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April 25, 2016

Kimberly D. Bose
Secretary, Federal Energy Regulatory Commission
888 First Street, NE Room 1-A
Washington, D.C. 20426

**RE: ROBUST REDHORSE REPORT VOLUME 10
SINCLAIR HYDROELECTRIC PROJECT (FERC NO. 1951)**

Dear Madam Secretary,

Please find enclosed a report entitled Conservation and Restoration of the Robust Redhorse *Moxostoma robustum*, in the Oconee River, Georgia, Volume 10, submitted in partial fulfillment of the requirements of Article 404 of the above-referenced license.

Since publication of the first robust redhorse report (Vol. 1, 1998), much increased knowledge has been gained about robust redhorse life history as well as conservation management progress throughout its historic range. Those research and management efforts have collectively been a truly monumental success in discovery, re-building, sustaining and monitoring robust redhorse populations in the historic range. The collective results of those efforts were effectively summarized in past report Volumes 1 through 9. Since 2008, surveys of the Oconee River population possibly indicate diminishing presence of wild and stocked robust redhorse. Of equal concern has been the apparent substantial decline in available surficial gravels which are critical for successful natural reproduction of robust redhorse. Since 2011, Sinclair's Flow Advisory Team has worked to address uncertainty as to whether the modified flow regime in the Oconee River below Sinclair Dam is benefiting robust redhorse. Within view of consideration more recently is the possibility that re-examination of the 1995 negotiated Sinclair Project flow and subsequent modification may be warranted, particularly as it relates to instream flow processes that affect surface gravel availability. This current report, Volume 10, provides update on the status of Oconee River robust redhorse. Thorough discussions of past robust redhorse conservation efforts can be found in previous volumes and in the vast information maintained on the Robust Redhorse Conservation Committee (RRCC) website, www.robustredhorse.com.

If you have any questions or comments, please contact me at 404/799-2142.

Sincerely,

Anthony Dodd, CFP, CLM
Environmental Specialist

**Conservation and Restoration of the Robust Redhorse
(*Moxostoma robustum*) in the Oconee River, Georgia**

**Volume
10**

April 2016

Prepared for the

**Federal Energy Regulatory Commission
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Washington, DC 20426**

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Attachment 1: 2014 Springtime Survey for Oconee River Robust Redhorse

1. Introduction

This document is the tenth report in a series of bi-annual reports, first initiated in 1998, documenting the status of the robust redhorse (*Moxostoma robustum*) as required by the Federal Energy Regulatory Commission (FERC) license for Georgia Power Company's (GPC) Sinclair Hydroelectric Project (FERC No. 1951). Robust redhorse is a fish species once believed to be extinct then "rediscovered" in 1991 in the Oconee River downstream of the Sinclair Project. Sinclair Project license Article 404 requires continuing documentation summarizing "status of the robust redhorse and ... a determination on the adequacy of flow releases in meeting the needs of this species." The reporting period for this volume, Volume 10, focuses on activities conducted between May 2014 and March 2016. Thorough discussions of past robust redhorse conservation efforts including flow modifications can found in previous volumes (Vols. 1 through 9) and in the vast information maintained on the Robust Redhorse Conservation Committee (RRCC) website at www.robustredhorse.com. Material for this report was gathered from project reports, status updates, Robust Redhorse Conservation Committee updates and personal communications.

1.1 Sinclair Hydroelectric Project

Sinclair Dam, located on the Oconee River near Milledgeville, GA was completed in 1952. The project is a GPC-owned and operated 45-megawatt hydroelectric facility. The dam impounds Lake Sinclair which is a 15,330-acre reservoir known as a popular fishing and recreation destination (Figure 1). The project's primary function is to provide hydroelectric generation capacity during peak electricity demand periods and serve as the lower reservoir for GPC's Wallace Dam pumped storage project (located immediately adjacent upstream).

1.2 Robust Redhorse (*Moxostoma robustum*)

During the early stages of FERC relicensing of Sinclair Dam in 1991, robust redhorse, a fish species believed to be extinct, was "rediscovered" in the Oconee River downstream of the Sinclair Project. Robust redhorse was originally described in 1870 by naturalist Edward Cope from specimens collected in the Yadkin River, North Carolina. Cope's original specimens were lost and labels and taxonomic names were mistakenly applied to other species through time. Robust redhorse remained unnoticed by ichthyologists for nearly 100 years until 1991. In August 1991, Georgia Department of Natural Resources (GDNR) fisheries biologists collected five large suckers (taxonomically members of the Catostomidae fishes) from the Oconee River downstream of Sinclair Dam. Several well-known ichthyologists including Dr. Henry Bart, Dr. Byron Freeman, and Dr. Robert Jenkins worked to identify the fish. All concluded that the five suckers were the same species originally described by Cope in 1870. In the past, ichthyologists also determined that single individual specimens collected in the Savannah River, 1980, and in the Pee Dee River,

North Carolina, 1985, were robust redhorse, although previously assumed to be an undescribed sucker species.



Figure 1. State of Georgia showing the location of GPC's Sinclair Hydroelectric Project and major rivers within the Georgia portion of the historic range for the robust redhorse.

With robust redhorse presence confirmed in the Carolina's and Georgia, the currently accepted historic range for robust redhorse is Atlantic slope rivers with a northern extent of the Yadkin / Pee Dee River drainages in North and South Carolina down to the Altamaha River system in Georgia (Figure 2). "Rediscovery" of robust redhorse immediately initiated interests in planning and conducting conservation and restoration actions for the species as rapidly as possible. Concerns about the species' population status arose when the possibility that the Oconee robust redhorse may have represented a sole remnant population were realized. In addition, all captured robust redhorse were large, mature individuals (> 400 mm TL), and may represent a senescing population or evidence of unsuccessful recruitment. Over time, other concerns arose including the effect of modified

flows from power generation, erosion, siltation, availability of spawning habitat, environmental quality, and introduced predators such as flathead catfish (*Pylodictis olivaris*).

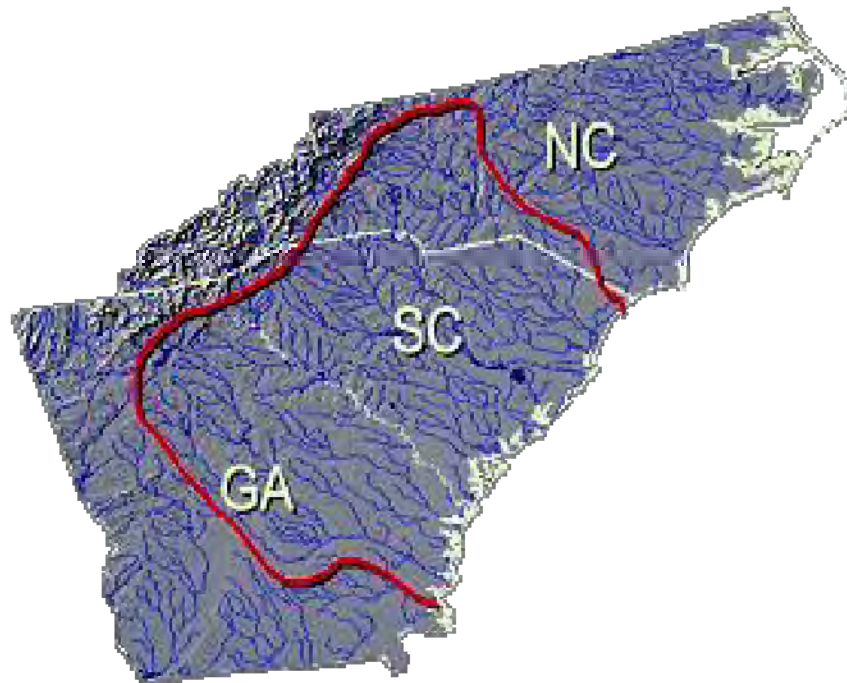


Figure 2. Presumed historic range of robust redhorse (Coughlan, 2000).

1.3 Robust Redhorse Conservation Committee

The discovery of the Oconee River robust redhorse population led to the establishment of the Robust Redhorse Conservation Committee (RRCC), a multi-stakeholder partnership, codified under a Memorandum of Understanding (MOU) in 1995. The RRCC was designed to restore the robust redhorse throughout its currently accepted historic range by implementing research and conservation measures, enhancing recruitment in existing populations, and re-establish robust redhorse populations in appropriate river systems within the species' former range.

Through collaborative efforts and information-sharing among members and other interested parties, the RRCC has identified and prioritized potential threats to the species, conducted research related to those threats, and formulated the potential solutions through various conservation actions. The RRCC's recovery efforts have been effectively publicized, and have been the driving force behind the conservation and restoration of robust redhorse.

