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

REPLY TO
ATTENTION OF

January 31, 2011

Inland Environment Team
Planning and Environmental Division

Mr. Donald Imm
Field Supervisor
U.S. Fish and Wildlife Service
1601 Balboa Avenue
Panama City, Florida 32405-3721

Dear Mr. Imm:

On June 1, 2008, the U.S. Army Corps of Engineers (Corps), Mobile District, received a Biological Opinion (BO) from the U.S. Fish and Wildlife Service (USFWS) regarding the impacts of our Revised Interim Operations Plan (RIOP) and associated releases from the Jim Woodruff Dam to the Apalachicola River. In accordance with Reasonable and Prudent Measure (RPM) 2008-1, we are hereby submitting the Annual Report for Fiscal Year 2010, which summarizes the status of compliance with the RPMs and terms and conditions of the BO. The BO requires a status of efforts to comply with the terms and conditions for the previous fiscal year (i.e., October 1, 2009 through September 30, 2010). However, since the Annual Report submitted on January 31, 2010 captured all activities to that point, this Annual Report will provide a summary of efforts undertaken to date by the Mobile District since February 1, 2010.

The BO recognizes that certain studies and other outreach programs in the RPMs and conservation measures are subject to the availability of funds by Congress. The Corps has agreed to exercise its best efforts to secure funding for those activities. However, in the event the necessary funding is not obtained to accomplish the RPM activities by the dates established, the Corps would reinitiate consultation with USFWS. The Corps has obtained sufficient funding for Fiscal Year 2011 to continue the mussel depth distribution study and further refine the Gulf sturgeon recruitment study. We will continue to coordinate with your staff regarding implementing additional studies.

If you have any questions regarding the enclosed Annual Report, please feel free to contact Mr. Brian Zettle, Biologist, (251) 690-2115, or Email: brian.a.zettle@usace.army.mil.

Sincerely,

Curtis M. Flakes
Chief, Planning and Environmental
Division

Enclosures

Jim Woodruff Dam Revised Interim Operations Plan Biological Opinion
Annual Report
31 January 2011

This annual report summarizes, since submittal of the previous annual report (31 January 2010), the status of compliance with the terms and conditions of the Revised Interim Operations Plan (RIOP) Biological Opinion (BO) issued on 1 June 2008.

Background: On 7 March 2006, the U.S. Army Corps of Engineers, Mobile District, submitted a request to initiate formal consultation pursuant to Section 7 of the Endangered Species Act (ESA) regarding the impact of releases from the Jim Woodruff dam to the Apalachicola River on Federally listed endangered or threatened species and critical habitat for those species. Operations regarding releases to the Apalachicola River were described in an Interim Operations Plan (IOP) for Jim Woodruff Dam, since consultation on the overall project operations for the Apalachicola, Chattahoochee,Flint Rivers (ACF) system would be deferred until future efforts to update the water control plans and basin manual for the system. Species of concern include the threatened Gulf sturgeon (*Acipenser oxyrinchus desotoi*) and critical habitat for the Gulf sturgeon; the endangered fat threeridge mussel (*Amblema neislerii*); the threatened purple bankclimber mussel (*Elliptoideus sloatianus*); and the Chipola slabshell mussel (*Eliptio chipolaensis*). On September 5, 2006, the U.S. Army Corps of Engineers (Corps), Mobile District, received a Biological Opinion (BO) from the U.S. Fish and Wildlife Service (USFWS) regarding the impacts of our Interim Operations Plan (IOP) and associated releases from the Jim Woodruff Dam to the Apalachicola River. This BO was further amended by the USFWS to address a temporary Exceptional Drought Operation (EDO) modification to the IOP on November 15, 2007. By letter dated April 15, 2008, the Corps requested formal consultation with the USFWS regarding the Revised Interim Operations Plan (RIOP) which incorporated drought provisions into the IOP among other modifications. On June 1, 2008 the Corps, Mobile District, received a BO from the USFWS for the RIOP. This new BO is not an amendment to the previous BOs. This BO and the Reasonable and Prudent Measures (RPMs) included in the accompanying Incidental Take Statement (ITS) supersede the previous BOs and ITS.

Description of the RIOP: The RIOP does not represent a new water control plan for Jim Woodruff Dam. The RIOP is a modification of the IOP, which is a definition of temporary discretionary operations within the limits and rule curves established by the existing water control plan (1989). The drought plan incorporated into the RIOP requires a temporary waiver from the existing water control plan to provide for minimum releases less than 5,000 cfs from Jim Woodruff Dam when the appropriate triggers are met and also includes provisions to allow temporary storage above the winter pool rule curve at the Walter F. George and West Point projects if the opportunity presents itself and/or begin spring refill operations at an earlier date in order to provide additional conservation storage for future needs. Operations under the RIOP will be implemented and continued until such time as additional formal consultation may again be initiated and completed, either in association with the update of water control plans for the ACF system, or sooner if conditions change or additional information is developed to justify a possible revision to operations.

The Corps operates five Federal reservoirs on the ACF as a system, and releases made from Jim Woodruff Dam under the RIOP reflect the downstream end-result for system-wide operations measured by daily releases from Jim Woodruff Dam into the Apalachicola River. The RIOP does not address operational specifics at the four federal reservoirs upstream of Woodruff or other operational parameters at these reservoirs unless the drought contingency operations have been triggered. At that time, temporary changes to the amount and timing of storage at the Walter F. George and West Point projects would be triggered. During normal operations, the RIOP does not include specific operational requirements at the upstream reservoirs other than the use of the composite conservation storage of the system and releases from the upstream reservoirs as necessary to assure releases from Jim Woodruff Dam support and minimize adverse impacts to endangered or threatened species or critical habitat. Because the listed species and critical habitat areas of concern are predominately located only on the Apalachicola River downstream of Jim Woodruff Dam, the primary operational consideration for the RIOP is the timing and quantity of flows released from the dam.

Like the IOP, the RIOP specifies two parameters applicable to the daily releases from Jim Woodruff Dam: a minimum discharge and a maximum fall rate. Also like the IOP, the RIOP places limitations on refill, but does not require a net drawdown of composite conservation storage unless basin inflow is less than 5,000 cfs. However, the RIOP modifies how the minimum discharge is determined and identifies conditions under which maintenance of the maximum fall rate schedule is suspended and more conservative drought contingency operations begin. The RIOP does not change the IOP basin inflow calculation (7-day moving average daily basin inflow), use of Chattahoochee gage to measure releases/river flow, use of volumetric balancing as described in the May 16, 2007 letter to USFWS, nor the limited hydropower peaking operations at Jim Woodruff Dam. A detailed description of the RIOP and how it modified the IOP is provided below.

Minimum Discharge: Like the IOP, the RIOP varies minimum discharges from Jim Woodruff Dam by basin inflow and by month and the releases are measured as a daily average flow in cubic feet per second [cfs] at the Chattahoochee gage. Table 1 shows minimum releases from Jim Woodruff Dam prescribed by the RIOP and shows when and how much basin inflow is available for increasing reservoir storage. Except when basin inflow is less than 5,000 cfs, the minimum releases are not required to exceed basin inflow. The IOP defined three basin inflow threshold levels that varied by two seasons (spawning and non-spawning season). The RIOP defines additional basin inflow threshold levels that vary by three seasons: spawning season (March-May); non-spawning season (June-November); and winter (December-February). The RIOP further modifies the IOP by also incorporating composite conservation storage thresholds that factor into minimum release decisions. Composite conservation storage is calculated by combining the storage of Lake Sidney Lanier, West Point Lake, and Walter F. George Lake.

Each of the individual storage reservoirs consists of four Zones. These Zones are determined by the operational guide curve for each project. The composite conservation storage utilizes the four Zone concepts as well; i.e., Zone 1 of the composite conservation storage represents the combined storage available in Zone 1 for each of the three storage reservoirs. During the spawning season, two sets of four basin inflow thresholds and corresponding releases exist based on composite conservation storage. When composite conservation storage is in Zones 1 and 2, a less conservative operation is in place. When composite conservation storage is in Zone 3, a more conservative operation is in place while still avoiding or minimizing impacts to listed species and critical habitat in the river. When composite conservation storage falls below the bottom of Zone 3 into Zone 4 the drought contingency operations are “triggered” representing the most conservative operational plan. A detailed description of the drought contingency operations is provided below. During the spawning season, a daily monitoring plan that tracks composite conservation storage will be implemented in order to determine water management operations. Recent climatic and hydrological conditions experienced and meteorological forecasts will be used in addition to the composite conservation storage values when determining the appropriate basin inflow thresholds to utilize in the upcoming days.

During the non-spawning season, one set of four basin inflow thresholds and corresponding releases exists based on composite storage in Zones 1-3. When composite conservation storage falls below the bottom of Zone 3 into Zone 4 the drought contingency operations are “triggered”.

During the winter season, there is only one basin inflow threshold and corresponding minimum release (5,000 cfs) while in composite conservation storage Zones 1-3. There are no basin inflow storage restrictions as long as this minimum flow is met under these conditions. When composite conservation storage falls below the bottom of Zone 3 into Zone 4 the drought contingency operations are “triggered”.

The IOP included a higher minimum flow provision that identified conditions where a desired minimum flow (6,500cfs) would be maintained and a “trigger” to determine those conditions when the required minimum flow (5,000 cfs) would be more prudent than the desired minimum flow. The RIOP does not include this higher minimum flow provision since the incorporation of additional basin inflow thresholds for the spawning and non-spawning seasons as well as composite conservation storage thresholds meets the intent of the higher flow provision.

Like the IOP, the flow rates included in Table 1 prescribe minimum, and not target, releases for Jim Woodruff Dam. During a given month and basin inflow rate, releases greater than the Table 1 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.

Table 1. RIOP Releases From Jim Woodruff Dam

Months	**Composite Storage Zone**	**Basin Inflow (BI) (cfs)**	**Releases from JWLD (cfs)**	**Basin Inflow Available for Storage**[1]
March - May	Zones 1 and 2	>= 34,000	>= 25,000	Up to 100% BI > 25,000
		>= 16,000 and < 34,000	>= 16,000 + 50% BI > 16,000	Up to 50% BI > 16,000
		>= 5,000 and < 16,000	>= BI	
		< 5,000	>= 5,000	
	Zone 3	>= 39,000	>= 25,000	Up to 100% BI > 25,000
		>= 11,000 and < 39,000	>= 11,000 + 50% BI > 11,000	Up to 50% BI > 11,000
		>= 5,000 and < 11,000	>= BI	
		< 5,000	>= 5,000	
June - November	Zones 1,2, and 3	>= 24,000	>= 16,000	Up to 100% BI > 16,000
		>= 8,000 and < 24,000	>= 8,000 + 50% BI > 8,000	Up to 50% BI > 8,000
		>= 5,000 and < 8,000	>= BI	
		< 5,000	>= 5,000	
December - February	Zones 1,2, and 3	>= 5,000	>= 5,000 (Store all BI > 5,000)	Up to 100% BI > 5,000
		< 5,000	>= 5,000	
At all times	Zone 4	NA	>= 5,000	Up to 100% BI > 5,000
At all times	Drought Zone	NA	>= 4,500[2]	Up to 100% BI > 4,500

[1] Consistent with safety requirements, flood control purposes, and equipment capabilities.
[2] Once composite storage falls below the top of the Drought Zone ramp down to 4,500 cfs will occur at a rate of 0.25 ft/day drop.

Maximum Fall Rate: Fall rate, also called down-ramping rate, is the vertical drop in river stage (water surface elevation) that occurs over a given period. The 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 yesterday's) are not addressed. The RIOP did not change the maximum fall rate schedule (Table 2) prescribed by the IOP other than to suspend it when composite conservation storage is in Zone 4 and the drought contingency operation described below is implemented.

Unless otherwise noted, fall rates under the drought contingency operation would be managed to match the fall rate of the basin inflow. Also, the RIOP does not change the use of volumetric balancing as described in the May 16, 2007, letter to USFWS, which is intended to prevent a substantial drawdown of storage due to gradual down ramping while following declining basin inflow.

Drought Contingency Operations: The RIOP incorporates a drought contingency operation (referred to as drought plan) that did not exist in the IOP. The drought plan is similar to the EDO in that it specifies a minimum release from Jim Woodruff Dam and temporarily suspends the other minimum release and maximum fall rate provisions until composite conservation storage within the basin is replenished to a level that can support them. The minimum discharge is determined in relation to composite conservation storage and not average basin inflow under the drought plan. The drought plan is "triggered" when composite conservation storage falls below the bottom of Zone 3 into Zone 4. At that time all the composite conservation storage Zone 1-3 provisions (seasonal storage limitations, maximum fall rate schedule, minimum flow thresholds, and volumetric balancing accounting) are suspended and management decisions are based on the provisions of the drought plan. The drought plan includes a temporary waiver from the existing water control plan to allow temporary storage above the winter pool rule curve at the Walter F. George and West Point projects if the opportunity presents itself and/or begin spring refill operations at an earlier date in order to provide additional conservation storage for future needs as well as provide for a minimum releases less than 5,000 cfs from Jim Woodruff Dam.

The drought plan prescribes two minimum releases based on composite conservation storage in Zone 4 and an additional zone referred to as the Drought Zone. The Drought Zone delineates a volume of water roughly equivalent to the inactive storage in lakes Lanier, West Point and Walter F. George plus Zone 4 storage in Lake Lanier. The Drought Zone line has been adjusted to include a smaller volume of water at the beginning and end of the calendar year. When the composite conservation storage is within Zone 4 and above the Drought Zone, the minimum release from Jim Woodruff Dam is 5,000 cfs and all basin inflow above 5,000 cfs that is capable of being stored may be stored. Once the composite conservation storage falls below the Drought Zone, the minimum release from Jim Woodruff Dam is 4,500 cfs and all basin inflow above 4,500 cfs that is capable of being stored may be stored. When transitioning from a minimum release of 5,000 to 4,500 cfs, fall rates will be limited to a 0.25 ft/day drop. The 4,500 cfs minimum release is maintained until composite conservation storage returns to a level above the top of the Drought Zone, at which time the 5,000 cfs minimum release is re-instated. The drought plan provisions remain in place until conditions improve such that the composite conservation storage reaches a level above the top of Zone 3 (i.e., within Zone 2).

Table 2. RIOP Maximum Fall Rate Schedule Composite Conservation Storage Zones 1,2, and 3*	
Release Range (cfs)	Maximum Fall Rate (ft/day), measured at Chattahoochee gage
> 30,000**	No ramping restriction***
> 20,000 and <= 30,000*	1.0 to 2.0
Exceeds Powerhouse Capacity (~ 16,000) and <= 20,000*	0.5 to 1.0
Within Powerhouse Capacity and > 8,000*	0.25 to 0.5
Within Powerhouse Capacity and <= 8,000*	0.25 or less

*Maximum fall rate schedule is suspended in Composite Zone 4

**Consistent with safety requirements, flood control purposes, and equipment capabilities.

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

At that time, the temporary drought plan provisions are suspended, and all the other provisions are re-instated. During the drought contingency operations a monthly monitoring plan that tracks composite conservation storage in order to determine water management operations (the first day of each month will represent a decision point) will be implemented to determine which operational triggers are applied. In addition, recent climatic and hydrological conditions experienced and meteorological forecasts will be used when determining the set of operations to utilize in the upcoming month.

Although the drought plan provides for flows lower than 5,000 cfs in the river, incorporation of provisions that allow for reduced flows during the refill period when system storage is lower and storage conservation measures when composite storage is in Zone 4 should result in fewer occasions when these low flows are triggered or in occasions where storage shortages result in flows less than 5,000 cfs.

OPERATIONS AND CONSULTATION CONDUCTED IN 2010

Throughout the year of 2010, releases from Jim Woodruff Dam were made in accordance with the normal operating provisions of the RIOP. Drought operations were never implemented and the composite conservation storage remained in Zone 1 throughout the entire calendar year and currently remains in Zone 1.

Flows on the Apalachicola River remained above 6,000 cfs until September. As flows dropped below 6,000 cfs, Dr. Gangloff, contract supervisor for the mussel depth distribution study on the river, noted the recolonization of fat threeridge mussels at stages greater than 5,000 cfs.

By letter dated 14 September 2010, the USFWS recommended that the Corps reinitiate Section 7 consultation under the BO of the RIOP due to new information not considered at the time of the 2008 BO. Specifically, the USFWS was informed, by the Corps that in some areas of the river endangered fat threeridge mussels had recolonized to stages greater than 5,000 cfs. By letter dated 20 September 2010, the Corps agreed with the USFWS recommendation and requested the reinitiation of Section 7 formal consultation. In the letter, the Corps also noted that no changes to the RIOP were recommended at this time. By letter dated 14 October 2010, the USFWS acknowledged receipt of the request to reinitiate for fat threeridge and recommended beginning the reinitiated consultation after the completion of the purple bankclimber mussel surveys at Race Shoals scheduled for later that month. By letter dated 17 November 2010, the Corps informed the USFWS that the scheduled mussel surveys at Race Shoals had been unavoidably delayed due to continuing rains and requested that the reinitiated consultation begin rather than continue to await the completion of the purple bankclimber surveys. By letter dated 23 November 2010, the USFWS agreed to beginning the fat threeridge reinitiated consultation and anticipates completion of the new BO in early April 2011.

