2003), but the weed shiner and bluegill ranked first (29.5% vs. 24.7%) and third (9.6 vs. 12.4%) in both periods, respectively. These data indicate that host fish are present in the main channel in areas where the fat threeridge occur, and, with the exception of the blackbanded darter, they comprise relatively large proportions of the fish assemblage (particularly weed shiners and bluegills).

Although the three mussels are not generally found in floodplain habitats, their host fish species are likely to use floodplain habitats, and, as previously mentioned, mussel population viability is likely dependent on fish host population density. Reproduction of many fishes is intricately tied to the floodplain, and alteration of flow regimes can affect reproductive success, year-class strength, growth, condition, and other life-history attributes (Guillory 1979; Welcomme 1979; 1985; Kilgore and Baker 1996; Raibley *et al.* 1997; Gutreuter *et al.* 1999; Ribeiro *et al.* 2004). For example, the largemouth bass is known to use seasonally inundated floodplain habitats for spawning and rearing (Kilgore and Baker 1996). Walsh *et al.* (2006) documented 64 species of fishes (including all five host species) using floodplain habitats in the middle reaches of the Apalachicola River and firmly established the importance of these habitats for spawning adults and young-of-the-year fishes.

The FFWCC and USGS (Walsh *et al.* 2006) have monitored the fish assemblage in floodplain habitats (*e.g.*, loop streams, backwaters, tributaries, and distributaries) in the middle reach of the Apalachicola River using backpack and boat electrofishing from 1983-1985 (FFWCC) and 2001-2004 (USGS). FFWCC data presented here are summarized from Walsh *et al.* (2006), and only samples from Poloway Cutoff, Iamonia Lake, Florida River, and River Styx were used because they are the most comparable to the sites sampled by the USGS. From 1983 to 1985, bluegill was the most abundant species collected (30.9% of the total catch) in floodplain habitats in the middle reach of the Apalachicola River. Largemouth bass was the second most abundant species (7.4% of the total catch), and redear sunfish was the fourth most abundant species (5.8% of the total catch). Weed shiner and blackbanded darter were not detected at these locations by the FFWCC in 1983-1984. From 2001 to 2004, bluegill was also the most abundant species collected (22.9% of the total catch), weed shiner comprised 8.7% of the total catch (third most abundant), and largemouth bass comprised 2.9% of the total catch (ninth most abundant). Redear sunfish and blackbanded darter were not considered dominant species, but they were collected (1.4 and 0.17% composition, respectively).

Results from Walsh *et al.* (2006) confirm that three components of the hydrologic cycle are especially important for Apalachicola River fishery resources: the timing, extent, and duration of floodplain inundation immediately preceeding, during, and following the spawning, early growth, and survival phases. For instance, YOY bluegill and weed shiners were collected in the floodplain over a long period of time (March to September), indicating prolonged spawning periods. These species are characterized as flood-plain exploitative species (Ross and Baker 1983), which often have breeding seasons that extend well beyond the time of spring flooding (Ross and Baker1983; Walsh *et al.* 2006). Therefore, flow connectivity for some portion of the floodplain or adjacent shallow water main channel habitat may be needed in the summer months, beyond the typical spring spawning months. Results of analyses presented in Section 3.3.5.2 indicate that floodplain connectivity is substantially lower since the construction of dams in the ACF Basin, despite an increase in the annual duration of flows greater than 50,000 cfs (Figure 3.3.2.A). Additional decreases in floodplain connectivity may contribute to a decrease in productivity of several species of fish, including some that serve as hosts for the listed mussels (Kilgore and Baker 1996; Raibley *et al.* 1997; Walsh et. al 2006). However, the effect to the proposed critical habitat and listed mussels is unknown, as the relationship of fish host densities to mussel densities are unknown at this time.

3.7 Factors Affecting Species Environment within the Action Area

This section describes factors affecting the environment of the species or critical habitat in the action area. The baseline includes State, tribal, local, and private actions already affecting the species or that will occur contemporaneously with the consultation in progress. Related and unrelated Federal actions affecting the same species and critical habitat that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat. The following actions have influenced over time to some degree the environment of the listed species in the action area, and these influences are reflected in the flow regime, the channel morphology, and other physical and biological features discussed previously as the baseline for this consultation.

3.7.1 Related Federal Actions

3.7.1.1 Navigation Channel Maintenance

Jeanne (2002) summarized the Corps' history of activity associated with navigation on the Apalachicola River. The first record of this history is in the Corps' annual report of 1832, which refers to clearing obstructions to navigation in the river. The first formal navigation survey of the ACF was commissioned in 1871, and the first navigation improvement project was authorized in 1873. At that time, work began on a 100-ft wide and 4-ft deep channel on the Chattahoochee River, jetties and wing dams to control sand and gravel bars, snag removal, and rock blasting to widen and deepen shoals. Snags were cleared annually on the Apalachicola River to provide for a channel 100 ft wide by 6 ft deep at low water. In 1874, the Corps bypassed six miles of the main channel by widening and straightening an alternate channel through the River Styx and Moccasin Slough.

By 1881, the Corps recognized that these various attempted improvements to navigability in the basin were temporary fixes in the highly dynamic alluvial river system (Jeanne, 2002). Dredged areas filled in more rapidly than anticipated, especially in channels near the mouth of the river. This "excessive silting" eliminated the town of Apalachicola from consideration as the area's deepwater port (Jeanne, 2002). Despite these difficulties, a federal navigation project on the Apalachicola has continued for over 100 years, during which several major federal reservoir projects were authorized and constructed, all of them linked in some way to the navigation project.

The Mobile District's web site includes an "Information Paper on Navigation on the Apalachicola River" that summarizes federal management of the river to date:

> The water resources of the ACF River Basin have been developed to serve multiple purposes, including flood control, navigation, hydropower, water supply, water quality, recreation, and fish and wildlife enhancement. A basin-wide development plan, authorized by the River and Harbor Act of 1945 and modified in 1946, consisted of three multi-purpose reservoirs on the Chattahoochee above Columbus, Georgia (only two were constructed); three multi-purpose reservoirs on the Flint River above Albany, Georgia (none were constructed); and six locks and dams (three were constructed). Navigation was to be provided by (1) dredging, cutoffs, training works, and other open river methods; (2) a series of locks and dams; and (3) flow regulation from upstream storage projects. The project ultimately constructed consisted of a 9- by 100-ft navigation channel along 107 miles of the Apalachicola River between the Gulf Intracoastal Waterway and Jim Woodruff Lock and Dam. From there the navigation channel extends 155 miles up the Chattahoochee River to Columbus, Georgia, and Phenix City, Alabama, and 28 miles up the Flint River to Bainbridge, Georgia.
>
> The controlling depth for navigation has often been less than the authorized 9 ft channel during a large portion of the normal low flow period of the summer and fall each year. Over the period 1970-1999, a 9-ft channel has been available only about 62% of the time and a 7.5-ft channel 82% of the time. In dry years a 7.5-ft channel may be available only 25% of the time. The original design of the project estimated that a discharge from Jim Woodruff Dam of 9,300 cubic ft per second (cfs) together with dredging would provide a 9-ft channel. In the mid-1980's the discharge providing a 9-ft channel was estimated to be 11,000 (an increase of 18%). The majority of the dredging activity in the Apalachicola River occurs between miles 35 and 45 and between miles 76 to 81, accounting for about 40% of the annual dredging quantities.

> Following discussions with navigation users during and after the 1986 drought, the Corps developed a technique to provide for a planned period of navigation called a Navigation Window. This technique involves temporarily storing water in West Point Lake, Walter F. George, and Lake Seminole that then is released over a 10-day to two week period at a rate to provide for economically navigable depths (at least a 7.5-ft channel) in the Apalachicola River. During the Drought of 1988, a Navigation Window was planned for early September 1988, but sufficient rain occurred so that the Window was not necessary. This technique was employed beginning in 1990 and continued throughout the decade. Beginning in the mid 1990's, Navigation Windows were scheduled in advance, approximately one per month during the low water months, in order to provide the waterway users a predictable reliable channel. Because channel conditions were also deteriorating, Navigation Windows were used with increasing frequency, as many as six a year, generally between May and December. Maintenance of navigation depths became increasingly dependent upon flows due to continued channel degradation and a lack of adequate dredged material disposal capacity. In the 1990s, the discharges from Jim Woodruff Dam required to provide a limited 8-ft channel during navigation windows ranged from 13,000 cfs to over 20,000 cfs, dependent upon the condition of the dredged channel. With increased water supply and recreational demands in the upstream reservoirs, fluctuations of reservoir levels necessary to support navigation window releases have become increasingly controversial.

The navigation channel on the Apalachicola River was last dredged in 2001, but the dredge ran aground due to low flow, and the job was not completed. The last complete cycle of dredging a 100-ft by 9-ft channel occurred in 1998 (in 1999, dredging was discontinued in the middle of the dredging season due to lack of dredged material disposal capacity). In 2005, the State of Florida denied the Corps' application to renew its certification under section 401 of the Clean Water Act for maintaining the navigation channel. Although navigation remains an authorized purpose for the ACF system, it does not now figure into daily operational decisions for the reservoirs. The most recent approved Water Control Plan for the system is dated 1959, although operations have been conducted in recent year in accordance with the draft Water Control Plan for the ACF dated 1989, with adjustments as necessary in recent years to accommodate current needs, such as operations in support of fish and wildlife and endangered and threatened species. Finalizing the 1989 draft plan awaits resolution of ongoing litigation filed by State of Alabama in 1990, which is currently the subject of court-ordered mediation.

3.7.1.2 Other Authorized Reservoir Purposes

In addition to navigation, the ACF federal dams and reservoirs are authorized for several other purposes, including flood control, hydropower, water supply, water quality, recreation, and fish and wildlife conservation. Power generation is marketed through the Southeastern Power Administration (SEPA), which enters contracts with power customers. Storage in the larger reservoirs is specifically allocated to the hydropower purpose and for flood control purposes. All other project purposes must share the water resources within the conservation pool of the reservoirs. The Corps may enter into contracts for storage with municipal and industrial water users, subject to completion of a reallocation study and approval by higher authority, and potentially requiring Congressional authority. There are currently no water supply contracts in the ACF basin – previous contracts were allowed to expire in 1989-1990, and have not been renewed due to ongoing litigation. Water withdrawals are currently being made under water withdrawal permits issued by the State of Georgia. No allocation of storage in the upstream reservoirs has been made in support of water supply, and no contracts from the Corps authorize water withdrawals or provide for storage in support of water supply. However, the Corps is currently under court order to implement the Southeastern Federal Power Customers, Inc. Settlement Agreement. This settlement involves issuing interim water storage contracts at Lake Lanier pending future permanent reallocation of storage to the water supply purpose, subject to completion of a NEPA document, Section7 consultation, and a determination that the interim contracts may proceed. Water storage contracts do not authorize use of the water, *per se*, only use of the reservoir storage that could provide a source of water supply.

Each of these authorized purposes receives operational consideration, and the operational decisions stemming from such consideration affect how basin inflow is stored and released from the dams. The releases from Woodruff Dam are the downstream end result of all of these decisions, for which the action evaluated in this consultation provides the sideboards of a minimum flow and a maximum fall rate schedule relative to basin inflow. Actions associated with the specific purposes listed above have not yet undergone the section-7 consultation process for effects to listed species in the Apalachicola River. Significant changes in any operating procedures that would appreciably alter the effects analysis of this BO would require reinitation of this consultation.

3.7.2 Unrelated Federal Actions

The Corps administers Section10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. These permit programs regulate dredge, fill, and construction activities in waters of the United States. Construction activities regulated by the permit programs include: agricultural, municipal, rural, and industrial water intakes; residential, marina, and recreational developments; storm-water and waste-water outlet works; cable, pipeline, and transmission line crossings; bridges; piers; docks; navigational aids; platforms; sand and gravel operations; small dams for recreation and/or water supply; and bank stabilization projects.

The National Pollutant Discharge Elimination System (NPDES) permit program authorized by the Clean Water Act regulates point-source discharges of pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. The NPDES permits issued for discharges within the action area are summarized in section 3.4. The USEPA oversees the NPDES program, but the states of Alabama, Florida, and Georgia, have each been authorized to administer the permitting process.

3.7.3 Contemporaneous Non-Federal Actions

Water use in the basin is regulated independently by each of the three states within their boundaries. Water use in Alabama and Georgia affects basin inflow to Woodruff Dam, which affects the Corps' operations of the federal reservoir projects. Water use in Florida, with the possible exception of water use in Jackson County along the west side of Lake Seminole, does not affect the Corps' operations, but may influence flow downstream of Woodruff Dam.

We summarize the current levels of consumptive water use in the ACF basin upstream of Woodruff Dam in our effects analysis, section 4.2.1. We also consider possible increases in consumptive water use in our cumulative effects analysis, section 7.1.

3.8 Tables and Figures for Section 3

Table 3.5.2.1.A. Summary of USFWS survey results from all locations sampled between 14 June 2006 and 28 July 2006. Equivalent discharge (cfs) at the Chattahoochee gage was calculated using USGS stage-discharge relationships (Light *et al.* 2006). "ND" indicates that no data is available.

Site	**Z142**	**Z141**	**C155**	**C152**	**Z203**	**Z213**	**Z218**	**C157**	**C156**
Stream	Apalachicola	Apalachicola	Apalachicola	Apalachicola	Swift Slough	Swift Slough	Swift Slough	Chipola Cut	Chipola Cut
Navigation Mile	43.7	44.3	46.8	48.3	40.3	40.3	40.3	0.92	0.47
Mean Daily Stage at Wewahitchka Gage	12.55	12.55	12.55	12.55	12.6	12.6	12.6	12.47	12.47
Equivalent Site Discharge at Chattahoochee	6400-6500	7100-7200	6400-6500	6400-6500	6500-6600	6500-6600	6500-6600	6300-6400	6300-6400
Effort (min)	50	45	30	45	45	45	45	45	99
Number of Listed Species	841	91	84	12	110	14	10	63	62
Number of *Amblema neislerii*	841	91	84	12	108	14	10	63	61
Number of *Elliptoideus sloatianus*	0	0	0	0	2	0	0	0	1
Number of Dead Listed Species	ND	75	7	2	21	3	3	12	13
Number of Exposed Listed Species	ND	83	2	0	19	7	4	15	13
CPUE (hr) Listed	1009.2	121.3	168.0	16.0	146.7	18.7	13.3	84.0	37.6
CPUE (hr) *A. neislerii*	1009.2	121.3	168.0	16.0	144.0	18.7	13.3	84.0	37.0
CPUE (hr) *E. sloatianus*	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.6
CPUE (hr) Dead Listed Species	ND	100.0	14.0	2.7	28.0	4.0	4.0	16.0	7.9
CPUE (hr) Exposed Listed Species	ND	110.7	4.0	0.0	25.3	9.3	5.3	20.0	7.9
% Listed Species Dead	ND	82.4%	8.3%	16.7%	19.1%	21.4%	30.0%	19.0%	21.0%
% Listed Species Exposed	ND	91.2%	2.4%	0.0%	17.3%	50.0%	40.0%	23.8%	21.0%
Mean Length (mm) of Dead *A. neislerii*	ND	64	53	55	52	50	52	69	47
Mean Length (mm) of Exposed *A. neislerii*	ND	64	51	None	53	47	53	70	50

Table 3.5.2.2.B. Results from quantitative sampling of fat threeridge for a population estimate in Swift Slough from 3 August 2006 to 7 August 2006.

Reach	Start (m from inflow)	End (m from inflow)	Est. Density (m2)	Est. Abundance	90% CL
4	200	250	4.407	1983	1332-2952
8	400	450	0.957	431	221-840
15	750	800	1.431	644	206-2009
27	1350	1400	0.20*	90	-

*No fat threeridge were detected in these quadrats. 0.20 is a conservative estimate of density at 90% confidence based on non-detection of species using 45 quadrats (EnviroScience 2006b).

Table 3.6.2.3.A. An estimate of the percentage of fat threeridge that would be exposed to the atmosphere at various discharges in the Apalachicola River (Miller 2005). Sites were grouped by location in the river where group A included RM 30.0, group B included RM 41.5, 46.8, 48.4, and 49.0, and group C included RM 73.3.

	Discharge (cfs)							
Location	3000	4000	5000	6000	7000	8000	9000	10000
A	55.0	47.0	19.1	0.0	0.0	0.0	0.0	0.0
B	100.0	85.1	77.0	59.8	15.4	0.0	0.0	0.0
C	84.1	66.5	46.3	33.9	14.8	7.4	0.0	0.0

Table 3.6.2.3.B. The percent of surveyed listed mussels that occurred at bed elevations equivalent to the discharges (cfs) listed (Chattahoochee gage) at sites in the middle reach of the Apalachicola River, Chipola Cutoff, and Swift Slough, collected during USFWS surveys from June 14 to 28, 2006 (USFWS unpubl. data 2006).

Discharge (cfs) Chattahoochee Gage	% Occurrence All Sites	% Occurrence Apalachicola	% Occurrence Swift Slough	% Occurrence Chipola Cutoff
>5000	2%	1%	4%	10%
5000 – 6000	14%	5%	53%	46%
6000 – 7000	51%	57%	25%	28%
7000 – 8000	16%	17%	15%	9%
8000 – 9000	16%	19%	2%	6%
9000 – 10000	1%	1%	2%*	1%

Values do not necessarily add up to 100% due to rounding.

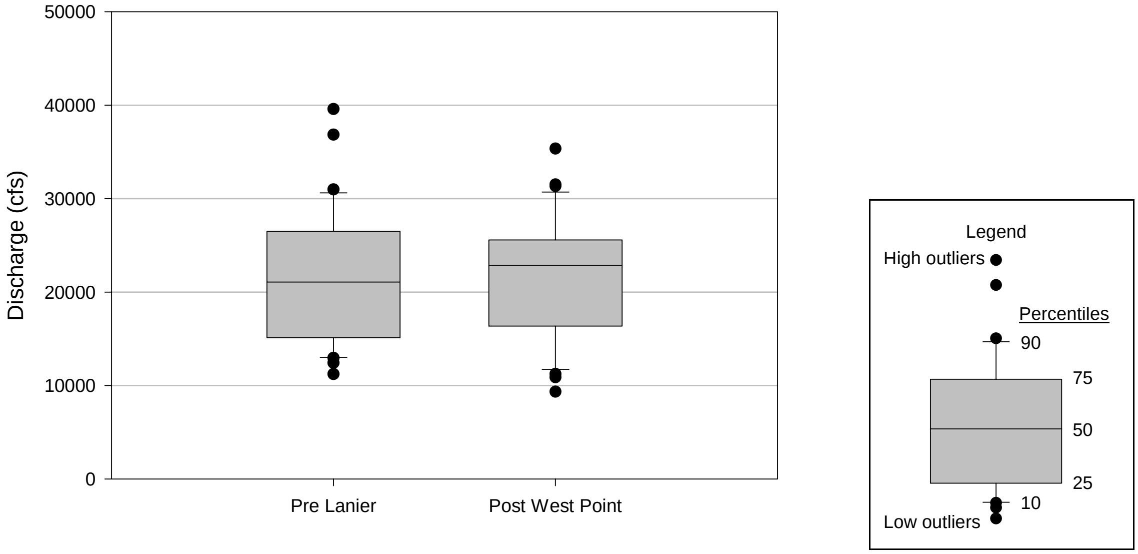


Figure 3.3.1.A. Average annual discharge (cfs) of the Apalachicola River at Chattahoochee, FL, for the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

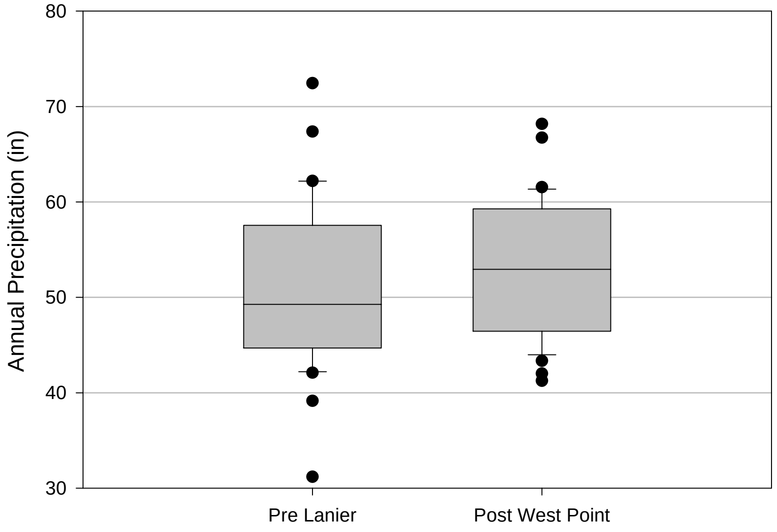


Figure 3.3.1.B. Total annual precipitation (inches) for the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods computed as the average of Alabama climate zones 5, 6, and 7, and Georgia climate zones 1, 2, 3, 4, 5, 7, and 8, weighted by the area of each zone within the ACF Basin.