Jaci Zelco of the U.S. Fish and Wildlife Service (FWS) is currently serving as Chair of the

RRCC (current term ending in 2016). While some individual representatives have changed, member organizations comprising the Executive Committee (Excom) have remained the same since 2005. Those members include the GDNr, South Carolina Department of Natural Resources (SCDNR), North Carolina Wildlife Resources Commission (NCWRC), FWS, U.S. Geological Survey (USGS), GPC, utility representatives, representatives from academia, and others.

Memorandum of Understanding

The MOU's purpose is to establish, describe and maintain the Robust Redhorse Conservation Committee (RRCC). The Committee identifies priority conservation needs for the robust redhorse and its habitat as well as coordinates implementation of programs addressing those needs. Three revisions of the first MOU have expired since 1995. A revised MOU is expected to become effective in the spring of 2016.

Robust Redhorse Conservation Strategy

The Robust Redhorse Conservation Strategy (Strategy) provides overall conservation guidance to assure the continued survival of the species was adopted by the RRCC in 1998 and updated in 2003. It establishes short- and long-term goals conservation goals, describes the status and distribution of the species, discusses problems facing the species, and presents conservation actions to be implemented to accomplish the short- and long-term goals.

RRCC: Policies

The RRCC policy document, as adopted on October 18, 2002, unifies protocols, practices, and activities of member organizations needed to implement the long- and short-term goals established in the Strategy. These policies provide a framework for development of individual management plans for specific robust redhorse populations. In general, the policies are organized such that consistency among goals, conservation activities, and administration at the RRCC are maintained at all levels.

1.4 Candidate Conservation Agreement with Assurances (CCAA) for the Robust Redhorse: Ocmulgee River, Georgia

One of the primary stated goals for the RRCC is to create additional populations of robust redhorse by introducing the species to rivers within its historic range. The RRCC recognized that the reintroduction of a rare species with potential to require future listing under the Endangered Species Act (ESA) could be problematic. So, the RRCC adopted use of a Candidate Conservation Agreement with Assurances (CCAA) as a conservation method. CCAAs promote conservation actions by encouraging partnerships between private entities and state and federal natural resources agencies to protect rare species with the goal of

addressing potential threats to their survival. Voluntary participants in such agreements may receive assurances from the FWS that limit risk, should the target species of that agreement become listed under the ESA.

The Ocmulgee River, at the time, was a candidate site for reintroduction and provided an opportunity to apply CCAA policy. The Ocmulgee River's upper reaches are influenced by generation from GPC's Lloyd Shoals Dam hydroelectric facility, which has a 30-year FERC license expiring January 1, 2024. GDNR, FWS, and the RRCC determined that the 18-mile reach downstream of Lloyd Shoals Dam was suitable habitat for a proposed reintroduction. GPC has invested considerable resources on environmental enhancements to the upper Ocmulgee River and believed these enhancements also would benefit any potential robust redhorse population. However, reintroduction of robust redhorse potentially represented an undefined risk to the Lloyd Shoals facility/GPC, if robust redhorse becomes listed under the ESA. GPC's risk concern, expressed to GDNR and the FWS led to use of a CCAA for the robust redhorse [Candidate Conservation Agreement with Assurances for the Robust Redhorse (*Moxostoma robustum*), Ocmulgee River, Georgia, 2001].

Under the CCAA, GPC agreed to support specific conservation actions following introduction by the GDNR, including funding for telemetry studies on the reintroduced fish, surveys, and population estimates. In return, GPC received assurances that if robust redhorse becomes listed under the ESA, and the CCAA has been implemented in good faith by GPC, the FWS will not require additional land, water, or resource restrictions beyond those that GPC voluntarily committed to under the terms of the original agreement. These assurances include the preservation of the flow regime described in the current FERC license for the Lloyd Shoals Project. The assurances are provided through an Enhancement of Survival Permit, which will take effect if and when the robust redhorse becomes federally listed under the ESA.

It is believed that the CCAA for the robust redhorse was the second CCAA implemented in the United States, and was the first CCAA to involve an aquatic species and a private company.

Since its beginning, the CCAA's annual reporting requirements have resulted in progress summaries describing phased conservation actions. GPC's four conservation actions of the CCAA were completed in 2011; although, the CCAA's 3-phase reporting requirement lived past the completed conservation activities through 2015. In 2014 and 2015, GPC was an active participant in activities that continued to support needs to monitor abundance and distribution of introduced robust redhorse. During that recent period, the collaborative efforts of GDNR, USFWS and GPC and others resulted in development and implementation of a visual monitoring protocol for robust redhorse at a spawning site below Juliette Dam. Visual monitoring is low-cost and non-invasive that helps determine if recruitment is occurring in populations that are no longer being stocked. Those survey data indicated a very short spawning season lasting about one week and fewer than 15 fish on the spawning site at any one time. Proposed modifications to the protocol in 2016 will provide for incomplete capture probability and allow for an unbiased estimate of the number of adults on the

spawning site.

River flow and robust redhorse population monitoring activities that support CCA objectives for 2016 are underway. GPC's submittal of a 2014 and 2015 report to USFWS fulfills and concludes its CCAA annual reporting requirement.

1.5 Potential ESA Listing of the Robust Redhorse

In 2010, the Center for Biological Diversity (CBD) submitted a citizen's petition to the FWS for the listing consideration of 404 Southeastern Aquatic Species: http://www.biologicaldiversity.org/programs/biodiversity/1000_species/the_southeast_fresh_water_extinction_crisis/index.html), including the robust redhorse. CBD's in-house assessment of the status of robust redhorse was largely informed by NatureServe online data, miscellaneous reports, meeting notes from the RRCC website, and earlier volumes of this report. The CBD asserted in its petition that dams, channel dredging/straightening, and land use have and continue to destroy suitable habitat; historical overfishing may have occurred; predation potential is likely high due to the introduction of nonnative piscivores; and state listing designations are inadequate to fully protect the species. The CBD also stated that while actions by the RRCC MOU signatories to recover the species are to be applauded, the MOU and RRCC lack the requisite regulatory protection to ensure conservation of the species. The CBD's petition also acknowledges the existence of the Ocmulgee CCAA, but discounts the ability of that agreement to provide adequate protections to the species given the continued degradation of habitat across the species range. Furthermore, the CBD petition fails to acknowledge any FERC related compliance obligations of RRCC members (such as this report and flow augmentation for robust redhorse at the Sinclair Dam) and any ongoing FERC relicensing project activities with other facilities or entities designed to accommodate and enhance robust redhorse recovery activities.

In response to this and several other petitions, the FWS agreed to a settlement with CBD which sets a rough timetable for consideration and listing decision for the species contained in the petition. The FWS publishes annual timelines updating activities toward listing review for these species and prioritizing their process such that those species who were already candidates would be considered first, followed by non-candidate species. Since robust redhorse was not considered a candidate species as of 2010, the FWS will defer a listing determination until a later date, although their information gathering process is ongoing. As a result of this petition and subsequent new listing review, the RRCC embarked upon revision and update to its website (www.robustredhorse.com) which includes updating information, reports, meeting minutes and presentations. Although a work-in-progress, FERC is invited to engage the current status assessment or any of the RRCC partners for additional information and resources beyond that which is included in this report.

1.6 Flow Advisory Team for the Oconee River

The Flow Advisory Team for the Oconee River (Advisory Team) is implemented under Article 404 of Sinclair's FERC license. Current Advisory Team members include GDNR, GPC, Georgia Wildlife Federation (GWF), FWS, and USGS. Primary responsibilities of the Advisory Team are to monitor the effect of the negotiated flows for the Sinclair Project on the robust redhorse in the Oconee River. The Advisory Team is tasked to review flow data from the Oconee River, studies developed by the RRCC, and any other pertinent information related to the robust redhorse to help determine if any changes to the negotiated flow agreement are necessary. If studies suggest that flow changes are needed for the Oconee River to improve habitat for the robust redhorse, the Advisory Team may petition the FERC, under consensus of members, with its recommendations. These recommendations would then be subject to appropriate FERC evaluation and approval.

Negotiated Flow Agreement

A negotiated flow agreement was finalized in 1995 (implemented June 1996) prior to the submittal of the FERC license application for the Sinclair Project. The negotiated flow agreement (Table 1 below), was designed primarily to enhance reproductive success of the robust redhorse by providing significant increases in minimum flows, flow stability throughout the year and run-of-river flows during spawning and early rearing periods for robust redhorse. Anadromous species also were also considered during formation of the negotiated flow agreement.