STATUS OF COMPLIANCE WITH TERMS AND CONDITIONS OF THE BIOLOGICAL OPINION AND AMENDED BIOLOGICAL OPINION

As noted above, the USFWS issued a BO on 1 June 2008 for the RIOP. This new BO is not an amendment to the previous BOs. This BO and the Reasonable and Prudent Measures (RPMs) included in the accompanying Incidental Take Statement (ITS) supercede the previous BOs and ITS. (Excerpts of the BO terms and conditions are included below for easy reference) In order to be exempt from the prohibitions of section 9 of the ESA, the Mobile District must comply with the following terms and conditions, which implement the reasonable and prudent measures described in the BO. These terms and conditions are mandatory. However, the studies and other outreach programs in the RPMs and conservation measures are also subject to the availability of funds from 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 in the BO, the Mobile District will reinitiate consultation with USFWS as necessary. (*Note: All of the referenced documents have previously been provided to the USFWS and most are posted on the Mobile District Website at the following location:* http://www.sam.usace.army.mil/ACF.htm.)

"RPM 2008-1. 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.*
>
> ***a.*** *The Corps shall organize semi-annual meetings with the Service to review implementation of the RIOP 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."*

STATUS: In discussions with USFWS, it was recommended that a semi-annual meeting be held in the early fall of each year (preferably in August); and in the late winter or early spring prior to initiation of fish spawn activities (preferably in February).

The first 2010 semi-annual meeting was held on 6 April 2010 at the Mobile District Office. The meeting was generally informal (no presentation) and consisted of review and comment on the recently submitted Annual Report (31 January 2010) as well as discussion regarding operations throughout the spring and summer. The USFWS provided feedback on the status update provided in the Annual Report regarding the RPMs and Terms and Conditions outlined in the BO and introduced the acting Field Office Supervisor, Mr. Donald Imm, upon Gail Carmody's retirement. The second 2010 semi-annual meeting was held on 13 December 2010 at the Mobile District Office. The second meeting was also informal and focused on reviewing implementation of the RIOP terms and conditions and discussion of the reinitiated consultation. Both meetings also included general discussion of the ACF Master Water Control Manual update effort.

> ***"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."*

STATUS: As described below, the design and conduct of several studies is a requirement of the BO. The Corps accepts responsibility for those reasonable and necessary actions, subject to authority and funding limitations. Due to budget constraints, implementation of some of the activities requiring additional studies or procurement of other services may be delayed or deferred until funding is available. However, all the actions related to project operations that can be accomplished within current funding levels are being implemented. The mussel depth distribution study was initiated (approximately 30% completed) in October 2008, but was not completed due to increased river flows and flows remained too high to complete the study during 2009. The remainder of the mussel depth distribution study, with the exception of the purple bankclimber sampling at Race Shoals, was completed this year (see Draft Report attached). The Gulf sturgeon recruitment study was conducted in 2010 (see Report attached) and funding for additional Gulf sturgeon recruitment data collection may be available in FY2010. Additional funding will be used for in-house support to continue to evaluate the effectiveness of the RIOP and complete compliance actions required under the RPMs.

> ***"c.** The Corps shall evaluate alternative hydrologic modeling tools and techniques for operating the reservoirs and for assessing the impacts of water management alternatives. The goal of this evaluation is to identify tools and techniques that might improve the Corps' ability to forecast flows and levels during droughts and to more realistically simulate flows and levels (e.g., fall rates) for impact assessments. The Corps shall report the results of its evaluation as part of the annual report due January 31, 2009."*

STATUS: The Mobile District has actively pursued two actions that will assist in the use of predictive modeling tools. They include the extension of the unimpaired flow dataset for the Apalachicola-Chattahoochee-Flint River (ACF) basin from 2001 through 2008 and updating the predictive hydrological model from HEC-5 to HEC-ResSim. The ResSim model is more flexible, and can be programmed to run model simulations with if/then/else statements. The Corps is using the updated ResSim model to assist in evaluations associated with the update to the water control manual. The HEC-5Q water quality model has also been adapted by HEC to assure that it is compatible with outputs from the ResSim model and is being utilized to evaluate water control manual alternatives.

In the 2008 annual report, the Corps requested additional time to complete the requirements of RPM 2008-1c. The extension request was granted until 15 March 2009. By email correspondence on 6 March 2009, the Corps requested additional time to complete the evaluation and the USFWS further extended the submittal date to 31 May 2009. By letter, dated 29 May 2009, the Corps provided the alternative hydrologic modeling tools and techniques evaluation report. Since the Corps and USFWS agreed that the ResSim model will provide the necessary tool to realistically simulate flows and levels for impact assessments, the May 2009 report focused on the evaluation of forecast tools and methods.

> ***"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."*

STATUS: The 2009 report submitted on 31 January 2010 represented the second RIOP annual report and summarized the accomplishments of 2009, status of compliance with the terms and conditions of the BO, and those RPM actions programmed for 2010. This annual report represents the third RIOP annual report and summarizes the accomplishments of 2010, status of compliance with the terms and conditions of the BO, and those RPM actions programmed for 2011.

> ***"e.*** *The Corps shall provide by email or other electronic means to the Service on a monthly basis the status of RIOP implementation including the hydrology of the system, composite system storage, and any data related to any other adopted criteria."*

STATUS: Throughout 2010, the Corps has provided to the USFWS a monthly email describing the recent river discharges, current composite conservation storage, and short-term weather forecast. Each email also describes the operational plan to be implemented at Jim Woodruff Dam for the current month.

"RPM 2008-2. Drought Operations. *Clarify the drought contingency component of the RIOP that provides for reducing the minimum release to 4,500 cfs so that this option is exercised only when necessary to balance impacts to other project purposes that are reasonably certain to occur without the reduction.*

> ***Rationale.*** *Take of listed species will occur when minimum releases are reduced below 5,000 cfs. This occurs under the RIOP when composite storage declines into the drought zone and considering "recent climatic and hydrological conditions experienced and meteorological forecasts." Reducing the minimum release at certain times of year under certain circumstances may result in little improvement in composite storage levels. The Corps can minimize mussel mortality by using a minimum flow reduction only when it is reasonably certain*

that doing so will result in an appreciable increase in storage and thereby avoid impacts to other project purposes, including support of minimum releases for water quality and fish and wildlife conservation.

***a.** In consultation with the Service, the Corps shall provide to the Service by August 30, 2008, written clarification of the process and criteria that shall apply to the decision to reduce minimum releases to levels less than 5,000 cfs."*

STATUS: By letter dated 29 August 2008, the Corps submitted to the USFWS written clarification of the process and criteria that shall apply to the decision to reduce minimum releases to levels less than 5,000 cfs. A copy of this submittal is available at http://www.sam.usace.army.mil/ACF.htm . In the 27 March 2009 letter from the USFWS to the Corps, the USFWS stated that the previously submitted criteria for the 4,500 cfs minimum flow decision was too vague and needed further clarification. The Corps provided additional clarification on the criteria for the 4,500 cfs minimum flow decision in a reply letter to the USFWS on 29 May 2009. By letter dated, 8 June 2009, the USFWS stated that the clarification provided addressed their concerns.

***"b.** The clarification of the RIOP shall describe, at minimum, the methods by which the Corps will estimate the impacts to other project purposes if a minimum release reduction is not implemented and the expected magnitude and duration of the reduction."*

STATUS: By letter dated 29 August 2008, the Corps described the method utilized to estimate impacts to project purposes if a minimum release reduction is not implemented. This evaluation is generally consistent with previous analyses which considered the lake elevations associated with various hydrologic scenarios and whether or not conservation storage is depleted. The expected magnitude and duration of the minimum flow reduction are directly related to the hydrologic conditions experienced and are more difficult to estimate. Although, there is generally a range of possible conditions that can be evaluated with the hydrologic model. A copy of this submittal is available at http://www.sam.usace.army.mil/ACF.htm . In the 27 March 2009 letter from the USFWS to the Corps, the USFWS stated that the previously submitted description of the methods for estimating impacts to project purposes if the minimum flow is not reduced to 4,500 cfs was too general. The Corps provided additional clarification on the methodology in a reply letter to the USFWS on 29 May 2009. By letter dated, 8 June 2009, the USFWS stated that the clarification provided addressed their concerns.

***"c.** The Corps shall establish internal communication procedures to address unanticipated events that could have adverse effects to listed species. These procedures should be written and include 1) alerting the Service and appropriate State agencies, and 2) completing a summary on how the event was handled and recommendations to further improve procedures that will assist in minimizing harm to listed species."*

STATUS: By letter dated 29 August 2008, the Corps described the Standard Operating Procedures (SOP) for daily operational decisions at projects in the ACF river basin. A copy of this submittal is available at http://www.sam.usace.army.mil/ACF.htm . By letter dated, 27 March 2009, the USFWS stated the status of this RPM was complete.

"RPM 2008-3. Basin Inflow Calculation. *Evaluate alternative methods to estimate current levels of depletions to basin inflow so that this information can inform monthly operational decisions.*

> ***Rationale.*** *The basin inflow calculation is an underpinning of the RIOP. It is not a true measure of the total surface water flow of the basin to Woodruff Dam, but rather a calculation of total flow minus depletions. In the cumulative effects section, we discussed the possibility of increases in consumptive use triggering a minimum flow reduction. Improved estimation of current and ongoing depletions due to withdrawals and inter-basin transfers would allow the Corps to better forecast flows and levels in the system. Improved estimation of current depletions may also help to inform state and local governments when to implement water conservation steps that would avoid the harm to listed species associated with minimum flow reductions.*
>
> *In consultation with the appropriate water resource and management agencies, the Corps shall provide to the Service by June 1, 2009, an evaluation of methods to estimate total surface water flow of the basin to Woodruff Dam by accounting for the depletions to basin inflow. The goal of this evaluation is to outline the steps whereby the Corps may integrate up-to-date estimates of water depletions into its monthly operational decisions."*

STATUS: By letter, dated 29 May 2009, the Corps provided the evaluation of methods to estimate total surface water flow of the basin to Woodruff Dam by accounting for depletions to the basin inflow. In the evaluation the Corps noted that one of the intended purposes of using basin inflow to regulate minimum releases at Jim Woodruff Dam is to mimic a "natural" flow regime in the Apalachicola River and that the current method of computing basin inflow does not account for M&I depletions. However, the Corps determined that the current computations of local inflows represent the most accurate accounting of the water available for storage and regulation while still simulating a natural flow regime. Therefore, the Corps did not propose any changes to the current basin inflow calculation. By letter dated, 8 June 2009, the USFWS stated concurrence with the Corps determination.

"RPM 2008-4. Fall Rates. *Evaluate alternative strategies for avoiding stranding Gulf sturgeon eggs and larvae when flows are declining from 40,000 cfs during the months of March, April, and May.*

> ***Rationale.*** *Take of Gulf sturgeon eggs and larvae due to the RIOP may occur when river stage declines by 8 feet or more in less than 14 days when flows are less than 40,000 cfs in March, April, and May. Such take may occur while*

operating under both normal and drought fall rate provisions of the RIOP, because the fall rate schedules apply only to daily rates of stage decline. Results of the current HEC-5 model of the RIOP include numerous fall rate anomalies that preclude an accurate assessment of fall rate impacts due to the RIOP. Operating to slow declining fall rates may require storage drawdowns that are not necessarily prudent during droughts. Therefore, the Corps should develop improved models that more realistically represent fall rates, re-assess the effects of the RIOP on fall rates and sturgeon spawning, and formulate appropriate strategies to avoid and minimize adverse effects.

The Corps shall provide to the Service by January 31, 2009, an updated assessment of the effect of fall rates on sturgeon spawning based on the past operating procedures and results of a model that accurately represents the operational rules of the RIOP, including it's fall rate provisions. The Corps shall propose appropriate means to avoid and minimize any impacts identified in this analysis."

STATUS: The Corps provided this information in the 2008 annual report (dated 31 January 2009). A copy of this report is available at http://www.sam.usace.army.mil/ACF.htm
By letter dated, 27 March 2009, the USFWS stated the status of this RPM was complete.

"RPM 2008-5. Monitoring. *Monitor the level of take associated with the RIOP and evaluate ways to minimize take by studying the distribution and abundance of the listed species in the action area.*

Rationale. *Take of Gulf sturgeon eggs and larvae will be difficult to monitor, and we anticipate developing a surrogate measure of such take through RPM 2008-4. Take of sturgeon eggs/larvae would have a direct effect on spawning success and recruitment, for which no data have been previously collected. Take of mussels due to exposure from declining minimum releases needs to be monitored within 4 days to ensure that the anticipated level of take (section 7.1) is not exceeded. Further, as habitat conditions change, it is necessary to monitor the numbers and spatial distribution of the populations to determine the accuracy of the take estimates. Monitoring populations and relevant habitat conditions will also serve the Corps' information needs for future consultations on project operations, water supply contracts, hydropower contracts, etc.*

In consultation with the Service, the Corps shall plan and implement the following monitoring efforts relative to the listed species and their habitats that will develop information necessary to understand the impact of incidental take and to ensure that the authorized levels of incidental take are not exceeded.

a. *By January 31, 2009, the Corps shall design studies to estimate Gulf sturgeon recruitment rates to age 1 in the Apalachicola River. The Corps will implement these study plans as soon as practicable thereafter."*

STATUS: On 9 December 2008, Corps staff including personnel from the Engineering Research and Development Center (ERDC) and USFWS staff participated in a teleconference to discuss study design options. Following the call, ERDC staff drafted a Scope of Work (SOW) to address the requirements of Condition a. The SOW included two tasks. Task 1 tested the applicability of the Missouri trawling technique for the Apalachicola River and was implemented and completed during the final week of January 2009. Task 2 expanded the search to include sites in the upper, middle, and lower Apalachicola River and Brothers River and was implemented in June 2009. Three young-of-year (i.e., age-0) Gulf sturgeon were captured at one site in the upper Brothers River during the June sampling. The report documenting the results of the study and recommending additional study was provided in the 2009 Annual Report. ERDC also conducted a sampling effort in spring/summer 2010. No yoy Gulf sturgeons were captured despite trawling over 132 miles and expending 223 individual trawl hauls. A copy of the report documenting the results of the sampling effort and making recommendations for future Gulf sturgeon recruitment studies is attached.

> ***"b.** By July 15, 2008, the Corps shall update its previous study plan for estimating mussel take following minimum release reductions. Within 4 days of a reduction in minimum releases from Woodruff Dam to flows less than 5,000 cfs, the Corps will implement the listed mussels take monitoring plan."*

STATUS: By letter dated 11 July 2008, the Corps submitted to the USFWS an updated study plan for estimating mussel take following minimum release reductions. This submittal updated the previous incidental take monitoring methodology utilized in November 2007 per the provisions of the EDO. A copy of this submittal is available at http://www.sam.usace.army.mil/ACF.htm . By letter dated, 27 March 2009, the USFWS stated the status of this RPM was complete.

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

STATUS: By letter dated 11 July 2008, the Corps submitted to the USFWS an updated study plan for estimating the number of listed mussels present in the action area at 0.1-ft elevation intervals between the stage that is equivalent to a release of 5,130 cfs from Woodruff Dam and an elevation that is 3 ft lower than that stage. This submittal is an update to the previous mussel depth distribution study submitted with the 2007 annual report on 31 January 2008. The modifications to that study proposal were developed by Corps and USFWS staff in collaboration with Dr. Michael Gangloff of Southeastern Aquatic Research. A copy of this submittal is available at http://www.sam.usace.army.mil/ACF.htm

Dr. Gangloff initiated the mussel depth distribution study in October 2008 and completed approximately 30% of the effort prior to the onset of higher river flows that prevented completion. A preliminary report documenting the results of the study thus far was submitted in the 2008 annual report. High flows throughout 2009 prevented completing the study. This year the Corps and USFWS in collaboration with Dr. Gangloff modified the current SOW for the mussel depth distribution study to evaluate how the mussels have responded to extended periods of flow greater than 5,000 cfs (only 3 days in 2009 with flows less than 6,000 cfs). The modification consisted of working when flows were at higher stages than 5,000 cfs and documenting the location of mussels, if any were observed, at these higher stages. Mean daily flows ranged from 7000-9000 cfs during the sampling periods. Sites were sample to a depth of 2.0 m to estimate both the number of mussels exposed as flows reduced to 5000 cfs as well as the numbers potentially susceptible at flows <5000 cfs. The modified study plan also made it possible for the USFWS to document the movement of mussels at one of the sites as the river stages decreased below 6,000 cfs. The most current draft report documenting the results thus far is attached. The only remaining mussel depth distribution sampling consists of the purple bankclimber sampling at Race Shoals. This site requires the use of diving equipment and cannot be sampled when flows are greater than 5,000 cfs. We anticipate completing the depth distribution study in the summer/fall of 2011. Funding is secured to complete the mussel depth distribution study in FY2011 when river flows allow. A copy of the preliminary report documenting the results of the study thus far is attached.

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

STATUS: By letter dated 11 July 2008, the Corps submitted to the USFWS an updated study plan focusing on life history, movement, and habitat for listed mussels in the action area. This submittal updated the previous mussel study plan provided in March 2008 per the provisions of the EDO. A copy of this submittal is available at http://www.sam.usace.army.mil/ACF.htm . By letter dated, 27 March 2009, the USFWS requested additional information regarding funding requests to complete the additional studies. The Corps provided clarification in the 29 May 2009 letter and the USFWS indicated satisfaction with the response in their 8 June 2009 letter. Copies of these letters are available at http://www.sam.usace.army.mil/ACF.htm .

As we previously agreed, to the extent practicable, population monitoring and life history data will be collected in conjunction with completion of the mussel depth distribution study which is funded in FY2010/2011. As described above, other aspects of the study plan such as movement will be further developed and implemented this year or when additional funding becomes available. USFWS has expressed interest in conducting some additional laboratory work regarding host fish for listed mussel species and has inquired about funding support from the Corps for this effort. Should additional FY2011 funds become available, they may be better suited for this need.