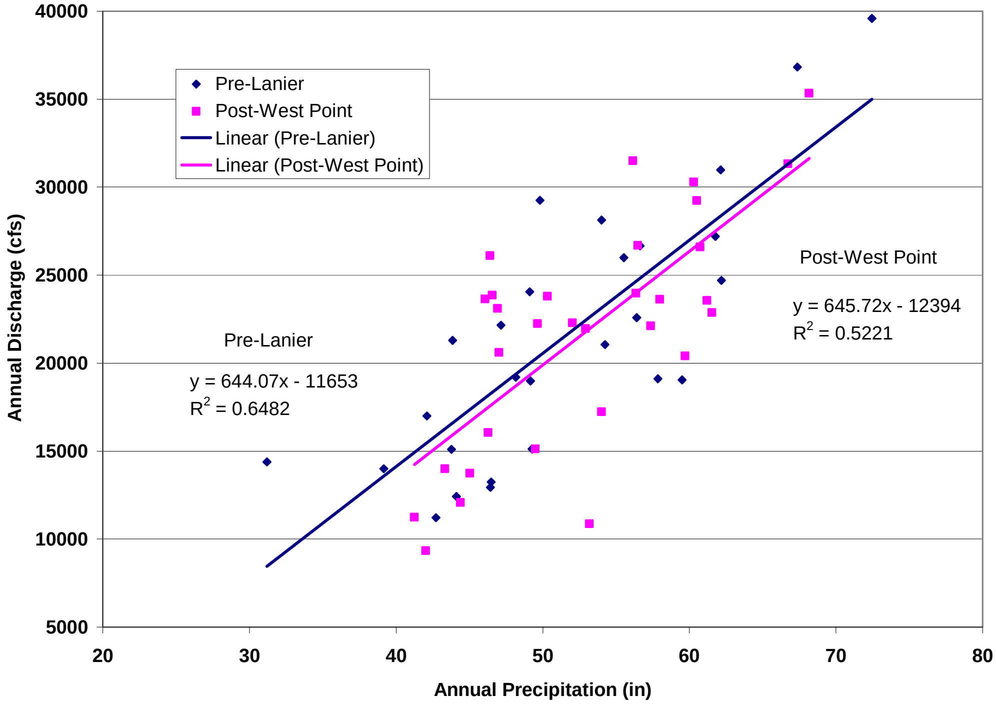


Figure 3.3.1.C. Relationship between average annual precipitation (inches) in the ACF basin upstream of Woodruff Dam and average annual discharge (cfs) at the Chattahoochee gage for the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

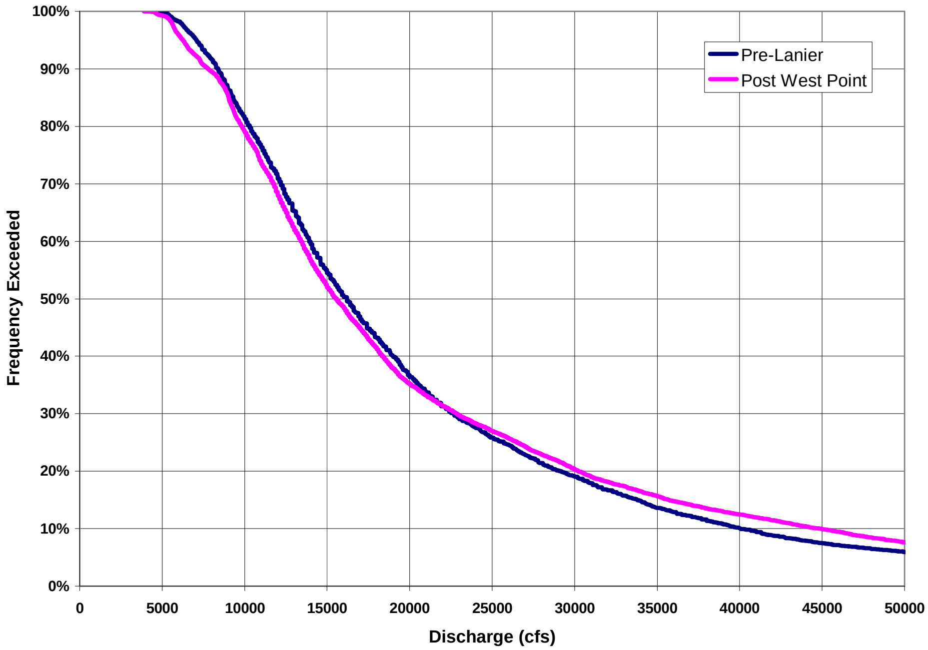


Figure 3.3.1.D. Flow frequency of the Apalachicola River at Chattahoochee, FL, for the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods (discharge rates greater than 50,000 cfs are not shown).

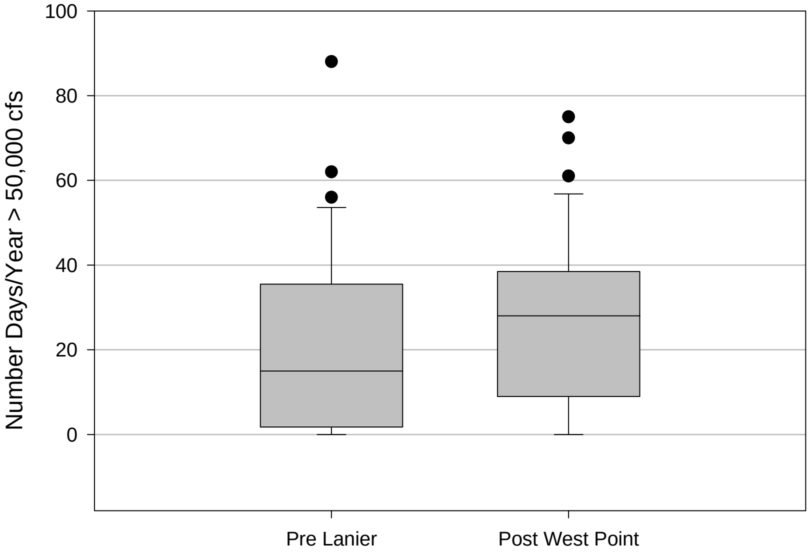


Figure 3.3.2.A. Annual duration of discharge > 50,000 cfs for the Apalachicola River at Chattahoochee, FL, calendar years 1929-1955 (Pre Lanier) and 1975-2005 (Post West Point [baseline]).

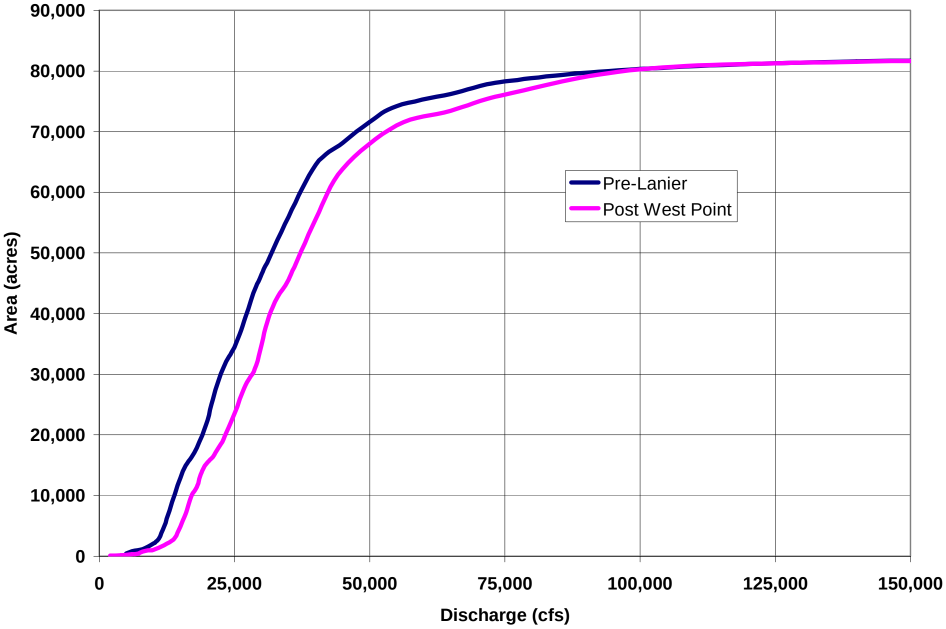


Figure 3.3.2.B. Area (acres) of aquatic habitat connected to the main channel of the non-tidal Apalachicola River at discharges of 5,000 to 150,000 cfs (taken from Light *et al.* 1998) for the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods, accounting for changes in stage versus discharge relationships between these periods (Light *et al.* 2006).

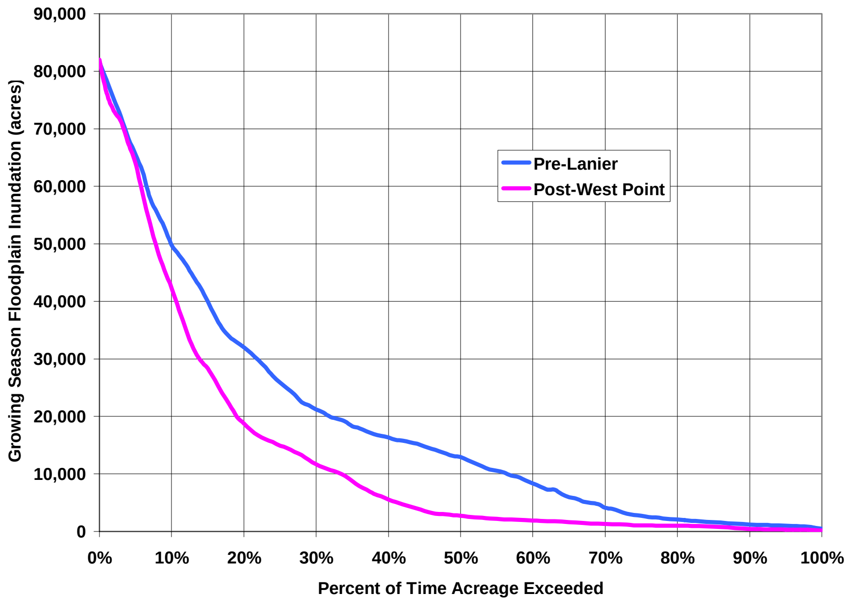


Figure 3.3.2.C. Frequency (% of days) of growing-season (April-October) floodplain connectivity (acres) to the main channel during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

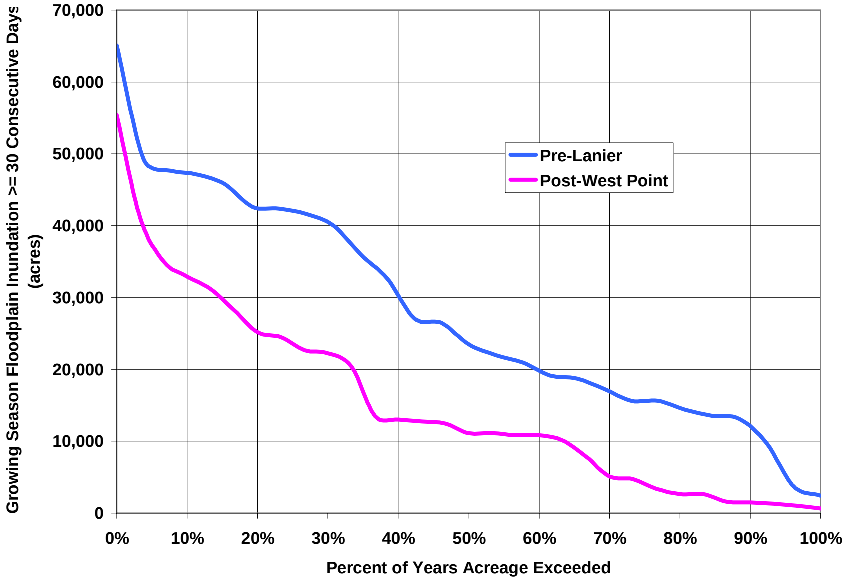


Figure 3.3.2.D. Frequency (% of years) of growing-season (April-October) floodplain connectivity (maximum 30-day continuous connectivity, acres, per year) to the main channel during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

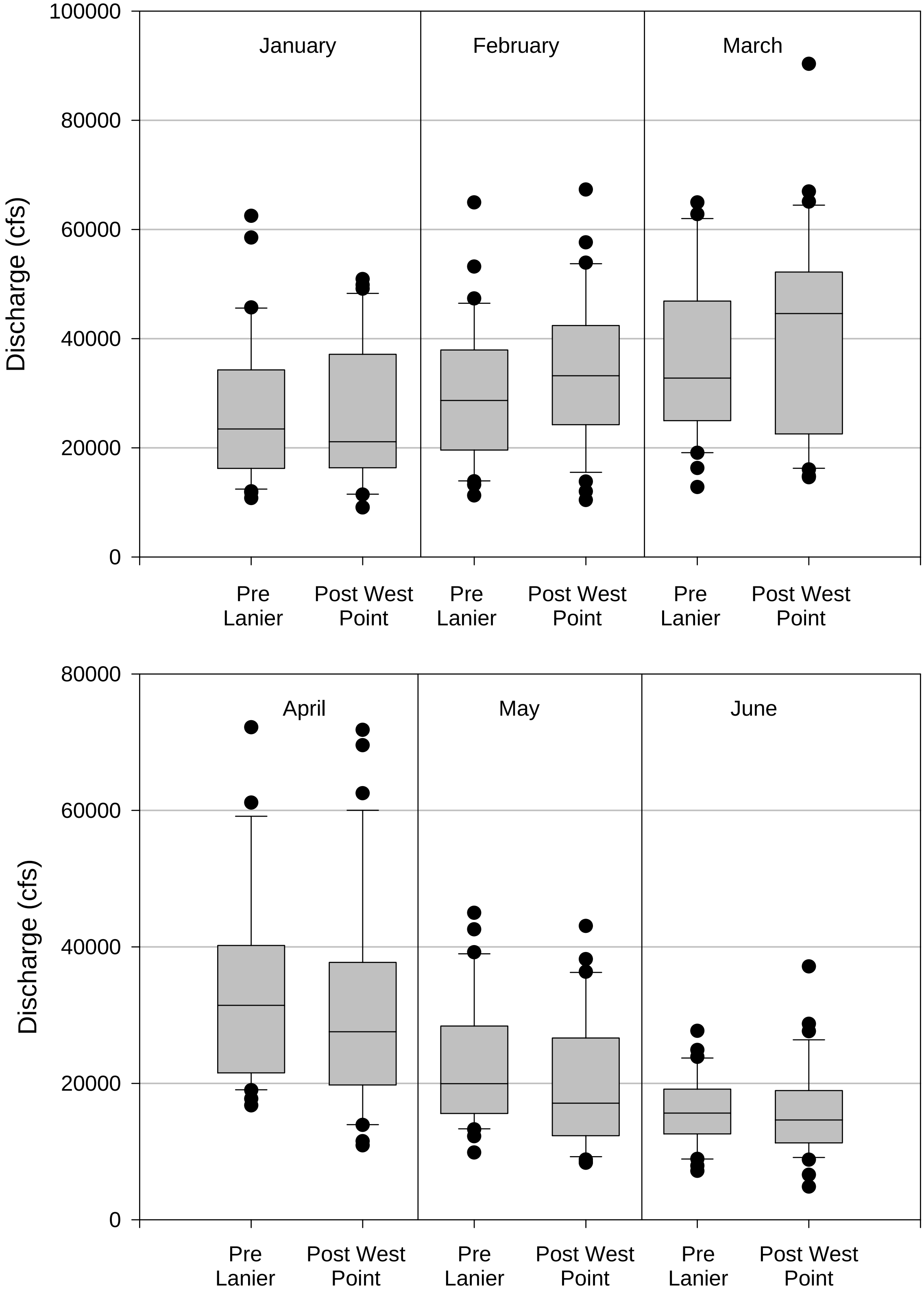
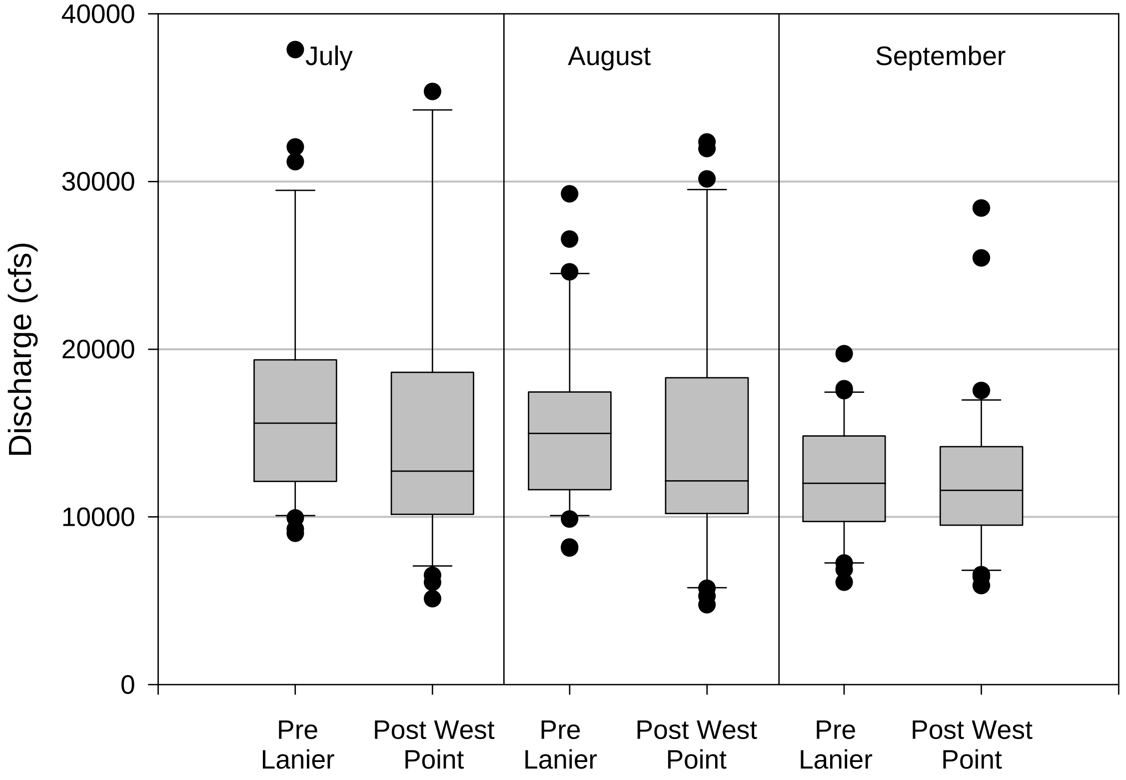


Figure 3.3.3.A. Distribution of January through June average monthly discharge (cfs) during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.



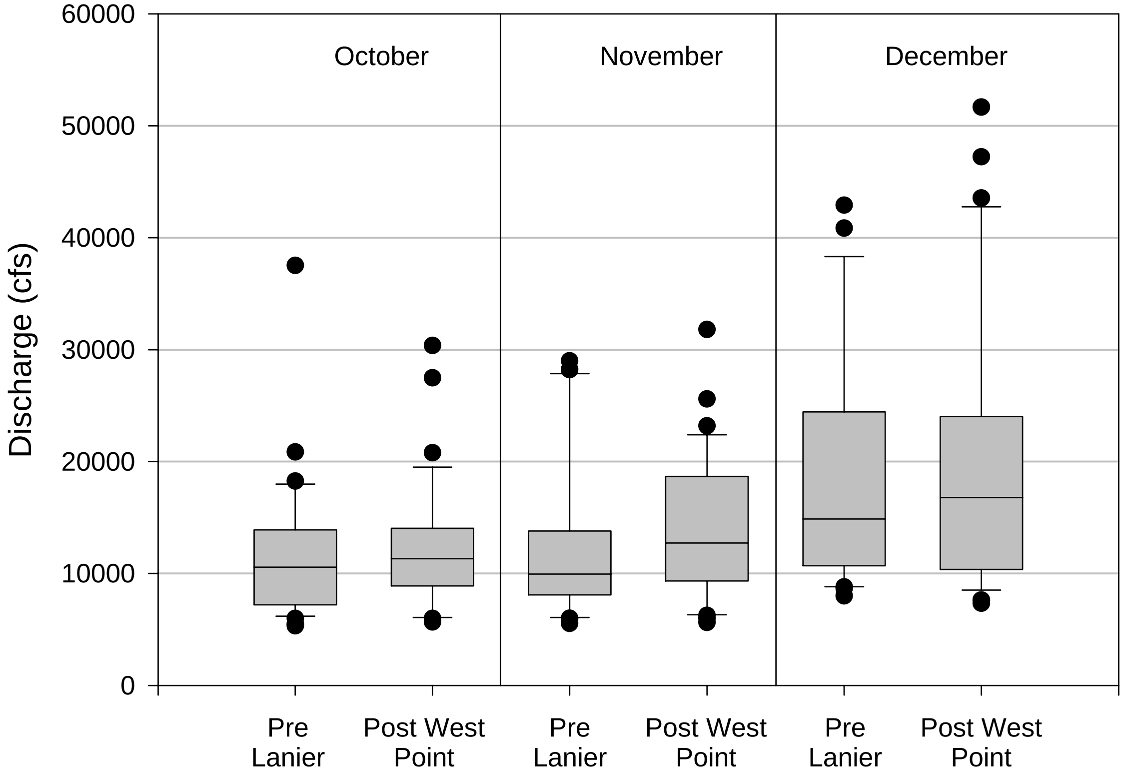


Figure 3.3.3.B. Distribution of July through December average monthly discharge (cfs) during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

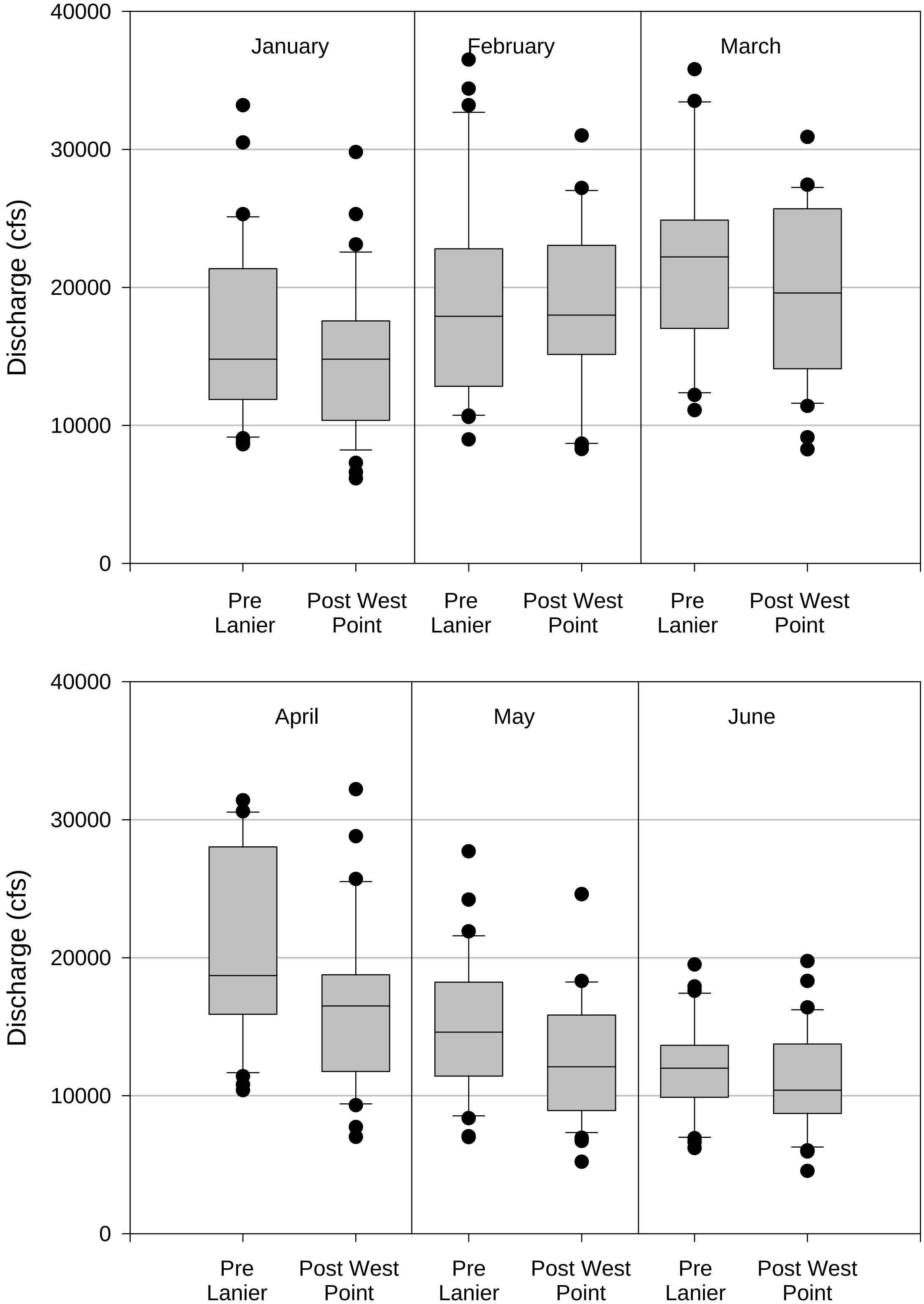


Figure 3.3.4.A. Distribution of January through June monthly 1-day minimum discharge (cfs) during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