Table 1. Negotiated flow agreement for the Sinclair Hydroelectric Project.		
Month	Flow	Operation
December – February	500 cfs minimum	normal peaking
March – April	1500 cfs minimum	modified peaking
May	run-of-river	
June ^b – November	700 cfs minimum	normal peaking

^a modified peaking refers to the number of units (1 or 2) utilized, depending on inflow into the reservoir

^b from June 1-10, units are operated run-of-river unless electric system demands necessitate normal peaking operation. The agreement also provides for an increase in generation (from 5 to 7 days per week) to reduce extended low-flow periods that previously resulted from little weekend generation.

The 2013 report (Volume 8) indicated uncertainty as to whether the existing flow regime in the Oconee River at Sinclair Dam had benefitted robust redhorse. Following its flow effects assessment in 2013, the Oconee Flow Advisory Team developed a flow modification

recommendation that was to be evaluated for efficacy resulting in a formal flow recommendation request before presentation to the Commission (Volume 9, Part 2). Oconee Flow Advisory Team's proposed modification was as follows:

(e) during June through November, the Sinclair Project shall release 700-cfs minimum flow with NP with the following exception. From **June 1 through June 15** the Sinclair Project shall continue the May ROR flows, unless electric system requirements necessitate that the Sinclair Project be operated in NP mode. The biological responses to the flow modification would be evaluated every three years. Management actions that could affect the future flow regime will result from recommendations by the Flow Advisory Team based on the observed responses in the Oconee River robust redhorse population. The modification was implemented beginning in 2014.

2. Current Range-wide Status of Robust Redhorse

As shown in river basins highlighted in Figure 3, populations of robust redhorse currently exist in the Altamaha, Ogeechee, Savannah, Santee and Pee Dee basins in Georgia, South Carolina, and North Carolina. Figure 4 illustrates occurrence of native wild vs stocked populations of robust redhorse in drainages throughout the known range. Native populations of robust redhorse exist in the Oconee, Savannah, and Pee Dee Rivers; whereas the remaining populations were introduced into Broad, Ocmulgee, Ogeechee and Santee drainages. Wild fish may occur in the Ocmulgee as well.

The current status of each population is generalized and compiled below. Information regarding the current status of each robust redhorse population has been compiled from published peer-reviewed journal articles, finalized research reports from various agencies, academic research, personal communications, as well as abstracts and status updates submitted to the RRCC for their 2014 and 2015 annual meetings.

2.1 Oconee River Population (Georgia)

Since its discovery in 1991, the Oconee River robust redhorse population has been sampled extensively by diverse sampling strategies and effort among various life stages and habitat types. Numerous datasets have generated highly variable results. Targeted surveys at known spawning (gravel) sites were highly productive in the early monitoring years, but Oconee's wild robust redhorse population has declined since. Based on analyses of electrofishing catch rates and calculated population estimates, Oconee robust redhorse population estimates have declined from 400 - 600 adults in the 1990's to less than 100 adults in recent years. Since 2004, population estimates have been mathematically unattainable due to low catch rates. To investigate this further a decision was made beginning in 2014 to increase sampling effort to include the entire river reach between Milledgeville and Dublin,

GA (~55 miles), as it had been sampled in the early 1990's. In spring of 2014, two reproductively ripe specimens including a male and female were collected in the Oconee River in areas previously known as productive for collection of spawning condition robust redhorse. A third visually-observed uncaptured, adult-sized specimen was noted then as well (Attachment 1). Neither of the two captured fish had been previously tagged.

From high level perspective, the Oconee population was relatively stable in early years, but has declined since the implementation of the relicensing flow regime at Sinclair Dam in 1996. The license flow regime was designed to benefit all life stages of robust redhorse as well as other aquatic species; however, the continued decline of robust redhorse following flow implementation may indicate that flow combined with other direct or indirect factors may be limiting the Oconee robust redhorse population. In addition to flow, those factors may include competition or predation by invasive species, deterioration of spawning (gravel) habitats (related to flow), possible trophic shift in the fish community, and possibly a pathogenic fish health stressor(s) especially among sucker species (although this has not been confirmed). Regarding flow as a potential stressor for survival of larval robust redhorse, beginning in 2014, the Sinclair Flow Advisory Team implemented an extended low flow modification after May. That modification, being assessed during a three year term, includes up to five more days of run-of-river flows during 1 June through 15 June (as compared to the prior 1 – 10 June run-of-river flow regime; Table 1).

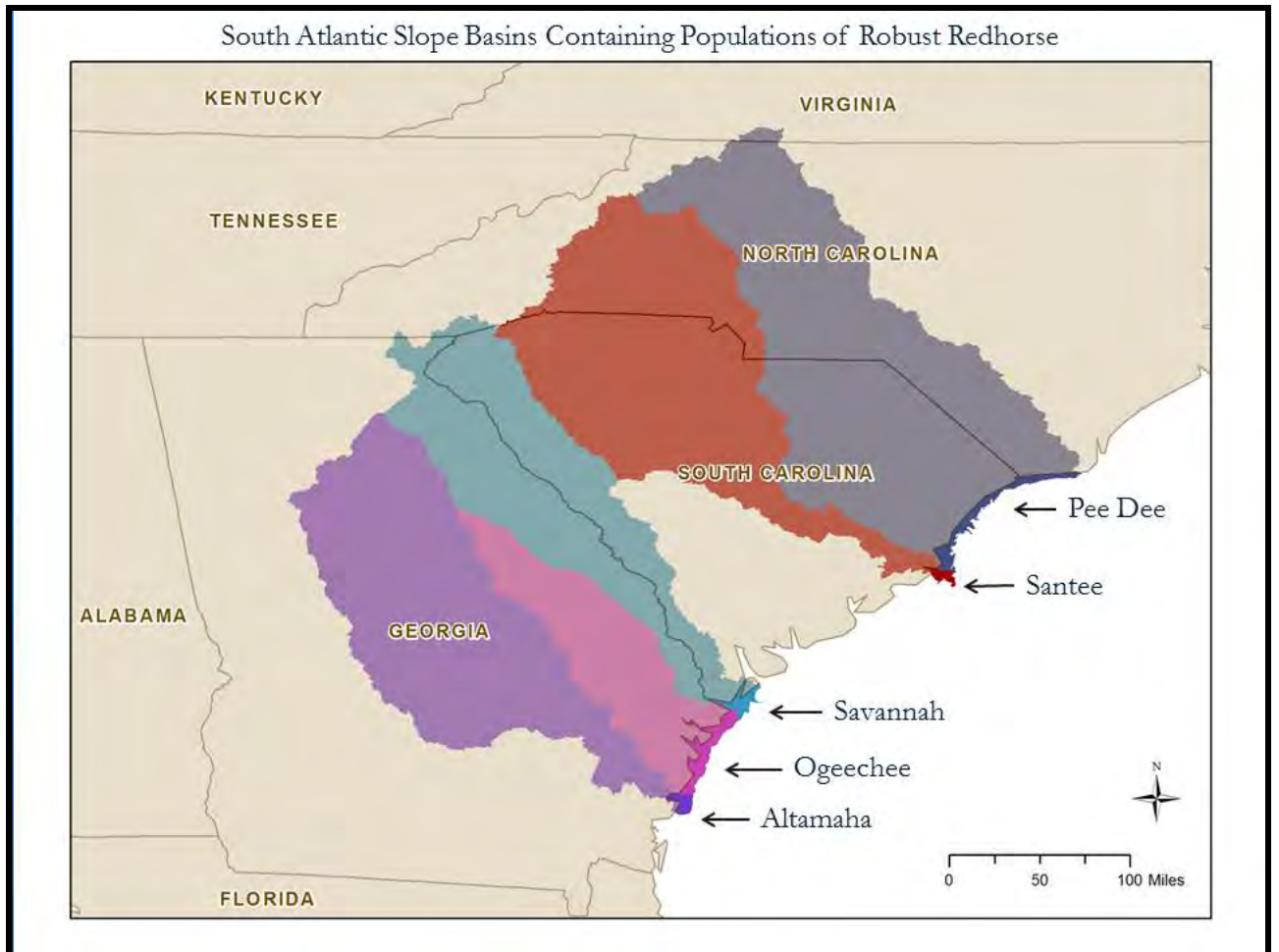
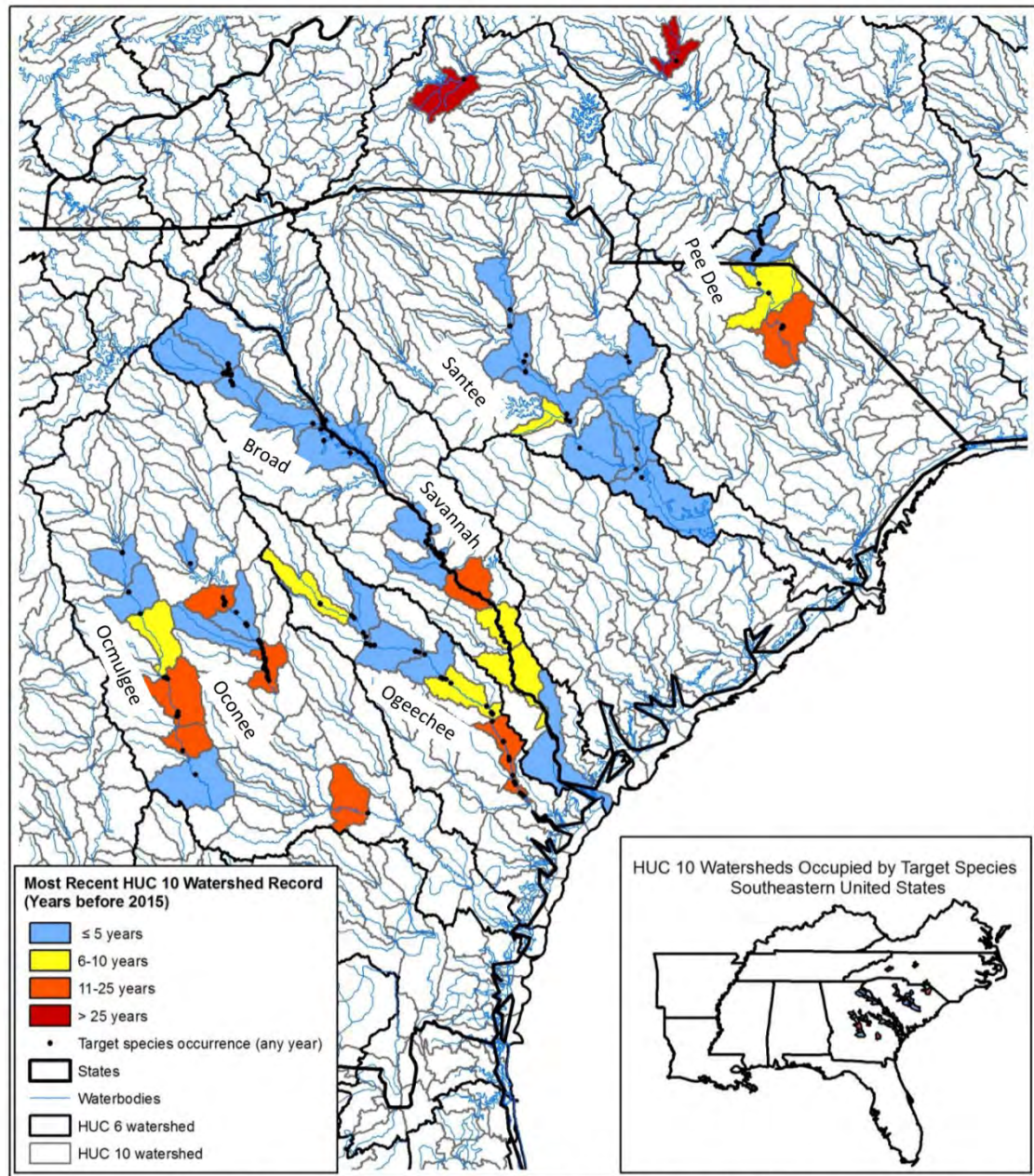