2010 REPORT TO THE US ARMY CORPS OF ENGINEERS, MOBILE DISTRICT: FEASIBILITY OF MEASURING GULF OF MEXICO STURGEON RECRUITMENT IN THE APALACHICOLA RIVER, FLORIDA

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28 January 2011

Background and Objective

In their Biological Opinion on the operation of the Jim Woodruff Lock and Dam, the U. S. Fish and Wildlife Service (USFWS) included a Reasonable and Prudent Measure (RPM) to monitor the distribution and abundance of listed species in the Apalachicola River. The terms and conditions of the RPM specific to Gulf sturgeon include: 1) design studies measuring recruitment to age-1 in the Apalachicola River by January 31, 2009 and 2) to then implement these studies (RPM 2008-5, U. S. Fish and Wildlife Service 2008). Water releases from the Jim Woodruff Lock and Dam that benefit federally listed species, such as Gulf sturgeon, are a consideration. In evaluating operations that benefit Gulf sturgeon, estimates of recruitment to age-1 are critical. However specific sampling techniques have not yet been developed, so we tested the feasibility of using specially modified trawls to capture age-0 to age-1 Gulf sturgeon in the Apalachicola River during January and June of 2009 and April, June and August of 2010. This report summarizes activities for 2010 and makes recommendations for 2011.

Methods

Trawling was conducted during April, June, and August in the upper, middle, and lower Apalachicola River and Brothers River (Figure 1.) The Missouri trawl, described in

Herzog and others (2005), is a two-seam, balloon trawl with an inner and outer mesh that allows both large and larval fish to be captured. The dimensions of trawl were modified to make it smaller (the mouth of the trawl was 10 feet wide) and thus easier to deploy and retrieve.

Sampling locations for all gears were obtained using a GPS. Also measured for all trawls were distance from shore, direction of the haul, starting and stopping depths, distance trawled, and substrate. Water quality attributes including temperature, conductivity, pH, dissolved oxygen, and turbidity were measured by river section. Captured sturgeon were measured for length (total and standard) and weighed at the capture sites. A species list of incidentally captured fishes was also prepared.

Results

No age-0 Gulf sturgeon were captured during 2010 sampling. During April, three eggs were collected in trawl hauls in the upper Apalachicola River. Subsequently the eggs were sent for identification via genetic analysis and were positively identified as being Gulf sturgeon (B. Kreiser, University of Southern Mississippi, personal communication). These eggs were found in trawl 11 and trawl 8 on 20 April 2010. Both trawls were located near known spawning sites described by Scollan and Parauka (2008) at river miles 101 and 105 (see Figure 2 for the locations of trawl 8 and trawl 11). During June, one Gulf sturgeon approximately 90 cm total length was captured in the upper reach. This fish was immediately measured, tagged, and released by USFWS personnel who were netting nearby. During 2010, we trawled over 132 miles expending 223 individual trawl hauls (Table 1). Water quality attributes are recorded in Table 2. A total of 36 species of fishes were collected and a species list by river reach is included in Table 3.

Discussion and Recommendations

The trawling techniques developed in the Mississippi River (Herzog et al. 2005) for capturing larval Scaphirhynchus (i.e., pallid and shovelnose sturgeon) have yielded favorable success (Hrabik et al. 2007) and were applied to other study reaches within the basin (Braaten and Fuller 2007, Tripp et al. 2009, Phelps et al. 2010). Given the successes (i.e., thousands of age-0 fish were captured), this approach was deemed a credible sampling tool for assessing Gulf sturgeon recruitment in the Apalachicola River. However, trawling for age-0 Gulf sturgeon proved of little success. During 2009 and 2010 a sampling effort of 323 trawl hauls totaling almost 183 trawl miles resulted in three age-0 Gulf sturgeon being captured.

In the Suwannee River, 18 age-0 Gulf sturgeon were captured using benthic sleds, otter trawls, and electrofishing over four sampling seasons (Sulak and Clugston 1998). However, these 18 individuals comprised only 2% of the juvenile fish (ages 0 to 6) captured suggesting that age-0 fish are difficult to capture by any means.

Measuring recruitment of Gulf sturgeon to age-1 is critical for monitoring the operation of the Jim Woodruff Lock and Dam and for monitoring the population viability of Gulf sturgeon in the Apalachicola River. Because Sulak and Clugston (1998) found that monitoring juvenile Gulf sturgeon was much easier than monitoring age-0 fish, indirectly measuring recruitment to age-1 is readily feasible by a process known as back calculation - in which juveniles would be aged to determine the year they were spawned. By comparing the abundance of age-1 Gulf sturgeon to the operation of the Jim Woodruff Lock and Dam, the USFWS Reasonable and Prudent Measure (RPM 2008-5, U. S. Fish and Wildlife Service 2008)) of evaluating operations can be achieved.

The best way to measure recruitment success to age-1, could be to sample in the lower reaches of the Apalachicola River system during June through November with small mesh monofilament gill nets. Support for this sampling approach was recently provided by Frank Parauka of the USFWS. During June through August 2010, USFWS personnel captured 66 juveniles in the lower reaches of the system by routine netting using 5-inch stretch mesh nets (Frank Parauka, USFWS Panama City Office, personal communication). Age classes could be separated using an age-length key or sectioned pectoral fin rays. Despite paucity of age-0 Gulf sturgeon captured by trawling, it appears very feasible to capture sufficient juvenile Gulf sturgeon in the mouth and lower reaches of the system to estimate yearly recruitment to age-1. Also, the presence of juvenile cohorts captured by netting demonstrates continued reproductive success in the Apalachicola River system. Thus, we recommend evaluating this approach during 2011, and if successful, implementing a yearly sampling protocol.

Acknowledgements

We thank F. Parauka of the USFWS for his help, field data, and advice in performing this study. Likewise, personnel of the Florida Fish and Wildlife Conservation Commission provided assistance in navigating the river during January 2009 and assisted with permitting. The help from W. Lancaster, B. Lewis, J. Collins, and R. Lehnert was indispensible. Field assistance was also provided by A. B. Harrison, C. Taylor, H. Northcutt, S. Martin, and J. Christoferson.

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Table 1. Sampling effort expended using a Missouri trawl in the Apalachicola River system during 2010

Month	Miles trawled in each river reach and number of trawls (in parentheses)			Total
	Upper	Middle	Lower	
April	10.99 (25)	15.22 (20)	14.37 (21)	40.58 (66)
June	16.33(26)	12.67 (25)	15.69 (27)	44.69 (77)
August	17.57 (28)	14.95 (28)	14.98 (24)	47.50 (80)
Total Effort				132.77 (223)

Table 2. Water quality parameters measured in the Apalachicola River while sampling for young-of-year Gulf sturgeon during 2010. See Figure 1 for a diagrammatic location as to river section. Units of measure include water temperature in degrees C, conductivity in mS/cm, dissolved oxygen in mg/L and turbidity in NTU's.

Date	Section	Water temperature	Conductivity	pH	D.O.	Turbidity
20-Apr-10	Upper	21.69	0.129	7.45	8.78	14.30
21-Apr-10	Middle	22.41	0.128	7.50	8.68	15.80
22-Apr-10	Lower	21.29	0.124	7.36	6.05	28.50
	MEAN	21.80	0.127	7.44	7.84	19.53
8-Jun-10	Upper	28.68	0.106	7.70	7.90	9.31
9-Jun-10	Middle	29.60	0.114	7.69	7.53	16.60
10-Jun-10	Lower	28.26	0.126	7.65	5.66	20.00
	MEAN	28.85	0.115	7.68	7.03	15.30
3-Aug-10	Upper	31.35	0.137	5.59	5.21	5.14
4-Aug-10	Middle	31.50	0.350	7.08	5.51	4.81
5-Aug-10	Lower1	31.27	0.133	7.03	5.74	9.23
5-Aug-10	Lower2	32.89	0.135	7.20	6.56	7.64
	MEAN	31.75	0.189	6.73	5.76	6.71

Lower1 is the Brickyard section of the Brothers River
Lower2 is the mouth of the Brothers River at the confluence of the Apalachicola River

Table 3. Species list of fishes noted during trawling in Apalachicola River system during April, June and August 2010. Sampled reaches included UPPER (U) (below Jim Woodruff Dam), MIDDLE (M) (Blountstown) and LOWER (L) (Apalachicola, Brothers, Little St. Marks and East rivers) areas of the system.

		April			**June**			**August**		
Scientific name	**Common name**	**U**	**M**	**L**	**U**	**M**	**L**	**U**	**M**	**L**
Acipenseridae										
Acipenser oxyrinchus desotoi	Gulf sturgeon				X					
Ophichthidae										
Myrophis punctatus	Speckled worm eel						X			
Engraulidae										
Anchoa mitchilli	Bay anchovy						X		X	X
Clupeidae										
Alosa alabamae	Alabama shad				X	X	X	X		X
Dorosoma cepedianum	Gizzard shad					X				
Cyprinidae										
Cyprinella callitaenia	Bluestripe shiner	X	X		X	X		X	X	X
Cyprinella venusta	Blacktail shiner	X	X	X		X		X	X	
Cyprinus carpio	Common carp			X	X	X				
Notropis longirostris	Longnose shiner					X	X		X	
Notropis maculatus	Taillight shiner	X		X			X	X		X
Notropis petersoni	Coastal shiner			X	X	X		X		X
Notropis texanus	Weed shiner	X	X	X	X	X	X	X	X	
Opsopoeodus emiliae	Pugnose minnow						X		X	X
Catostomidae										
Moxostoma sp. cf. *M. poecilurum*	Apalachicola redhorse	X	X		X		X	X		

Ictaluridae										
Ameiurus natalis	Yellow bullhead						X			
Ictalurus furcatus	Blue catfish		X	X	X		X			X
Ictalurus punctatus	Channel catfish	X	X	X	X	X	X	X	X	X
Noturus gyrinus	Tadpole madtom					X	X			X
Pylodictis olivaris	Flathead catfish						X			X
Aphredoderidae										
Aphredoderus sayanus	Pirate perch						X			
Moronidae										
Morone saxatilis	Striped bass	X	X			X	X			
Centrarchidae										
Lepomis auritus	Redbreast sunfish	X		X	X	X	X	X		X
Lepomis gulosus	Warmouth						X			
Lepomis macrochirus	Bluegill	X	X	X	X	X		X		X
Lepomis microlophus	Redear sunfish	X		X	X	X	X			X
Lepomis miniatus	Redspotted sunfish									X
Micropterus punctulatus	Spotted bass				X	X			X	
Pomoxis annularis	White crappie				X					
Pomoxis nigromaculatus	Black crappie	X								
Percidae										
Ammocrypta bifascia	Florida sand darter	X	X	X	X	X	X	X	X	X
Etheostoma swaini	Gulf darter			X		X	X			X
Percina nigrofasciata	Blackbanded darter	X	X	X	X	X	X	X	X	X
Sparidae										
Archosargus probatocephalus	Sheepshead									X
Gobiidae										

Ctenogobius shufeldti	Freshwater goby			X				X				X
Paralichthyidae												
Paralichthys lethostigma	Southern flounder							X				X
Achiridae												
Trinectes maculatus	Hogchocker	X	X	X		X	X	X		X	X	X
Total Taxa	36	14	11	15		17	19	24		13	11	21

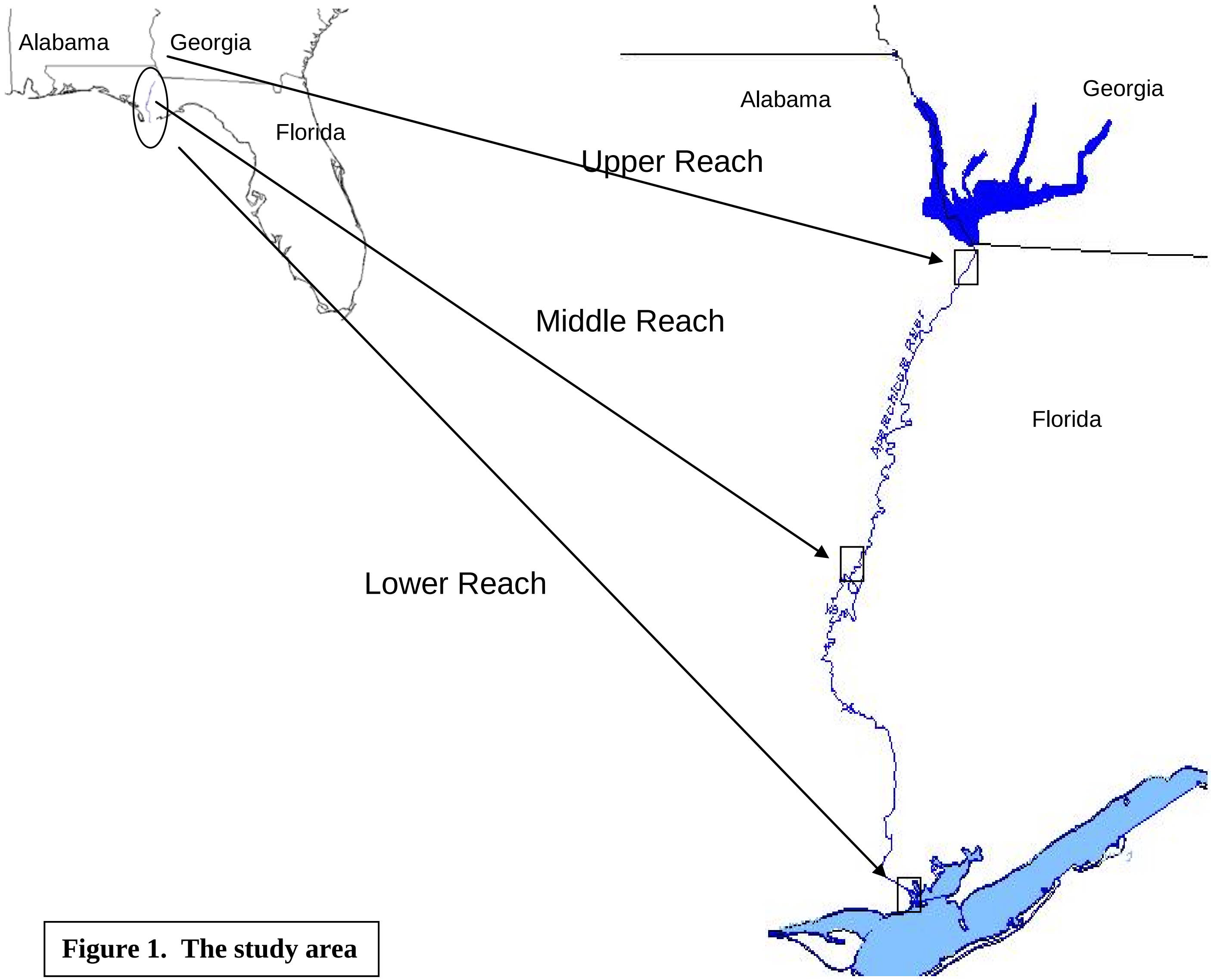
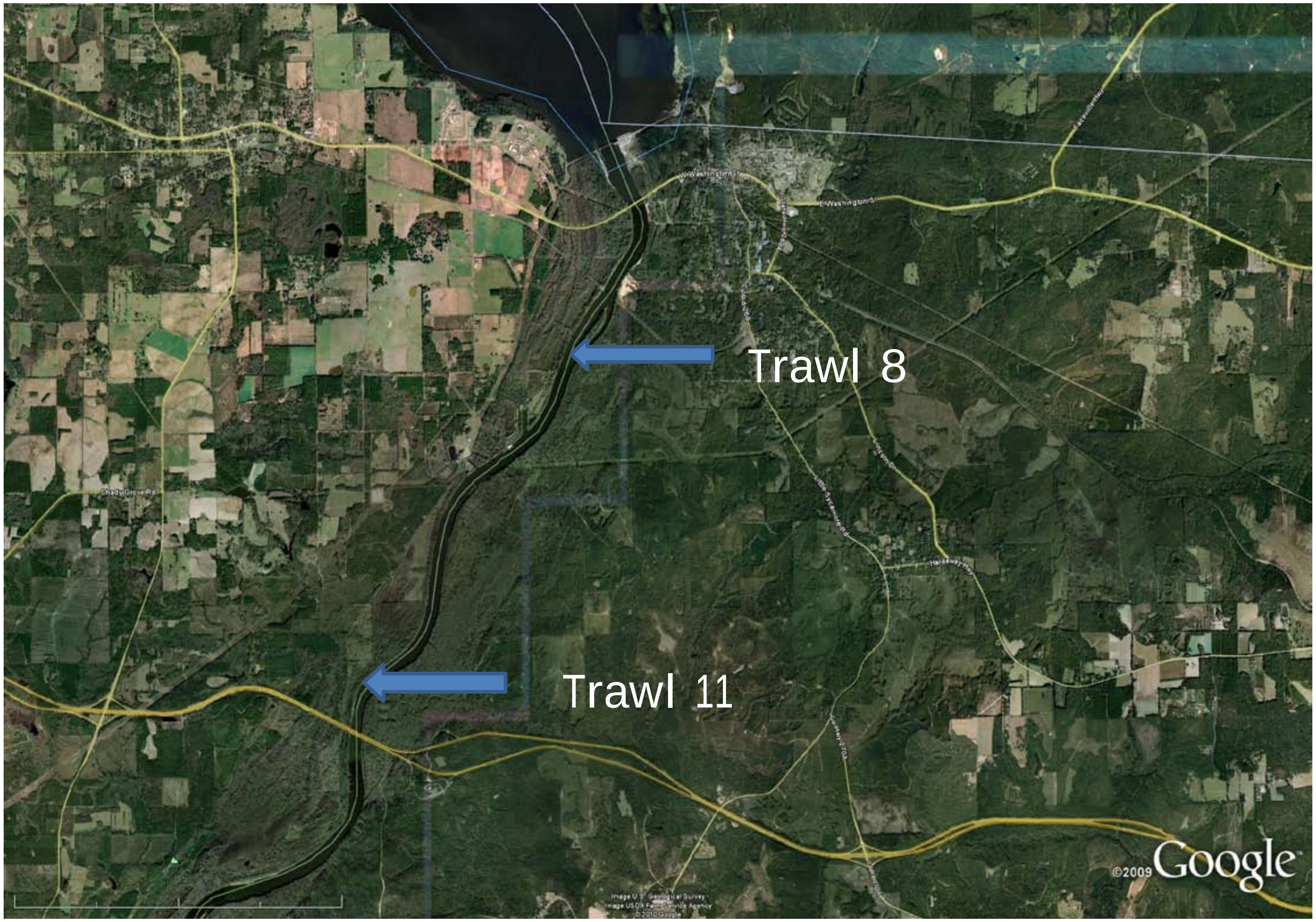


Figure 1. The study area

Figure 2. Location of Gulf sturgeon eggs collected in the upper reach of the Apalachicola River by trawling near known spawning sites at river miles 101 and 105 on 20 April 2010. A single egg was collected in trawl 11 and two eggs were collected in trawl 8.