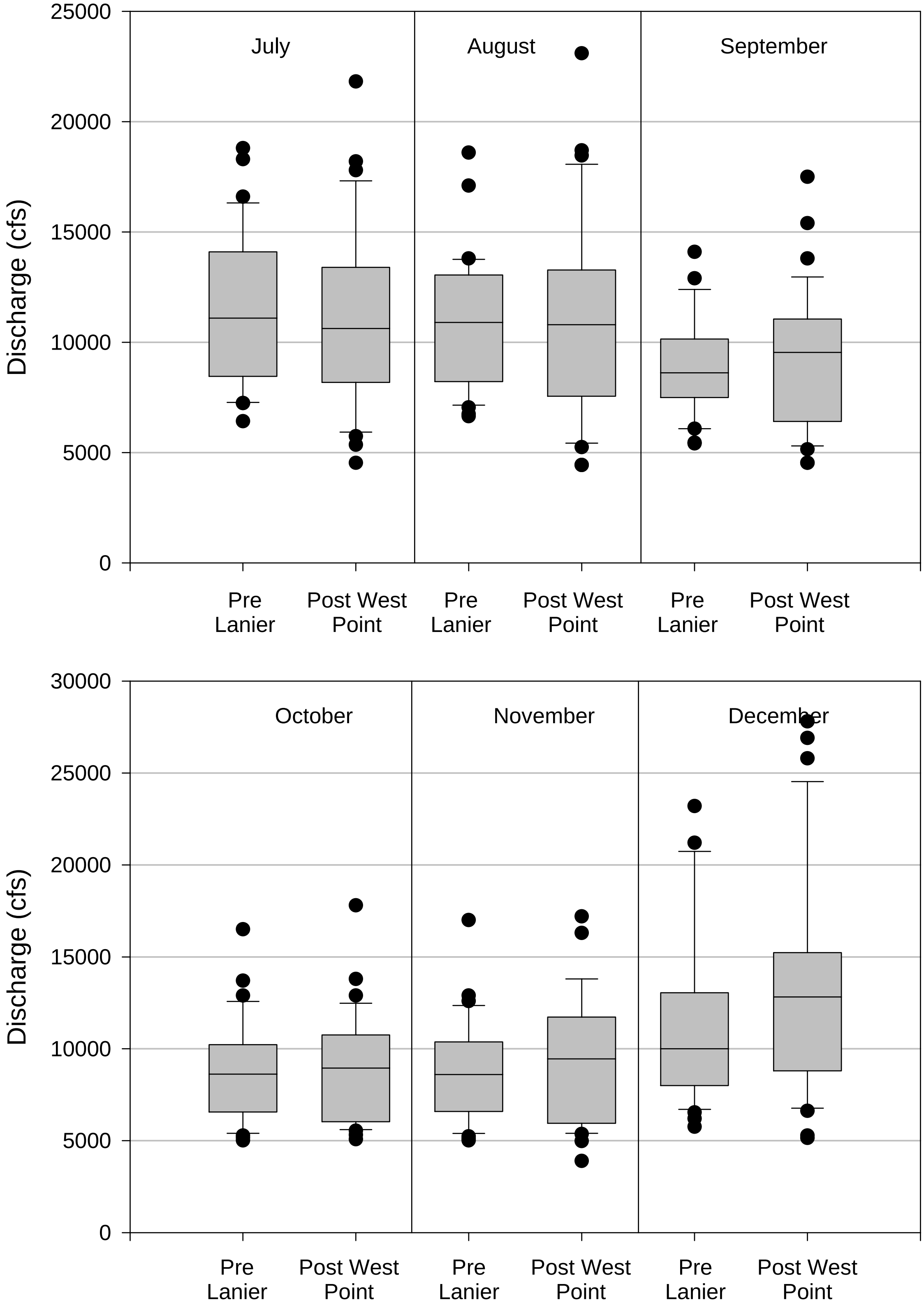


Figure 3.3.4.B. Distribution of July through December monthly 1-day minimum discharge (cfs) during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

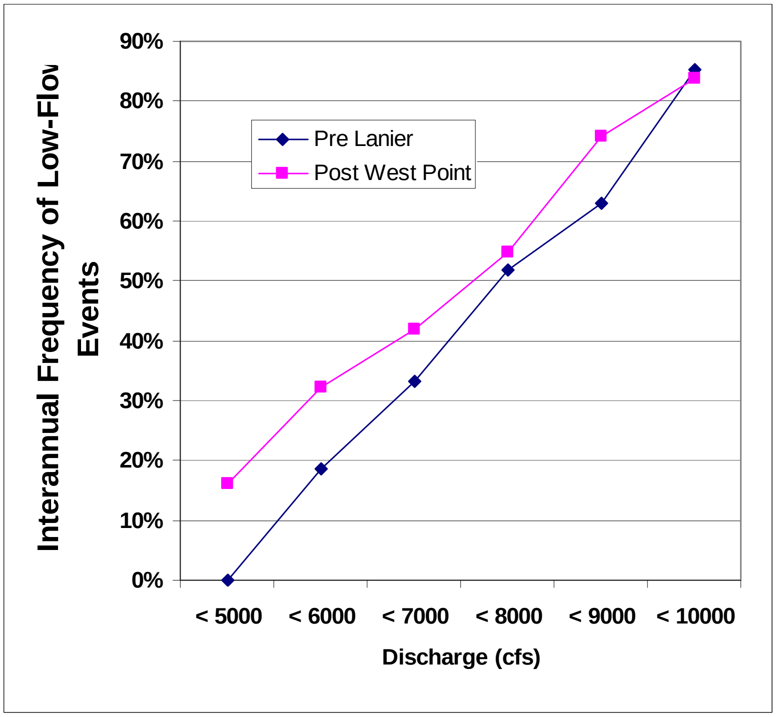


Figure 3.3.4.C. Inter-annual frequency (% of years) of discharge events less than 5,000 to 10,000 cfs during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

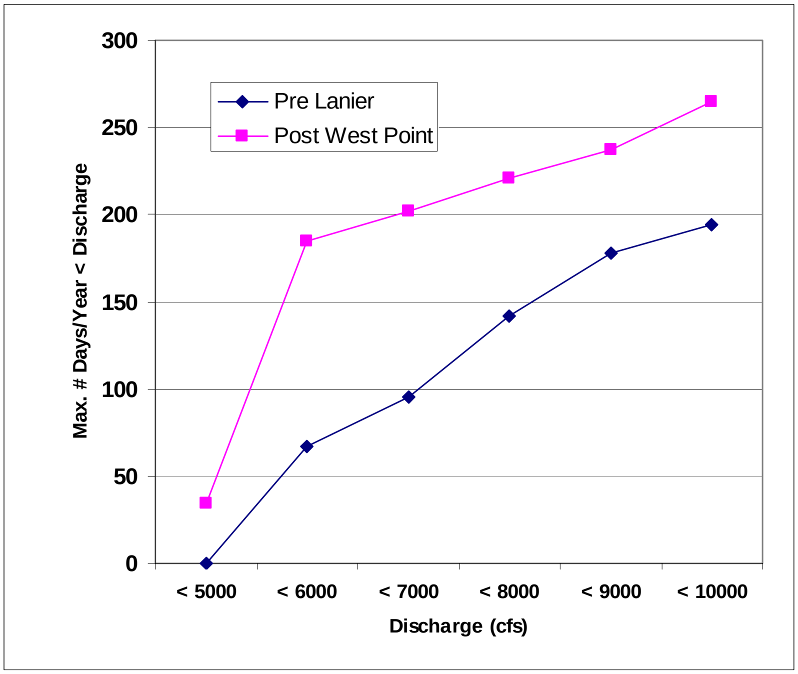


Figure 3.3.4.D. Maximum number of days per year of discharge less than 5,000 to 10,000 cfs during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

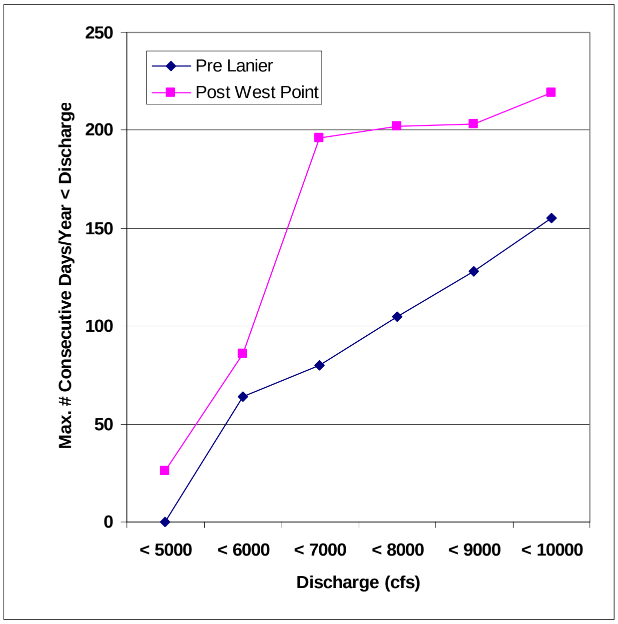


Figure 3.3.4.E. Maximum number of consecutive days per year of discharge less than 5,000 to 10,000 cfs during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

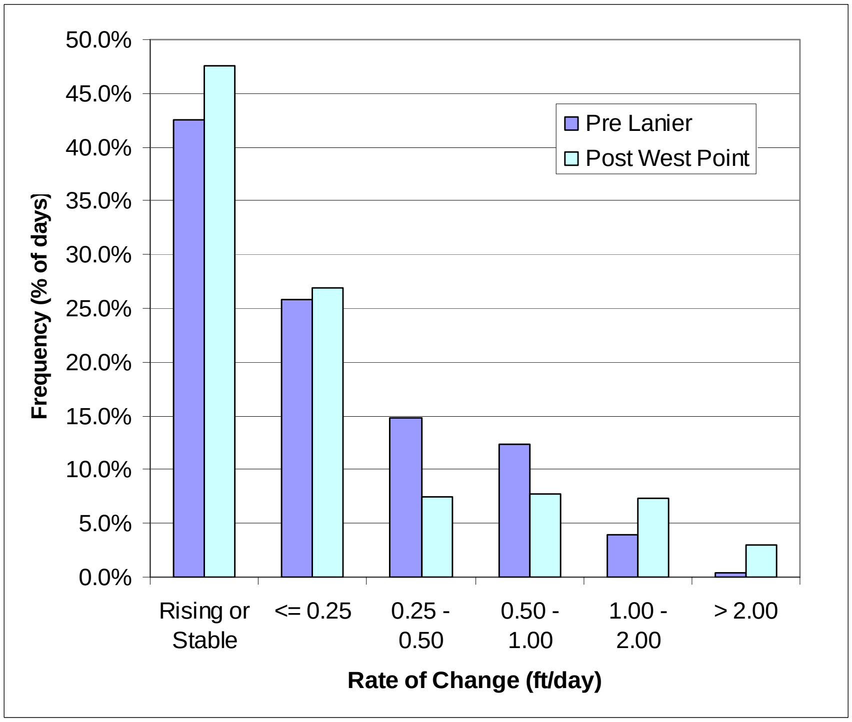


Figure 3.3.5.A. Frequency (% of days) of daily stage changes (ft/day) during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

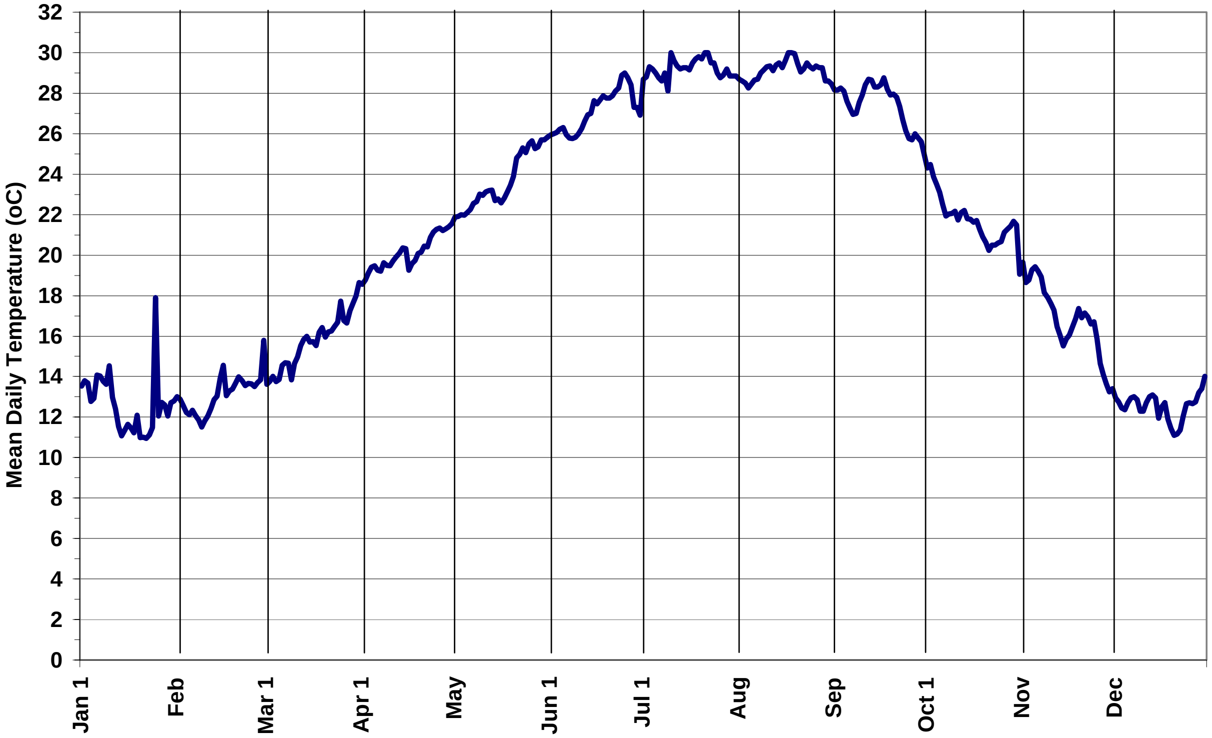


Figure 3.4.A. Mean daily water temperature (°C) by calendar date of the Apalachicola River near Chattahoochee, FL, calculated from available records 1974-1978 and 1996-1997 (source: USGS).

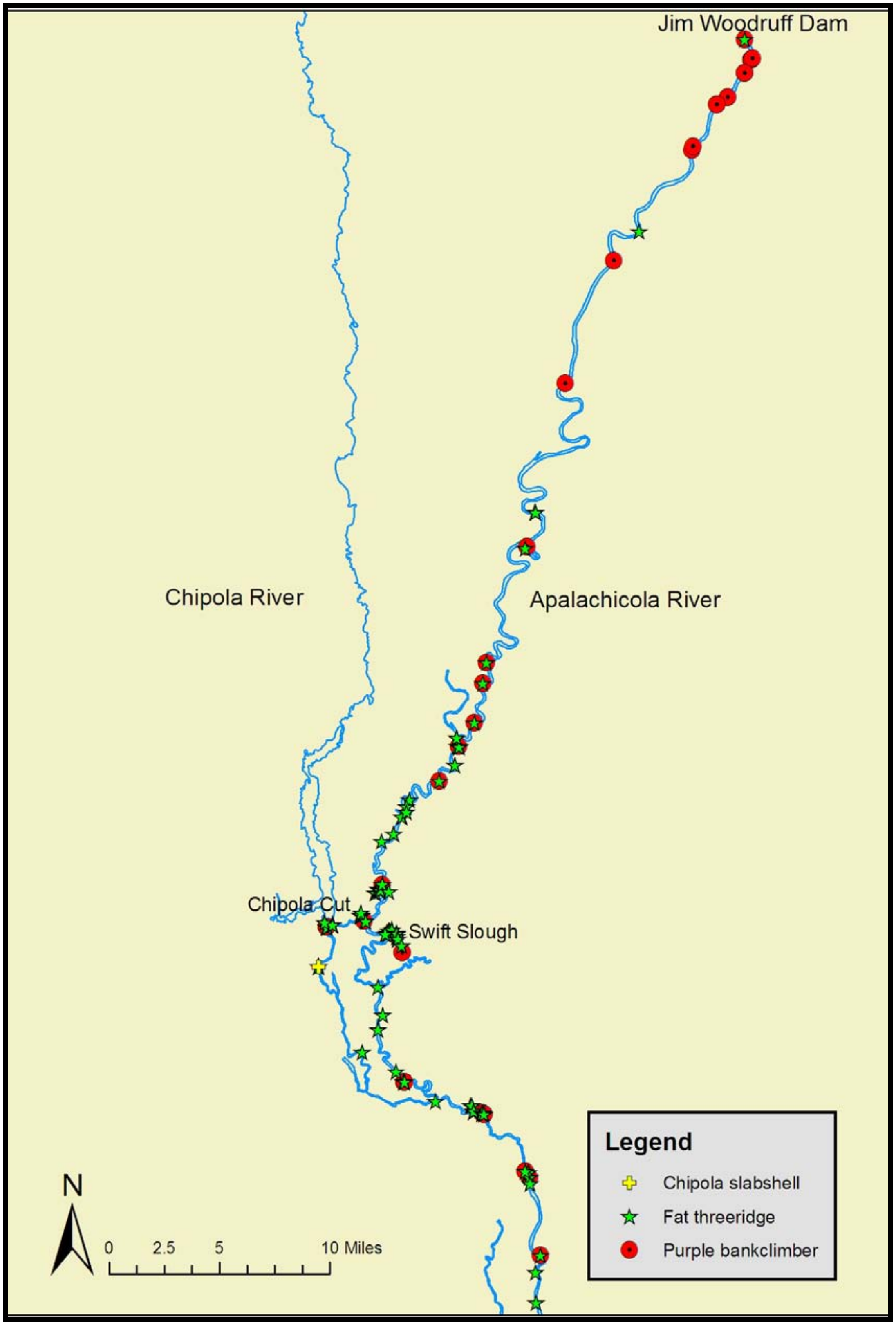


Figure 3.5.2.1.A. Distribution of the fat threeridge, purple bankclimber, and Chipola slabshell in the action area.

Figure 3.6.1.2.A. Map showing location of documented Gulf sturgeon spawning sites, resting areas, hard-bottom sites (potential spawning sites), and other landmarks in the action area.

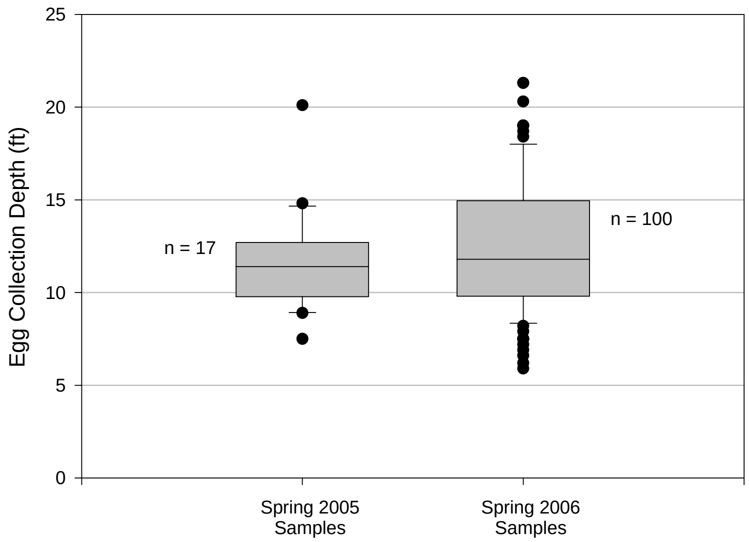


Figure 3.6.1.4.A. Distribution of depths at which Gulf sturgeon eggs were collected during 2005 (USFWS unpublished data 2005) and during 2006 (Pine *et al.* 2006).