Figure 3. Map of the range of robust redhorse as of 2013.

Conservation Status Assessment Map Robust Redhorse (*Moxostoma robustum*)



Oconee, Pee Dee, and Savannah are wild populations. Broad, Ocmulgee, Ogeechee, and Santee populations have been stocked. However, population augmentation has occurred in the Pee Dee and Oconee and wild fish may occur in the Ocmulgee. Watersheds in upper Santee (Catawba River) and upper Pee Dee (Yadkin River) basins are historic localities referenced by Cope in 1870. Zooarchaeological occurrences not shown. Map created December 31, 2015 by Georgia Department of Natural Resources and Tennessee Aquarium Conservation Institute and is available for use (please include this note). Contact Brett Albanese for data sources.

Figure 4. Map of robust redhorse distribution as of December 2015.

Cause(s) of the apparent population decline of Oconee robust redhorse is unclear. Several hypotheses or combination of factors may explain the reduction in catch rates. Those hypotheses include but are not limited to:

- realization of an original senescing population
- possible population effects related to sampling only in known spawning areas
- oversampling/harassment/extirpation from known spawning areas
- long-term trophic displacement/community species shift
- severe decline in availability of surficial gravels needed for spawning
- predation effect due to increasing flathead and blue catfish abundance
- direct and indirect effects of altered instream flow/habitat dynamics
- pathogenic health stressor in the Catostomidae (sucker) family

Ongoing surveys of the Oconee in 2015 included monitoring of Oconee River gravel augmentation sites and conducting surveys in two Oconee locations. GPC surveyed the Wallace Dam tailrace, but no robust redhorse were detected. Also, GPC had planned to again survey the Oconee River between Sinclair Dam and Dublin, GA in 2015 to search for wild and/or stocked robust redhorse. Due to drought-driven sampling constraints, that survey was postponed. The attempt to expend increased sampling effort in the mainstem Oconee will continue in 2016 in an effort to assess current status of the robust redhorse population and contribute to the knowledge base so the population's apparent decline can be understood and addressed.

2.2 Ocmulgee River Population (Georgia)

As part of the Ocmulgee River CCAA between GPC and FWS, the USGS Cooperative Fish and Wildlife Research Unit (GA Coop Unit) was contracted in 2010 to conduct a study in attempt to estimate adult redhorse population size within the ~18-mile reach of the Ocmulgee between Lloyd Shoals Dam and Juliette Dam. The 2010 and 2011 surveys showed that robust redhorse stocked during 2002-2005 had survived and were participating in spawning activities in the Lloyd Shoals Dam tailrace, but evidence of successful recruitment had not been verified. In 2012, Master's research entitled "Use of hierarchical occupancy models to estimate the seasonal distribution and habitat use of stocked Robust Redhorse *Moxostoma robustum* in the upper reaches of the Ocmulgee River, Georgia" (W. A. Pruitt, 2013) evaluated the scale of influence of various habitat characteristics on robust redhorse distribution in the upper reaches of the Ocmulgee River. Occupancy models revealed that robust redhorse had an average conditional detection probability of 0.518 (± 0.046) meaning that samplers had about a 51.8% chance of detecting robust redhorse if the species was present in that unit at the time of sampling. Although detection was much higher than expected, occupancy was low in units containing shoals (0.281 ± 0.049) and even lower in non-shoal habitats (0.038 ± 0.011); meaning robust redhorse are 28.1% likely to be present

in units containing shoals and 4.8% likely in units without a shoal present. In 2010-2012 sampling seasons, only seven robust redhorse were captured – all of which were captured within 1 km of Lloyd Shoals Dam. Robust redhorse occupancy was highest in units where coarse 19 substrates (bedrock, boulders, gravel, etc) dominated the streambed, and fish generally avoided units containing abundant woody debris. To date, detection levels of robust redhorse in the Ocmulgee River have been too low to yield a population estimate.

The GDNr Stream Team collected a YOY robust redhorse (69.3 mm TL) in the Ocmulgee River on August 20, 2014 approximately 10.5 miles SE of Hawkinsville, Georgia in Pulaski County.

In 2014, visual monitoring of robust redhorse was conducted at spawning sites below Juliette Dam during five separate occasions during 6-14 May 2014. Robust redhorse were observed on 5 of the 6 events in aggregations ranging from as few as 4 to as many as 25 fish among those events. GDNr developed the visual monitoring protocol for robust redhorse and implemented the method at the known Juliette spawning site on the Ocmulgee River in 2015. Those data indicate a very short spawning season lasting about one week and fewer than 15 fish on the spawning site at any one time. Visual monitoring is low-cost and non-invasive that will help determine if recruitment is occurring in populations that are no longer being stocked. Proposed modifications to the protocol in 2016 will provide for incomplete capture probability and allow for an unbiased estimate of the number of adults on the spawning site.

2.3 Ogeechee River Population (Georgia)

A total of 43,048 robust redhorse fingerlings representing 7 year-classes from Oconee broodstock were stocked at four locations in the Ogeechee River during 1997 to 2004 as an attempt to establish a refugial population. Research conducted in 2010 through 2012 concluded those stocked fishes had survived and spawned.

Robust redhorse were collected in GDNr's annual standardized sport-fish sampling in the Ogeechee River yearly during 2000 through 2004, 2009 through 2011 and 2014. Through 2014, the data showed that robust redhorse, once distributed throughout the sampled areas, have migrated to areas upstream around Highway 1, near Louisville, GA which lies outside the standardized sampling area. Spawning behavior has been conclusively documented by UGA just above Highway 1 at Louisville.