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Fat threeridge (*Amblema neislerii*) and Chipola slabshell (*Elliptio chipolaensis*) population size and depth distribution study in the Apalachicola and Lower Chipola rivers

DRAFT FINAL REPORT

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Introduction

The Apalachicola and Lower Chipola (ALC) river systems in Northwest Florida support one of the most intact and diverse freshwater mussel assemblages in North America (Brim-Box & Williams 2000). Twenty-eight mussel species were historically known from the ALC river system (Brim-Box & Williams 2000). Recent records suggest an extant mussel fauna comprised of 21 taxa including populations of 3 threatened or endangered species (EnviroScience 2006, M. Gangloff, unpublished data).

The ALC system is the last stronghold of 2 mussels endemic to the Apalachicola Basin, the federally endangered fat threeridge (*Amblema neislerii*) and the federally threatened Chipola slabshell (*Elliptio chipolensis*). Federally threatened Purple bankclimbers *(Elliptoideus sloatianus*) are extant in the ALC system and at multiple localities throughout the upper Apalachicola (e.g., Flint, Chattahoochee rivers) and Ochlockonee basins (USFWS 2007). Four other taxa that historically occurred in the ALC basin are believed extirpated. *Hamiota subangulata* (Shiny-rayed pocketbook), *Medionidus penicillatus* (Gulf moccasinshell), and *Pleurobema pyriforme* (Oval pigtoe) were last collected in the ALC in the 1980s (Brim-Box & Williams 2000). *Fusconaia apalchicola* (Apalachicola ebonyshell) is known only from relict material collected from Native American shell dumps (Williams & Fradkin 1999).

Reduced flows into and from upstream reservoirs may have significant impacts on ALC river levels and mussel populations. Previous studies documented mussel aggregations along mainstem channel margins and in distributary systems. Surveys of deeper habitats found relatively few T&E mussels (primarily *E. sloatianus*) in deeper, mainstem habitats (Miller & Payne 2005, EnviroScience 2006, K. Herrington USFWS, unpublished data). Channel-margin mussel aggregations are presumed to be less vulnerable to water level fluctuations than distributary populations. However, because distributary *A. neislerii* populations are strongly affected by flow fluctuations, channel-margin mussel beds may comprise a significant portion of the total ALC population (EnviroScience 2006).

The primary goals of this study were threefold. First, we quantified T&E mussel population size and demography for use in total (i.e., system-wide) and effective population size estimates. Second, we examined habitat use by T&E mussels during low (5000 CFS) and moderate (8000-9000 CFS) discharge levels. We quantified mussel densities occurring between the wetted edge and the depth of the wetted edge at 5000 CFS (1 m drop in river levels from 9000 CFS). These mussels may potentially be exposed during low-flow events and likely die if river levels drop too quickly. We computed the density of *A. neislerii* occurring in this critical zone and estimated the number likely to occur below the exposure depth threshold at each site. We then extrapolated these estimates to the section and whole-river-system scales. Using depth distributional data we examined microhabitat use patterns including associations between mussel density and size and distance to bank and bank slope. Finally, we used microhabitat data to model distances that *A. neislerii* would have to move to reach the 5000 CFS wetted-channel level.

Methods

Study Site

The Apalachicola River drains 50,800 km^2 in eastern Alabama, western and central Georgia and portions of Northwestern FL on its path to the Gulf of Mexico. The Apalachicola River originates at the confluence of the Chattahoochee and Flint rivers at a point that is presently submerged beneath Jim Woodruff Reservoir in southwestern Georgia. However, the lower 170 km (105 miles) of the Apalachicola River is a free-flowing and wild river system. This unique ecosystem supports a diverse aquatic community characterized by numerous imperiled or endemic taxa (Blaustein 2008). Flow levels in the Apalachicola are primarily regulated by a series of upstream reservoirs. Coastal Plain reservoirs in the Apalachicola River Basin are shallow and have little water storage. One Piedmont reservoir, Lake Lanier, northeast of Atlanta, Georgia contains a large proportion of the Basin’s storage.

The Chipola River is the fourth-largest tributary to the lower Apalachicola River and originates in karst geology in Southeastern Alabama north of Dothan. The Chipola drains 1649 km^2 in Alabama and Florida including numerous spring basins before joining the Apalachicola River just south of Wewahitchka, FL (Apalachicola RM 28.0, Brim-Box & Williams 2000). Under baseflow conditions, discharge in the upper Chipola River is buffered by substantial groundwater recharge.

Mussel Distribution, Demography and Habitat Use

Prior to this study, the U.S. Fish and Wildlife Service (USFWS) identified ~116 sites in the lower Apalachicola and ~66 sites in the lower Chipola River. USFWS verified *A. neislerii* presence using visual spot-checks at 81% of sites in 2007 and 2008. USFWS surveys and EnviroScience (2006) both reported dense T&E mussel aggregations along moderately sloping banks on the up-and downstream end of point bars. These habitats are also frequently associated with willow stands. In 2007 and 2008 large numbers of mussels were exposed in these habitats by falling water levels. Minimum flows of 5000 CFS were established by USACOE and USFWS biologists in 2007 and flows at Chattahoochee did not drop below 5000 CFS during this study (Figs 1 & 2, http://waterwatch.usgs.gov)

We randomly selected 36 sites (26 in the Apalachicola River and 10 in the Chipola River) from among the initial 182 sites for more extensive sampling. Fall 2008 river conditions were only at appropriate levels long enough for us to complete sampling at 14 sites. From 1-10 October and 23-24 October 2008 we conducted quantitative depth-distribution surveys at 10 Apalachicola and 4 Chipola river sites when the river was between 6000 and 5000 CFS (Mean daily discharge for these periods = ~5500 CFS, Fig. 1). In 2008 we sampled to a depth of 1.0 m to estimate the number of mussels occurring in bankside habitats and the numbers likely affected by additional river draw-downs. In 2010 we sampled from 23-31 July and 10-23 August at 19 Apalachicola and 6 Chipola sites (Fig. 2). In 2010 mean daily flows averaged ~7500 CFS (Range 7000-9000 CFS) during the sampling periods. We attempted to sample to a depth of 2.0 m to estimate both the number of mussels exposed at 5000 CFS as well as the numbers potentially susceptible at flows <5000CFS. Three sites sampled in 2008 were re-sampled in 2010 (A76, A80, & C16) to determine if mussels re-colonized previously exposed bank habitats. Additionally, because we were unable to complete sampling at A64 in 2008, we also have 2010 for this site.

At each site, we delimited the up-and-downstream boundaries using GPS coordinates and aerial photographs (Appendix A). We used a random number table to select a starting point for the first transect. Transects were then placed at regular intervals (30 m for sites <200 m, 50-100 m for longer sites) along the bank. At the beginning of each transect, we placed a 0.5 x 0.5 (0.25 m^2) rebar quadrat at the water's edge and turned it laterally (perpendicular to the channel margin) to a depth of 1.0 m (2008) or 2.0 m (2010). We measured depth and distance to bank (DTB) at the center of each quadrat. In transects <10 m, we alternated quadrats. If the transect was >10 m, we sampled every other quadrat. Sites frequently included both moderately-sloping, muddy channel banks (targeted high-quality habitats) and gently-sloping, unstable sand banks (poor-quality habitat). To minimize time spent sampling poor-quality habitats, we terminated sampling when 10 successive quadrats yielded no mussels.

Substrates in much of the ALC system are dominated by sand and mud so we were able to maximize mussel sampling efficiency by using a hydraulic gold dredge (Keene Enterprises, CA). We excavated substrates to a depth where no additional mollusks were detectable by visual or tactile examination (the Asiatic clam *Corbicula fluminea* was tremendously abundant at most sites and served as marker for the bivalve layer, typically 10-15 cm). Dredged material was first collected in a mesh bag (mesh diameter ~3 mm) then passed through a 6 mm-sieve. All mussels were identified to species and enumerated. We measured total shell length for T&E mussels. Mussels were only briefly removed from the water for measurements and photography before being returned to the streambed.

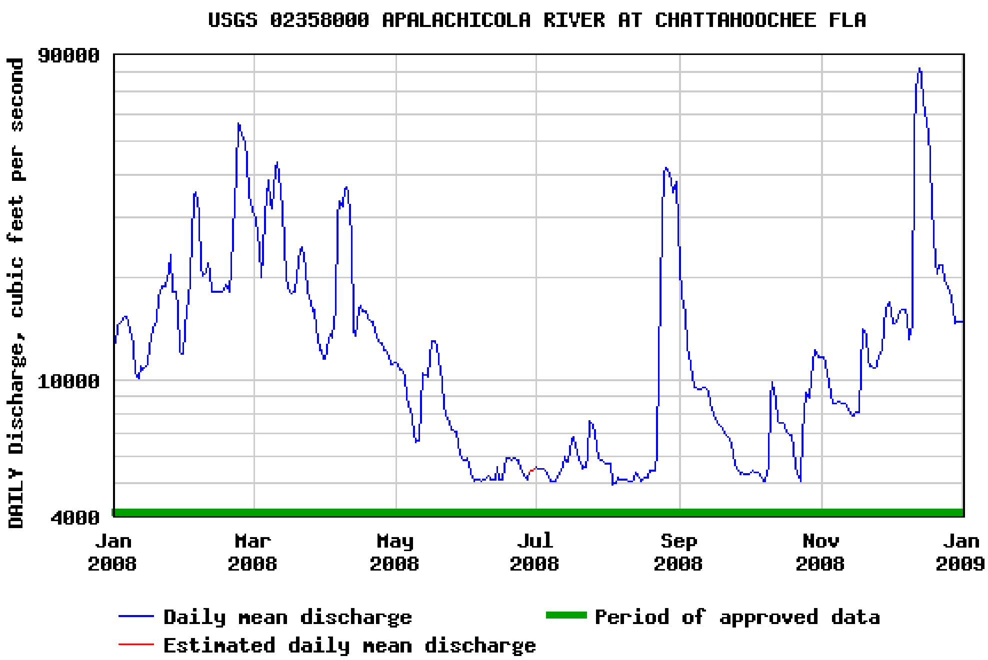

Figure 1. Hydrograph for the Apalachicola River at Chattahoochee, Florida in 2008. Sampling occurred between 30 September and 15 October at flows between 5500 and 5000 CFS.

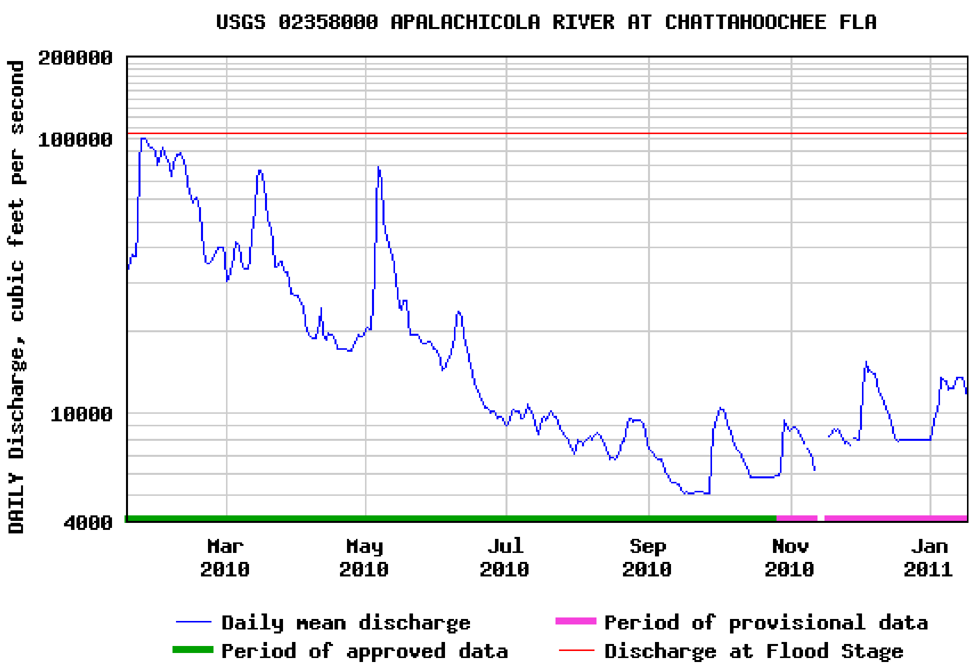

Figure 2. Hydrograph for the Apalachicola River at Chattahoochee, Florida in 2010. Sampling occurred between 24 July and 15 August at flows between 9000 and 7000 CFS.

Data Analysis

Population Estimates

Prior to this study USFWS sub-divided the Apalachicola River into 3 distinct sub-units with the Chipola River comprising a fourth unit. These river units correspond to distinctive shifts in river geomorphology and mussel diversity/abundance. In the Upper River section the Apalachicola is sediment-starved and its waters run clear under base-flow conditions. Channel margin substrates are relatively coarse and streambank *A. neislerii* habitat is rare in this reach. The Upper Apalachicola River section is the largest study section (>53 miles or ~86 km long, ARM 105.3-ARM 50) and comprises approximately one half the current length of the Apalachicola River. However the Upper Apalachicola only contains <11 km of the ~34 km mapped *A. neislerii* habitat in the system. The 10-mile (16.1 km) Middle River section begins just north of Blountstown FL (ARM 40-50) and contains some of the highest-density *A. neislerii* populations ever documented. The Lower Apalachicola River section extends for approximately 20 miles (32.2 km) from the mouth of the Chipola Cut (ARM41.5) downstream to Brickyard Island (ARM 21.7). The Lower Chipola section includes ~4.5 km of the Chipola Cut (3 sites, C9, C11, C12 were located in the Chipola Cut) a semi-engineered channel linking the Apalachicola to the Lower Chipola River and X km of the mainstem Chipola extending from just downstream of the Dead Lakes to the Chipola's confluence with the Apalachicola at ARM 28.0.

We calculated total *A. neislerii* and *E. chipolaensis* population sizes for each site by first computing site-scale mean population sizes. We then multiplied the mean site-scale transect length by the site length to determine site area. Next, we multiplied site-scale population means by site area to estimate the total number of mussels and the total *A. neislerii* population size for each site. We estimated river-section scale *A. neislerii* population sizes by dividing the total predicted number in all study sites by the total proportion of suitable habitats in each river section sampled during our study. We then summed all river section-scale population estimates to produce total population size estimates for total mussel, *A. neislerii*, and *E. chipolaensis* populations in channel bank habitats. We created length-frequency histograms for *A. neislerii* within all sites and within the Apalachicola and Chipola rivers in 2008 (Fig. 1), for each river section in 2010 (Fig. 2) and for each Apalachicola River section across both years (Fig. 3) to examine demographic differences between mussel sub-populations. Relatively few *E. chipolaensis* were collected during this study so we plotted 2008 and 2010 length data together and elsewhere combined data from both years prior to analyses (Fig. 4).

Mussel Exposure Estimate

We estimated the proportion of the 2010 population susceptible to exposure at 5000 CFS by estimating the number of *A. neislerii* occurring at depths that would be emmersed if flows were instantaneously dropped to 5000 CFS. Because river levels fluctuated greatly over the course of our study, we adjusted our definition of this ‘critical zone’ accordingly. We used river levels measured at the USGS Chattahoochee gauge (http://waterwatch.usgs.gov) during summer and fall 2010 to determine exposure depth thresholds (Table 1). We used depth distribution data to calculate critical zone area and critical zone mussel densities (CZDs) for all mussels and *A. neislerii* at the transect-scale. Mean CZD was multiplied by the total area of the critical zone (determined by multiplying the site length by the mean distance to the exposure depth) to yield site scale CZDs. River-section-scale mean CZD’s were divided by the proportion of each section sampled to estimate the total numbers of mussels and *A. neislerii* occurring below exposure depth in each river section. Finally, river section-scale estimates were summed to provide a system-wide estimate of the number of mussels and *A. neislerii* potentially exposed by a 1 m drop in flow levels.

Table 1. Discharge (Cubic Feet per Second, CFS) and critical depth (level of river at 5000 CFS) fluctuations during sampling on the Apalachicola and lower Chipola rivers in July and August 2010.