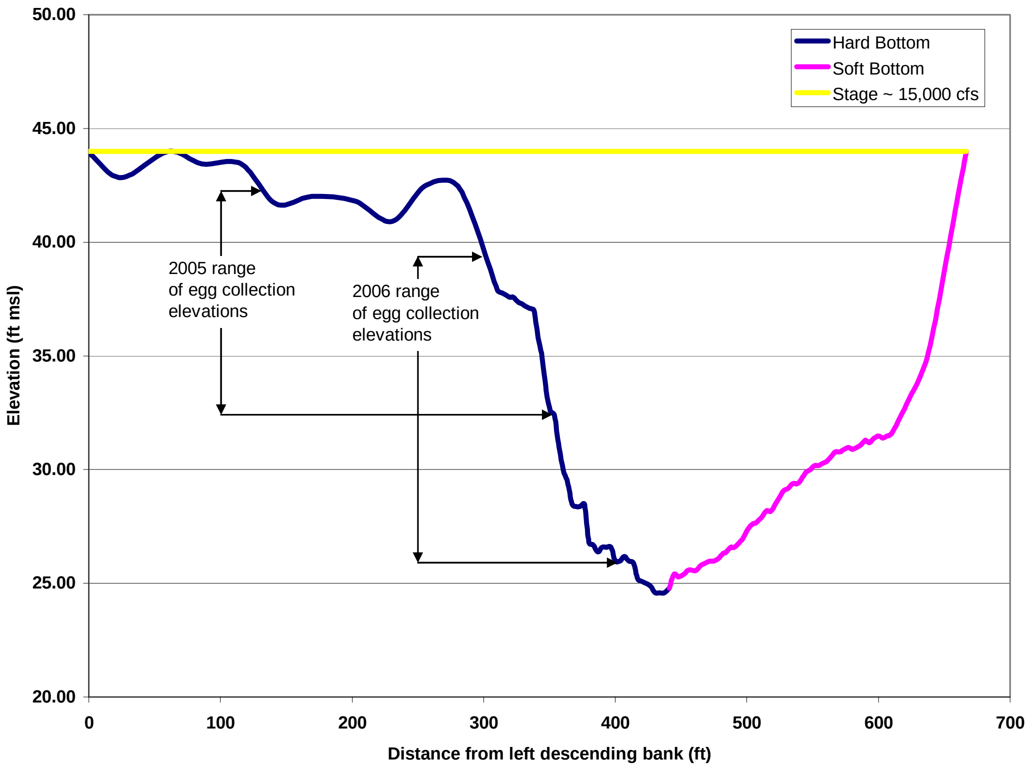


Figure 3.6.1.4.B. Cross section of the river at RM 105.25, which spans the limestone shoal where sturgeon eggs were collected in both 2005 and 2006.

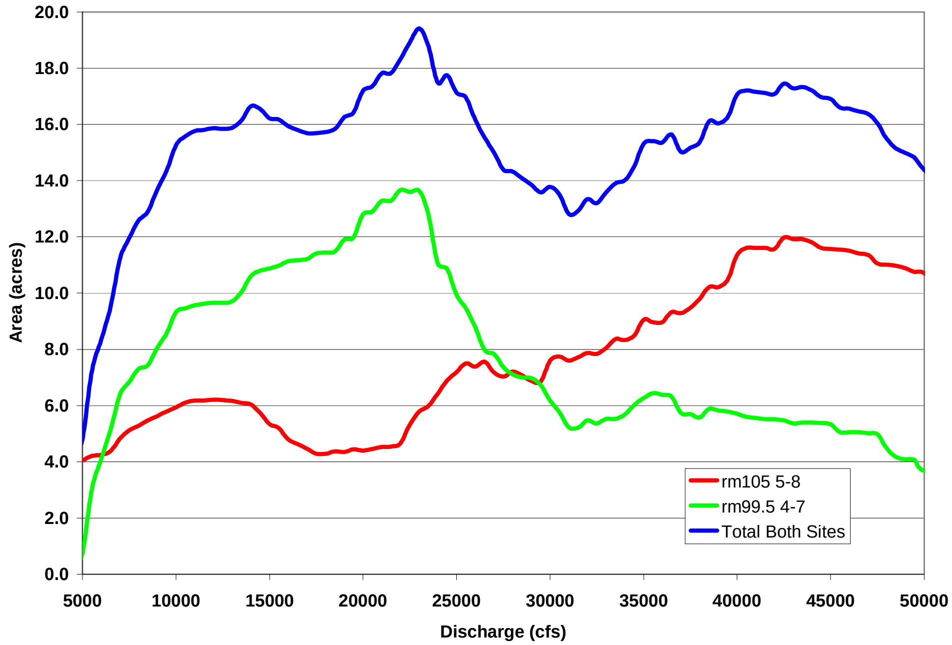


Figure 3.6.1.4.C. Area (acres) of hard substrate inundated to depths of 8.5 to 17.8 ft deep at the two known Gulf sturgeon spawning sites on the Apalachicola River (RM 105 and RM 99) at flows of 5.000 to 50,000 cfs, based on the cross sections located closest to egg collections during 2005 and 2006.

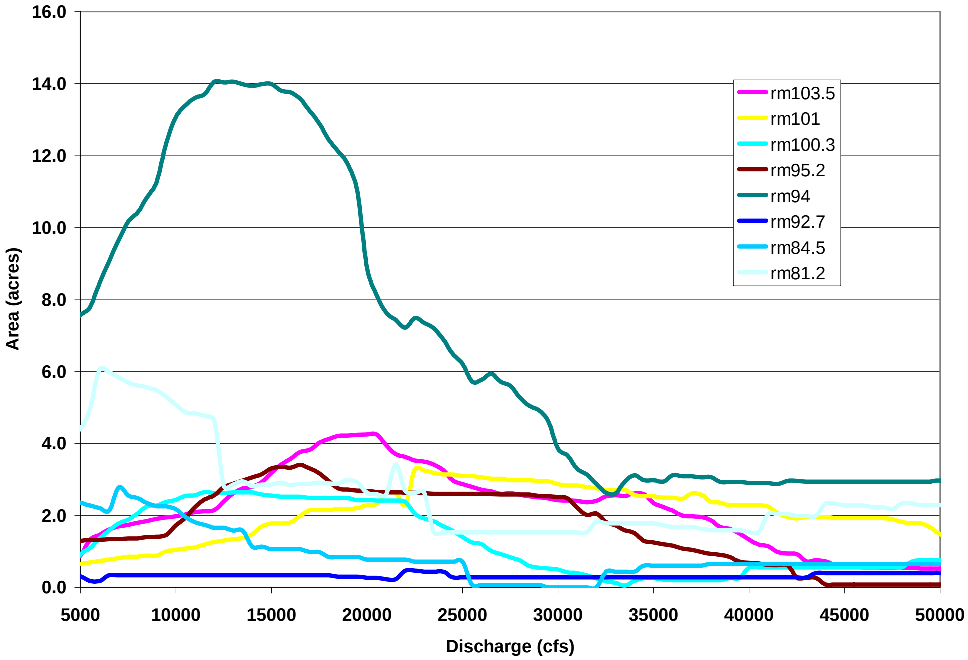


Figure 3.6.1.4.D. Area (acres) of hard substrate inundated to depths of 8.5 to 17.8 ft deep at eight potential Gulf sturgeon spawning sites on the Apalachicola River (river mile [RM] shown) at flows of 5.000 to 50,000 cfs, based on all cross sections measured at these sites.

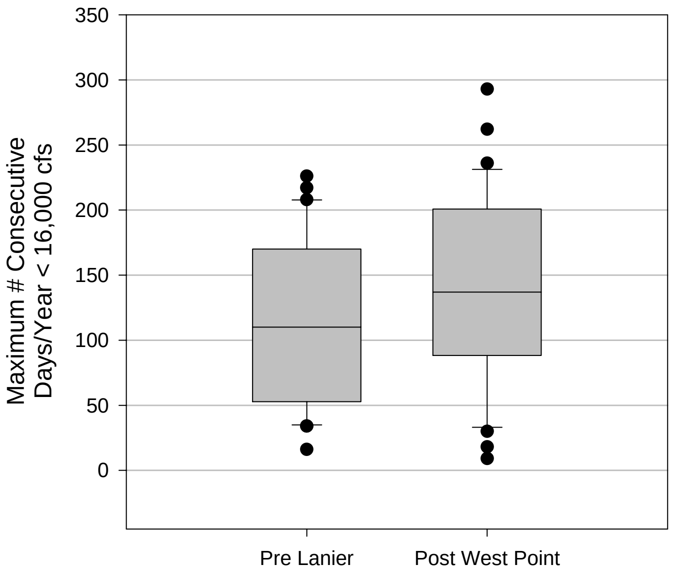


Figure 3.6.1.5.A. Maximum number of consecutive days/year of flow less than 16,000cfs during the pre-Lanier (1929-1955) and post-West Point (1975-2005) periods.

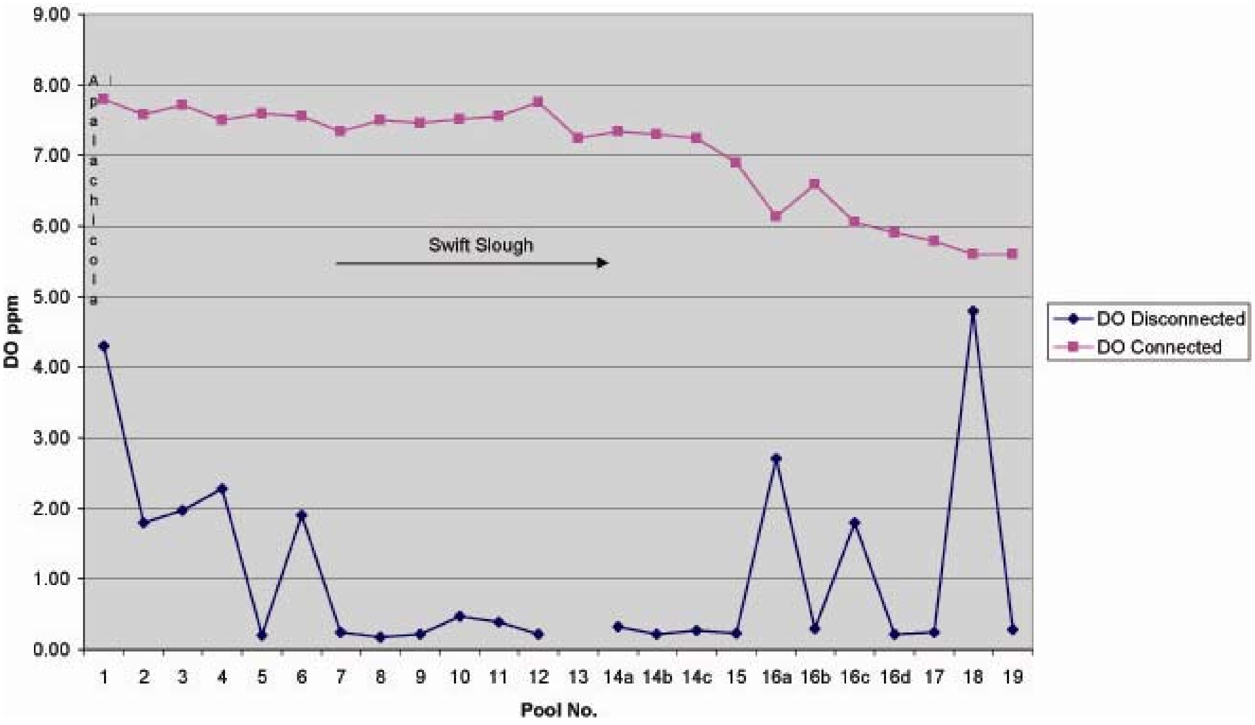


Figure 3.6.2.4.A. Dissolved Oxygen (DO) concentrations in Swift Slough when it was disconnected (4 August 2006) and connected (8 August 2006). Isolated pools were numbered from the head of Swift Slough (where it connects to the main channel) downstream.

4 EFFECTS OF THE ACTION

This section is an analysis of the effects of the IOP on the species and critical habitat. In most consultations, the Service typically evaluates a project that has not been constructed or implemented. In this consultation, the Service is evaluating the effects of a project that is ongoing. The previous "Environmental Baseline" section described the effects of all past activities, including the effects of past construction and operation of the Corps ACF projects, current non-Federal activities, and Federal projects with completed section 7 consultations. This section addresses the future direct and indirect effects of the IOP, including the effects of any interrelated and interdependent activities. Our determination of total effects to the species and critical habitat in the "Conclusion" section is the sum of the effects evident in the baseline plus effects of the action and cumulative effects.

4.1 Factors Considered

In the "Environmental Baseline" section, we outlined three principal components of the species' environment in the action area: channel morphology, flow regime, and water quality. The Service does not have enough information to determine if IOP implementation will itself alter the baseline water quality of the action area; however, we recognize a potential for salinity changes in the bay and localized dissolved oxygen changes. 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. Channel morphology continues to change in the Apalachicola River, and may not reach a dynamic equilibrium in the foreseeable future. We have no ability at this time to predict specific effects on channel morphology due to the influence of the IOP on the flow regime. The IOP defines 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 our analysis is the flow regime of the Apalachicola River with and without project operations. Our analysis of flow regime alteration relative to the listed species and critical habitats considers the following factors.

<u>Proximity of the action:</u> The proposed action will affect habitat occupied by all life stages of Gulf sturgeon in both the Apalachicola River and Bay, which are both 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 mussels 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 the releases from Woodruff Dam, which is less than a mile from some of the species' life history stages and habitat features we examine and over 100 miles from others, it affects both.

<u>Distribution:</u> The proposed action could alter flows in the Apalachicola River and its distributaries downstream of Woodruff Dam, and alter freshwater inflow to Apalachicola Bay. The Gulf sturgeon may occur throughout the Apalachicola 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. 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 its junction with the Chipola cutoff within the action area. We

examine how the IOP may variously affect different portions of the action area according to the distribution of the species and important habitat features in the action areas.

Timing: The proposed action could alter flows in the Apalachicola River and into Apalachicola Bay at all times of the year. It will reduce flows when increasing cumulative storage in the ACF resevoirs and increase flows when decreasing cumulative reservoir storage. Gulf sturgeon occupy the Apalachicola River year-round as larval and juvenile fish, and then seasonally as subadults and adults, spawning in the Apalachicola River around May. Subadults and adult Gulf sturgeon likewise occupy Apalachicola Bay seasonally, during the coldest months of the year. The fat threeridge and purple bankclimber occupy the Apalachicola River year-round and during all life phases. The fat threeridge, a species that tends to occupy shallower waters, may be more susceptible to effects of low flows during the breeding period, in late spring/early summer. We examine how the IOP may alter the seasonal timing of biologically relevant flow regime features in our analysis.

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

Duration: This proposed action is an *Interim Operating Plan* applicable until revised or until a new Water Control Plan is adopted. Although the duration of the IOP is indefinite, the nature of its effects is such that none are permanent. The Corps may conceivably alter its reservoir operations 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 IOP 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 IOP 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 the IOP is revised or a new Water Control Plan is adopted. However, we examine how the proposed IOP 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: As proposed, the IOP temporarily suspends discretionary alteration of the flow regime when basin inflow declines below the seasonal low-flow thresholds defined in Table 1.2.A, but maintains a minimum flow of 5,000 cfs. We examine how the IOP affects the magnitude of flow events relative to the baseline and to no action.

4.2 Analyses for Effects of the Action

To determine the future effect of continued project operations as prescribed by the IOP, we must compare the environmental conditions expected under the IOP to the environmental baseline. The principal factor we examine is the flow regime of the Apalachicola River and how the flow regime affects habitat conditions for the listed species. However, we cannot attribute all differences between the flow regime expected under the IOP and the baseline flow regime to the IOP alone. Some of the differences are due to consumptive water uses in the basin.

The level of consumptive water uses supported in the basin upstream of Woodruff Dam, which affects basin inflow to the Corps' projects, increased throughout the post-West Point period (post-1975) that we use as the baseline flow regime. The Corps is implementing the IOP using basin inflow available under the present level of consumptive water uses, which is a feature of the most recent years only in the baseline period. Using the inflow based on present consumptive uses means that conditions predicted under the IOP are due in part to the IOP and due in part to an increase in consumptive uses.

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, we must examine environmental conditions that would result if project operations were not continued, *i.e.*, the effects of no action on the part of the Corps. By "no action", we do not mean continuing reservoir operations without the changes represented by the IOP; we mean discontinuing reservoir operations that alter the flow regime of the river. In our effects analyses, no action is "run-of-river" operations (RoR). RoR is the expected flow regime if the Corps maintained a constant water surface elevation on all of the ACF federal reservoirs, never diminishing basin inflow by raising reservoir levels and never augmenting basin inflow by lowering reservoir levels. RoR is the constant release of basin inflow (as defined in the "Description of Proposed Action") from Woodruff Dam.

The Corps has provided models that represent the expected flow regime under both the IOP and RoR (see section 4.2.1. below). The Corps does not use the historically calculated daily basin inflow data to represent the RoR scenario, which as we noted above, was influenced by consumptive water uses that increased over time to present levels. Instead, they have used basin inflow data calculated using estimated present (using year 2000 data) levels of consumptive water use in the basin. We recognize that consumptive demands have continued to increase since 2000, primarily for municipal and industrial use, as agricultural water withdrawals likely peaked in 2000 (C. Couch, GAEPD, pers. comm. 2006). Our analysis of the cumulative effects of increasing water demands is found in section 5, "Cumulative Effects".

Our effects analyses involve comparing the characteristics of three flow regimes: Baseline, IOP, and RoR. We use flow regime characteristics that are relevant to the listed species and their habitats; the same characteristics that we examined in section 3 of this BO to evaluate baseline effects. For each of these regime characteristics, we compare the values computed for the Baseline, IOP, and RoR. If the IOP does not alter the Baseline, its effect on the species/habitat is a continuation of the Baseline effect, if any. If the IOP condition represents a beneficial or adverse alteration of the Baseline condition, the effect is accordingly beneficial or adverse; however, whether we attribute the effect to the IOP depends on the RoR flow regime, *i.e.*, what would occur with no action on the part of the Corps.

Figure 4.2.A shows the logic involved in comparing the three flow regimes by placing all six combinations of the three in a matrix where the columns represent their relative order on an adverse/beneficial gradient of flow regime alteration. Where the IOP is on the beneficial side of the gradient relative to Baseline and RoR, the IOP has a clear beneficial effect that exceeds both (rows 2 and 5). Where the IOP is on the adverse side of the gradient relative to Baseline and RoR, the IOP has a clear adverse effect that exceeds both (rows 3 and 4).

The adverse or beneficial effect of the IOP relative to baseline is not attributable to the IOP in the remaining two combinations (rows 1 and 6) shown in Figure 4.2.A. In these circumstances, reservoir operations under the IOP are modifying the RoR flow regime, but not so much that it represents an impact or benefit relative to Baseline greater than the impact or benefit of RoR. In these circumstances, no action on the part of the Corps (RoR) would have the greatest benefit (row 1) or the greatest impact (row 6); therefore, these alterations are attributable to actions or lack of actions implied in the RoR flow regime, *i.e.*, consumptive water uses and no retention of water in federal reservoirs. Although not attributable to the IOP itself, we must still consider these alterations in our evaluation of total effects to the species and habitat.

4.2.1 Model Description

The Corps has provided a simulation of ACF project operations under the IOP using the HEC-5 hydrologic simulation software. The version of the HEC-5 model we examine in this analysis is labeled “IOP23K_70_2RI”, and represents the revised IOP operations as described in the June 12, 2006, letter from the Corps to the Service. To represent flow conditions without the influence of Corps project operations, we use the same basin inflow time series upon which the HEC-5 model bases its simulation of the IOP, to which we refer in the analyses below as the “run-of-river” (RoR) scenario. As previously defined in the “Description of Proposed Action” section, basin inflow is the amount of water that would flow by Woodruff Dam during a given time period if all of the Corps’ reservoirs maintained a constant water surface elevation during that period. Basin inflow is not the natural flow of the basin at the site of 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. Both the RoR and IOP scenarios include these influences, and both use the same estimates of reservoir evaporation and current water demands; therefore, the difference between the two scenarios is the net effect of continued operation under the IOP apart from the effect of influences that are unrelated to project operations.

The consumptive water demands used in the model represent an estimate of present 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). Table 4.2.1.A summarizes these depletions. Negative values under the reservoir evaporation columns indicate a net gain due to interception of precipitation. In addition to these consumptive demand estimates, the other model settings and techniques used to represent the IOP were described at two "Hydrological and Modeling Technical Workshops" organized during the preparation of this BO (May 23 and 24, 2006 and July 12, 2006); the first at the Corps' Lake Seminole Project Offices near Chattahoochee, FL, and the second at Columbus, Georgia, Convention and Trade Center. A presentation summarizing the modeling approach is available on the Corps' Mobile District website.

To provide a potential range of flows that might be experienced while the IOP is in effect, the HEC-5 model simulates river flow and reservoir levels using a daily time series of unimpaired flow data for a certain period of record. 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 HEC-5 model imposes reservoir operations and consumptive demands onto the unimpaired flow time series to simulate flows and levels under those operations and demands. The unimpaired flow data set is the product of the Tri-State Comprehensive Study, in which the States of Alabama, Florida, and Georgia, participated.

The current unimpaired flow data set represents the years 1939 to 2001. The Corps has not yet computed unimpaired flow for 2002 through 2005, which are years included in our description of the baseline flow regime (section 3 of this BO), but is currently in the process of extending the unimpaired flow through 2004. To ensure comparisons that are most likely to reflect anthropogenic differences between the three sets of environmental conditions (IOP, RoR, and Baseline) and not hydrologic differences between years, we use only the output from the models for the period that is also represented in the baseline, which is 1975 to 2001 (27 years). Using only the latter 27 years of the HEC-5 results removes 36 years from the simulation, including a drought during the 1950's. However, the drought of 1999 to 2001, at the end of the simulated period, appears to serve as the "critical" period for the model, as this is when reservoir levels and flows reach their lowest levels in the simulation. We have concluded that the latter 27 years provides a sufficient range of flows to represent anticipated effects during IOP implementation. For simulating the effects of year 2000 estimated depletions, the 1975-2001 period in the model includes 3 years classified as wet (1975, 1991, and 1994), 6 classified as dry (1981, 1986, 1988, 1990, 1999, and 2000), and the rest as normal.

Figure 4.2.1.A displays data from the HEC-5 model in pie-chart form to show the relative differences in unimpaired flow, basin inflow, estimated depletions, reservoir storage/releases, and Apalachicola River flow during two months of the simulation: a very dry month (June 2000) and a normal month (June 1997). This figure conceptually shows the elements represented in the model to simulate flow in the Apalachicola River. The size of the pies is proportional to the flow amounts indicated, illustrating the relative effect of depletions and reservoir operations on river flow in each of these two climatic situations.

4.2.2 General Effects on the Flow Regime

Table 4.2.2A compares flow frequency for the Apalachicola River at the Chattahoochee gage observed during 1975-2001 (Baseline), and simulated by the HEC-5 model for 1975-2001 (IOP and RoR). IOP is the simulated flow of the river under the operational rules of the proposed action, and RoR is the synthesized unimpaired flow of the river minus the estimated present level of consumptive water use in the basin upstream of Woodruff Dam. The RoR regime generally has the highest flow associated with the lowest exceedance frequencies, and the lowest flow associated with the highest exceedance frequencies. This is because the reservoirs are operated, both in the Baseline and the IOP, for flood control purposes that generally decrease high flows, and for other purposes, such as hydropower, that generally increase low flows. The IOP model maintains a minimum of 5000 cfs, a flow which occurs 3.1% of the time. Flows less than or equal to 5,000 cfs occurred for 80 days in the Baseline record, or 0.81% of the time. The RoR scenario includes 579 days less than or equal to 5,000 cfs (5.9%). Figure 4.2.2.A displays in greater detail the frequency analysis of Table 4.2.2.A, focusing on flows that are exceeded 65% of the time or more, *i.e.*, the lowest flows, to illustrate these low-flow differences between the three regimes.