In spring 2015, GDNr and Georgia Southern University attempted to find the known spawning site in the Ogeechee, but the trip was unsuccessful. GDNr reported high water events precluding effective sampling in the Ogeechee, but they visited 14 out of the typical 18 sampling sites with no robust redhorse documented. They did not visit the Louisville site, which is where a large portion of their captures have been documented in the past.

To date, reproductive recruitment has not been observed in the Ogeechee. Overall, the population appears to be aging due to the lack of stocking and apparent lack of natural

recruitment. Georgia DNR will continue to search for younger fish with hopes that the recent recovery from over a decade of drought conditions will allow for successful natural recruitment.

2.4 Broad River Population (Georgia)

GDNR's 2014 status assessment indicated that 32,189 Oconee-stock robust redhorse representing year classes 1993, 1995, 1997, and 1998 were stocked into the Broad River during 1995 – 1998. Stocking in the Broad River was halted after discovery of wild robust redhorse in the Savannah River (receives Broad River flow).

Fish tracking studies generally indicated that adult fish exhibit springtime spawning migration from Clarkes Hill Reservoir (impoundment of the Savannah River which receives Broad River flow) as far as >62 river miles upstream into the Broad River. There are six known spawning sites in the Broad River system, all of which are composed of habitat complexes of distinct gravel patches. Broad River spawning sites occur in larger tributaries as well as the mainstem, and tagged robust redhorse have been documented moving between these patches within a single spawning season and between seasons. To date, no wild-spawned young of the year robust redhorse have been collected in the Broad River drainage. Due to observed spawning activity in past years, it is hoped that continued sampling of spawning grounds in coming years will reveal if wild-spawned fish have survived and been assimilated into the active spawning population.

Monitoring conducted by GDNR in the Broad River at Anthony Shoals during spring of 2014 resulted in capture of six adult robust redhorse (2 males and 4 females) ranging in length from 581 to 643 mm TL. All were PIT-tagged. Three of those had been previously tagged with coded wire indicating they originated from 1997 year-class.

In 2014 Carrie Straight (FWS) visited two Broad River spawning sites when water temps were 18 C° on May 6th. Visibility was low and she observed four males with no evidence of spawning activity. It appeared this was either at the beginning or the end of the spawning season.

In 2015 Carrie Straight (FWS) visited two known spawning sites in the Broad River (18 C°) on one day; the visibility was marginal at best. Four males were observed, and their behavior indicated that it was near either the beginning or the end of the spawning season. Visibility was poor for the 2015 spawning season in the Broad drainage.

2.5 Savannah, Broad, and Wateree River Populations (South Carolina)

The Savannah River population has been monitored through the 10 years of brood stock collection at a spawning bar located below the New Savannah Bluff Lock and Dam (NSBLD). By 2013, 271 robust redhorse had been collected in the Savannah River with the population downstream of the lock and dam believed to be one of the most stable and healthy natural populations. South Carolina's efforts have focused on establishing self-sustaining

populations of robust redhorse in the Santee River Basin by stocking individuals from Savannah River broodstock (SCDNR, Final Report for the SC State Wildlife Grant, 2013).

Nearly 72,000 robust redhorse have been stocked in the Broad and Wateree Rivers through 2013. Successful stocking occurred annually from 2004-2009, with none during 2010-2012, then resumed in 2013 resulting in matured fish repeatedly observed spawning. Migrating robust redhorse have been documented moving upstream in the Congaree River, through the Columbia Fishway into the Broad River, and upstream to the tailrace of Parr Dam, where spawning activity has been observed (SCDNR Final Report for the SC State Wildlife Grant, 2013). Spawning activity has also been confirmed in the Wateree Dam tailrace (Scott Lamprecht, SCDNR, personal communication). Although natural reproduction has not been confirmed, the condition of the wild and stocked populations of robust redhorse with the Savannah River and the Santee River Basin (Broad and Wateree Rivers) appeared secure through 2013.

As provided by the Duke Energy update, a total of nine robust redhorse were collected in 2014 below the Wateree Hydroelectric station during anadromous fish surveys. Those captures ranged in size from 475 mm to 644 mm. Seven of the nine specimens were previously un-tagged fish.

Savannah

In 2012 -2013, SCDNR and FWS each separately collected a juvenile robust redhorse in the lower Savannah River (roughly near Hardeeville, SC). The two collection locations were approximately four river miles apart, and the uppermost capture is approximately 131 miles below the lowermost gravel bar known for robust redhorse spawning.

Because of these two incidental captures of juveniles that were closely collected in proximity and time of year, SCDNR, FWS, Georgia Department of Natural Resources (GDNR), and South Carolina Aquarium sampled the Lower Savannah River encompassing these capture locations on November 18-21st, 2014 via boat electrofishing. Bank habitats were sampled over 16.2 river miles resulting in pedal time of approximately 23.27 hours: the mainstem Savannah River from Ebenezer Landing down to the confluence with Collis Creek, the lowermost kilometer of Collis Creek, and two kilometers of Union Creek. Water temperatures ranged from 11.0-13.5 degrees C and salinities in the sampled reach ranged between 0.04-0.09 parts per thousand (ppt).

A 297 mm TL juvenile robust redhorse (336 grams) was captured on November 18, 2014 along the west bank of the mainstem Savannah River below Ebenezer Landing; a fin clip was subsequently genetically verified as robust redhorse by FWS Warm Springs Genetics Laboratory. This individual was captured over sandy substrate with overhanging vegetation in approximately 7.4 feet water depth and water velocity of approximately 1.0 feet/second. Water temperature was 13.5 degrees C, dissolved oxygen was 9.88 mg/L, and salinity was 0.06 ppt. This now totals three yoy/juvenile robust redhorse captures in the mainstem Lower

Savannah River, all in or around Savannah National Wildlife Refuge within a 6.8 river mile reach.

In 2015, FWS and Georgia Southern University made one visit to the lower spawning site in the Savannah River below NSBLD. They made several numerical counts of individuals (1= 106 fish, 2=105 fish, 3= 112 fish, equaling a mean daily count of 107.6 fish).

2.6 Yadkin/Pee Dee River Population (North Carolina)

Pee Dee River below Blewett Falls Dam

Since 2013, as related to FERC relicensing and by agreement among Yadkin-Pee Dee River TWG, NCWRC and Duke Energy, modifications and increase in minimum flow below Blewett Falls Dam were maintained to ensure that spawning areas and newly hatched robust redhorse larvae were not dewatered during non-generation periods. In spring 2013, a pilot project commenced in preparation for a long-term Pee Dee River stocking program.

In May of 2014, NCWRC collected 19 robust redhorse suckers. Nine were untagged and the remaining 10 were among year recaptures. There were 10 individuals captured from Jones Creek shoal and 9 from Hitchcock Creek shoal, the two main spawning shoals. Eight fish were male and 11 were female. Total length ranged from 505 to 774 mm. Four of the 6 smaller individuals (under 580 mm) were untagged, which suggests that successful recruitment continues to occur. Using annual capture-recapture data from 2006-2014, whereas the population estimate applies to the number of adults on the spawning areas, population estimates of robust redhorse ranged from 34 (95% CI 21-47) in 2013 to 58 (95% CI 36-80) individuals in 2008.

In 2014, the Yadkin Pee Dee Propagation Study (R. Bradford) successfully spawned three female robust redhorse in 2014. The fertilized eggs were reared in hatcheries in North Carolina and South Carolina. In October 2014, 13,000 robust redhorse fingerlings were released at the Hitchcock Creek and Jones Creek Shoals. Opportunities for reintroduction upstream were being considered then and an option to move forward may include a Candidate Conservation Agreement with Assurances (CCAA).

In 2015, the total electrofishing effort (pedal time) conducted by NCWRC in the Blewett reach was 61.2 hours. Eighteen (18) robust redhorse were captured in spring 2015 which includes 3 within season recaptures. Five robust redhorse were previously untagged and 10 were among year recaptures, which means our among year recapture rate was 66.7%. Seven fish were male and 8 were female. Ten robust redhorse were collected from the Jones Creek shoal and 8 from the Hitchcock Creek shoal. Total length ranged from 552 to 760 mm TL.

Also in 2015, NCWRC spawned 3 females year yielding roughly 70,000 eggs that were split between NCWRC and SCDNR hatcheries for rearing. On November 4, 2015, NCWRC stocked over 22,000 robust redhorse into the Pee Dee River (a substantial increase from 2014 at 13,000). Fish raised at the Dennis Center were stocked at Cheraw, SC and fish raised at McKinney Lake were stocked at Hitchcock Creek Shoal. Fish were not released at Jones

Creek Shoal in 2015 because of logistics complications due to high water. Approximately 1,500 fish were held back at each hatchery for further grow-out and for stocking next fall.