Sampling Event	Date	Discharge (CFS)	Critical Depth (m)
23 July-1 August	7/23	9000	1.0
	7/25	8500	0.9
	7/27	8000	0.77
	7/29	7500	0.67
	7/31	7000	0.54
10-23 August	8/10	8000	0.77
	8/13	7500	0.67
	8/15	7000	0.54
	8/18	7500	0.67
	8/20	8000	0.77
	8/22	8500	0.9

Slope and Micro-habitat Relationships

Data were pooled at both the transect and site scales. We calculated densities for individual quadrats by dividing the number of mussels in each sample by the internal area of each quadrat, 0.25 m^2. We calculated transect slope by measuring the distance from the wetted edge of the river to the last quadrat and dividing by the depth of the last quadrat (~1.0 m in 2008 and 1.5-2.1 m in 2010).

We examined relationships between transect slope and depth parameters and mussel assemblage metrics using regression analysis. Mean transect slope, slope standard error, and both minimum and maximum transect slope were treated as independent variables. We considered total mussel density, *A. neislerii* density, estimated within-site *A. neislerii* population size, proportion *A. neislerii*, mussel species richness, critical zone *A. neislerii* density, and the total number of *A. neislerii* estimated to occur within the critical zone as dependent variables in regression analyses. Additionally, we compared transect-scale mean slope, total mussel density and *A. neislerii* density among the 4 river sections using 1-way ANOVA.

Results

Mussel Assemblages

In 2008 we excavated a total of 658 quadrats from 81 transects at 14 sites in the Apalachicola (10 sites, 64 transects, 546 quadrats) and Chipola (4 sites, 17 transects, 112 quadrats) rivers. Overall 2008 mussel density was 25.5 mussels/m^2 and was not significantly different between Apalachicola (25.7 mussels/m^2) and Chipola River (24.6 mussels/m^2) sites. Similarly, mean *A. neislerii* densities were not significantly different between Apalachicola (4.79 mussels/m^2) and Chipola (5.77 mussels/m^2) river sites. In 2008 we measured the highest density mussel assemblages at sites in the Apalachicola River (e.g., site A66 density = 66.3 mussels/m^2, Table 1). However, 2008 total mussel densities at 3 of the 4 Chipola sites exceeded 28 mussels/m^2 (Table 2).

In 2010 we excavated a total of 1479 quadrats from 127 transects at 26 sites in the Apalachicola (102 transects, 1179 quadrats) and 6 sites in the Chipola (25 transects, 300 quadrats) rivers. Overall 2010 mussel density was 12.1 mussels/m^2 and *A. neislerii* density was 3.98 mussels/m^2 and both differed significantly among river sections (both ANOVA $F > 2.8$, $p < 0.015$). We measured the highest density mussel assemblages in the Middle Apalachicola River section (e.g., site A64b density = 66 mussels/m^2, Table 2). Chipola River sites sampled in 2010 also supported high-density mussel populations (mean =

19 mussels/m^2) with densities at several sites exceeding 17 mussels/m^2 (Table 3).

We collected 3985 mussels and 17 species overall during October 2008 surveys (Appendix B). We found 16 species in the Apalachicola River and 14 species in the Chipola River. *Elliptio pullata*, *Glebula rotundata*, and *Amblema neislerii* were the three most abundant unionids encountered during 2008 surveys (n = 1117, 1081, and 791 individuals, respectively). Only one species, *Elliptio chipolensis*, (n = 7) was found in the Chipola River but not in the Apalachicola River. Three species, *Anodonta heardi* (n = 5), *Elliptio fumata* (n = 1), and *Utterbackia peggeyae* (n = 8) were found in the Apalachicola River but were not found in the Chipola River (Appendix B).

In 2010 we collected 4484 mussels and 17 species during 2 sampling periods, late July and mid-August (Appendix C). We found 16 species in the Apalachicola River and 12 species in the Chipola. *Amblema neislerii* was the most abundant mussel encountered in 2010 (n = 1345) followed by *G. rotundata* (n = 1177) and *E. pullata* (n = 935). In the Apalachicola River, *A. neislerii* was the fourth most abundant mussel (n = 626) behind *G. rotundata* (n = 917), E. pullata (n = 771), and *L. floridensis* (n = 659, Appendix C). However, *A. neislerii* was by far the most dominant mussel encountered in the Chipola River (56% of total catch). *Glebula rotundata* (n = 260), *E. pullata* (n = 164) and *L. floridensis* (n = 101) were the next 3 most abundant mussel taxa at 2010 Chipola River sites (Appendix C). In 2010 we found 5 taxa in the Apalachicola River that were not found in the Chipola River (*Elliptio arctata*, *Megalonaias nervosa*, *Pyganodon grandis*, *Utterbackia peggyae*, *Utterbackia imbecillis*). Our surveys also found 3 *E. chipolaensis* at Chipola River sites in 2010. *Elliptio chipolaensis* was believed to be restricted to the Chipola River but in 2010 USFWS personnel found a single individual in the Apalachicola River (K. Herrington USFWS pers. com.).

Amblema neislerii- Population Estimates

Amblema neislerii was the third most abundant mussel detected overall during 2008 (n = 791, density = 4.99 individuals/m^2) and the most abundant mussel detected in 2010 (n = 1345, mean density = 3.88 mussels/m^2). In 2008 mean *A. neislerii* density was similar between the Apalachicola and Chipola rivers (4.79 and 5.77 mussels/m^2, respectively). *Amblema neislerii* population size estimates in 2008 ranged from 0 (several sites) to 27,376 at A64a. In 2010 we saw a similar range in *A. neislerii* abundance Middle Apalachicola and Chipola sites supporting the largest *A. neislerii* populations. Surveys at A64 revealed high *A. neislerii* densities (22.2 *A. neislerii*/m^2) were consistent throughout that site (in 2008 we were only able to complete sampling at 4 of 9 transects at A64). Site A64b had the largest estimated 2010 *A. neislerii* population (32,374, Table 2). In 2010 site C59 had the highest *A. neislerii* population density, 26.7 *A. neislerii*/m^2) and the second largest estimated *A. neislerii* population size (Table 3).

2010 section-scale mean *A. neislerii* density ranged from a low of 0.44 mussels/m^2 in the Upper Apalachicola River to 10.9 mussels/m^2 in the Chipola River. 2010 mean *A. neislerii* density in the Middle Apalachicola River was nearly 2x (8.9 mussels/m^2) the 2008 mean density (5.0 mussels/m^2, Table 2). *Amblema neislerii* densities at Chipola River sites also nearly doubled (from 5.8 to 10.9 mussels/m^2) between 2008 and 2010 whereas total mussel density decreased (from 24.6 to 19 mussels/m^2). Both total mussel and *A. neislerii* density declined at 3 of 4 sites sampled in both years (A64, A76, A80, C16) at 3 of 4 sites (Tables 2 & 3). ANOVA revealed that both total mussel density and *A. neislerii* density differed significantly among river sections (both $F > 8.1$, $p < 0.001$). Overall (i.e., 2008 & 2010) *A. neislerii* density was 8.86 mussels/m^2 in the Chipola River but was not significantly different from the Middle Apalachicola River (5.83 mussels/m^2, Tables 2 & 3).

The total size of the *Amblema neislerii* population occurring just within these 36 sites is estimated to be 132,895 animals. We estimate that system-wide, at least 767,020 *A. neislerii* occur in stream bank habitats at depths <2.0 m (at 9000 CFS). The Lower Chipola River supports what is by far the largest *A.*

neislerii population in the Lower Apalachicola River System with 553,779 animals (72% of the total *A. neislerii* population), the middle Apalachicola supports the second largest population with an estimated population of 118,863 in a ~16.1 km (10 mile) reach. Lower Apalachicola *A. neislerii* populations are estimated to be 70,117 in the lower ~64 km (40 miles) of the Apalachicola River. The Upper Apalachicola River supports a population of only 24,261 *A. neislerii* within ~90 km (54+ miles), more than half the current length of the Apalachicola River.

Amblema neislerii- Exposure Potential

The largest *Amblema neislerii* populations in the lower Apalachicola River system occur in the Chipola and Middle Apalachicola River sections (Tables 2 and 3). Populations in these 2 sections comprise >75% of the population in the Apalachicola River system. Based on 2010 data, we estimate that 14,780 Apalachicola River *A. neislerii* (or 23% of the total estimated site populations) occur at depths that would potentially subject them to emersion at 5000 CFS flow levels. Extrapolating to the larger Apalachicola River population yields an estimate of 48,777 *A. neislerii* at risk of exposure under low flow conditions. In the Chipola River we estimate that 12,768 (or 23% of the total estimated site populations) occur at depths that would potentially subject them to emersion at 5000 CFS flow levels. Extrapolating to the larger Apalachicola River population yields an estimate of 116,072 *A. neislerii* at risk of exposure at low flow conditions (Tables 2 & 3).

Amblema neislerii- Demographics

Mean overall 2008 *A. neislerii* length was 48.2 mm and ranged from 9.5 to 88.4 mm (Fig 1). Mean size of A. neislerii in the Apalachicola River was greater (49.4 mm) than the mean size in the Chipola River (41.3 mm). In 2008 mean lengths of Apalachicola and Chipola River *A. neislerii* populations were similar (49.3 and 44.7 mm, respectively). However, in 2008, Apalachicola River *A. neislerii* populations exhibited a greater size class range than did Chipola River populations (9.5-88.4 mm vs. 19.4-70.3 mm, respectively, Figs. 2 & 3) in 2008. In 2010 overall *A. neislerii* length was 44.5 mm and ranged from 4.0 to 85.8 mm (Figs. 2 & 3). Mean 2010 *A. neislerii* length was 49.4 mm in the Apalachicola River and 40.3 mm in the Chipola River (Figs. 2 & 3). Overall *Amblema neislerii* mean length in the Apalachicola River was greatest in the Upper section (54.9 mm) and lowest in the Lower section (42.4 mm, Fig. 4).

Table 2. Site scale mean ± standard error (and range) total mussel assemblage and *Amblema neislerii* (AN) densities (no. individuals/m^2), estimated total number of *A. neislerii* at 10 Apalachicola River sites sampled in 2008 (A59, A64a, A66, A76, A77, A79, A80a, A83, A84, A87) and mean ± standard error (and range) *A. neislerii* density at depths <1 m (at 9000 CFS flows), and the estimated number of *A. neislerii* at depths < 1 m at 19 sites sampled during July and August 2010 (A08, A09, A12, A13, A28, A29, A30, A37, A42, A64b, A68, A76b, A80b, A85, A92, A94, A96, A108 and A111).

Site	Mean ± SE (Range) Mussel Density	Mean ± SE (Range) *AN* Density	Estimated Number AN	Mean ± SE (Range) AN Density at Depths <1 m	Estimated Number AN at Depths <1 m
A08	1.2±0.6 (0-12)	0	0	0	0
A09	3.7±0.7 (0-20)	0.1±0.1 (0-4)	170	0	0
A12	0.4±0.2 (0-8)	0	0	0	0
A13	2.2±0.4 (0-20)	0.1±0.1 (0-4)	160	0	0
A28	2.5±0.5 (0-28)	0.3±0.1 (0-8)	538	0.46±0.19 (0-1.33)	253
A29	13.6±2.1 (0-52)	4.5±1.3 (0-44)	4,137	5.3±2.67 (0.67-12.8)	2,131
A30	1.3±0.3 (0-20)	0.1±0.1 (0-4)	584	0.37±0.19 (0-1.33)	754
A37	3.4±0.7 (0-32)	0.1±0.1 (0-4)	51	0	0
A42	2±0.3 (0-12)	0.2±0.1 (0-4)	126	0.46±0.15 (0-0.8)	273
A59	38.1±6.7 (8.0-62.8)	1.0±0.25 (0-2.3)	1,491	-----	-----
A64a	62.3±16.1 (33-100)	30.3±15 (2.0-68.0)	27,376	-----	-----
A64b	66±5.9 (8-172)	22.2±4.1 (0-124)	32,374	4.2±2.06 (0-12)	2,394
A64c			29,875	4.2±2.06 (0-12)	2,394
A66	53.7±4.9 (38.3-77.1)	10.37±0.9 (8.6-14.3)	5,359	-----	-----
A68	13.8±1.1 (0-44)	2.4±0.4 (0-20)	5,468	0.74±0.41 (0-2.57)	977
A76a	1.8±0.46 (0.8-3.2)	0.16±0.16 (0-0.8)	31	-----	-----
A76b	1.1±0.5 (0-4)	0	0	0	0
A77	23.8±4.03 (3.0-53.1)	3.88±0.96 (0-12.0)	4,015	-----	-----
A79	8.18±1.27 (2.67-12.0)	0.92±0.32 (0-2.5)	241	-----	-----
A80a	27.7±4.39 (10.4-42.8)	4.22±1.05 (1.0-10.5)	3,395	-----	-----

Site	Mean ± SE (Range) Mussel Density	Mean ± SE (Range) *AN* Density	Estimated Number AN	Mean ± SE (Range) AN Density at Depths <1 m	Estimated Number AN at Depths <1 m
A80b	19.6±2.6 (0-76)	4.5±0.9 (0-28)	6,696	7.09±3.32 (2.67-13.6)	4,650
A80c			5,046	7.09±3.32 (2.67-13.6)	4,650
A83	9.59±3.92 (0.67-27.6)	1.6±0.7 (0-4.89)	1,485	-----	-----
A84	0.89±0.36 (0.53-1.25)	0	0	-----	-----
A85	0.7±0.3 (0-12)	0±0 (0-0)	0	0	0
A87	5.26±0.67 (4.3-6.6)	0.76±0.09 (0.62-0.92)	692	-----	-----
A92	9.3±1.2 (0-52)	2.2±0.4 (0-24)	6,694	3.04±1.23 (0-11)	2,264
A94	6.1±1.2 (0-28)	1.9±0.6 (0-16)	946	1.5±1.5 (0-3.0)	158
A96	31.3±3 (0-132)	2.2±0.4 (0-16)	2,715	1.29±0.32 (0.57-2.0)	484
A108	8.8±1.4 (0-56)	1.4±0.4 (0-16)	2,039	0.92±0.61 (0-3.0)	442
A111	31.5±4.7 (0-108)	1.5±0.5 (0-12)	1,134	0	0
Upper 2010	**2.91±0.54 (0-25.1)**	**0.44±0.21 (0-11.0)**	**5,767**	**0.58±0.26 (0-12.8)**	**3,411**
Middle 2008	**26.7±2.9 (0.53-100)**	**4.98±1.31 (0-68)**	**43,393**	**-----**	**-----**
Middle 2010	**29.8±8.4 (1.0-132.4)**	**8.84±3.74 (0-56)**	**44,538**	**2.92±1.05 (0-13.6)**	**8,021**
Middle 2008-10	**27.3±2.88 (0.53-132.4)**	**5.79±1.29 (0-68)**	**53,011**	**2.92±1.05 (0-13.6)**	**8,021**
Lower 2008	**16±1.2 (14-18)**	**2.3±0.33 (2.0-3.0)**	**692**	**-----**	**-----**
Lower 2010	**13.2±2.5 (0-58)**	**1.44±0.3 (0-5.0)**	**13,528**	**1.38±0.45 (0-11.0)**	**3,348**
Lower 2008-10	**12.5±2.34 (0-58)**	**1.38±0.28 (0-5.0)**	**14,220**	**1.38±0.45 (0-11.0)**	**3,348**
2008 Sites	**25.6±2.85 (0.53-100)**	**4.79±1.25 (0-68)**	**44,085**	**-----**	**-----**
2010 Sites	**10.3±1.81 (0-132.4)**	**2.08±0.29 (0-56)**	**63,833**	**1.20±0.27 (0-13.6)**	**14,780 (23%)**
All Sites	**16.3±1.67 (0-132.4)**	**3.13±0.64 (0-68)**	**72,998**	**1.20±0.27 (0-13.6)**	**14,780**

Table 2. Site scale mean ± standard error (and range) total mussel assemblage, *A. neislerii* (AN), and *E. chipolaensis* (EC) densities (no. individuals/m^2), estimated total number of *A. neislerii* at each site, mean ± standard error (and range) *A. neislerii* density at depths <1 m, and the estimated number of *A. neislerii* at depths < 1 m at 10 sites in the Chipola River during October 2008 (C9, C11, C12, C16a) and July-August 2010 (C16b, C35, C37, C53, C54, C59).