Average daily discharge (1975-2001) in the Baseline, IOP, and RoR flow regimes is 21,884, 21,652, and 21,420 cfs, respectively. Because unimpaired flow in the IOP model was calculated from observed flow by adding to it estimated depletions over time, the lower flow of the IOP relative to Baseline (232 cfs less) is most likely due to simulating depletions that were greater than observed. The RoR average flow is less than the IOP average because reservoir storage augmented flow during the period as a whole, by ending the period with less water in storage than at its beginning. While the difference between the IOP and Baseline average flows is small (1.1%), the depletions simulated represent over half of the unimpaired flow during some dry months (see Figure 4.2.1.A). The potential biological effect of a flow of 2,500 cfs versus a flow of 5,000 cfs or more is substantial.

4.2.3 Submerged Hard Bottom

Our principal analysis for effects of the action on sturgeon is an extension of the analysis included in section, 3.6.1.4, which quantified the area of potential spawning habitat available versus discharge based on our physical surveys of river reaches with hard substrate types and sturgeon egg collections in 2005 and 2006. We combined the relationship shown in Figure 3.6.1.4.C (hard bottom area versus discharge relationship) with the time series of daily flow values from the three flow regimes (Baseline, IOP and RoR) 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 RM 105 and RM 99, is shown in Figure 4.2.3.A. This figure represents how much hard-bottom habitat was inundated to depths of 8.5 to 17.8 feet (the range of 80% of sturgeon egg collections in 2005 and 2006) during the months of March, April, and May, under each of the three flow time series. Although the three curves cross each other multiple times over the full range of 0 to about 20 acres, habitat availability under the three flow regimes is generally equivalent (median daily habitat availability about 16 acres for all three).

The analysis shown in Figure 4.2.3.A combines data from all 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. It is important to ascertain whether the IOP would produce exceptionally low and high habitat availability between years or within a year to produce the average conditions that are comparable to the baseline. Spawning may commence when water temperature reaches about 17°C and is concluded by the time temperature reaches about 25 °C (see section 3.6.1.5). Based on available data from the Chattahoochee gage, the mean dates for these events in the Apalachicola River are March 26 and May 23 (Figure 3.4.A), respectively, a span of 58 days. Sturgeon egg collections during 2005 and 2006 spanned a period of 17 and 27 days, respectively (USFWS 2005 unpublished data; Pine *et al.* 2006). Eggs require at least 2 days to hatch in this temperature range, and larvae require several more days to develop a free-swimming ability. To address continuous habitat availability within a year that would minimally encompass the time for spawning and early development, we computed the 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 three flow time series (Figure 4.2.3.B). It is important to emphasize that frequency in Figure 4.2.3.B is percent of years (not percent of days as in the previous figure) that a given area of continuously available habitat is exceeded

The IOP and RoR flow regimes provide generally slightly more 30-day continuous habitat than the Baseline, with median values of about 15 acres versus 14 acres. All three time series provide at least 13 acres of 30-day continuous habitat in the depth range 8.5 to 17.8 ft in all years, which is the amount that was continuously available at these two sites during the 27-day period of sturgeon egg collections of 2006. The overall effect of the IOP is beneficial with respect to this measure of a flow-dependent habitat feature.

4.2.4 Changes in Salinity and Invertebrate Populations in Apalachicola Bay

Our direct knowledge of Gulf sturgeon feeding behavior and habitat selection in Apalachicola Bay is extremely limited. The first studies to examine juvenile sturgeon movements and habitat characteristics in the lower river and bay will commence this fall as a cooperative effort between the USGS, NOAA, the Florida FFWCC, and the Service. We must rely largely upon inference from Gulf sturgeon studies in other systems, known life history patterns, and other studies of the role of freshwater inflow in estuarine ecology in order to evaluate the possibility of effects of the action on Gulf sturgeon in Apalachicola Bay.

It is firmly established that almost all adult and sub-adult sturgeon do not feed much, if at all, during the months of riverine residency, and are feeding instead in estuarine and marine environments (see section 2.1.3.1). Juvenile Gulf sturgeon cannot survive direct transition from fresh water into salinities greater than 30 parts per thousand (ppt), but can gradually acclimate to 34 ppt seawater, and juvenile growth rates are highest at 9 ppt salinity (Altinok *et al.* 1998). Apalachicola Bay is necessarily the first estuarine habitat that both juvenile fish, who cannot tolerate a rapid transition to marine salinity, and older fish, who have not eaten for months, would encounter upon departing the river.

As noted in section 3.6.1.1, about 80% of the open water habitat of Apalachicola Bay is underlain by soft, muddy, unvegetated sediments, and the other 20% is divided between oyster reefs and submerged aquatic vegetation (SAV). Gulf sturgeon appear to prefer generally sandy substrates for feeding, and these areas are not necessarily associated with SAV, *e.g.,* sea grasses. Therefore, it is not readily apparent which portions of the Bay would most likely support sturgeon feeding activity. We have some telemetry data of Gulf sturgeon movements in the Bay, but not enough to discern patterns and infer preferences.

The role of freshwater inflow in the ecology of Apalachicola Bay was a primary focus of the "Apalachicola River and Bay Water Demand Element" of the Act/ACF Comprehensive Study from 1992 to 1998. One product of this element was a spatially-explicit hydrodynamic model of the Bay that simulated salinity and other parameters as a function of fresh water inflow, tides, and winds. Application of this model, in combination with benthos mapping, could identify areas most likely to support sturgeon; at this time, however, such information has not yet been generated.

Although sturgeon were not specifically investigated in the River and Bay Element of the Comprehensive Study, its findings strongly suggest that altering the flow regime of the river may alter the ecology of the bay. The following is an excerpt from the final report of the River and Bay Element (Lewis 1998:13-15), which synthesizes the results of the several studies that were included in the element:

> "River flow appears to be one of the most important factors influencing the physical and biological components of the Apalachicola estuarine system. Despite the seasonal and interannual variation, river flow displays a recurrent pattern of winter peaks and summer-fall lows. This pattern is reflected in the seasonality of individual estuarine organisms that display species-specific phase-lagged relationships to flow. These individual, highly variable relationships combine to produce an overall recurrent pattern of trophic organization. Within certain flow constraints, this trophic pattern (whether examined for fishes separately or for the combined assemblage of infauna, macroinvertebrates and fishes) is fairly stable despite its continually changing individual components. However, when events occur outside the range of normal flows (*e.g.*, droughts) the trophic organization may be perturbed. Major changes in the various trophic categories may be initiated that can last for several years after resumption of normal flow patterns….
>
> Primary productivity in Apalachicola Bay is intimately linked to the riverine input of dissolved inorganic nutrients. However, this relationship is mediated by the residence time of freshwater in the estuary, which is clearly a function of freshwater inflow (primarily) and winds and tides (secondarily)….
>
> While previous studies suggested that most of the secondary production in the estuary resulted from detrital export from the Apalachicola River floodplain, results from the current studies provide evidence that the bulk of the secondary production in the bay is fueled from *in situ* phytoplankton productivity…. Organisms inhabiting areas closest to the mouth of the river and its distributaries (*i.e.*, East Bay) appear more reliant on riverborne detritus than those living in areas more distant. However, even for these organisms, phytoplankton productivity plays a major role in faunal diets, making up at least half of the carbon transferred on average. Mid- and outer-bay organisms rely heavily on plankton production for subsistence.
>
> These results have important implications to management of the ecosystem. If secondary production within the estuary was supported primarily by a detrital foodchain, then it would be critical to preserve peak or high flood conditions in winter/spring. During this

> time the river inundates its banks and sweep leaves and organic materials from the floodplain to the estuary. However, since in situ primary production drives much, but not all, of the secondary production within the estuary, it is necessary to preserve or maintain flow during the period when estuarine primary production is greatest. This period generally coincides with low river flow during late summer and early fall. Thus, results of the study suggests that maintaining particular levels of discharge at both the low and high flow end of the flow regime are needed to assure that all organisms in all regions of the bay receive the necessary nutritional inputs.

This synthesis suggests to us that the substantial alteration of the pre-dam flow regime evident in our baseline analysis (see section 3) has probably already affected ecological processes in the bay by changing nutrient input and salinity patterns. However, substantial further alteration of flow regime features, such as number of consecutive days per year less than 16,000 cfs (Figure 3.6.1.5.A), that may directly relate to sturgeon and sturgeon critical habitat elements is not evident in the flow regime under the IOP (Figure 4.2.4.A). Therefore, at this time, we believe that the IOP itself is not likely to have an appreciable effect on sturgeon estuarine habitat.

4.2.5 Submerged Habitat Below 10,000 cfs

This section focuses on direct effects to mussels by exposure during low-flow conditions. As discussed in the baseline section, the Service and others documented large numbers of fat threeridge mussels exposed in the summer of 2006 during the preparation of this BO. We had not previously observed anything comparable to this event before 2006, although the flow levels this summer were no lower than those during the last period of low flows, 1999 to 2002. We believe the relatively sudden vulnerability to low-flow exposure of the fat threeridge population, and probably a small fraction only of the purple bankclimber population, is related to ongoing channel instability in the RM 50 to RM 40 reach of the main channel (see section 3.2) and the coincidence of three circumstances: cessation of dredging in 1998; no flows less than 7,000 cfs since the fall of 2002; and two extremely high-flow events in 2005 (see section 3.5.2.1).

We found listed mussels exposed and stranded at elevations as high as about 10,000 cfs during our summer 2006 surveys. Although we believe these observations represent an anomaly in the recent history of the river and the listed mussels, we must acknowledge that continuing channel instability may lead to additional aggradation in areas occupied by listed mussels, and that future high flow events may again move and deposit mussels in areas vulnerable to stranding and exposure. We therefore analyzed the differences between the Baseline, IOP, and RoR flow regimes in the range of flow less than 10,000 cfs.

Figure 4.2.5.A shows the inter-annual frequency of flow rates less than 5,000 to 10,000 cfs in the Baseline, IOP and RoR flow regimes. Except for preventing the occurrence of flows less than 5,000 cfs, which occurred occasionally in the Baseline, the inter-annual frequency of flow events less than 10,000 cfs is substantially higher in the IOP flow regime than in the baseline regime. At flows less than 8,000 cfs, this is primarily due to the higher frequency of low flows in the RoR, upon which operational decisions in the IOP are based.

For basin inflow rates less than 8,000 cfs, the IOP prescribes the 7-day average basin inflow, but not less than 5,000 cfs, as the minimum release from Woodruff Dam. For 7-day basin inflow rates between 8,000 and 10,000 cfs, the Corps may store up to 30 percent of basin inflow, releasing the other 70 percent, but not less than 8,000 cfs. However, other project considerations, such as the hydropower schedule, storage limitations, head limits, and occasionally the IOP ramping rate schedule, prompt releases 10 cfs or more greater than the IOP minimum flow schedule most (80.6%) of the time. Indeed, for the entire simulated period of the model 1939 to 2001, releases from Woodruff Dam under the IOP exceed its minimum release requirements more than 80% of the time, and half of these additional releases exceed the minimum requirement by more than 4,600 cfs. These additional releases offset to some degree the effect of depletions in the RoR. The use of the 7-day moving average basin inflow also reduces the number of years with releases less than 10,000 cfs, because it eliminates brief periods when basin inflow is less than this amount. On the other hand, the 7-day averaging also eliminates brief periods when basin inflow is above this amount, which may extend the duration of days of consecutive low flow.

The IOP has a slightly higher frequency of flows less than 9,000 cfs than the RoR (96.3% versus 92.6%, or 26 versus 25 years out of 27), which is due to storage of up to 30% of basin inflow at this flow rate. In the 27 years used for this comparison, the IOP is less than daily RoR for 262 days when daily basin inflow is in the range of >= 8,000 and < 10,000 cfs. In our surveys of locations at which mussels were exposed during 2006, we found about 74% of the listed mussels dead at one site that was almost entirely exposed at flows less that 8,000 cfs. At the other sites, we found, we found 3.4% at elevations corresponding to discharges greater than 8,000 cfs.

We use the maximum number of days per year with flows less than 5,000 to 10,000 cfs as a measure of the most severe year for aquatic biota under each flow scenario. In this respect, the IOP has a lesser effect than the baseline flow regime (Figure 4.2.5.B), except at the 9,000 cfs level. For this parameter, the IOP closely tracks RoR, except for its elimination of days less than 5,000 cfs. Maximum annual duration of flow less than 5,000 cfs in the RoR was 145 days, which occurs in the year 2000 of the synthesized time series. The IOP benefits mussels by supplementing flows to maintain a minimum 5,000 cfs.

Some mussels may survive brief periods of exposure by closing their shells tightly or burrowing into the substrate, as we have seen this year with the fat threeridge, but unless water temperature is extreme, the stress of exposure is most likely a function of exposure duration. In addition to the most-severe year analysis shown in Figure 4.2.5.B, we performed a most-severe event analysis by computing the maximum number of consecutive days of flow less than the 5,000 to 10,000 cfs thresholds, which is shown in Figure 4.2.5.C. With respect to this parameter, the IOP improves upon the Baseline flow regime at the 5,000 to 9,000-cfs thresholds, but increases the maximum number of consecutive days per year at the 9,000 and 10,000 cfs-thresholds by 29 and 18 days, respectively.

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. Figure 4.2.5.D shows the median number of days per year less than the thresholds of 5,000 to 10,000 cfs. Half of the years in the IOP and the Baseline have no days less than 6,000 cfs, but the median number days less than 7,000 through 9,000-cfs thresholds in the IOP exceeds the Baseline. The median number of days at all 6 thresholds is greater in the RoR than both the IOP and Baseline, so the differences between the IOP and the Baseline are attributable either to increased consumptive demands or a lower degree of flow augmentation in the IOP.

Recognizing the vulnerability of some fraction of the listed mussels to exposure during declining flow in the range of 8,000 to 5,000 cfs, the maximum fall rate schedule of the IOP (Table 1.3.A) was formulated to facilitate 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 schedule limits operations to more gradual fall rates as flow declines to the river stages where listed mussels may occur. The threshold of 8,000 cfs is the 90% exceedance flow and based on the Corps' mussel surveys during 2003, which found fat threeridge at stages as high as about 8,000 cfs.

To analyze effects due to altered fall rates, we computed daily rates of stage change of the Baseline period directly from the daily average gage height values recorded for the Chattahoochee gage 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). For the modeled flow regimes, the IOP and RoR, 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 in the same fashion as for the observed gage heights.

Figure 4.2.5.E 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 IOP 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). Among the falling days, rates less than 0.25 ft day are the most common occurrence in each flow regime except the IOP, which has a higher percentage of days in the 0.25 to 0.50 ft/day range. Collectively, IOP has a higher percentage of days in the fall rate categories of greater than 0.25 ft/day than either the Baseline or RoR (38.9% versus 24.9% in the Baseline, and 32.8% in the RoR). This shift increases the relative risk of stranding and exposure of aquatic organisms; however, most of the shift is confined to the 0.25 to 0.50 ft/day category and not the more extreme categories.

As noted earlier, we observed mussels exposed this year at stages as high as about 10,000 cfs. To determine whether an increase in the percentage of days in the greater than 0.25 ft/day ranges of fall rates might directly affect listed mussels, we performed a second analysis that focused on flows 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. Figure 4.2.5.F shows a count of days in the various rate-of-change categories when flow was less than 10,000 cfs. We use a count of days here for the vertical scale of this figure instead of a percentage of days as in Figure 4.2.5.E, because each flow regime has a different number of days less than 10,000 cfs, and this difference is relevant to the effects analysis (Baseline 2,025, IOP 2,414, and RoR 2,839 days). The number of days in the greater than 0.25 ft/day categories for the IOP is 534, more than double the number in the Baseline, but only slightly more than in the RoR. Although the model output is consistent with the maximum fall rate schedule of the IOP, this increase relative to historic operations may represent a an increased risk of mussel stranding in the 8,000 to 10,000 cfs range.

Based on our observations of mussels this year during low-flow conditions, we believe that the 0.25 ft/day maximum fall rate for flows less than 8,000 cfs provides sufficient protection of listed mussels that are situated in locations with access to flowing water during declining flow. Mussel exposure occurred almost entirely where mussels did not have such access by moving laterally downward on the channel cross section; *i.e.*, in the broad, irregular stream bed of Swift Slough or in the side-channel swales along the main river. It is likely that even a more gradual down-ramping rate would not have prevented exposing these mussels.

Most, but not all, of the effects of increased duration and inter-annual frequency of low flows in the IOP relative to the baseline appears to be a function of low basin inflow (unimpaired flow minus depletions expected in the near term); *i.e.*, the RoR scenario would have greater adverse effects. The IOP eliminates the most severe effects of flow less than 5,000 cfs by supporting this level as a minimum flow with releases from reservoir storage when basin inflow is less than 5,000 cfs. Although we attribute most of the adverse differences between the IOP and Baseline to increased depletions from non-project related water uses and not to the IOP itself, the reality for mussels and other aquatic biota is increased stress and probable mortality in the future as the river will experience low-flow conditions more often under the IOP than under the baseline conditions.

4.2.6 Floodplain Connectivity and System Productivity

We analyze here the indirect effects on mussels and sturgeon via changes to the frequency, timing, and duration of floodplain habitat connectivity/inundation. These productive areas most likely serve as spawning and rearing habitats for one or more of the host fishes of the purple bankclimber and fat threeridge (see baseline section). 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.

Our analysis uses the relationship documented by Light *et al.* (1998) between total area of non-tidal floodplain area inundated and discharge at the Chattahoochee gage (Figure 3.3.2.B). Figure 4.2.6.A displays a frequency analysis of the results of transforming the Baseline, IOP, and RoR daily discharge time series during the growing season months (April – October) to connected floodplain area. The overall area/frequency pattern of the IOP is comparable to the baseline and to RoR. An area of about 50,000 floodplain acres is inundated slightly more often under the IOP than the other flow regimes, and an area of about 16,000 acres is inundated slightly less often. The more frequent inundation of 50,000 acres is associated with operations at flows around 37,400 cfs, when in April and May, the IOP shifts operations from unrestricted storage of basin inflow to releasing at least 70% of basin inflow. The less frequent inundation of about 16,000 to 40,000 acres is associated with storage of 30% of basin inflow in the range of 37,400 cfs to 20,400 cfs.

It is important also to consider the temporal pattern of floodplain inundation to interpret biological effects. In section 3.3.2, we explained our method for quantifying 30-day continuous floodplain habitat inundation. We extend this analysis to the IOP and RoR flow regimes in Figure 4.2.6.B. The operational transitions around the mid range of basin inflow during April and May again account for differences between the IOP and Baseline flow regimes. The reduction in storage of basin inflow that occurs under the IOP at basin inflow rates above 37,400 cfs and 20,400 cfs result in an increased inter-annual frequency of 30-day continuous floodplain inundation at about 50,000 acres and 16,000 acres. The storage of up to 30% of basin inflow in the range of 24,400 to 37,400 cfs, however, reduces the frequency that about 16,000 to 28,000 floodplain acres are connected. The net overall effect of this is probably beneficial: in half the years, the IOP provides at least 15,117 acres of 30-day continuous floodplain connectivy, compared to 11,128 acres in the Baseline, and 12,485 acres in the RoR.

4.3 Species' Response to the Action

4.3.1 Gulf Sturgeon

The data from two consecutive years of Gulf sturgeon spawning studies has vastly increased our understanding of the species' spawning habitat in the Apalachicola River. The remarkable similarity of depths of egg collection between these two years, each with substantially different flow rates during the spawing period, strongly suggests a depth preference for spawning, one that is likely related to velocity as well. We interpreted habitat availability as the amount of suitable substrate inundated to the range of depths at which most of these eggs were collected (8.5 to 17.8 ft; see baseline section) and produced habitat area versus discharge relationships for these two sites (Figure 3.6.1.4.C). Flow during 2005 provided an amount of habitat that was approaching the maximum availability for the RM 105 site and was substantially less than the maximum at the RM 99 site, at which no evidence of spawning was detected. Flow during 2006 provided an amount of habitat that was approaching the minimum availability for the RM 105 site and was approaching the maximum availability for the RM 99 site, at which eggs were collected. The rough limestone rock of the RM 105 site was used for spawning in both years, which suggests that it is preferred over the hard but smooth, consolidated clay-like substrate at the RM 99 site. However, use of the RM 99 site in 2006 during lower flow, which inundated a greater area of the 8.5 to 17.8-ft depth range at that site, also suggests that area matters. If so, the analysis shown in Figure 4.2.3.B indicates that the IOP would provide at least about 13 to 16 acres of 30-day continuous spawning habitat each year, slightly improving upon the Baseline and RoR.

The combination of low- and high-flow alterations evident in the IOP relative to Baseline (Table 4.2.2.A) may adversely affect the extent or suitability of Gulf sturgeon estuarine feeding habitats. As discussed in section 4.2.4, we know very little about sturgeon feeding habitats in Apalachicola Bay; however, other studies suggest a strong linkage between freshwater inflow and ecological processes in the bay. Increasing consumptive uses of water will increase the frequency and duration of low freshwater inflow to the bay, with or without implementation of the IOP. We do not know at this time whether estuarine feeding habitat is limiting the survival or recovery of the Apalachicola sturgeon population. Studies of sturgeon use of the bay and the effects of low flows on estuarine sturgeon habitat conditions are needed to provide a basis for evaluating effects, and possibly for estimating take of sturgeon, in future assessments of either revisions to the IOP or the ACF Water Control Plan.

4.3.2 Mussels

The mussel mortality associated with low flow during the summer of 2006 was large and is a measurable impact to the Apalachicola River population of the fat threeridge. It is an impact to the river's purple bankclimber population as well, but one of lesser magnitude. We summarized above the evidence that suggests this impact is an unusual and unfortunate coincidence of channel instability, high flow events that deposited sediment and mussels in side channels and in Swift Slough, and an extended period of low flow that exposed these areas from which movement to deeper water was not possible for the mussels. The continuing channel instability is a condition set in motion by past actions that are not the subject of this consultation, including dam construction, navigation channel improvements, and navigation channel maintenance. Of these past actions, only the annual dredging that occurred almost annually before 2000 has undergone consultation for its effects on listed mussels.