Pee Dee River below Tillary Dam, above Blewett Falls Dam

Currently, a known population of robust redhorse does not occur above Blewett Falls Dam. A habitat modeling study, completed by Fisk et al. in 2014, determined that suitable habitat exists in the Pee Dee River between Tillary Dam and Blewett Falls Dam. Reintroducing fish above these dams, which regulate flow and prevent migration, may benefit robust redhorse by expanding its range.

Also in 2014, an update via NC State University was provided (T. Kwak, et al.) on water quality, intersex fish and robust redhorse in the Pee Dee River, NC. Robust redhorse (RRH) populations in the Yadkin-Pee Dee River (Y-PD) currently include approximately 38-55 adult individuals with little evidence of recruitment. These low population numbers have prompted the investigation of issues that could be impacting the reproductive success and overall survival of the species. Studies were pursued through a series of related objectives to examine water and sediment contaminants, occurrence and severity of the intersex condition in fish, and survival of young fish in the river. Low in-situ survival rates of young fish, occurrence of intersex, and contaminant levels are a concern for the already imperiled RRH populations, and future results will further enhance our understanding of this fish's biology and ecology to inform conservation and management.

Literature Cited

Peer-reviewed Journal Articles

Fisk, J.M, T.J. Kwak, and R.J. Heise. 2014. Modeling riverine habitat for Robust Redhorse: assessment for reintroduction of an imperiled species. *Fisheries Management and Ecology* 21: 57-67.

Theses and Dissertations

Pruitt, W.A. 2013. Use of hierarchical occupancy models to estimate the seasonal distribution and habitat use of stocked Robust Redhorse *Moxostoma robustum* in the upper reaches of the Ocmulgee River, Georgia. Master of Science Thesis. University of Georgia, Athens, Georgia.

Abstracts and Summaries

Evans, J.W.; Georgia Department of Natural Resources; Wildlife Resources Division. Update on Robust Redhorse recovery activities in Georgia. Summary provided for the 2013 Robust Redhorse Conservation Committee annual meeting, Charlie Elliot Wildlife Center, Mansfield, Georgia.

Lamprect, Scott; South Carolina Department of Natural Resources; Wildlife and Freshwater Fisheries Division. March 6, 2014.

ATTACHMENT 1

2014 Springtime Survey for Oconee River Robust Redhorse

2014 Springtime Survey for Oconee River Robust Redhorse



Moxostoma robustum

Sponsored by Georgia Power Company with logistics coordination by GWRD/Jimmy Evans

The Survey

Objective:

Document presence/absence of robust redhorse in historically prime areas (gravel patch spawning) throughout the range of Oconee RRH

Methods:

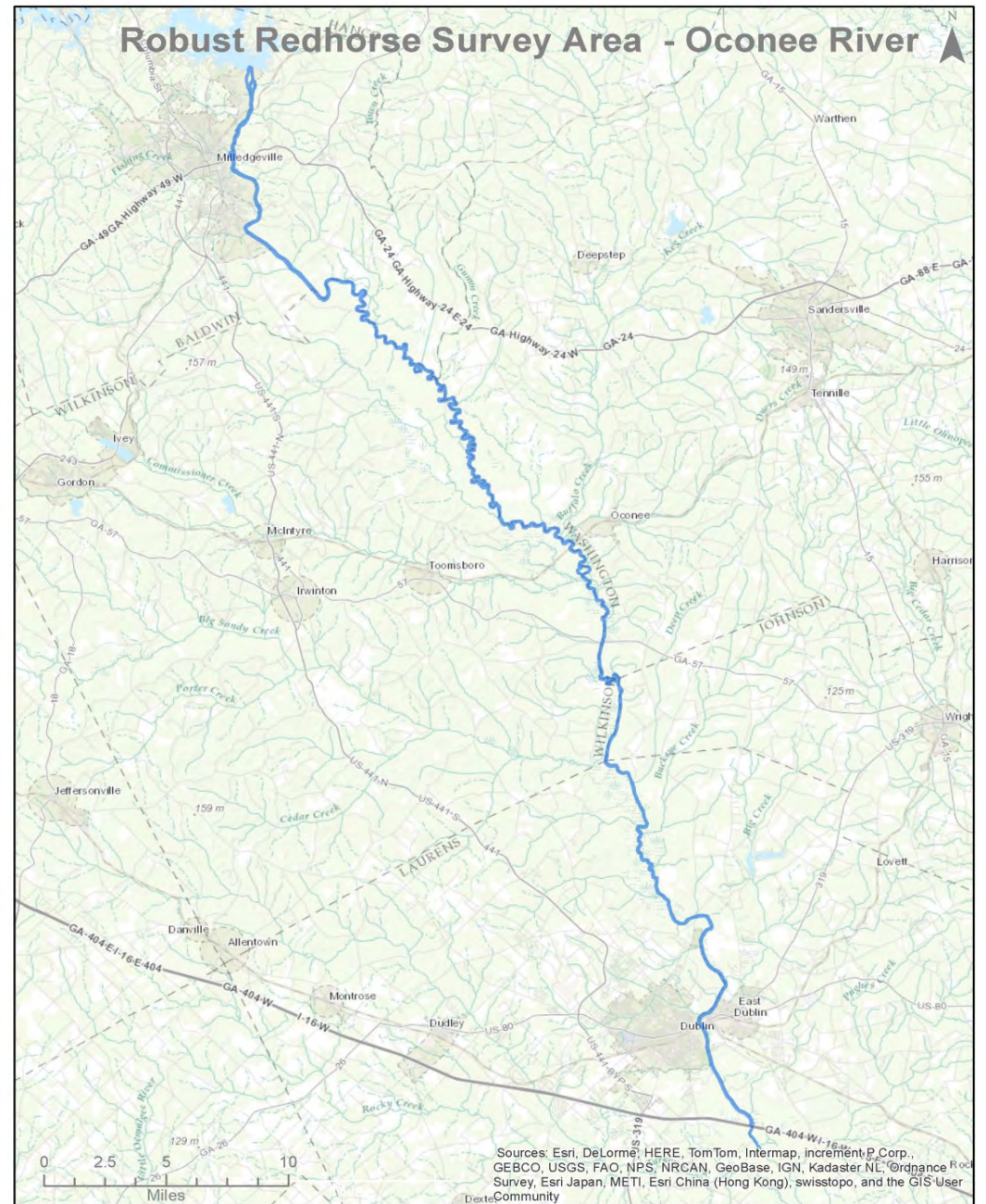
Wayne Clark (former GWRD staff) of AquaEscapes employed to sample using boat electrofishing during spawning temperature range

WRD's previously established Oconee survey reaches 1 – 8, weighted to sample in previous spawning areas