Site	Mean ± SE (Range) Mussel Density	Mean ± SE (Range) AN Density	Mean ± SE (Range) EC Density	Estimated Number AN	Mean ± SE (Range) AN Density at Depths <1 m	Estimated Number AN at Depths <1 m
C9	32.9±13.41 (19.5-46.3)	9.8±6.82 (2.93-16.6)	0	3,962	-----	-----
C11	28.7±6.36 (16-36)	2.2±1.72 (0-5.6)	0	427	-----	-----
C12	13.4±3.87 (5.33-23.4)	1.54±1.07 (0-5.71)	0	601	-----	-----
C16a*	28.5±6.95 (10.4-65.6)	9.17±3.56 (1.6-25.6)	0.4±0.4 (0-2.8)	5789	-----	-----
C16b	10.4±1.3 (0-44)	5.0±1.1 (0-32)	0	7,326	1.26±0.65 (0-2.18)	1,216
C16c				6,558	-----	-----
C35	17.1±2.7 (0-104)	11.4±2.4 (0-100)	0.2±0.1 (0-4)	11,436	6.67±2.36 (1.09-10.7)	3,674
C37	1.3±1.3 (0-8)	0.7±0.7 (0-4)	0	77	1.33±1.3 (0-1.33)	70
C39	17±5.3 (0-152)	13.4±4.9 (0-140)	0	10,487	7.15±3.25 (1.6-16)	2,138
C53	9±1.8 (0-88)	3.7±1 (0-36)	0	7,235	2.15±1.25 (0-7.2)	2,709
C54	6.7±1.3 (0-36)	2.2±0.7 (0-20)	0	1,432	2.22±1.62 (0-6.86)	683
C59	51.9±9.5 (4-268)	26.7±7.8 (0-216)	0	17,683	11.6±8.19 (1.0-36)	2,278
2008	**24.6±3.8 (5.3-65.6)**	**5.8±1.8 (0-26)**	**0.04±0.4 (0-2.8)**	**10,779**	**-----**	**-----**
2010	**19.0±4.4 (1.3-96)**	**10.9±3.3 (1.0-72)**	**0.01±0.01 (0-0.9)**	**55,676**	**4.94±1.48 (0-36)**	**12,768 (23%)**
All	**21.2±3.0 (1.3-96)**	**8.9±2.2 (0-72)**	**0.02±0.01 (0-2.8)**	**59,821**	**4.94±1.48 (0-36)**	**12,678**

*Note that C16 was sampled in both years. Mean C16 data reported as site C16c.

Habitat Associations

Habitat data suggest that mussel aggregations and T&E taxa (primarily *A. neislerii*) are highly clumped with the greatest densities occurring at depths of 0.3-0.6 m along transects sloping at ~20-30% grade (Fig. 6). Total mussel and *A. neislerii* densities were normally distributed and relatively few mussels (and almost no T&E mussels) occurred within the first and last quadrats on each transect. Total mussel density and *A. neislerii* density were highest in moderately sloping transects.

Despite examining the effect of local-scale habitat parameters at multiple spatial and temporal scales, we were able to detect few associations with mussel assemblage metrics. At Apalachicola River sites, maximum transect grade was significantly correlated ($r = 0.36$, $p < 0.05$) with projected *A. neislerii* population size. Chipola River sites exhibited a similar (yet not statistically significant) pattern (Fig. 6). In contrast, the projected number of *A. neislerii* occurring within the critical depth zone was negatively associated with mean minimum transect grade for Chipola River sites ($r = 0.76$, $p < 0.05$) but showed an opposite, albeit non-linear, pattern for Apalachicola River sites. Finally, the proportion of the mussel assemblage comprised of A. neislerii exhibited a significant positive association with maximum mean transect depth at Chipola River sites ($r = 0.78$, $p < 0.01$).

Elliptio chipolaensis

Elliptio chipolaensis was only found at 2 sites in the Chipola River (2008- C16, n = 7; 2010-C35, n = 3) and ranged from 22.1 to 56.4 mm in length (Fig. 5). We estimate a total population sizes to be 252 at C16 and 165 individuals at C35. Extrapolating to the entire Chipola River provides an estimate of 2,645 E. chipolaensis in bank margin habitats <2.0 m deep at 9000 CFS.

Discussion

Our preliminary data suggest that a large and reproductively viable population of *Amblema neislerii* persists within a diverse riverbank mussel assemblage in the

Apalachicola and lower Chipola rivers. *Amblema neislerii* was the second most abundant mussel species encountered in this survey. However, although demographic data suggest evidence of recent *A. neislerii* recruitment in the Apalachicola River, few individuals <20 mm total length were found at Chipola River sites, suggesting that Chipola River populations may exhibit lower recruitment rates than Apalachicola River populations. It is also possible that *A. neislerii* growth rates in the Chipola River are lower than in the Apalachicola River and recent recruits have yet to reach detectable sizes (~6-7 mm). However, that does not explain the low numbers of individuals 10-20 mm (n = 45 both years) from a sample of 1345 mussels. In contrast, we found 99 *A. neislerii* <20 mm TL in the Apalachicola River during 2008 and 2010 sampling. A similar lack of recruits and the largest mean and median shell lengths was observed in the low-population density Upper Apalachicola River. *Amblema neislerii* populations in the Lower and Middle Apalachicola River appear to be actively recruiting juveniles.

Depth distributional data suggest that *A. neislerii* and other unionids in both the Apalachicola and Chipola rivers are strongly aggregated along the 0.3-0.6 m depth isocline. We found relatively few mussels in the first and last several quadrats. River-edge quadrats typically supported a distinctive, low-density mussel assemblage dominated by *Elliptio pullata*, *Toxolasma paulus* and *Villosa* spp. and deeper water quadrats tended to have taxa adapted to shifting substrates characteristic of mid-channel habitats (e.g., *Lampsilis teres*, *Glebula rotundata*). However, examination of critical zone mussel densities revealed that some sites support relatively large mussel and *A. neislerii* populations at depths between the 9000 and 5000 CFS river levels. Overall, we estimate that 23% of the *A. neislerii* population at bankside sites may occur in this zone. We obtained similar percentage estimates for the at-risk component of both the Apalachicola and Chipola river populations. However because the Chipola River population is much larger than the Apalachicola River population, we estimate that roughly 2x as many *A. neislerii* are potentially at-risk in the Chipola River (116,072) compared to the Apalachicola River (48,777).

Of the parameters measured in this study, bank slope (grade) appears to be the major factor affecting mussel distributions. We found that mussel and *A. neislerii* densities were highest in transects with a slope of 0.2-0.4 and that virtually no mussels were found in transects with slopes <0.10 (10%). Additionally, at the site scale, transect slope was an important predictor of mussel assemblage metrics including the projected number of *A. neislerii* at a site and the projected number of *A. neislerii* within the critical zone. Curiously, although the projected number of *A. neislerii* and the proportion of the mussel assemblage comprised by *A. neislerii* appear positively associated with maximum transect slope, the projected number of *A. neislerii* in the critical zone was negatively associated with mean bank slope. These results suggest that complex local (i.e., site or reach-scale) as opposed to micro-habitat (i.e., quadrat) scale habitat conditions may affect mussel distributions.

The Chipola slabshell, *Elliptio chipolaensis* occurred at only two sites (C16 and C35) and only 10 individuals were collected. Surveys in the upper Chipola found *E. chipolaenis* restricted to primarily deeper (> 2 m) habitats. Subsequent surveys in deeper habitats may encounter more individuals but currently a status assessment or examination of habitat associations for *E. chipolaensis* is premature.

Deeper water surveys are planned to examine *E. sloatianus* habitat associations in shoal habitats in the upper Apalachicola River. Additional data on river channel bathymetry and deep-water mussel assemblages are needed to evaluate the total size of the Lower Apalachicola System's *A. neislerii* population. More comprehensive geomorphic, hydrologic, and hydraulic data may permit a more complete understanding of how mussel aggregations and population demographics are influenced by local-scale habitat parameters.

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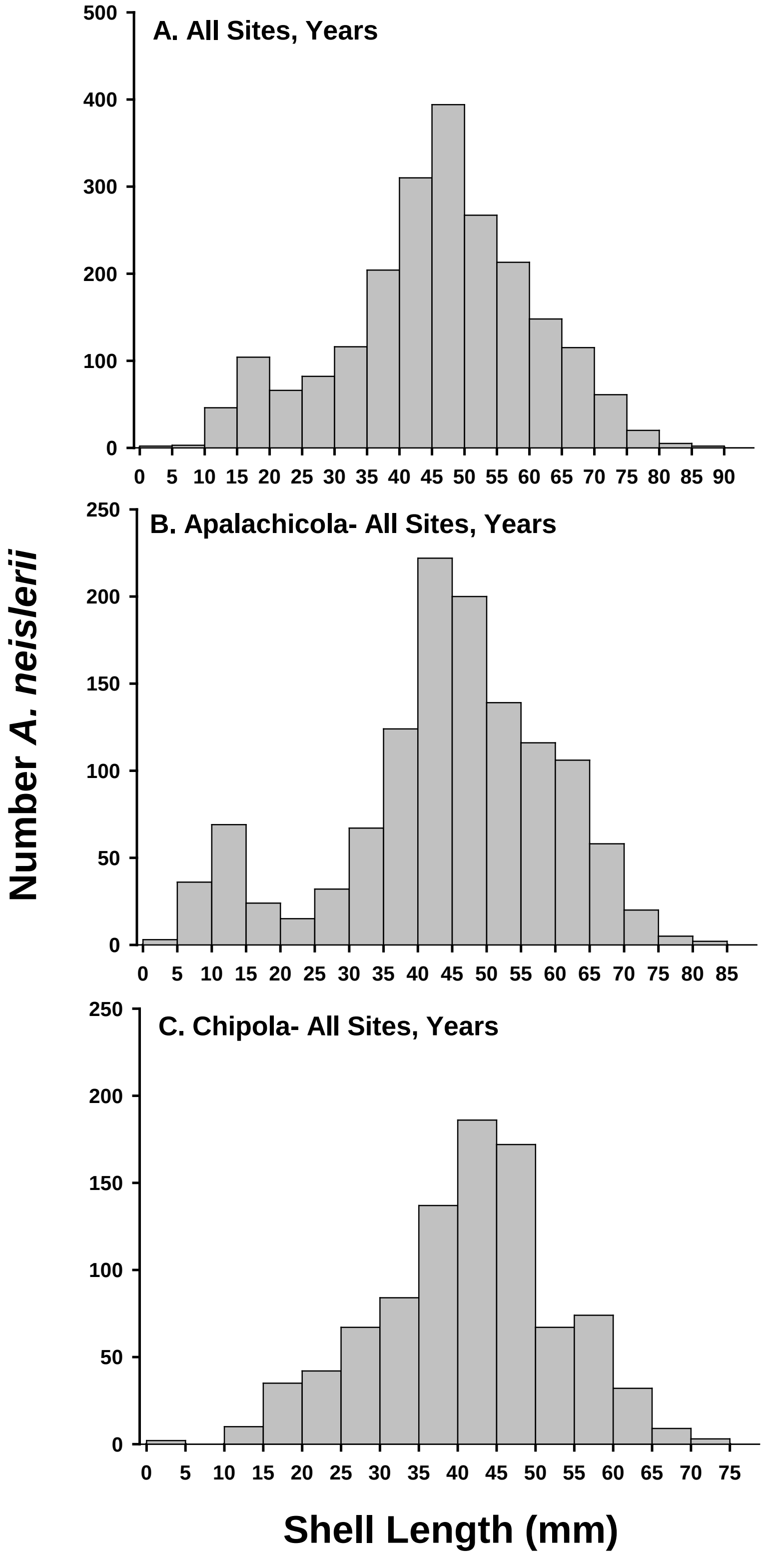

A. All Sites, Years
B. Apalachicola- All Sites, Years
C. Chipola- All Sites, Years
Number *A. neislerii*
Shell Length (mm)
500
400
300
200
100
0
250
200
150
100
50
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

Figure 1. Histograms showing *Amblema neislerii* length-frequency distributions in the A) Apalachicola and Chipola rivers, B) the Apalachicola River and C) the Chipola River in 2008 and 2010.

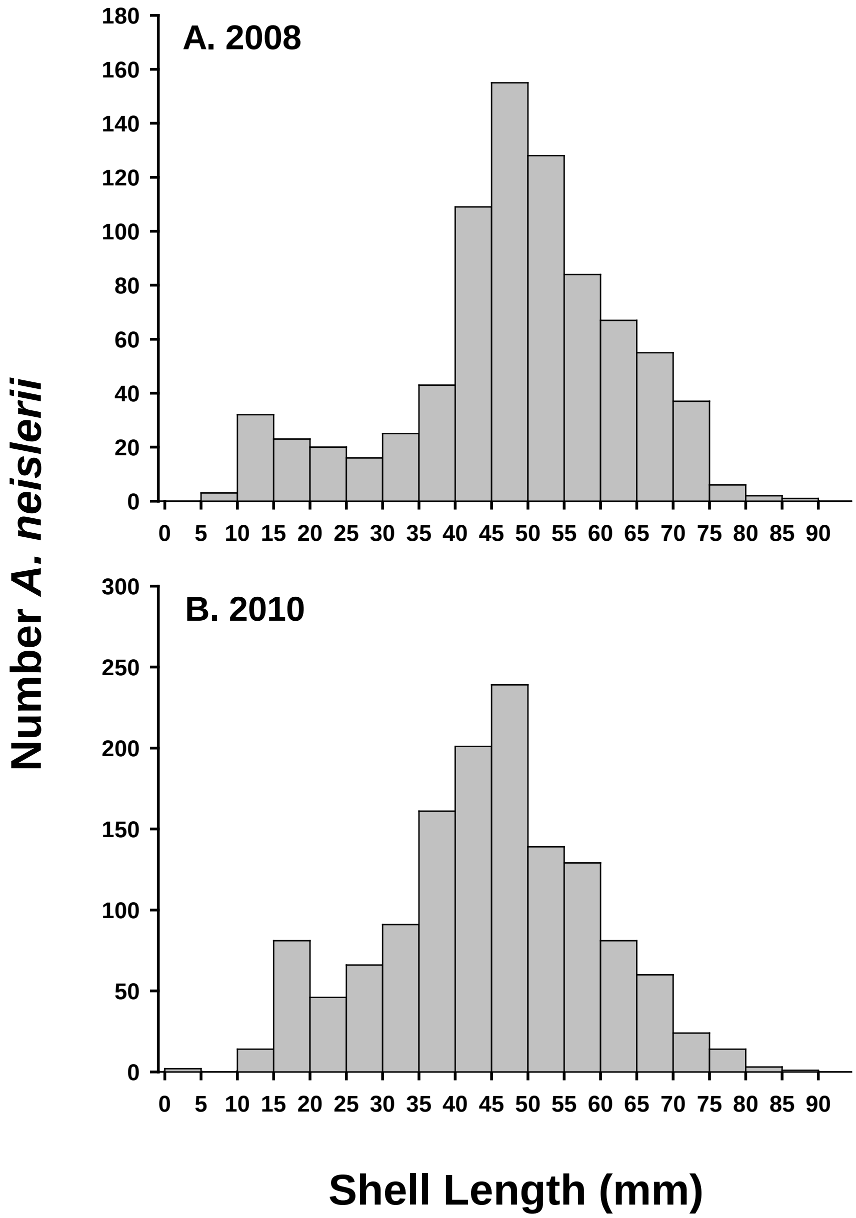

Figure 2. Histograms showing *Amblema neislerii* length-frequency distributions in the Apalachicola River in A) 2008 and B) 2010.

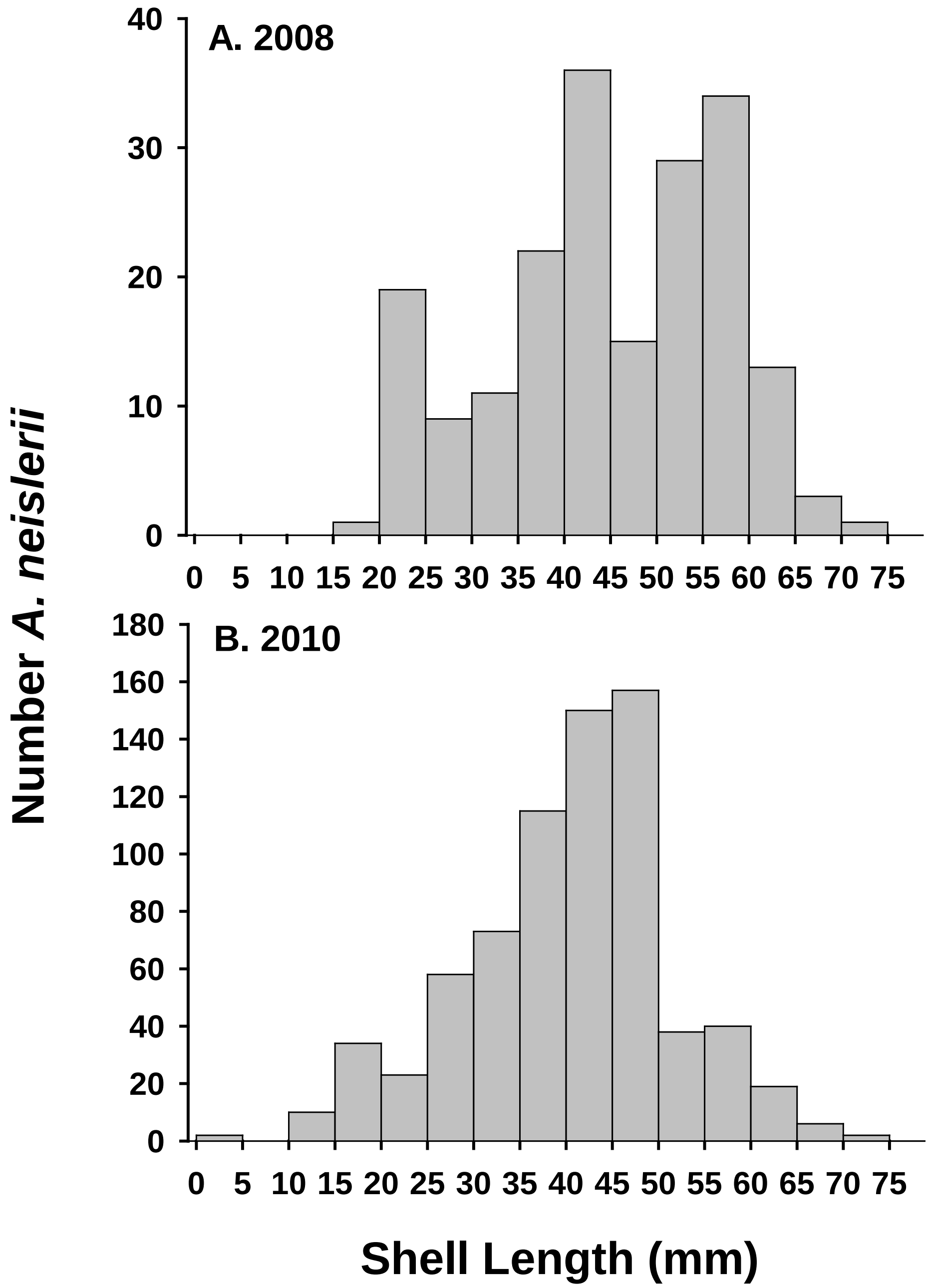

Figure 3. Histograms showing *Amblema neislerii* length-frequency distributions in the Chipola River in A) 2008 and B) 2010.

