REPORT OF THE

ROBUST REDHORSE CONSERVATION COMMITTEE ANNUAL MEETING

Morrow Mountain State Park
Albemarle, North Carolina
October 3 – 5, 2011

Attendees of the 2011 annual meeting

Report compiled by
Jaclyn Zelko
U.S. Fish & Wildlife Service

TABLE OF CONTENTS

ACRONYMS & ABBREVIATIONS……. 3

EXECUTIVE SUMMARY……. 4

INTRODUCTION……... 5

ADMINISTRATION
Welcome – Ryan Heise…….….. 6
Memorandum of Understanding Renewal – Ryan Heise…… 6

MANAGEMENT ACTIVITIES
Georgia 2011 Update – Jimmy Evans.……... 7
South Carolina 2011 Update – Scott Lamprecht……. 10
North Carolina 2011 Update – Ryan Heise……. 11
Wateree River Collections – Dave Coughlan…….. 11

RESEARCH UPDATES
Use of hierarchical occupancy models in Ocmulgee River, GA – Will Pruitt…… 12
Abundance, size structure, spawning in Ogeechee River, Georgia – Patrick Ely……12
Broad River, Georgia Research Update 2011 – Bud Freeman and Carrie Straight…… 12
Modeling Suitable Habitat – Michael Fisk……..……..……...14
Population Genetic Characterization – Tanya Darden…….14
Potential impacts of non-native flathead catfish – Jimmy Evans…….16
Interaction of Nonnative Flathead Catfish with Imperiled Redhorses – Kwak et al……18
Predation potential of flathead catfish on razorback suckers – Joey Slaughter……..….19

TECHNICAL WORKING GROUP REPORTS
Oconee River Technical Working Group – Alice Lawrence…….. 20
Yadkin/Pee Dee Technical Working Group – Ryan Heise……. 21
Information Technology Technical Working Group – Jaci Zelko…….. 22
Habitat Technical Working Group – Alice Lawrence…...…….. 22

BUSINESS
Research Topics and Resource Needs…… 23
Update on the 404 Species Petition…….…… 23

ATTACHMENTS: List of Attendees……. 25

ACRONYMS & ABBREVIATIONS

CPLC	Carolina Power and Light Company
CVIOG	Carl Vinson Institute of Government
DPC	Duke Power Company
FERC	Federal Energy Regulatory Commission
GA Coop	University of Georgia Cooperative Fish & Wildlife Resource Unit
GA DNR	Georgia Department of Natural Resources
GPC	Georgia Power Company
GRN	Georgia River Network
GWF	Georgia Wildlife Federation
NC WRC	North Carolina Wildlife Resources Commission
NCS MNS	North Carolina State Museum of Natural Sciences
NYU	New York University
SC Coop	South Carolina Cooperative Fish & Wildlife Research Unit
SC DNR	South Carolina Department of Natural Resources
SCEG	South Carolina Electric and Gas
SCA	South Carolina Aquarium
UGA	University of Georgia
USACOE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey (Biological Resources Division)

FTC	Fish Technology Center
NFH	National Fish Hatchery
SFH	State Fish Hatchery
WMA	Wildlife Management Area

CCAA	Consolidated Conservation Agreement with Assurances for the Ocmulgee River
Excom	Former Technical Advisory Group to the RRCC
GIS	Geographic Information System
IT TWG	Information Technology Technical Working Group
MOU	Memorandum of Understanding
PIT	Passive Integrated Transponder Tags
RRCC	Robust Redhorse Conservation Committee
TAG	Technical Advisory Group
TWG	Technical Working Group

AGR	Artificial genetic refuge
C	Celcius
cfs	Cubic feet per second
cm	Centimeter
g	Gram
kg	Kilogram
km	Kilometer
m	Meter
mg/l	Milligrams per liter
mm	Millimeter
MWe	Megawatts of electrical output
m3/s	Cubic meter per second
N*e*	Effective population size
ppt	Parts per thousand
rkm	River kilometer
RM	River mile
TL	Total length
YC	Year class
YOY	Young of year

EXECUTIVE SUMMARY

The robust redhorse recovery effort, in its 17th year, encompasses management activities and research and conservation efforts undertaken by members of the Robust Redhorse Conservation Committee (RRCC), university scientists, and other affiliates. The RRCC, established by a Memorandum of Understanding (MOU) signed in 1995, is responsible for developing and managing a recovery approach for the imperiled robust redhorse (*Moxostoma robustum*). The effort and expertise applied to the questions of recovery are brought together at the annual meeting of the RRCC.