Record fisheries metrics and document location data

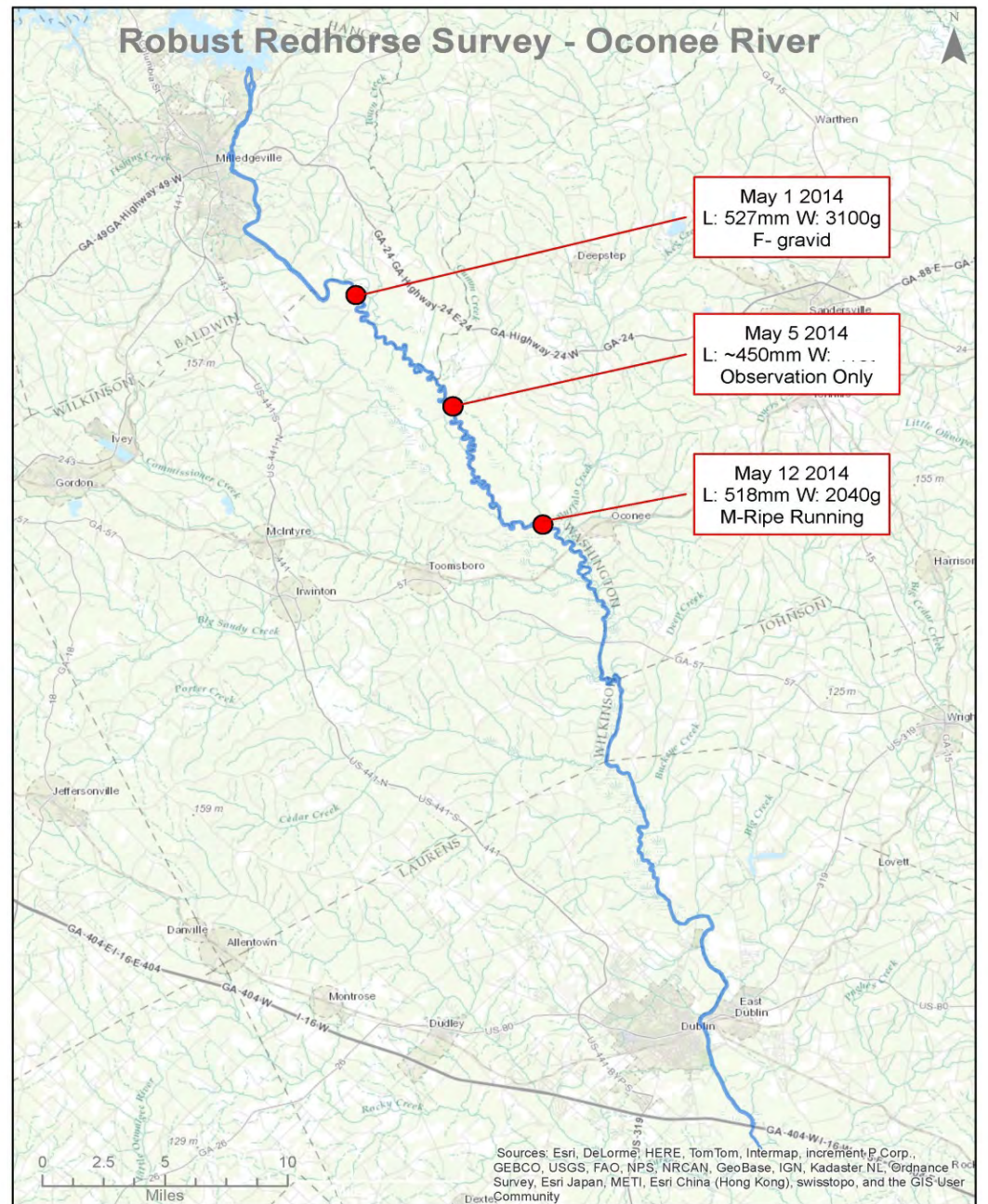
Survey – Method Study Area

- Oconee River: Sinclair Dam to Dublin; GWRD's 8 numbered study area segments
- Effort: 21 survey days between 15 March and 30 May 2014



Survey – Results Samples

- Collected 2 and observed 1 adult robust redhorse in study reaches 3, 4 and 6



Survey – Results

Individual RRH Data and Effort

Robust redhorse collection and observations from boat electrofishing on the Oconee River during April – May 2014

2014 Survey Date	Length (mm)	Weight (g)	Gender & Condition	Lat/Long	Recap Tags	CWT	PIT	New PIT No.	Fin clip collected
1 May	527	3,100	F - gravid	Lat 32 59.944 Long -83 07.708	No	No	No	6C00020151	Yes
5 May	~450			(Station 6)					
12 May	518	2,040	M – ripe running	Lat 32 55.768 Long -83 03.689	No	No	No	6C00020154	Yes

Total effort 234,217 secs (65.06 hrs) of boat electrofishing on-time.

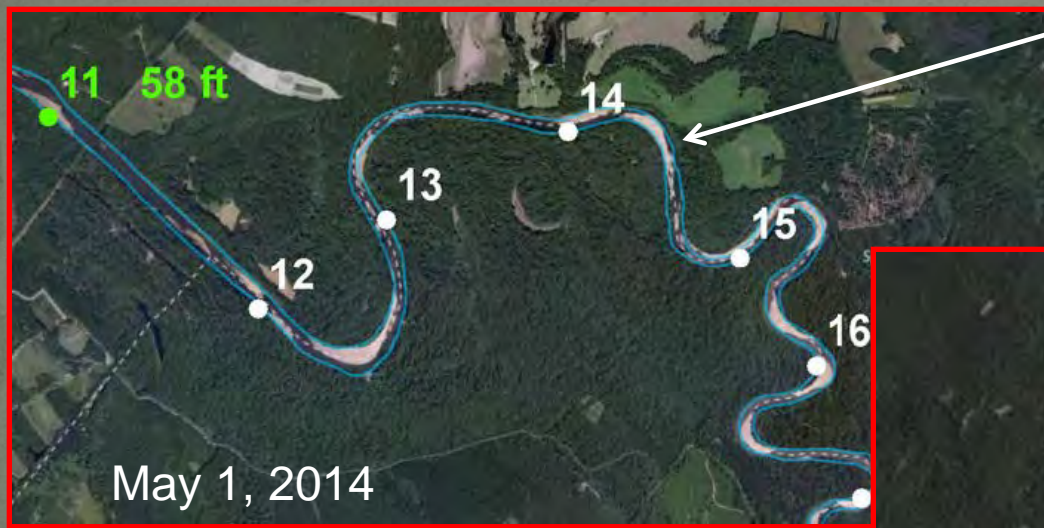
Electrofishing CPUE ~ 0.05 robust redhorse/hr including the visually observed, not-collected robust redhorse.