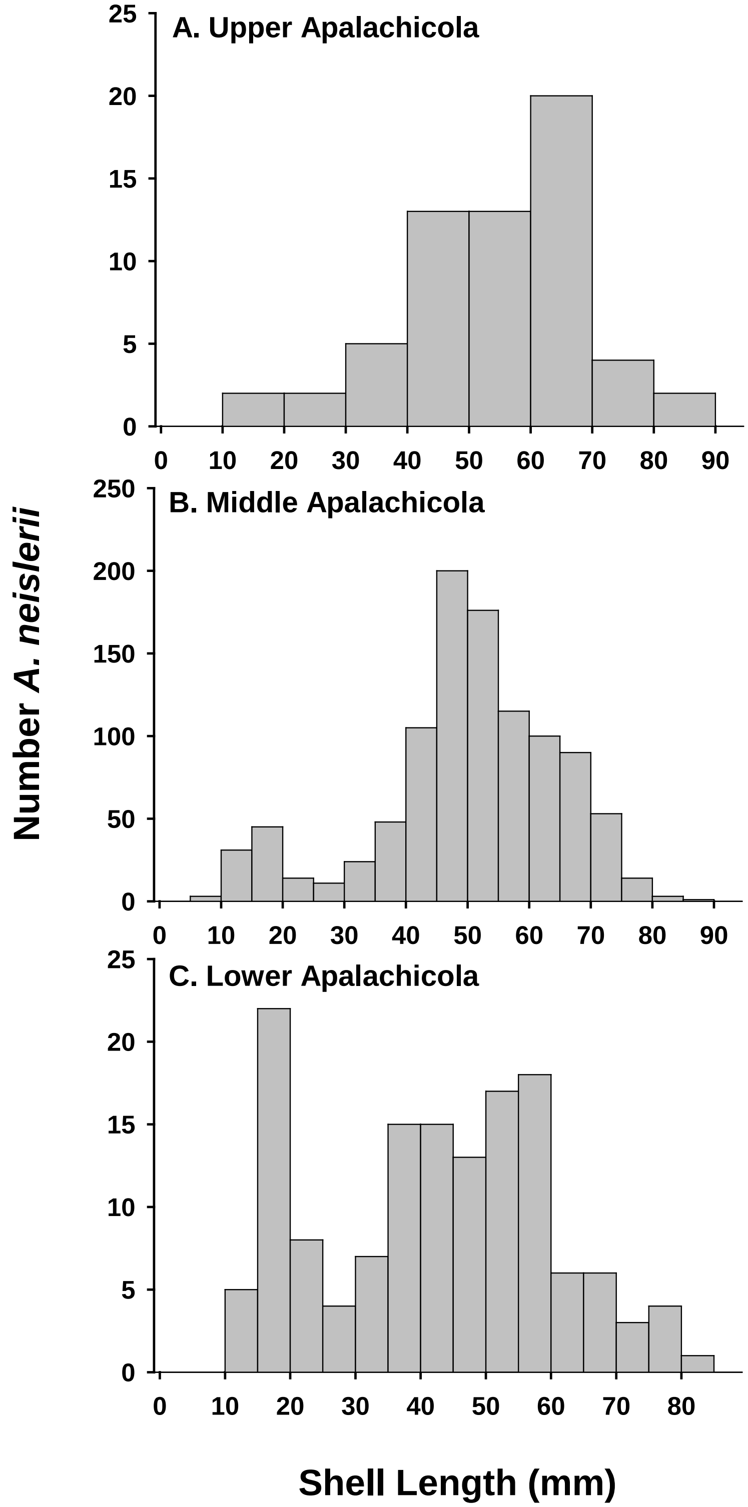

Figure 4. Histograms showing *Amblema neislerii* length-frequency distributions in the A) Upper, B) Middle, and C) Lower Apalachicola River in 2008 and 2010.

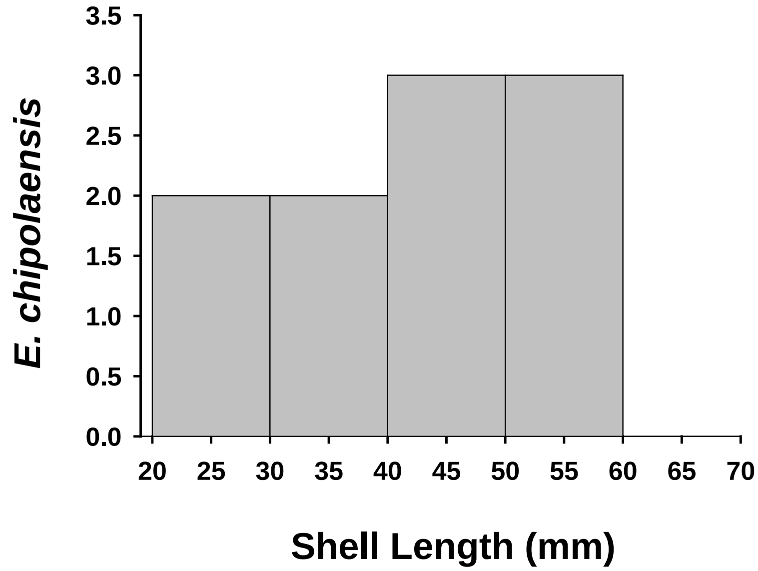

Figure 5. Histograms showing *Elliptio chipolaensis* length-frequency distributions for specimens collected in the Lower Chipola River, 2008 and 2010.

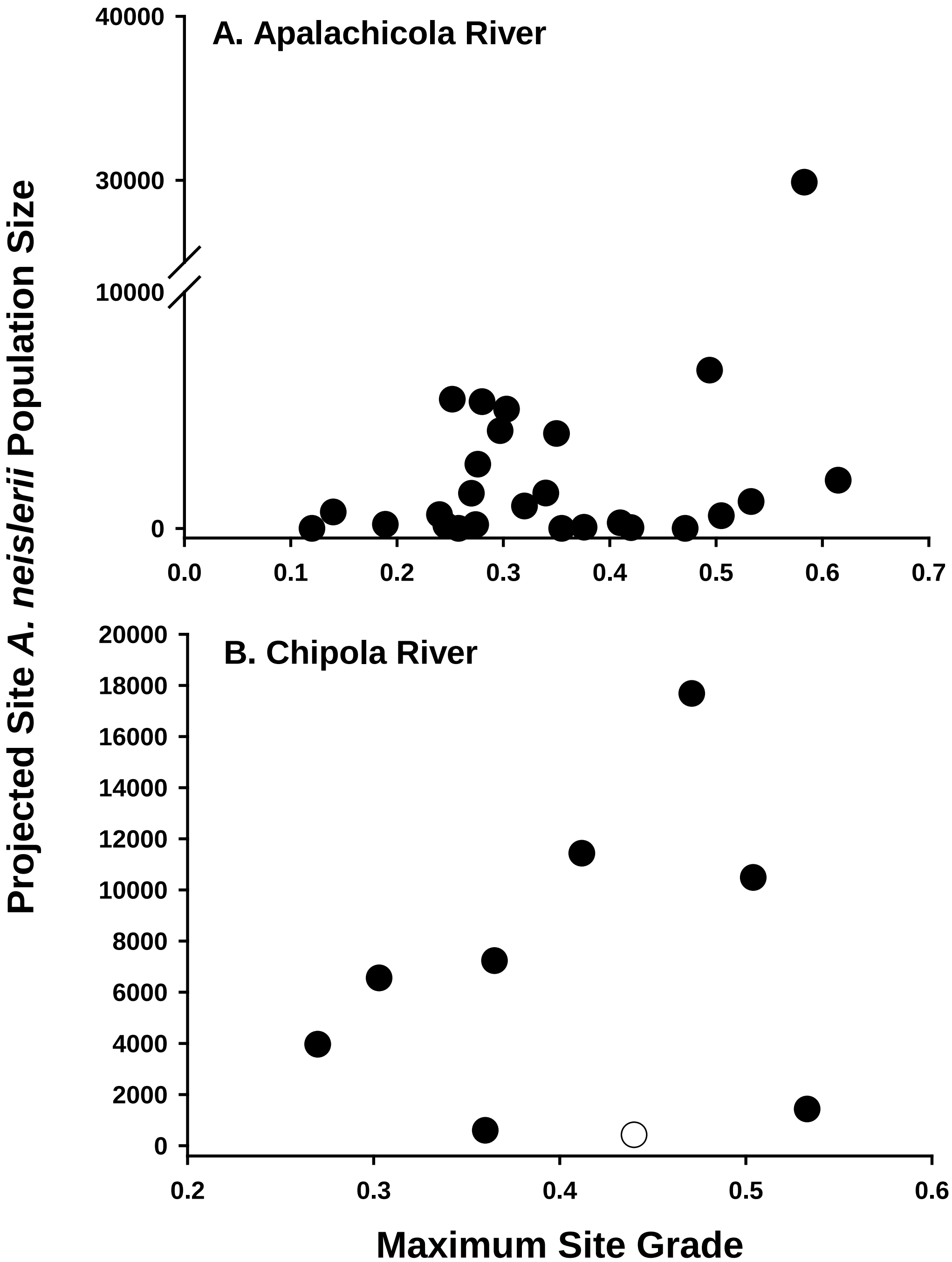

Figure 6. Relationship between maximum transect-scale bank grade and estimated *Amblema neislerii* population size at sites in the A) Apalachicola and B) Chipola rivers in 2008 and 2010.

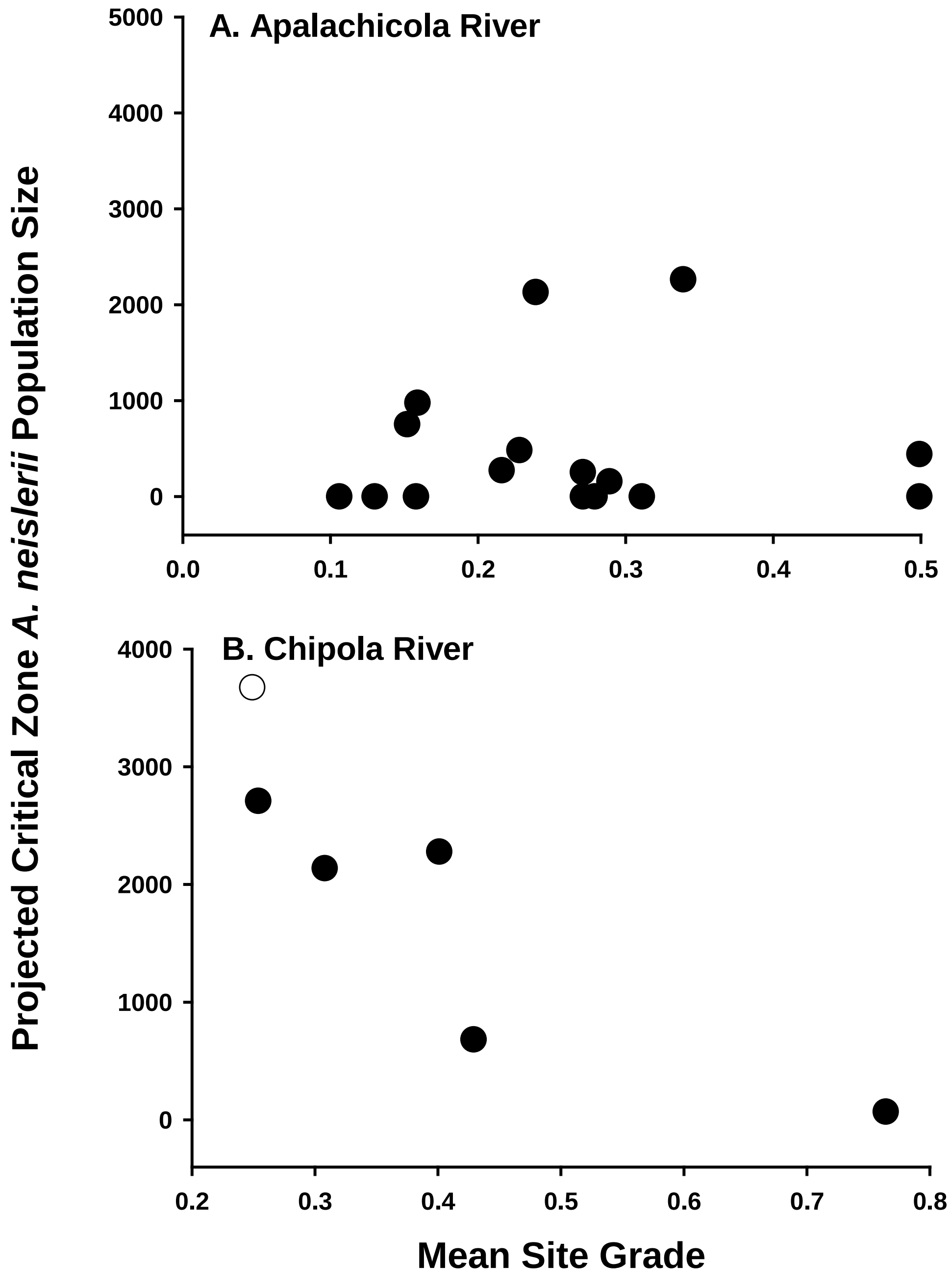

Figure 7. Relationship between maximum transect-scale bank grade and estimated *Amblema neislerii* critical zone population size at sites in the A) Apalachicola and B) Chipola rivers in 2008 and 2010.

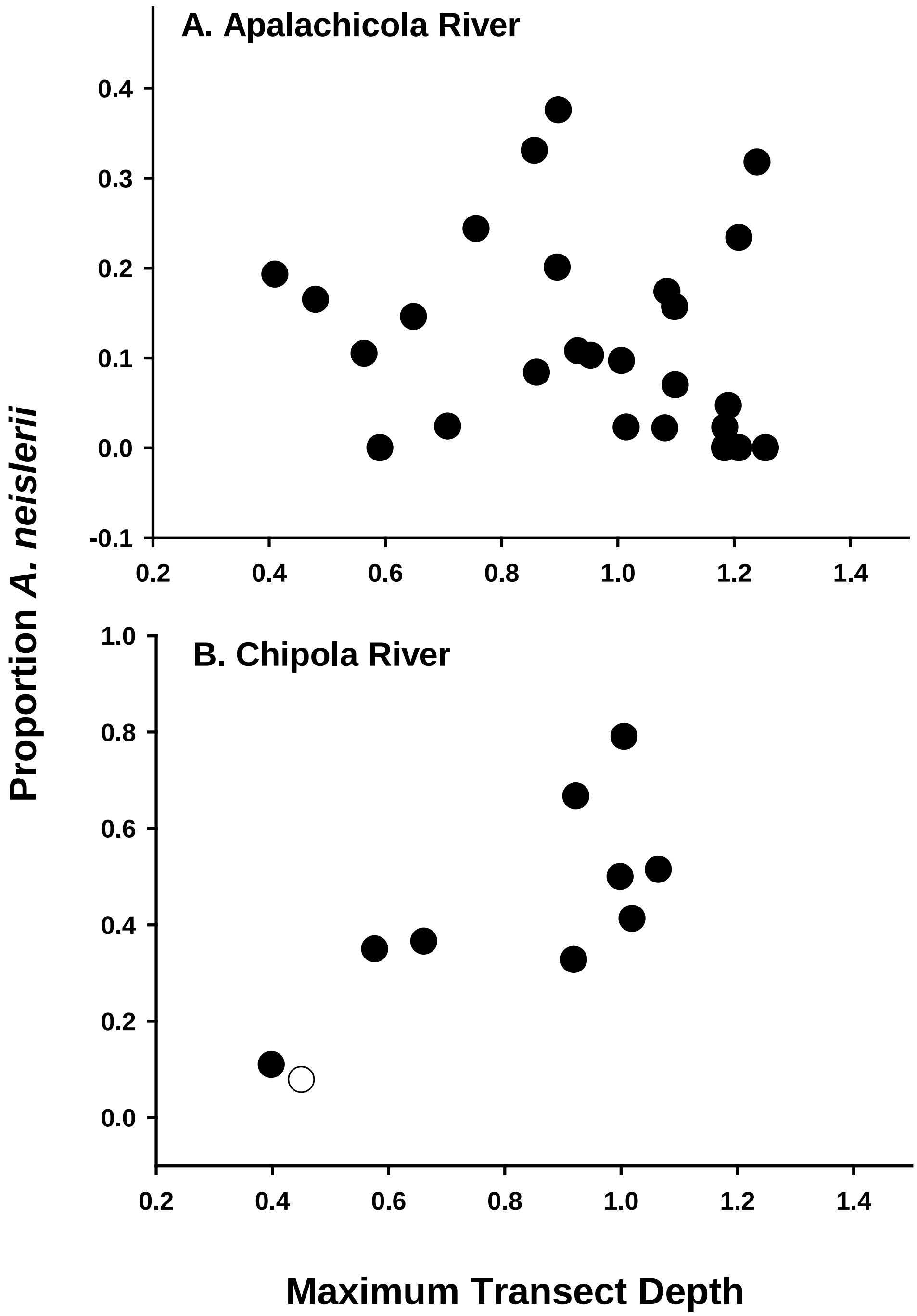

Figure 8. Relationship between maximum transect-scale depth and estimated proportion of the total mussel assemblage comprised by *Amblema neislerii* at sites in the A) Apalachicola and B) Chipola rivers in 2008 and 2010.