The low flows of the summer of 2006 were by no means an unprecedented event; however, it is clear that the current level of depletions to basin inflow will increase the frequency and duration of such events. The RoR or "no action" scenario is by far the flow regime with the greatest low-flow impacts of those examined in this effects analysis. Releases from Woodruff Dam under the IOP generally benefit the mussels, by reducing but not eliminating, these impacts relative to the baseline. Impacts attributable to the IOP itself (*i.e.,* the adverse effect is greater than in either the Baseline or RoR) include:

- An additional year in 27 with flows less than 9,000 cfs;
- 262 days in 27 years with releases less than basin inflow when daily basin inflow is in the range of >= 8,000 and < 10,000 cfs;
- An additional 7 days as maximum number of days per year less than 9,000 cfs;
- An additional 29 and 18 days as maximum consecutive days per year less than 9,000 and 10,000 cfs, respectively;
- An additional 14% of the time with fall rates greater than 0.25 ft/day; and
- An additional 410 days in 27 years with fall rates greater than 0.25 ft/day when releases are less than 10,000 cfs.

These adverse effects each represent a small increased risk of exposure and subsequent mortality or reproductive failure to mussels located in the range of 8,000 to 10,000 cfs. These adverse effects are generally limited to mussels that occur in depositional areas from which movement to deeper habitats is not possible.

Benefits attributable to the IOP itself (*i.e.,* the beneficial effect is greater than in either the Baseline or RoR) include:

- Elimination of days less than 5,000 cfs
- A reduction in maximum number of days per year less than 5,000 to 8,000 cfs.

- A reduction in the number of days with fall rates > 1.0 ft/day.
- Elimination of days with fall rates > 1.0 ft/day when flow is less than 10,000 cfs.

These beneficial effects represent a reduced risk of exposure and subsequent mortality or reproductive failure to mussels located at stages less than 8,000 cfs.

The adverse effects of low flow to fat threeridge and purple bankclimber could be minimized in several ways, including increasing minimum flows or conducting habitat management. The Service investigated Swift Slough in July, 2006, to determine whether dredging to remove the controlling sills (high points in the streambed that control flow to the next stream segment downstream) would benefit listed mussels. At the time, Swift Slough was about to become disconnected from the main channel and was a narrow (about 3 ft wide) stream flowing between a series of pools located at the sills. After careful examination of the channel morphology, we determined that deepening the channel thalweg at the sills, while restoring flowing water to a very narrow channel, would also substantially reduce the area of pool habitat between the sills, which is where most of the listed mussels were located. Substantial physical alteration of the slough would inevitably harm the mussels, as we detected several burrowed up to about 1 ft beneath the surface in addition to the hundreds visible on the surface. At this time, we believe that dredging is not an effective means to minimize harm to the listed mussels in Swift Slough.

We therefore asked the Corps to evaluate the feasibility of increasing the 5,000 cfs minimum flow to 6,000 cfs, which would maintain a minimal connectivity in Swift Slough (USGS letter to the Service dated July 13, 2006) and inundate portions of several side channels and “hooks and bays” on the main channel that contained listed mussels. Although maintaining 6,000 cfs appeared feasible using the HEC-5 IOP model with estimated year 2000 demands, the Corps advised us that doing so under current conditions would substantially risk depleting reservoir storage and the Corps’ ability to maintain even 5,000 cfs as the minimum flow (D. Otto, Corps, Memorandum for Record dated September 1, 2006).

4.3.2.1 Host Fish

Fish hosts that support the larval life stages of the listed mussels are one of the principal constituent elements identified for their proposed critical habitat. Host fishes are not known for the Chipola slabshell and the purple bankclimber. The fat threeridge appears to be a host fish generalist that may infect fishes of at least three different fish families (see section 2.2.3.3.1). Among these are species known to extensively use floodplain habitats for spawning and rearing, such as bluegill, redear sunfish, and largemouth bass. Fish are affected by low-flow events due to constriction of habitat, elevated temperature, reduced dissolved oxygen in backwaters, etc., but the measures of low-flow effects that we have used in the mussels exposure analysis apply also to other fish. We have instead used floodplain spawning habitat availability as the principal measure of effects to potential host fish of the listed mussels apart from low-flow effects. Most fish spawning activity occurs in the growing-season months of April through October, but most floodplain inundation occurs in the months of January through April, when discharge exceeds 20,000 cfs more often than in other months. Therefore, April is likely the month of greatest floodplain habitat utilization, with March and May serving when temperature and discharge coincide favorably.

Although the basin inflow thresholds for releases under the IOP in the months of March through May were formulated in recognition of sturgeon spawning in the main channel, these are also critical months for other fishes' spawning and rearing activity. Overall, fewer floodplain acres are inundated for a given number of growing-season days under the IOP than under the Baseline, but slightly more than under the RoR flow regime (Figure 4.2.6.A). However, the IOP shows a significant increase in the annual maximum 30-day continuous inundation of the floodplain compared to baseline and RoR (Figure 4.2.6.B). This is most likely due to: 1) decreasing the fraction of basin inflow stored while approaching the "but not less than" limits of 37,400 and 24,400 cfs that define the spring-time mid range of basin inflow; 2) observing the maximum fall rate (down ramping) schedule; and 3) using a 7-day average basin inflow as the basis for releases from Woodruff Dam. These practices combine to partially "fill the valleys" of the river hydrograph, which results in less inundation overall due to storage of basin inflow in the mid and high range of basin inflow compared to RoR, but a more continuous inundation of the floodplain compared to the Baseline. This effect is likely beneficial to floodplain-spawning fish that serve as hosts for mussel glochidia. Therefore, it is also a likely benefit to mussel reproduction. The principal effect to this element is the effect of reduced floodplain connectivity evident in the baseline itself (see section 3.3.2).

4.3.2.2 Chipola slabshell

The Chipola slabshell was only recently discovered in the Chipola River downstream of Dead Lake within the action area. A survey to determine the present distribution and abundance of the slabshell in the Chiopla River and its tributaries is currently underway. At this time, we believe only a relatively small fraction of the population may occur in the action area. Although some exposure-related mussel mortality was observed in the Chipola Cutoff, the slabshell was not detected in the Cutoff, and no mortality was observed this summer in the Chipola River downstream of its confluence with the Cutoff (C. Stringfellow, Columbus State University, personal communication, August 18, 2006). Therefore, while there is a slight potential for the flow-related adverse effects to the Chipola slabshell, we believe the probability is negligible.

4.3.2.3 Purple Bankclimber

The purple bankclimber is sparsely distributed in a large portion of the action area, from near Woodruff Dam in the main channel downstream to RM 21, and in some tributaries and distributaries of the lower river (*e.g.,* Swift Slough, River Styx). Because it appears to prefer somewhat deeper areas in the channel cross section of the Apalachicola River, diving gear is necessary to adequately survey the species and less is known about its population in this river (see section 3.5.3.2). It appeared only in small numbers in the exposure/mortality observations of 2006, which we do not believe represent a significant fraction of the total population in the Apalachicola River. Some of the increased frequency and duration of low flow may be attributed to the IOP. These conditions have and may again in the future contribute to mussel mortality.

Of the five principal constituent elements of purple bankclimbers proposed critical habitat, the action is likely to adversely affect only the flowing water element. Our low-flow measures that relate to take address these effects. Swift Slough, one portion of the proposed Apalachicola River critical habitat unit, was formerly connected at a flow of 5,000 cfs and is presently disconnected a flow greater than 5,000 cfs, which is the minimum flow supported under the IOP. However, this loss of perennial flow is due to channel instability in the main river and resulting bed aggradation, and is not due to water management actions on the part of the Corps. Therefore, we do not find that the IOP will appreciably diminish the ability of the proposed critical habitat to function for the conservation of the purple bankclimber. If possible to achieve without seriously compromising reservoir storage during an extended drought, maintaining perennial flow in Swift Slough would minimize mussel mortality associated with the bed aggradation.

4.3.2.4 Fat Threeridge

The total number of fat threeridge that died in 2006 due to the combined effects of drought, channel instability, depletions to basin inflow, and to a small degree, operations under the IOP, is unknown. Whether this mortality compromises the survival of the species depends in part on the fraction of the total population that is now located in Swift Slough and in the side-channel swales from which movement to deeper water during low flow is not possible. It is clear to us that these circumstances are not solely attributable to project operations, either under the previous water management practices or under the present and foreseeable future practices of the IOP. Indeed, our analyses in this section show that “no action” on the part of the Corps, *i.e.*, a run-of-river (RoR) operation, would generally exacerbate the adverse effects of these circumstances.

A statistically valid estimate of the fat threeridge population from which to estimate the fraction that occurs within the habitats vulnerable to exposure in the range of 5,000 to 10,000 cfs is not available. We have no evidence that animals located in the Chipola River itself (excluding the 3 miles of the Chipola Cutoff), in the main channel of the Apalachicola upstream of RM 50, and in the main channel downstream of RM 40, are vulnerable to exposure from flows in this range. The vulnerable areas represent 13 miles out of 128 miles of the post-1990 known extent of occurrence of the species (USFWS 2003), which doesn’t include the occurrence of a few live individuals found in August, 2006, in the lower Flint River. The species has become rare in the upstream-most 30 miles of the Apalachicola, likely due to substantial channel entrenchment in this reach following the construction of Woodruff Dam. Only a portion of this area has been recently searched. We believe that future surveys coordinated with channel morphology studies will likely find additional locations of fat threeridge. However, subtracting this reach from the core range of the species, 85 miles remain outside of Swift Slough and RM 50 to RM 40 where so many fat threeridge have become vulnerable to low flow.

Within the RM 50 to RM 40 reach, not all animals are located in vulnerable microhabitats. Our 2006 surveys focused on locations where mussels were exposed by low flow, and we did not search for mussels in the water at depths greater than about 2 to 3 ft. Nevertheless, it was apparent that where mussels can access deeper water they did so, and when we actively search for animals that avoided stranding, we find them. For example, we surveyed (30 minutes effort) a site at RM 46.8 on June 22, 2006, finding 82 fat threeridge in the water and 2 out of the water (Table 3.5.2.1.A). EnviroScience (unpubl data 2006) surveyed this site several weeks later on August 7, 2006, expressly to establish the depths at which fat threeridge might occur here and found 575 fat threeridge in the water at depths up to about 4 ft. This site is a short distance upstream of two other sites (RM 44.3 and RM 43.7) at which large numbers of fat threeridge were found stranded. Until channel morphology and mussel populations adjust to recent changes, future high-flow events followed by low-flow events may again create the circumstances for mussel strandings and mortality. We may determine how likely this is to occur by further studies of mussel distribution coordinated with studies of channel dynamics. At this time, we lack the information necessary to predict the effects of such future events.

At this time, we believe the fat threeridge has suffered during 2006 an anomalous impact that is due in small part only to the discretionary operations of the Corps' ACF projects. Although the impact is substantial, we believe the species will survive it. We described in the section 2 of this BO how most recent surveys of this species have detected evidence of recent recruitment, and how our analysis of shell lengths suggests a relatively normal age structure and annual survival rate leading up to 2006. These observations, plus the large portion of its extant range that is not so severely affected by the combination of low flow and channel instability, suggest to us that the fat threeridge will be able to recover from this impact.

Of the five principal constituent elements of fat threeridge proposed critical habitat, the action is likely to adversely affect only the flowing water element. Our low-flow measures that relate to take of mussels address this effect, and the proposed action will not otherwise appreciably alter the flow regime of the Apalachicola River. Swift Slough, one portion of the proposed Apalachicola River critical habitat unit, was formerly connected at a flow of 5,000 cfs and is presently disconnected a flow greater than 5,000 cfs, which is the minimum flow supported under the IOP. However, this loss of perennial flow is due to channel instability in the main river and recent high-flow events that have aggraded the slough, and is not due to water management actions on the part of the Corps. Therefore, we do not find that the IOP will appreciably diminish the ability of the proposed critical habitat to function for the conservation of the fat threeridge. If possible to achieve without seriously compromising reservoir storage during an extended drought, maintaining perennial flow in Swift Slough would minimize mussel mortality associated with the bed aggradation.

4.4 Interrelated and Interdependent Actions

We must consider along with the effects of the action the effects of other federal activities that are interrelated to, or interdependent with, the proposed action (50 CFR sect. 402.02). Interrelated actions are part of a larger action and depend on the larger action for their justification. Interdependent actions have no independent utility apart from the proposed action. At this time, the Service is unaware of actions that satisfy the definitions of interrelated and interdependent actions that will not themselves undergo section 7 in the future, or that are not already included in the Baseline or in our representations of flows under the IOP and RoR.

4.5 Tables and Figures for Section 4

Table 4.2.1.A. Summary of depletion estimates (cfs) based on year 2000 data in the ACF Basin upstream of Woodruff Dam used in the HEC-5 model of the IOP. Negative values for reservoir evaporation indicate a net gain from precipation.

		Reservoir Evaporation			Agricultural			Total		
	M&I	Dry	Normal	Wet	Dry	Normal	Wet	Dry	Normal	Wet
Jan	350	-51	-129	-162	15	14	12	314	235	199
Feb	365	-26	-87	-85	18	16	14	357	294	294
Mar	311	61	-19	-98	26	23	20	398	315	233
Apr	354	244	182	69	100	79	54	699	616	477
May	629	300	244	209	525	393	229	1454	1267	1068
Jun	665	293	225	231	1370	1014	569	2329	1905	1466
Jul	667	179	179	51	1077	803	461	1923	1649	1179
Aug	613	229	195	191	618	462	266	1460	1270	1069
Sep	467	214	177	183	156	123	82	837	767	732
Oct	507	175	175	164	68	58	46	749	740	717
Nov	394	40	-9	-5	37	31	24	471	417	413
Dec	371	-91	-103	-100	19	17	14	299	285	285
Annual Average	475	131	87	54	337	254	150	944	816	680

Table 4.2.2.A. Observed and simulated flow frequency (% of days flow exceeded) of the Apalachicola River at the Chattahoochee gage for the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

Frequency Exceeded	Baseline	IOP	RoR
0%	227,000	248,683	265,832
5%	58,300	58,078	59,082
10%	45,900	44,327	44,892
15%	36,585	37,400	37,656
20%	30,600	31,363	31,466
25%	26,792	26,277	27,238
30%	22,900	22,756	23,810
35%	20,000	20,400	21,125
40%	18,300	19,257	18,874
45%	16,900	17,299	17,011
50%	15,500	15,624	15,361
55%	14,333	14,103	13,831
60%	13,500	12,866	12,450
65%	12,600	11,815	11,158
70%	11,800	10,894	10,227
75%	10,900	10,089	9,223
80%	9,870	9,255	8,254
85%	9,060	8,396	7,411
90%	7,960	7,744	6,170
95%	6,250	6,225	4,708
100%	3,900	5,000	389

Biologically Relevant Flow Regime Characteristic

	Adverse ←	Condition Gradient	→ Beneficial	Interpretation of IOP Alteration
1	Baseline	IOP	RoR	Beneficial, but not attributable to the IOP
2	Baseline	RoR	IOP	Beneficial
3	IOP	Baseline	RoR	Adverse
4	IOP	RoR	Baseline	Adverse
5	RoR	Baseline	IOP	Beneficial
6	RoR	IOP	Baseline	Adverse, but not attributable to the IOP

Figure 4.2.A. Matrix showing the interpretation of effects of the IOP relative to Baseline, depending on the condition in the RoR flow regime, which provides the basis for isolating the effects of the IOP from the effects of simulated non-project related water depeletions.

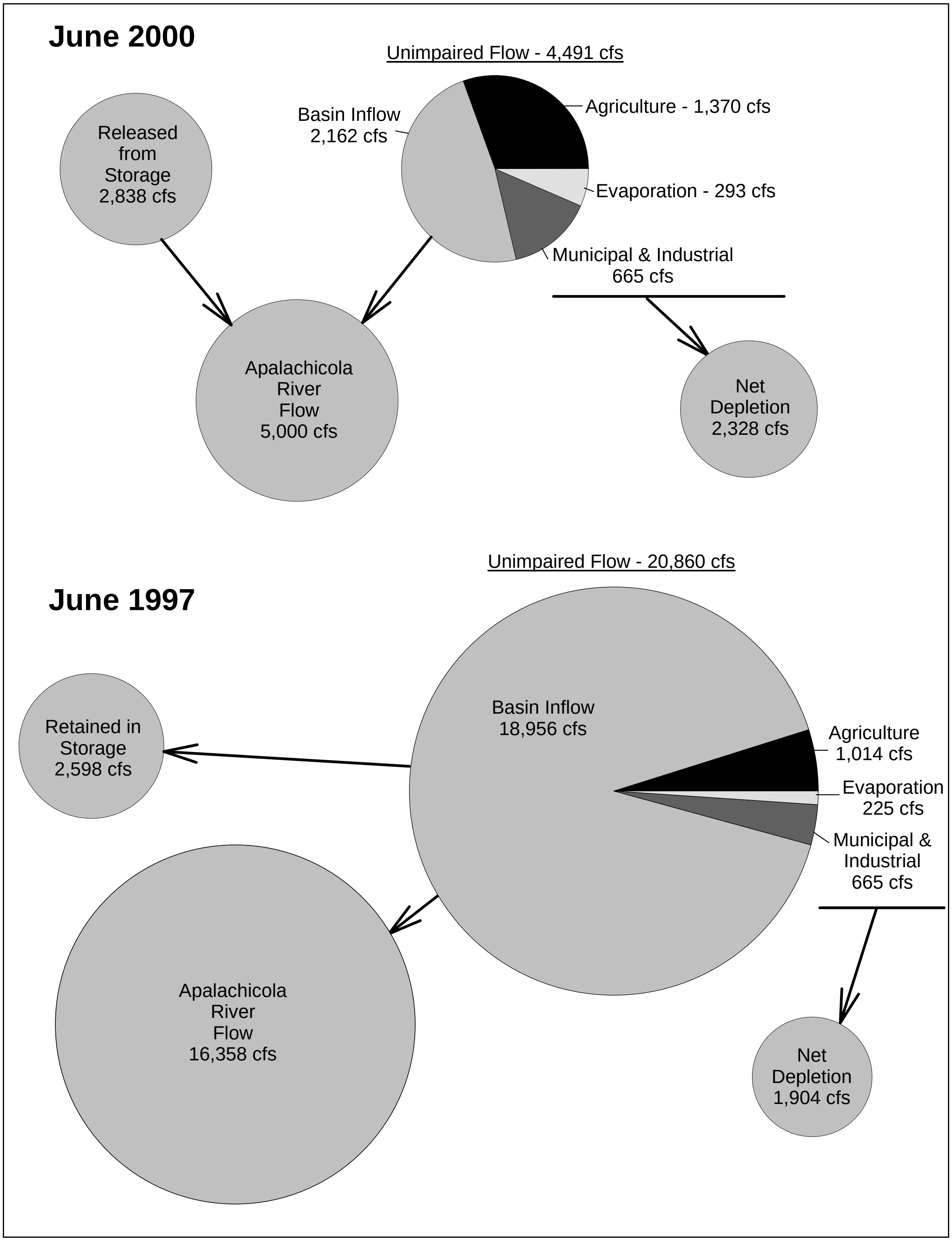


Figure 4.2.1.A. Monthly average unimpaired flow, estimated depletions, change in reservoir storage, and Apalachicola River flow from the HEC-5 model of the IOP during a dry summer month (June 2000, three upper circles) and a normal summer month (June 1997, three lower circles). The relative sizes of the circles are proportional to the cfs values indicated.