2014 Robust Redhorse springtime survey

Survey – Results

Oconee collection/observation sites



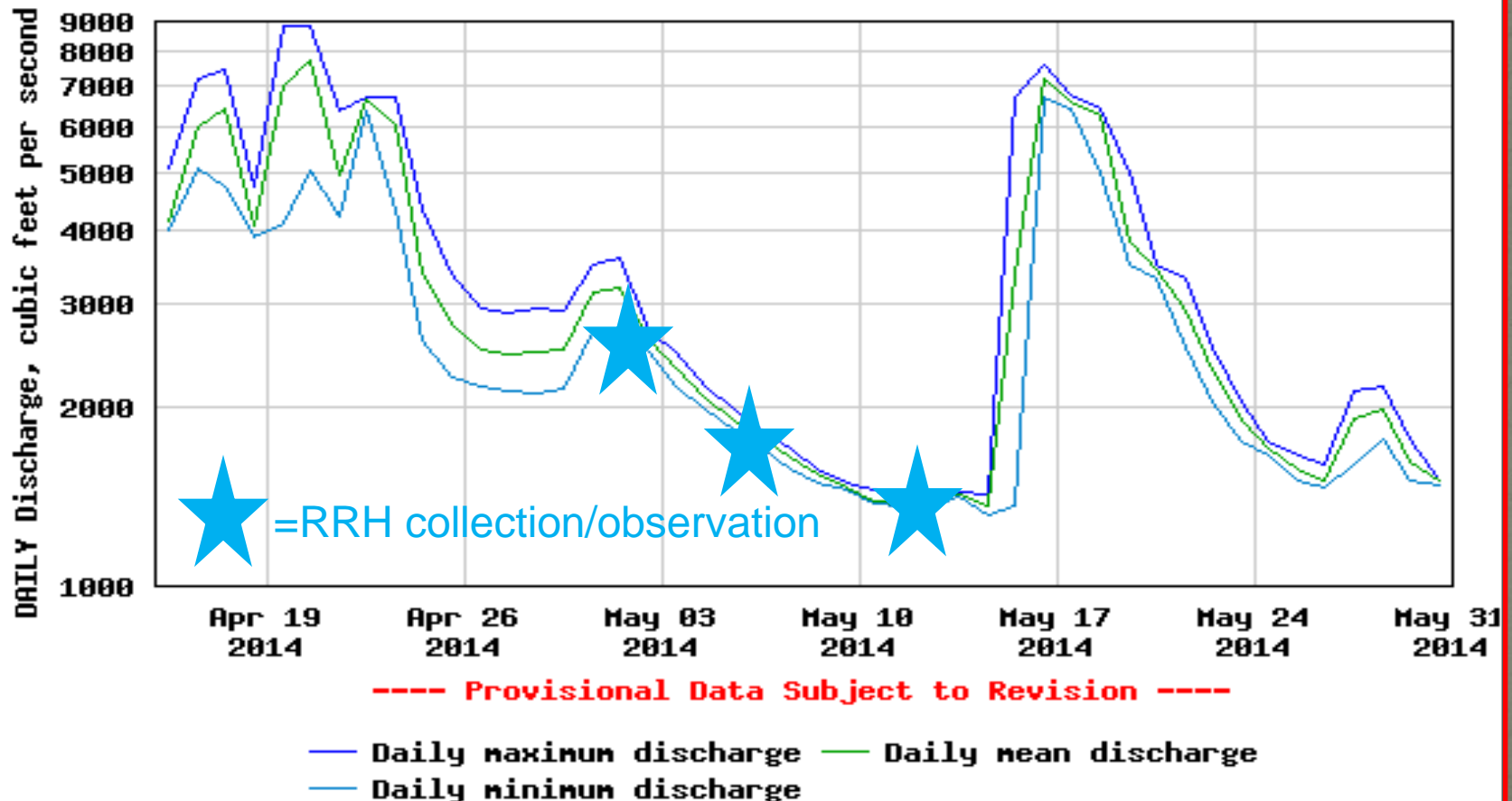
Survey – Results Summary

2014 Survey Date	Oconee River Sampling Station	River Reach	On-time Effort (s)	RRH Catch Abundance	Water Temp (C)	Discharge (cfs) *from Wayne ** Avant	Visual-Only Observations of RRH
16 April	2	Hwy 22	11,012	0	19.5	*3,750	No
17 April	5	Theile Balls Ferry to Black Ck	10,900	0	20.0	**6,430	No
21 April	4	Theile Downstream	10,188	0	19 to 19.5	*3,200 to 3,400	No
23 April	8	Dublin Downstream	12,273	0	20.0	**6,650	No
25 April	6	Balls Ferry Downstream	10,515	0	20.0	*2,400	No
25 April	5	Balls Ferry to Beaverdam Ck	11,444	0	20.5 – 21.0	**3,380	No
1 May	3	Theile Upstream	10,000	1	20.5	*2,130	No
2 May	7	Dublin Upstream	10,500	0	20.0	**2,950	No
5 May	6	Balls Ferry Downstream	10,500	0	22.0	**1,900	Yes
6 May	1	Dam	5,100	0	23.0	*1,790	No
7 May	7	Dublin; Upstream	10,405	0	23.0	**1,640	No
9 May	4 and 5	Theile; Balls Ferry to Beaverdam Ck	11,900	0	23.0	**1,460	No
12 May	4	Theile Downstream	10,500	1	24.0	**1,400	No
13 May	6	Balls Ferry Downstream	10,000	0	24.0	**1,430	No
14 May	8 Substituted for 3	Dublin; Downstream	13,800	0	25.0	**1,370	No
16 May	3	Theile Upstream	9,500	0	23.5	**7,240	No
20 May	4	Theile Downstream	10,900	0	24.5	*3,720	No
22 May	8	Dublin Downstream					
22 May	6 Substituted for 3	Balls Ferry Downstream	10,380	0	24.5 to 25.0	**2,320	No
23 May	Half of 4 and all 5	Theile; Balls Ferry to Beaverdm Ck	10,880	0		**1,900	No
27 May	6	Balls Ferry Downstream	10,400	0	26.5	**1,910	No
28 May	4	Theile; Downstream	11,192	0	27.0	**1,990	No
29 May	5	Balls Ferry to BC	11,928	0	26.0	**1,620	No

Survey – Results Flow



USGS 02223056 OCONEE RIVER AT AVANT MINE, NEAR OCONEE, GA

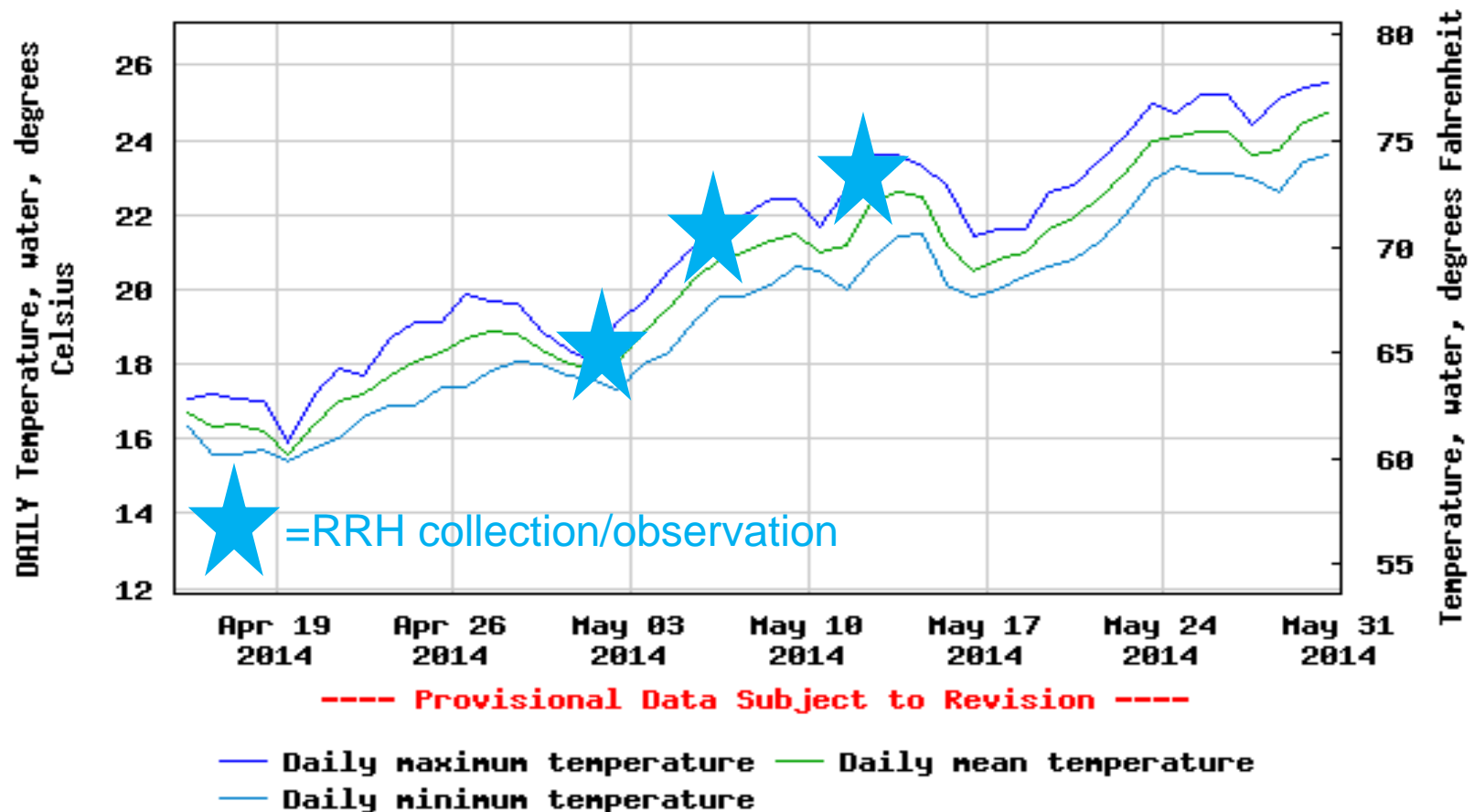


Survey – Results

Water temperature



USGS 02223056 OCONEE RIVER AT AVANT MINE, NEAR OCONEE, GA



Survey – Summary

- Conducted during time and in areas of typically concentrated abundance
- Effort comparable to previous (flow/ramp usability)
- Post survey meeting (Wayne's observations)
 - physical habitat alteration since the “old days”
 - >stable habitat types unchanged (e.g. bedrock and rock shoals)
 - >alluvial types - changes elsewhere
 - substantial bankside erosion
 - channel aggradation
 - minor flow path alteration
 - diminished gravel availability
 - “new” gravels at the Oconee trestle are gone (area drinking water upstream reservoir blow-out?)
 - >abundant recent LWD
- CPUE for other species, especially Centrarchids and American shad, appear much higher
- Seemingly lower abundance of Corbicula
- Flathead abundance reduced but blue catfish more abundant across all size classes
- Other Moxostoma species abundance reduced
- Much more angler activity than in years past

Discussion

Survey trend for Oconee robust redhorse

- Most population estimate information from 30-river mile sub-section during spring broodfish collections from 1994 to 2010
- 2002 and 2008 catch rates showed decrease; no juveniles collected
- 2012 - first-time sampling event - GADNR collected a single, near-spawning-condition female RRH in Little River upstream of the Sinclair impoundment . Origin of that fish being a natal is unknown
- Sinclair Dam licensed flow regime was designed for the benefit of robust redhorse and other. Continued population decline thought likely due to other factors (competition, predation, deterioration of certain habitats)
- 2014 springtime survey observations below Sinclair Dam may indicate still very low abundance and that spawning gravels appear degraded by bed load transition

Discussion

Questions , Questions

- Is decline being detected (timeline of significance? Let it rest?)
- Continue traditional monitoring in 2015 or is genetic remote sensing enough?
- Additional research?:
 - assessment of habitat change (fluvial geomorphological process)
 - riverine hydraulics comparison study (transferrable information?)
 - historical Oconee fisheries data comparison (flow/environmental data)
(trophic impacts/shift)
 - status of other Moxostoma fitness parameters as a surrogate
- Supplemental Oconee RRH stocking via Warm Springs... in the face of habitat unknowns
- Have RRH run their course (Oconee) – being functionally replaced in this system?
- Restoration of license flows with monitoring?
- What might sampling for RRH in lower Altamaha River reveal?