Appendix A. List of study sites, by river drainage section (Upper, Middle, Lower Apalachicola or Lower Chipola), date sampled, latitude/longitude, left or right descending bank (LDB/RDB), site length, number of transects (NT), number of quadrats (NQ), maximum quadrat depth, and mean, standard error and range for transect length (T-Length) and transect slope. Transect slopes are un-corrected (not multiplied by 100) percentages.

River Section	Site	Date	Latitude/Longitude U-upstream end D- downstream end	Bank	Site Length	NT	NQ	Maximum Quadrat Depth	Mean +SE (Range) T-Length	Mean ± SE (Range) Slope
Upper Apalachicola	A08	7/31/10	U:30.60262,-84.93355 D:30.60196,-84.93366	LDB	75 m	2	29	2.04	7.0±1.25 (5.75-8.25)	0.34±0.04 (0.3-0.37)
Upper Apalachicola	A09	7/31/10	U:30.59633,-84.94447 D:30.59572,-84.94595	RDB	157 m	5	47	2.05	12.75±0.88 (10.75-15.3)	0.18±0.01 (0.16-0.2)
Upper Apalachicola	A12	8/20/10	U:30.56457,-84.96258 D:30.55709,-84.96926	RDB	1048 m	9	93	2	11.25±1.38 (6.25-20.8)	0.17±0.01 (0.11-0.24)
Upper Apalachicola	A13	8/21/10	U:30.55598,-84.97132 D:30.55516,-84.97308	RDB	192 m	6	81	1.95	16.92±2.79 (6.75-22.75)	0.17±0.04 (0.09-0.31
Upper Apalachicola	A28	8/17/10	U:30.40653,-85.01857 D:30.40580,-85.02102	LDB	249 m	8	93	1.64	8.38±2.37 (3.25-22.25)	0.29±0.04 (0.1-0.44)
Upper Apalachicola	A29	8/10/10	U:30.39789,-85.02112 D:30.39804,-85.01973	LDB	134 m	4	41	1.62	6.88±0.90 (5.25-9.25)	0.24±0.03 (0.16-0.31)
Upper Apalachicola	A30	8/10/10	U:30.39264,-85.01474 D:30.38838,-85.01554	RDB	479 m	10	99	1.6	10.1+1.08 (6.25-15.25)	0.2±0.02 (0.11-0.28)
Upper Apalachicola	A37	8/11/10	U:30.33400,-85.04699 D:30.33339,-85.04614	LDB	106 m	4	51	1.6	6.13+1.03 (4.25-8.75)	0.32±0.02 (0.26-0.37)
Upper Apalachicola	A42	8/11/10	U:30.30062,-85.05687 D:30.29928,-85.05595	LDB	173 m	6	74	1.54	7.0+0.31 (6.25-8.25)	0.23±0.02 (0.18-0.31)

River Section	Site	Date	Latitude/Longitude U-upstream end D- downstream end	Bank	Site Length	NT	NQ	Maximum Quadrat Depth	Mean +SE (Range) T-Length	Mean + SE (Range) Slope
Middle Apalachicola	A59	10/6/08	U:30.21006,-85.11519 D:30.21156,-85.11790	RDB	310 m	9	76	1.00	4.81+1.33 (2.75-15.25)	0.25+0.03 (0.06-0.34)
Middle Apalachicola	A64a	10/23/08	U:30.18750,-85.12576 D:30.18505,-85.12637	RDB	278 m	4	28	1.00	3.25+0.65 (1.75-4.75)	0.30+0.04 (0.21-0.42)
Middle Apalachicola	A64b	7/27/10	U:30.18750,-85.12576 D:30.18505,-85.12637	RDB	278 m	4	55	2.07	5.25+0.83 (2.75-7.25)	0.45+0.11 (0.25-0.84)
Middle Apalachicola	A66	10/3/08	U:30.17521,-85.13444 D:30.1738,-85.1340	LDB	159 m	7	49	0.91	3.29+0.04 (3.25-3.50)	0.27+0.01 (0.25-0.28)
Middle Apalachicola	A68	7/26/10	U:30.16624,-85.13758 D:30.16517,-85.13633	LDB	169 m	6	115	2.15	14.3+2.19 (8.25-22.25)	0.17±0.03 (0.11-0.28)
Middle Apalachicola	A76a	10/1/08	U:30.14019,-85.13586 D:30.14014,-85.13628	LDB	41 m	5	40	1.00	4.75+1.63 (2.25-10.25)	0.28+0.1 (0.1-0.42)
Middle Apalachicola	A76b	7/23/10	U:30.14019,-85.13586 D:30.14014,-85.13628	LDB	41 m	2	15	2.00	2.88+0.88 (2.0-3.75)	0.50+0.11 (0.40-0.61)
Middle Apalachicola	A77	10/2/08	U:30.13513,-85.13730 D:30.13304,-85.13670	LDB	239 m	12	89	1.00	4.33+0.9 (2.25-11.25)	0.25+0.03 (0.09-0.35)
Middle Apalachicola	A79	9/30/08	U:30.13037,-85.14287 D:30.12997,-85.14341	LDB	69 m	7	49	1.00	3.25+0.46 (2.25-5.75)	0.31+0.03 (0.15-0.41)
Middle Apalachicola	A80a	10/5/08	U:30.12403,-85.14462 D:30.12247,-85.14376	LDB	192 m	9	78	1.00	4.19+0.34 (2.75-6.25)	0.22+0.02 (0.16-0.31)
Middle Apalachicola	A80b	7/24/10	U:30.12403,-85.14462 D:30.12247,-85.14376	LDB	192 m	3	48	2.00	7.75+1.0 (6.75-9.75)	0.24+0.04 (0.19-0.33)

River Section	Site	Date	Latitude/Longitude U-upstream end D- downstream end	Bank	Site Length	NT	NQ	Maximum Quadrat Depth	Mean +SE (Range) T-Length	Mean ± SE (Range) Slope
Middle Apalachicola	A83	10/4/08	U:30.12111,-85.13913 D:30.12102,-85.13825	LDB	85 m	6	69	1.00	10.9+2.71 (3.75-21.25)	0.13±0.03 (0.05-0.27)
Middle Apalachicola	A84	10/7/08	U:30.12018,-85.13207 D:30.11997,-85.13144	RDB	64 m	2	31	0.91	11.25±4.0 (7.25-15.25)	0.09±0.03 (0.06-0.12)
Lower Apalachicola	A85	7/25/10	U:30.11503,-85.13464 D:30.11571,-85.13712	RDB	250 m	6	55	2	5.17±1.05 (1.25-9.25)	0.35±0.02 (0.24-0.39)
Lower Apalachicola	A87	10/10/08	U:30.11075,-85.13951 D:30.11021,-85.13849	RDB	115 m	3	37	0.93	7.92±2.19 (5.25-12.25)	0.11±0.02 (0.08-0.14)
Lower Apalachicola	A92	7/28/10	U:30.08717,-85.13818 D:30.08334,-85.13570	RDB	488 m	9	92	2.11	6.35±0.75 (4.25-10.25)	0.38±0.02 (0.29-0.46)
Lower Apalachicola	A94	7/28/10	U:30.07780,-85.13555 D:30.07731,-85.13602	RDB	70 m	2	29	2	7.0±0.75 (6.25-7.75)	0.36±0.02 (0.35-0.38)
Lower Apalachicola	A96	7/28/10	U:30.06761,-85.13171 D:30.06691,-85.13054	LDB	136 m	4	75	2	9.13±1.25 (7.25-12.75)	0.25±0.03 (0.19-0.31)
Lower Apalachicola	A108	7/30/10	U:30.01392,-85.08659 D:30.01493,-85.08360	LDB	310 m	6	52	2.05	4.08±0.21 (3.25-4.75)	0.42±0.02 (0.35-0.5)
Lower Apalachicola	A111	7/30/10	U:30.00616,-85.07263 D:30.00499;-85.07127	RDB	185 m	4	35	2.12	4.13±0.24 (3.75-4.75)	0.48±0.04 (0.4-0.58)
Lower Chipola	C09	10/7/08	U:30.12748,-85.15970 D:30.12686,-65.16010	RDB	77 m	2	22	1.00	5.25±2.0 (3.25-7.25)	0.2±0.13 (0.14-0.27)
Lower Chipola	C11	10/10/08	U:30.12587,-85.1623 D:30.12543,-85.1632	RDB	101 m	3	13	1.00	1.92±0.17 (1.75-2.25)	0.37±0.04 (0.31-0.44)

River Section	Site	Date	Latitude/Longitude U-upstream end D- downstream end	Bank	Site Length	NT	NQ	Maximum Quadrat Depth	Mean +SE (Range) T-Length	Mean ± SE (Range) Slope
Lower Chipola	C12	10/9/08	U:30.12554,-85.1641 D:30.12630,-85.1653	RDB	142 m	5	30	1.00	2.75±0.16 (2.25-3.25)	0.29±0.03 (0.23-0.36)
Lower Chipola	C16a	10/10/08	U:30.11741,-85.1707 D:30.11558,-85.1706	RDB	203 m	7	47	1.00	3.11±0.37 (2.5-4.75)	0.27±0.18 (0.21-0.33)
Lower Chipola	C16b	7/24/10	U:30.11741,-85.1707 D:30.11558,-85.1706	RDB	203 m	3	45	2.00	7.25±0 (7.25-7.25)	0.23±0.04 (0.16-0.29)
Lower Chipola	C35	7/29/10	U:30.06804,-85.1640 D:30.06711,-85.1706	LDB	113 m	4	73	2.00	8.88±2.19 (4.25-13.75)	0.2±0.06 (0.1-0.38)
Lower Chipola	C37	7/28/10	U:30.05954,-85.1612 D:30.05991,-85.1611	LDB	42 m	1	6	2.10	2.75	0.6
Lower Chipola	C39	8/1/10	U:30.05651,-85.1630 D:30.05586,-85.1622	LDB	104 m	4	36	1.95	7.5±2.15 (3.75-13.25)	0.28±0.07 (0.14-0.4)
Lower Chipola	C53	8/23/10	U:30.02015,-85.1443 D:30.01848,-85.1453	RDB	212 m	6	62	2.25	9.29±1.59 (5.75-17.0)	0.19±0.03 (0.08-0.25)
Lower Chipola	C54	7/29/10	U:30.01782,-85.1449 D:30.01717,-85.1437	LDB	137 m	4	40	2.00	4.75±0.79 (3.25-6.75)	0.31±0.06 (0.2-0.47)
Lower Chipola	C59	7/28/10	U:30.01025,-85.1210 D:30.0105,-85.1196	RDB	143 m	4	38	2.00	4.63±0.13 (4.25-4.75)	0.39±0.03 (0.31-0.43)
Upper Apalachicola	**9**	**2010**	**-----**	**---**						
Middle Apalachicola	**10**	**2008 2010**	**-----**	**---**						
Lower	**7**	**2008**	**-----**	**---**						

River Section	Site	Date	Latitude/Longitude U-upstream end D- downstream end	Bank	Site Length	NT	NQ	Maximum Quadrat Depth	Mean +SE (Range) T-Length	Mean ± SE (Range) Slope
Apalachicola		**2010**								
Lower Chipola	**10**	**2008** **2010**	**-----**	**---**						
All Sections	**All**	**---**	**-----**	**---**						

*Note that A64, 76, A80, and C16 were sampled in both years. Mean data reported as sites A64c, A76c, A80c, C16c. For sites sampled in both years only mean and standard error transect length are reported except for site A76 where transect length data and slope data are not reported for 2010.

Appendix B- Mussel assemblage composition including totall number mussels (N), mussel species richness, and number of 18 taxa (includes unknown Elliptio forms as a separate taxon at 10 sites sampled in the Apalachicola (A59-A87) and 4 sites in the Chipola (C9-C16a) rivers during October 2008.

Site	**N**	**Taxa Richness**	***Anodonta heardi***	***Amblema neislerii***	***Elliptio chipolaensis***	***Elliptio crassidens***	***Elliptio fumata***	***Elliptio pullata***	***Glebula rotundata***	***Lampsilis straminea***	***Lampsilis teres***	***Pyganodon grandis***	***Quadrula infucata***	***Toxolasma paulus***	***Utterbackia imbecillis***	***Utterbackia peggeyae***	***Villosa lienosa***	***Villosa vibex***	***Villosa villosa***
A59	783	13		16		1	1	157	447		133	1	2	4	4	1		5	11
A64a	485	12	1	255		2		106	73		38	1	5	2		1			4
A66	658	13	2	127		2		227	204		68	4	2	16	3	1	1	1	
A76a	19	5		2				1	1		14			1					
A77	523	14	1	77				139	185	8	78	2	1	20	2	2	4	3	1
A79	107	7		10				22	5	1	66			2			1		
A80a	510	10		83				197	44		165	2	2	7	1	1		7	1
A83	113	10	1	20				16	30		36	2		4		1	1	2	
A84	7	2									6							1	
A87	48	6		7				9	3		27	1	1						
C9	154	8		40		2		50	2		51		4				1	4	
C11	90	6		8				48	5	1	27								1
C12	105	7		13				53	19		17			1				1	1
C16a	382	13		133	7	1		92	63		52	1	1	14		1	4	11	2
Apalachicola	**3254**	**17**	**5**	**597**		**4**	**1**	**874**	**992**	**9**	**631**	**13**	**13**	**56**	**10**	**7**	**7**	**19**	**17**
Chipola	**731**	**14**		**194**	**7**	**3**		**243**	**89**	**1**	**147**	**1**	**5**	**15**		**1**	**5**	**16**	**4**
Total N	**3985**	**18**	**5**	**791**	**7**	**7**	**1**	**1117**	**1081**	**10**	**778**	**14**	**18**	**71**	**10**	**8**	**12**	**35**	**21**

Appendix C- Mussel assemblage composition including totall number mussels (N), mussel species richness, and number of 18 taxa (includes unknown Elliptio forms as a separate taxon at 19 sites sampled in the Apalachicola (A8-A111) and 7 sites in the Chipola (C16b-C59) rivers during July and August 2010.

Site	**N**	**Taxa Richness**	***Amblema neislerii***	***Elliptio arctata***	***Elliptio chipolaensis***	***Elliptio crassidens***	***Elliptio fumata***	***Elliptio pullata***	***Elliptio sp.***	***Glebula rotundata***	***Lampsilis floridensis***	***Megalonaias nervosa***	***Pyganodon grandis***	***Quadrula infucata***	***Toxolasma paulus***	***Utterbackia imbecillis***	***Utterbackia peggeyae***	***Villosa lienosa***	***Villosa vibex***	***Villosa villosa***
A8	9	2						2			5									
A9	43	5	1					17		9	14					1				
A12	10	2						1			9									
A13	45	7	1	1				21		2	16		2	2						
A28	58	5	6					7			35		9	1						
A29	139	9	46					21		17	35		11	1	4	1	3			
A30	31	4	3					5			17		6							
A37	43	5	1					18		2	20		2							
A42	37	6	4					4		3	22		2		2					
A64b	907	12	305			2	2	325		112	86	1		14	5				1	6
A68	396	10	69					84		143	24	1	7		61	3		1		3
A76b	4	3						1		1	2									
A80b	235	7	54					64		18	90		7					1	1	
A85	9	1									9									
A92	214	5	50					39		58	63				4					
A94	44	4	14					7		4	19									
A96	587	10	41	1			1	138		268	133				1	1			1	
A108	115	5	18					8		62	26								1	

Site	N	Taxa Richness	*Amblema neislerii*	*Elliptio arctata*	*Elliptio chipolaensis*	*Elliptio crassidens*	*Elliptio fumata*	*Elliptio pullata*	*Elliptio sp.*	*Glebula rotundata*	*Lampsilis floridensis*	*Megalonaias nervosa*	*Pyganodon grandis*	*Quadrula infucata*	*Toxolasma paulus*	*Utterbackia imbecillis*	*Utterbackia peggeyae*	*Villosa lienosa*	*Villosa vibex*	*Villosa villosa*
A111	276	5	13					9		218	34								2	
C16b	117	7	56					27		18	10			2	3				1	
C35	312	10	208		3			28		58	7			3	2			1	1	1
C37	2	2	1								1									
C39	153	4	121					8		7	9									
C53	138	5	57					7		60	12									2
C54	67	5	22					8		13	23								1	
C59	493	10	254			1	1	86	1	104	39			4	1					1
Apalachicola.	**3202**	**17**	**626**	**2**	**0**	**2**	**3**	**771**	**8**	**917**	**659**	**2**	**46**	**18**	**77**	**6**	**3**	**2**	**6**	**9**
Chipola	**1282**	**12**	**719**	**0**	**3**	**1**	**1**	**164**	**1**	**260**	**101**	**0**	**0**	**9**	**6**	**0**	**0**	**1**	**3**	**4**
Total N	**4484**	**18**	**1345**	**2**	**3**	**3**	**4**	**935**	**9**	**1177**	**760**	**2**	**46**	**27**	**83**	**6**	**3**	**3**	**9**	**13**

Appendix D- Site Photos 2010

[to be added later]