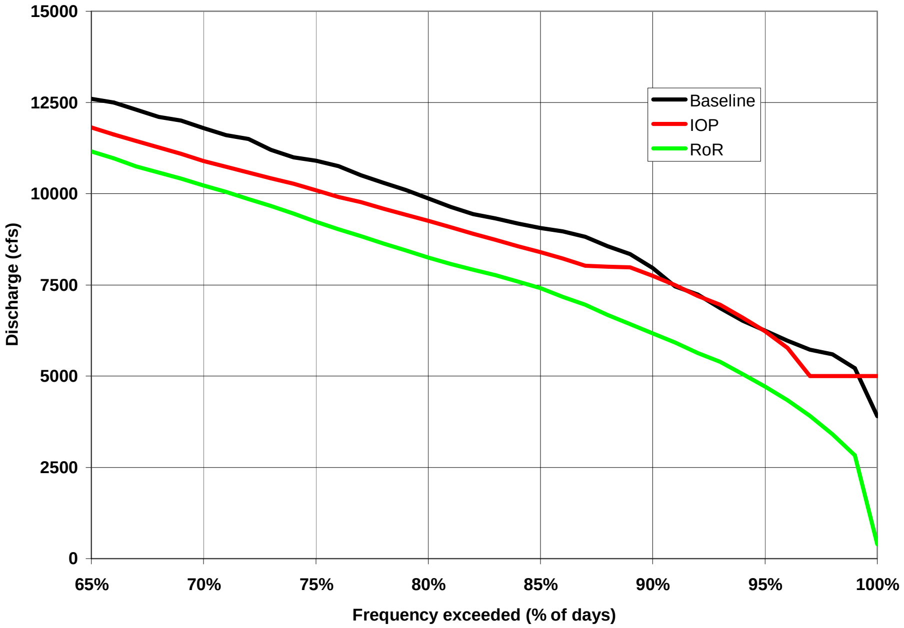


Figure 4.2.2.A. Flow frequency (% of days flow exceeded) of the Apalachicola River at the Chattahoochee gage for the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

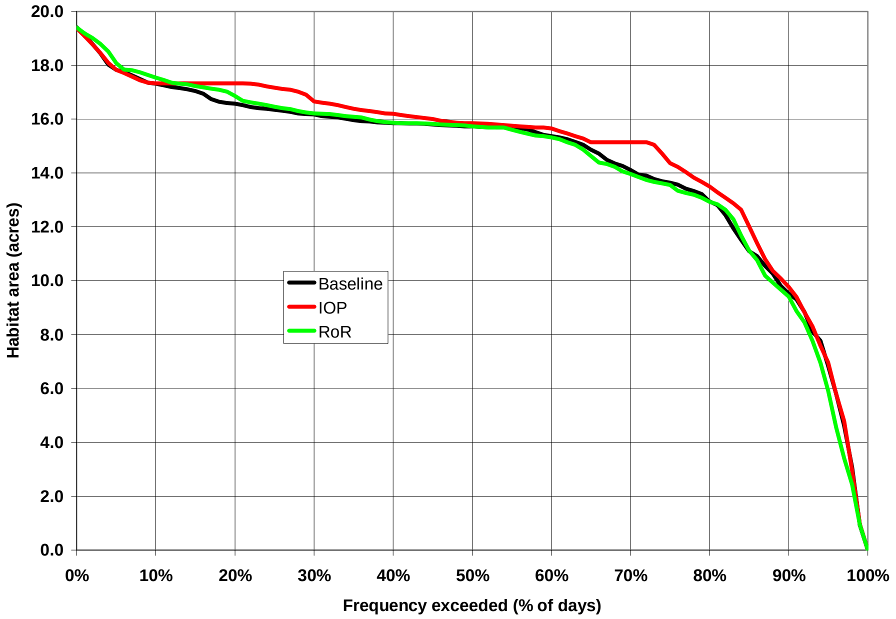


Figure 4.2.3.A. Frequency (% of days) of Gulf sturgeon spawning habitat availability (acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet), on each day March 1 through May 31, at the two sites known to support spawning, under Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

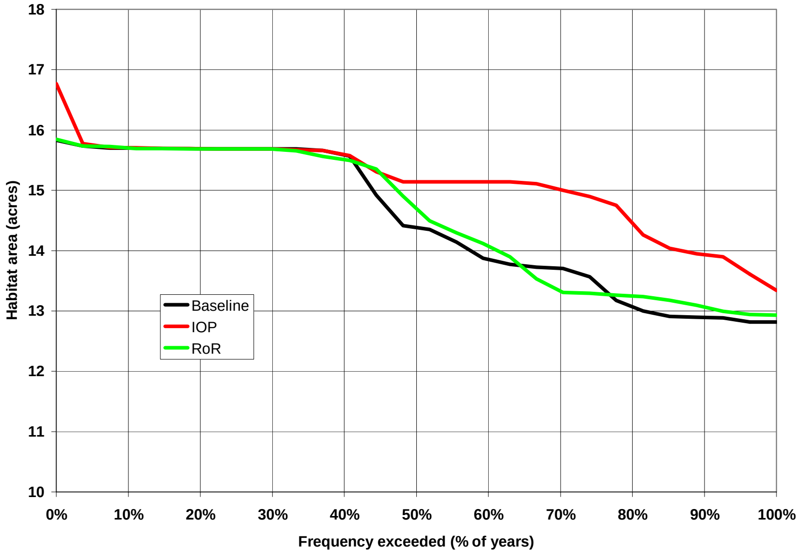


Figure 4.2.3.B. Frequency (% of years) of Gulf sturgeon spawning habitat availability (maximum acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet for at least 30 consecutive days each year), March 1 through May 31, at the two known spawning sites, under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

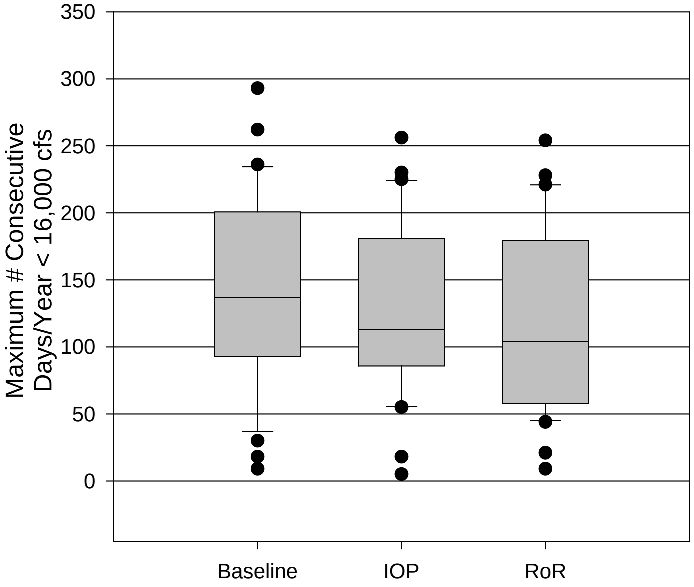


Figure 4.2.4.A. Maximum number of consecutive days/year of flow less than 16,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

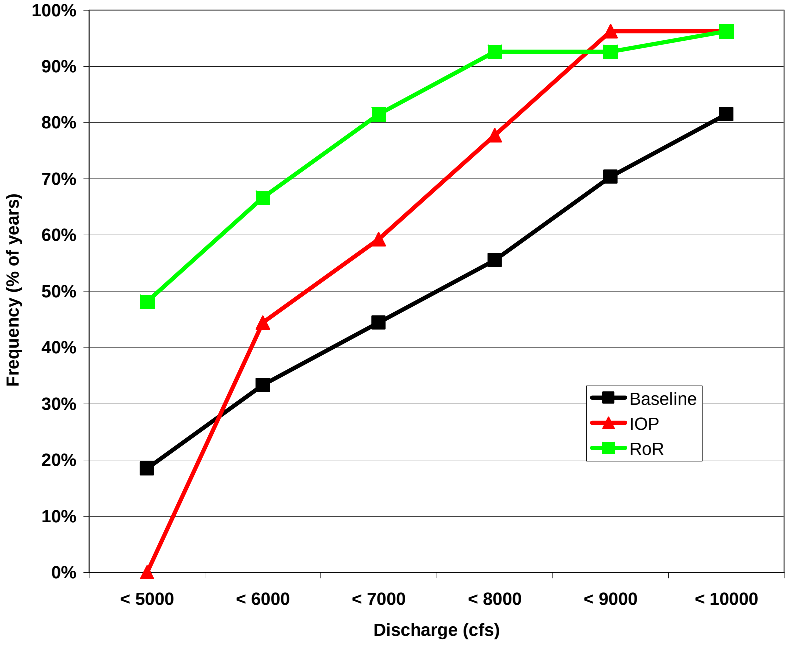


Figure 4.2.5.A. Inter-annual frequency (percent of years) of discharge events less than 5,000 to 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

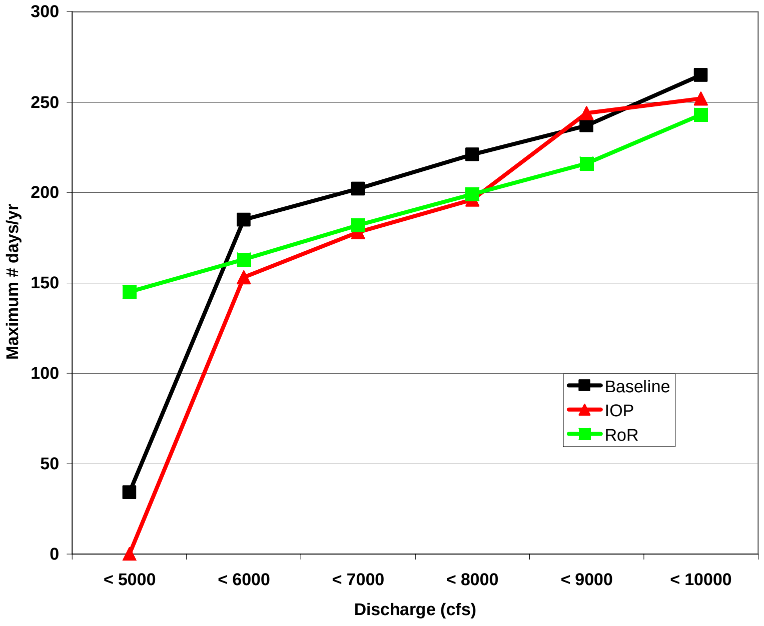


Figure 4.2.5.B. Maximum number of days per year of discharge less than 5,000 to 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

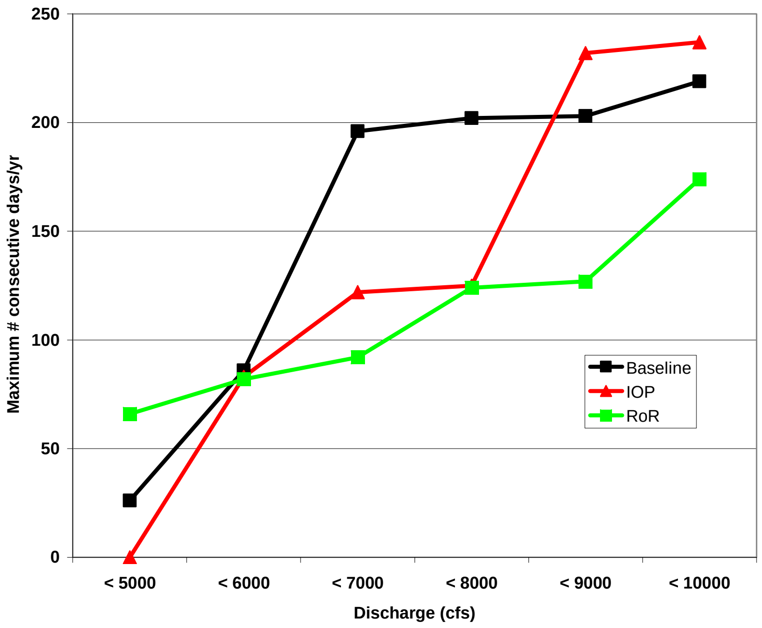


Figure 4.2.5.C. Maximum number of consecutive days per year of discharge less than 5,000 to 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

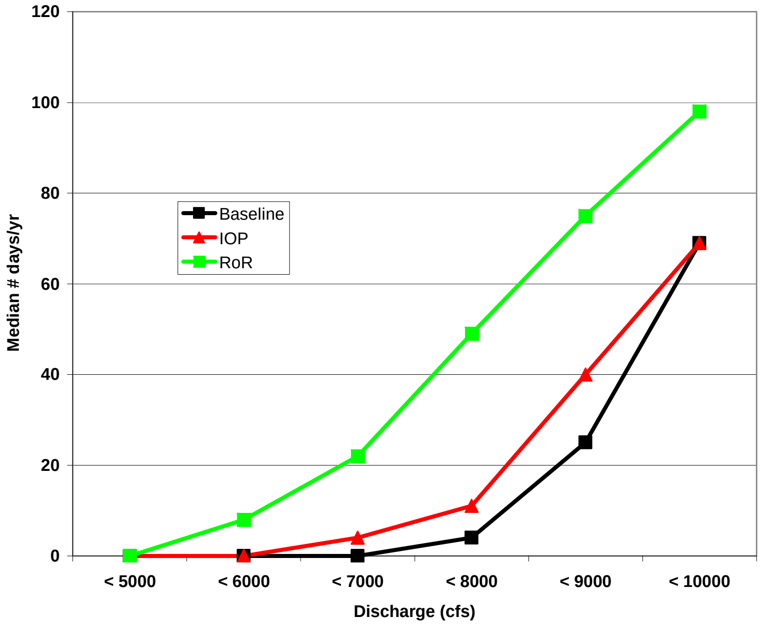


Figure 4.2.5.D. Median number of days per year of discharge less than 5,000 to 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

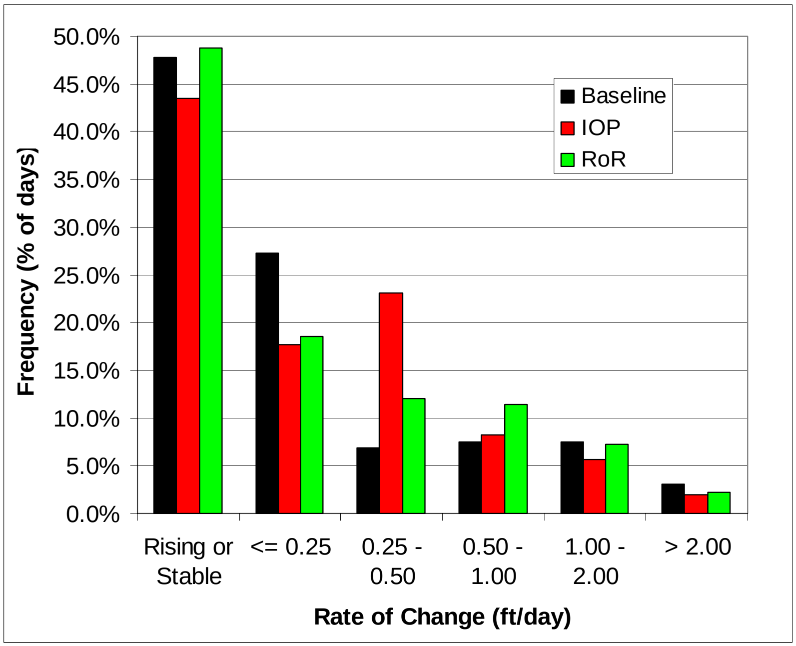


Figure 4.2.5.E. Frequency (percent of days) of daily stage changes (ft/day) under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

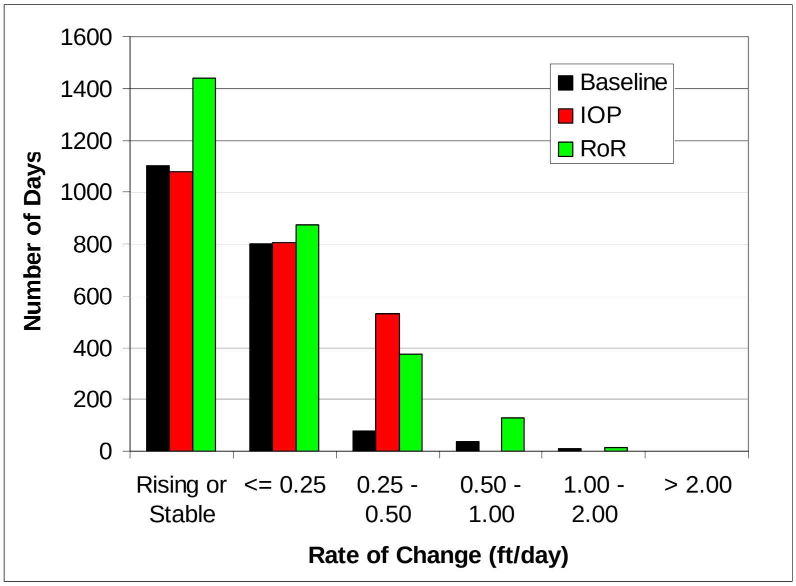


Figure 4.2.5.F. Frequency (number of days) of daily stage changes (ft/day) when releases from Woodruff Dam are less than 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

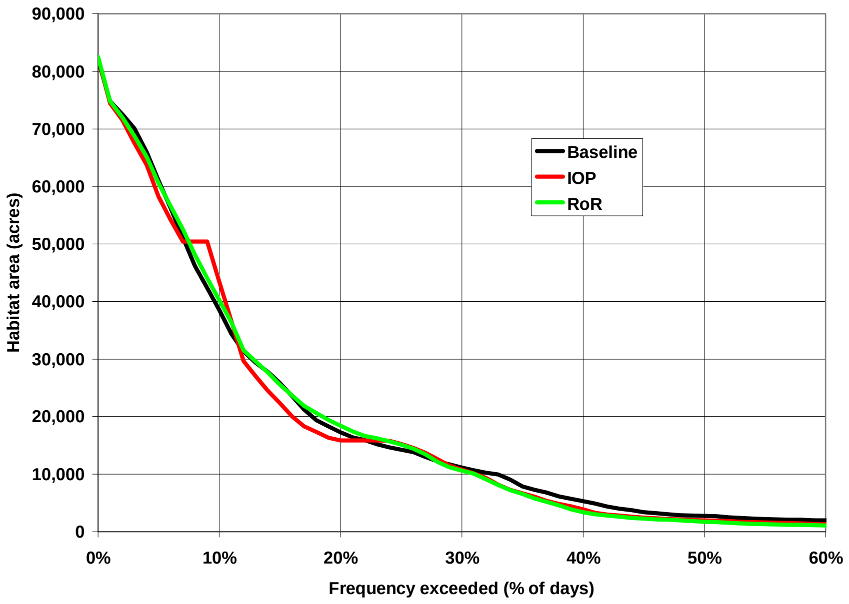


Figure 4.2.6.A. Frequency (percent of days) of growing-season (April-October) floodplain connectivity (acres) to the main channel under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

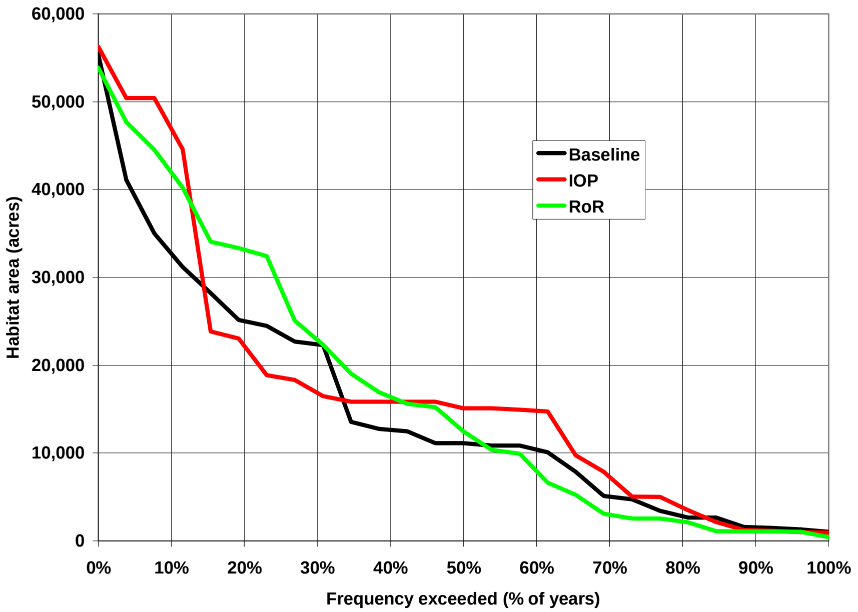


Figure 4.2.6.B. Frequency (percent of years) of growing-season (April-October) floodplain connectivity (maximum 30-day continuous connectivity, acres, per year) to the main channel under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001) and RoR (HEC-5 simulated run-of-river or basin inflow).

5 CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this BO.

5.1 Year 2010 Water Depletions Forecast

The Corps does not specify a time frame for the applicability of the IOP, but intends to operate under the IOP pending a future update to the WCP. By its name “Interim Operations Plan”, we anticipate that it will apply for a relatively brief time period. Lacking a sunset date for the IOP, we requested the Corps to provide a forecast of net consumptive depletions for the year 2010, and to provide a simulation of the IOP using this forecast. A 2010 forecast represents a 4-year projection relative to 2006. For our effects analysis, the Corps provided a model of the IOP that uses hydrologic data for the years 1939-2001 and water depletion data for the year 2000 to represent present depletion levels. In this context, the 2010 forecast is essentially a 10-year projection. Table 5.1.A summarizes the 2010 water depletions estimates.

The 2010 projected depletions show an increase in the municipal and industrial (M&I) demands only (an annual increase of about 329 cfs) compared to the 2000 depletions data used for the simulation of present conditions. To show the projected increase in M&I demands, Table 5.1.A also includes the 2000 M&I estimates. The Corps did not project an increased agricultural water demand for 2010, based on statements by the Georgia Environmental Protection Division that that most acres in the basin for which irrigation is economically feasible are already irrigated, and that agricultural demand has likely “plateaued” at close to the year 2000 demands. Possible changes in the amount of water applied per acre were not considered. Depletions due to evaporation from the federal reservoirs is partly a function of reservoir surface area, which varies between simulations depending on the operations, but the loss per acre per month is unchanged relative to the 2000 depletion estimates.

The projected 2010 M&I depletions shown in Table 5.1.A increase the total annual depletions to basin inflow that were estimated using year 2000 depletions at Woodruff Dam (see Table 4.2.1.A) by 35, 40, and 48% in dry, normal, and wet years, respectively. Although the average annual increase of 329 cfs in M&I demands is a small fraction of the average annual flow of the Apalachicola River (over 21,000 cfs), it contributes to a total depletion that during drought represents a majority of the flowing surface water in the system (Figure 4.2.1.A).

Additional depletions reduce basin inflow to the Corps’ reservoir projects. Table 5.1.B compares basin inflow frequency under the 2000 depletion estimates and the 2010 depletion estimates. The flow exceeded a given percentage of time under the 2010 depletion estimates is generally about 220 cfs less than under the 2000 depletion estimates. Our effects analysis examined direct effects to listed mussels at flows less than 10,000 cfs (section 4.2.5). The 2010 depletions would increase the frequency of basin inflows less than 10,000 cfs from 28.7% of the time to 30.7% of the time. Therefore, this change would increase the incidence of low-flow related effects by about 2%. While this increase is relatively small, any increase in depletions in the RoR would be significant if not for the ameliorating effects of the IOP to supplement flows of at least 5,000 cfs when basin inflow is less. As noted below, a proportion of the increase will be the subject of future consultations, which could not be segregated from Table 5.1.A.

5.2 Other Factors

Government and private actions may include changes in land and water use patterns, including ownership and intensity, any of which could affect listed species or their habitat. It is difficult, and perhaps speculative, to analyze the effects of such actions, considering the broad geographic landscape covered by this BO, the geographic and political variation in the action area, extensive private land holdings, the uncertainties associated with State and local government and private actions, and ongoing changes in the region's economy. Adverse effects to riverine habitat from continued urbanization in the basin are reasonably certain to occur. However, state and local governments have regulations in place to minimize these effects to listed species, including regulations regarding construction best management practices, storm water control, and treatment of wastewater.

5.3 Federal Actions Not Considered Under Cumulative Effects

Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. These actions include channel maintenance dredging and disposal, water quality criteria, new pesticides and/or uses, pipes in rivers for water withdrawals, small impoundments, and revisions to the WCP. The Corps gave notice on June 16, 2006, that it intends to prepare an Environmental Impact Statement for implementation of interim contracts for water storage in Lake Lanier. We expect to consult with the Corps on the Lanier water storage contracts and any future reallocation process. If the outcome of that process or any other modification of operations at the upstream projects would warrant a change in the Woodruff IOP or result in a change in the effects documented in this BO, the Corps would need to reinitiate this consultation. At this time, a full update to the Water Control Plan has been deferred to allow ongoing court-ordered mediation discussions to continue between the three States and the Corps.

5.4 Tables for Section 5

Table 5.1.A. Summary of depletions (cfs) to basin inflow estimated for the year 2010 by the Corps of Engineers. For depletions that vary by year in the HEC-5 model, values for dry, normal, and wet years are given. The municipal and industrial (M&I) depletions estimated for the year 2000 are also given for comparison with the 2010 M&I depletions. Negative values for reservoir evaporation indicate a net gain from precipation.

			Reservoir Evaporation			Agricultural			Total		
	M&I 2000	M&I 2010	Dry	Normal	Wet	Dry	Normal	Wet	Dry	Normal	Wet
Jan	350	634	-51	-129	-162	15	14	12	598	519	483
Feb	365	670	-26	-87	-85	18	16	14	662	600	600
Mar	311	583	62	-19	-98	26	23	20	671	587	505
Apr	354	644	245	182	69	100	79	54	989	906	767
May	629	1033	301	244	209	525	393	229	1859	1671	1471
Jun	665	1017	295	225	231	1370	1014	569	2682	2256	1817
Jul	667	1047	181	179	51	1077	803	461	2304	2029	1558
Aug	613	1005	232	196	191	618	462	266	1856	1663	1462
Sep	467	865	216	178	184	156	123	82	1237	1166	1130
Oct	507	768	177	176	165	68	58	46	1014	1002	979
Nov	394	689	40	-8	-5	37	31	24	767	712	709
Dec	371	676	-92	-103	-100	19	17	14	603	590	590
Annual Average	475	804	132	87	55	337	254	150	1274	1145	1008

Table 5.1.B. Simulated frequency (% of days flow exceeded) of basin inflow to the Apalachicola River at the Chattahoochee gage using depletions estimated for the years 2000 and 2010.

Frequency Exceeded	Basin Inflow under 2000 estimated depletions	Basin Inflow under 2010 estimated depletions
0%	265,832	213,596
5%	59,082	56,834
10%	44,892	44,769
15%	37,656	37,422
20%	31,466	31,514
25%	27,238	27,220
30%	23,810	23,872
35%	21,125	20,903
40%	18,874	18,631
45%	17,011	16,764
50%	15,361	15,145
55%	13,831	13,568
60%	12,450	12,083
65%	11,158	10,846
70%	10,227	9,867
75%	9,223	8,934
80%	8,254	7,938
85%	7,411	7,065
90%	6,170	5,900
95%	4,708	4,336
100%	389	299

6 CONCLUSION

The proposed action has a mix of both beneficial and adverse effects to the species and designated/proposed critical habitats. Those attributable to the IOP and not to depletions in basin inflow are summarized in general form below (for more details, see sections 4 and 5):

Beneficial Effects

- Basin inflow augmented when less than 5,000 cfs; no days less than 5,000 cfs.
- Decrease in maximum number of days/year between 5,000 and 8,000 cfs.
- Fewer days when the river falls more than 1 ft/day
- No days when the river falls more than 1 ft/day at flows less than 10,000 cfs
- Increase in Gulf sturgeon spawning habitat availability
- Increase in 30-day continuous floodplain inundation during high flows (greater than 37,400 cfs) and during low flows (less than 16,000 cfs)

Adverse Effects

- More days when flows are between 8,000 and 10,000 cfs
- An increase in the number of days when the river falls faster than 0.25 ft/day when flows are less than 10,000 cfs
- Decrease in 30-day continuous floodplain inundation during moderate flows (16,000 cfs to 37,400 cfs).

The remainder of this section summarizes and consolidates our findings in the previous sections for each listed species and critical habitat in the action area.

6.1 Gulf sturgeon

The principal effects to the Gulf sturgeon in the action area are those we described in section 3, Environmental Baseline. Woodruff Dam precludes migratory movements to additional spawning habitat located in the Flint and Chattahoochee basins. Substantial changes to both the low and high ends of the flow regime in the post-West Point period compared to the pre-Lanier period may have adversely affected estuarine habitat availability and/or suitability for sturgeon feeding. The IOP does not worsen these potential effects. Future depletions to basin inflow from non-project related water uses may further change sturgeon estuarine habitats, but this effect is unknown at this time pending results of studies of sturgeon use of the bay and application of appropriate hydrodynamic models that may predict salinity regime changes and benthic food resource responses.

The IOP has a small beneficial effect relative to the baseline on habitat availability at known spawning sites downstream of Woodruff Dam. The current Apalachicola population of Gulf sturgeon appears to be slowly increasing.

Our analysis indicates that the IOP would not appreciably affect the survival and recovery of the Gulf sturgeon and would not appreciably affect the ability of designated critical habitat to provide its intended conservation role for Gulf sturgeon in the wild.

6.2 Fat threeridge

The principal effects to the fat threeridge in the action area are those we described in section 3, Environmental Baseline. Channel morphology changes have likely contributed to a substantial decline of the species in the upstream-most 30 miles of the river. Instability in the middle reaches in combination with low flow, especially between RM 50 to RM 40, has recently adversely affected large numbers of the species. The inter-annual frequency and the intra-annual duration of low flows substantially increased between the pre-Lanier period and the post-West Point periods. Due mostly to lower modeled basin inflow (the RoR flow regime), flows under the IOP will further increase the frequency and duration of low flows. Flows less than 5,000 cfs were not recorded in the pre-Lanier period. The IOP supports a minimum flow of 5,000 cfs and benefits the fat threeridge. Flows less than 5,000 cfs are relatively frequent events in the modeled basin inflow time series (3.4% of the time under estimated 2000 demands; 7.0% of the time under estimated 2010 demands, using the full 63 years of the HEC-5 model). Supporting a minimum flow of 5,000 cfs or greater will therefore require greater storage releases from the reservoirs.

The exposure of several thousand fat threeridge in the middle reach of the river (RM 50 to RM 40) during the summer of 2006 revealed that the species is far more abundant in this reach than previously recognized. The sudden vulnerability of so many individuals to low-flow, however, we do not believe signals a sudden turn towards extinction for the species. The areas containing the vulnerable microhabitats occur within 13 miles out of 85 miles that are known to support the species (excluding the upper 30 miles of the river and a newly discovered extant location within the Flint River). Within the 13 miles, we did not observe substantial mortality in main channel areas (not side channels or distributaries) that had access to deeper water. The age structure of the population, inferred mostly from animals measured in the vulnerable habitats, does not show evidence of significantly different mortality rates between years, suggesting that 2006 is indeed an anomaly for the population.

Our analysis indicates that the IOP would have a small, but not appreciable additional impact on the survival and recovery of the fat threeridge. Similarly, while fat threeridge proposed critical habitat primary constituent elements may be adversely affected, we do not anticipate that the adverse affect to the proposed critical habitat would alter or affect the proposed critical habitat in the action area to the extent that it would appreciably diminish the habitat’s capability to provide the intended conservation role for fat threeridge in the wild.

6.3 Purple bankclimber

The principal effects to the purple bankclimber in the action area are those we described in section 3, Environmental Baseline. Channel morphology changes may have contributed to a decline of the species in the upstream-most 30 miles of the river, although the species may still be found in this reach in low numbers. Instability in the middle reaches in combination with low flow, especially between RM 50 to RM 40, has recently adversely affected small numbers of the species. The inter-annual frequency and the intra-annual duration of low flows substantially increased between the pre-Lanier period and the post-West Point periods. Due mostly to lower modeled basin inflow (the RoR flow regime), flows under the IOP will further increase the frequency and duration of low flows. Flows less than 5,000 cfs were not recorded in the pre-Lanier period. The IOP supports a minimum flow of 5,000 cfs and benefits the purple bankclimber. Flows less than 5,000 cfs are relatively frequent events in the modeled basin inflow time series (3.4% of the time under estimated 2000 demands; 7.0% of the time under estimated 2010 demands, using the full 63 years of the HEC-5 simulations). Supporting a minimum flow of 5,000 cfs or greater will therefore require greater storage releases from the reservoirs.

Due to its apparent preference for deeper portions of the channel, the purple bankclimber does not appear as vulnerable to low-flow impacts as the fat threeridge. However, its relative infrequent occurrence in the mussel exposure observations of 2006 may be due to its overall rarity in the Apalachicola River.

Our analysis indicates that the IOP would have a small, but not appreciable impact on the survival and recovery of the purple bankclimber. Similarly, while purple bankclimber proposed critical habitat primary constituent elements may be adversely affected, we do not anticipate that the adverse affect to the proposed critical habitat would alter or affect the proposed critical habitat in the Action Area to the extent that it would appreciably diminish the habitat’s capability to provide the intended conservation role for purple bankclimber in the wild.

6.4 Chipola slabshell

Our analysis indicates that the IOP would have an insignificant impact on the survival and recovery of the Chipola slabshell. Its presence in the action area is known from finding one live individual in the Chipola River downstream of its confluence with the Chipola Cutoff. This portion of the action area does not seem to have suffered the same channel morphology impacts, and in turn, the resulting vulnerability to low flows, as other portions of the action area.

6.5 Determinations

After reviewing the current status of the listed species and designated and proposed critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed action:

a) will not jeopardize the continued existence of the Gulf sturgeon, fat threeridge, purple bankclimber, and Chipola slabshell;
b) will not destroy or adversely modify designated critical habitat for the Gulf sturgeon; and
c) will not destroy or adversely modify proposed critical habitat for the fat threeridge, purple bankclimber; and Chipola slabshell.

7 INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering [50 CFR §17.3]. Incidental take is defined as take that is incidental to, and not the purpose of, an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement (ITS).

The measures described below are non-discretionary, and the Mobile District Corps must insure that they become binding conditions of any contract or permit issued to carry out the proposed action for the exemption in section 7(o)(2) to apply. The Mobile District Corps has a continuing duty to regulate the action covered by this incidental take statement. If the Mobile District Corps: (1) fails to assume and implement the terms and conditions or, (2) fails to require any contracted group to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Mobile District Corps must report the progress of the action and its impact on the species to the Service as specified in the ITS [50 CFR §402.14(I)(3)].

7.1 AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service does not expect the proposed action will incidentally take any Gulf sturgeon or Chipola slabshell. The Service expects that fat threeridge and purple bankclimber could be taken as the result of this proposed action as described below.

7.1.1 Fat threeridge and purple bankclimber

Take of listed species due to the IOP may occur when the Corps is increasing total storage in ACF reservoirs while releasing a discharge that either exposes listed mussels or isolates them from flowing water. The form of this take is habitat modification, *i.e.,* reduced flow when storing basin inflow in federal reservoirs that results in mortality or reduced reproductive success from oxygen stress, temperature stress, and/or increased predation. The take is most likely to occur in depositional microhabitats that become isolated from flowing water when releases from Woodruff Dam are greater than 8,000 cfs and less than 10,000 cfs.

Mussels move in response to changing flow conditions. Flows less than 10,000 cfs occur in almost all years in the Apalachicola River. Natural mortality occurs when mussels are not successful in moving down slope when flows decline and are stranded at higher elevations.

During a series of wet years with few or no low-flow events, a fraction of the population may naturally occur at relatively high elevations on the stream bed. Mussels may also be deposited at higher elevations following flood events. Recent data are consistent with both of these explanations for mussel stranding observed on the Apalachicola River during the summer of 2006. Of the mussels we observed in June 2006, 17% were found exposed at a stage above the 8,000 cfs level (see section 3). Adverse effects will occur when low flows follow an extended period without low flows or follow a flood event that reshapes mussel habitat and/or redistributes mussels.

We believe take attributable to the IOP is presently limited to specific areas in the RM 50 to RM 40 reach of the main channel, the Chipola Cutoff, and Swift Slough. A small number of purple bankclimbers may be exposed on the rock shoal at RM 105 as flows decline below 10,000 cfs. However, the expected number of individuals to be taken by the IOP is unquantifiable, for the following reasons:

- The number of mussels in the range of 8,000 to 10,000 cfs depends on flow conditions in the previous months and years, which influence mussel movements and the number vulnerable to stranding in this range.
- The number of mussels in the range of 8,000 to 10,000 cfs depends on the timing, magnitude, and duration of flood events in the previous months and years, which may create and deposit mussels in areas vulnerable to stranding in this range.
- It is not possible to distinguish mortality that occurs in the 8,000 to 10,000 cfs range of stages due to the IOP from that which is not due to the IOP.
- The Apalachicola River is highly variable. Some variability is natural and not possible to control so that it is unlikely to avoid all incidental take or to predict in any given year.

We, therefore, must quantify the take instead in terms of changes in the habitat of the listed mussels. We anticipate the IOP to reduce flows sometimes in the range of 8,000 to 10,000 cfs compared to no-action, i.e., run-of-river (RoR) operations. The Corps cannot control or predict the number of days that basin inflow will fall in this range, but can control releases during such times.

Although model results provide the basis for our estimate of anticipated take, we must recognize differences between modeled and actual operations to formulate a realistic surrogate measure of take to apply to actual operations. For example, the modeled releases match basin inflow exactly with very precise reservoir operation. In reality, however, such precise management isn’t achievable due to the uncertainty associated with forecasted flows. Ensuring that releases equal or exceed basin inflow as specified in the IOP is also more difficult because observed basin inflow is substantially more variable day-to-day than the modeled basin inflow, which was the motivation for using a 7-day moving average of basin inflow in the IOP.

We therefore examined the historic basin inflow record (May 12, 1975 to December 31, 2001), provided by the Corps, to estimate a real-world equivalent measure of how often we might expect actual releases under the IOP to be less than daily basin inflow when daily basin inflow is in the range of >= 8,000 to < 10,000 cfs. Daily basin inflow was in this range for a total of 781 days in this period, averaging about 29 days per year. The reference for the IOP operations is the

7-day moving average basin inflow, which was in the 8,000 to 10,000 cfs range for 1,052 days historically, averaging 39 days per year. The maximum difference within a year between the number of daily basin inflow days and the number of 7-day moving average basin inflow days in this range is also 39 days, which occurred in 1984.

The amount of take that we anticipate is therefore at most 39 days per year of releases less than daily basin inflow, otherwise consistent with the IOP minimum release and maximum fall rate schedules, when daily basin inflow is in the range of 8,000 to 10,000 cfs. The level of take will be exceeded in the calendar year if the number of days that releases from Woodruff Dam in the range of 8,000 to 10,000 cfs is less than daily basin inflow is 40 or more. Exceeding this level of take shall prompt a reinitiation of this consultation.

7.2 EFFECT OF THE TAKE

In the accompanying BO, the Service determined that the level of anticipated take would not result in jeopardy to the species or destruction or adverse modification of designated or proposed critical habitat.

7.3 REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take of fat threeridge and purple bankclimber on the Apalachicola River.

RPM1. Adaptive management. Identify ways to minimize harm as new information is collected.

Rationale. Additional information will be collected about the listed species and their habitats in the action area, water use upstream, and climatic conditions. This information needs to be evaluated to determine if actions to avoid and minimize take associated with the Corps' water management operations are effective or could be improved.

RPM2. Adjust June to February Lower Threshold to 10,000 cfs. Replace the proposed 8,000 cfs threshold in the IOP with a threshold of 10,000 cfs.

Rationale. Mussels may be in vulnerable areas where take may occur when flows are less than 10,000 cfs. Not increasing reservoir storage when basin inflow is 10,000 cfs or less from June to February will avoid and minimize the potential for take in the zone of 8,000 to 10,000 cfs.

RPM3. Drought provisions. Develop modifications to the IOP that provide a higher minimum flow to the Apalachicola River when reservoir storage and hydrologic conditions permit.

Rationale. Take of listed species due to the IOP may occur when the Corps is using a portion of basin inflow to increase ACF reservoir storage. The Corps can minimize mussel mortality due to low-flow conditions by supporting a higher minimum flow when total reservoir storage and/or hydrologic conditions permit. As proposed, the IOP uses reservoir storage to support a 5,000 cfs minimum flow. The available data indicates that higher minimum flows are supportable during normal and wet hydrologic periods, and during dry periods when the reservoirs are relatively full. Conversely, during extended drier than normal conditions, it may be prudent to store more water than allowed under the IOP during certain times of the year to insure minimum water availability later. Possible components and triggers of the drought plan could be, but are not limited to: Corps reservoir action zones, cumulative reservoir storage remaining, total basin inflows, indictors of fish spawn, climatic condition indices, and flow levels at gages downstream of the Chattahoochee gage, such as the gage at Wewahitchka.

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

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

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

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

7.4 TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are mandatory. Studies and other outreach programs in the RPMs and conservation measures are subject to the availability of funds by Congress. The Corps will exercise its best efforts to secure funding for those activities. In the event the necessary funding is not obtained to accomplish the RPM activities by the dates established, the Corps will reinitate consultation with USFWS.

7.4.1 Adaptive management (RPM1)

a. The Corps shall organize semi-annual meetings with the Service to review implementation of the IOP and new data, identify information needs, scope methods to address those needs, including, but not limited to, evaluations and monitoring specified in this Incidental Take Statement, review results, formulate actions that minimize take of listed species, and monitor the effectiveness of those actions.

b. The Corps shall assume responsibility for the studies and actions that both agencies agree are reasonable and necessary to minimize take resulting from the Corps' water management actions.
c. The Corps shall evaluate refinements to predictive tools.
d. The Corps shall provide an annual report to the Service on or before January 31 each year documenting compliance with the terms and conditions of this Incidental Take Statement during the previous federal fiscal year, any conservation measures implemented for listed species in the action area; and recommendations for actions in the coming year to minimize take of listed species.

7.4.2 Adjust June to February Lower Threshold to 10,000 cfs. (RPM2)

a. The Corps shall immediately release the 7-day moving average basin inflow, but not less than 5,000 cfs, when the 7-day moving average basin inflow is less than 10,000 cfs for the months of June to February, and shall incorporate this revision into the IOP table of minimum discharges.

7.4.3 Drought provisions (RPM3).

a. The Corps, with Service concurrence, shall initiate by January 30, 2007, IOP drought provisions that identify the reservoir, climatic, hydrologic, and/or listed species conditions that would allow supporting a higher minimum flow in the Apalachicola River, and that identify recommended water management measures to be implemented when conditions reach the identified drought trigger point(s).
b. If modifications to the IOP parameters for the months of March through May are adopted as part of the drought provisions, the Corps shall assess potential affects to Gulf sturgeon spawning and floodplain inundation. The Corps shall provide the models and a biological assessment of the effects of the drought provisions on listed species at least 135 days in advance of implementing the drought provisions in order to reinitiate this consultation relative to any proposed changes in the IOP.

7.4.4 Sediment dynamics and channel morphology evaluation (RPM4).

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

7.4.5 Monitoring (RPM5).

a. The Corps shall monitor the number of days that releases from Woodruff Dam (daily average discharge at the Chattahoochee gage) are less than the daily basin inflow when daily basin inflow is less than 10,000 cfs but greater or equal to 8,000 cfs. If the total number of days of releases in this range in a calendar year is projected to exceed the total number of days of daily basin inflow in this range by more than 39, the Corps shall reinitiate consultation immediately.

b. In coordination with the Service, the Corps shall develop on or before March 30, 2007, a feasible plan to monitor listed mussels in the action area. The goals are to: 1) periodically estimate total abundance of listed mussels in the action area; and 2) determine the fraction of the population that is located in habitats that are vulnerable to low-flow impacts.
c. The Corps shall implement the studies outlined above as soon as is practicable.
d. The Corps shall include monitoring results in the annual report provided to the Service under Condition 1.c.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that the action will result in no more than 39 days per year when project operations reduce basin inflow when it is in the range of 8,000-10,000 cfs. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring the reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking, and review with the Service the need for possible modification of the reasonable and prudent measures.

8 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by conducting conservation programs for the benefit of endangered and threatened species. Towards this end, conservation recommendations are discretionary activities that an action agency may undertake to minimize or avoid the adverse effects of a proposed action, help implement recovery plans, or develop information useful for the conservation of listed species.

The Service recommends that the Mobile District of the U.S. Army Corps of Engineers:

1. Identify watershed-planning opportunities that would assist in identifying alternatives to reduce overall depletions in the ACF basin, particularly the Flint River, thereby increasing baseline flow to the Apalachicola River.

2. Improve the public understanding of water management of the ACF system, the related conservation needs of listed species, and the management of the multiple purposes of the federal reservoirs.

3. Consider alternatives that would increase flexibility in the management of reservoir storage including the feasibility of flood control alternatives (e.g. moving structures from the floodplain, land acquisition) and providing for recreational access at a variety of pool elevations.

4. Provide additional data and hydrodynamic models that would assist in determining areas of bed stability that should be surveyed for listed mussels.

5. Implement freshwater mussel recovery actions including developing habitat suitability indices, conducting a population assessment of the listed mussels of the Apalachicola River, restoring reaches to provide stable habitat, and validating aging techniques for these species.

6. Use the models developed for the Tri-State Comprehensive Study to determine if changes in flow compared to pre-Lanier flows are significant relative to Gulf sturgeon juvenile growth and if changes in the operation of the reservoirs will benefit Gulf sturgeon recovery.

7. Implement Gulf sturgeon recovery actions such as studies of Gulf sturgeon ecology in Apalachicola Bay and possible effects of reduced basin inflow on the ability of the bay to support sturgeon and providing for fish passage at Jim Woodruff Dam.

8. Establish a clearinghouse for biological and water resource information about the ACF system and make such information readily available in several key locations in the basin.

9. Participate in stakeholder discussions to develop a long-term biological monitoring program for the ACF system and support, as feasible, implementation of a long-term program.

10. Update, as soon as practicable, tools for assessing the effects of ongoing and future system operations, including estimates of basin inflow and consumptive demands. The tools should assist in identifying flows that provide sufficient magnitude, duration, frequency, and rate of change to support the survival and recovery of the listed species in the ACF.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

9 REINITIATION NOTICE

This concludes formal consultation on the action outlined in the BO. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information shows that the action may affect listed species in a manner or to an extent not considered in this BO; (3) the action is subsequently modified in a manner that causes an effect to the listed species not considered in this BO; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

This further concludes the conference for proposed critical habitat for the fat threeridge, purple bankclimber and Chipola slabshell mussels as it may be affected by the action outlined in the BO. The Corps may ask the Service to confirm the conference report as the biological opinion issued through formal consultation if the critical habitat designation is finalized. If the Service reviews the proposed action and finds that there have been no significant changes in the action as planned or in the information used during the conference, the Service will confirm the conference report as the biological opinion on the projects and no further section 7 consultation will be necessary.

We appreciate the cooperation of your staff in preparing this BO. We look forward to working closely with you in implementing its provisions and other conservation actions for the listed species and critical habitat of the Apalachicola River and Bay ecosystem.

Sincerely yours,

//s// *Gail A. Carmody*

Gail A. Carmody
Field Supervisor

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