The seventeenth annual meeting of the RRCC was held October 3 – 5, 2011 at Morrow Mountain State Park in Albemarle, North Carolina. Approximately 30 representatives of the signatory agencies to the MOU, university research affiliates and other interests attended the meeting. The 13 signatory agencies include: Georgia Department of Natural Resources, South Carolina Department of Natural Resources, North Carolina Wildlife Resources Commission, Georgia Power Company, Progress Energy (formerly Carolina Power and Light Company), Duke Energy, South Carolina Electric and Gas Company, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Forest Service, U.S. Army Corps of Engineers, Georgia Wildlife Federation, and South Carolina Aquarium. University research affiliates include: University of Georgia Warnell School of Forest Resources, University of Georgia Institute of Ecology, University of Georgia Cooperative Fish and Wildlife Research Unit, Roanoke College Department of Biology, University of Georgia Carl Vinson Institute of Government, University of Georgia Department of Genetics, Cornell University Department of Molecular Biology and Genetics, Clemson University Cooperative Fish and Wildlife Research Unit, New York University School of Medicine Institute of Environmental Medicine, and State University of West Georgia. In addition, representatives of other concerns with interest in recovery of the robust redhorse include: Santee Cooper Power Company, Georgia Aquarium, Georgia River Network, and the North Carolina State Museum of Natural Sciences. The success of the recovery effort, to a large extent, depends on the willingness of RRCC members and others to participate in the annual meeting and to continue to support recovery throughout the year.

This report summarizes updates on management activities, research findings, and conservation efforts and decisions made at the 2011 RRCC Annual Meeting. The RRCC Annual Meeting Reports have become important documents of research, science, management, and recovery that are often referred to and cited. The format of this year's report closely follows the format of previous reports and it provides a more accurate record of activities. The report notes discussion points, questions, main ideas, and/or notes recorded by the participants.

I N T R O D U C T I O N

Historically, the robust redhorse (*Moxostoma robustum*) inhabited Atlantic slope drainages from the Pee Dee River system in North Carolina to the Altamaha River system in Georgia. The first scientifically confirmed sighting of robust redhorse since naturalist Edward Cope described the species in 1869 occurred when the fish was re-discovered in the Oconee River in Georgia in 1991. In the Altamaha River drainage, the species is presently known to exist in a relatively short reach of the Oconee River between Sinclair Dam and Dublin, Georgia and in a short upper Coastal Plain section of the Ocmulgee River. Individuals also have been found in the Savannah River (the boundary river between Georgia and South Carolina) in the Augusta Shoals area as well as below the New Savannah River Bluff Lock and Dam. In addition, robust redhorse have been captured in the Pee Dee River below Blewett Falls Dam in North Carolina. Robust redhorse populations have also been reintroduced within their historic range into the Broad and Ocmulgee Rivers, Georgia, as well as the Broad and Wateree Rivers, South Carolina. The robust redhorse appears to inhabit specialized areas of large rivers, which are difficult to sample but regardless of the absence of sightings, small numbers are usually found when species-targeted surveys are conducted.

River impoundments, predation by introduced nonnative species, and significant deterioration of habitat due to sedimentation and water pollution are believed to have contributed to the decline of the species. The complex and diverse problems facing the robust redhorse require an interdisciplinary approach, using a broad spectrum of experience, expertise, and management authority to maintain and restore this imperiled species. In addition, it is essential that recovery efforts include a process that works closely with the private sector as well as government agencies potentially impacted by and interested in robust redhorse conservation.

The Robust Redhorse Conservation Committee (RRCC) was established by a Memorandum Of Understanding (MOU) signed in 1995 to develop and manage a recovery approach for the robust redhorse (*Moxostoma robustum*), previously a Category 2 candidate for Federal listing under the Endangered Species Act. The RRCC is actively committed to the recovery of the imperiled robust redhorse throughout its former range. It identifies priority conservation needs for the robust redhorse and its habitat and coordinates implementation of research and management programs for addressing those needs.

A D M I N I S T R A T I O N

Welcome – Ryan Heise
Ryan welcomed the participants to the 17th Annual robust redhorse meeting. He thanked the sponsors of this year's meeting (NC Wildlife Resources Commission – state wildlife grant program, Duke Energy, SC Aquarium, Progress Energy, and NC State Parks). Ryan introduced Shannon Deaton, NCWRC Habitat Conservation Program Manager, and she welcomed all to the meeting. A presentation was given by J. R. Murr on the history and function of Morrow Mountain State Park.

Memorandum of Understanding Renewal – Ryan Heise
The MOU establishes the RRCC and allows the RRCC to establish operating guidelines. The previous MOU expired at the end of December, 2009. The newest version is valid from January 1, 2010 to December 31, 2014. Revisions made after the 2009 meeting were incorporated and representatives were sent the updated copy. At this time, Ryan has received signatures from all but 2 signatories. Once he receives the final copies, he will send them out to the group.

M A N A G E M E N T A C T I V I T I E S

Update on the 2011 robust redhorse recovery effort in Georgia – Jimmy Evans
In Georgia the robust redhorse recovery project is in what might be termed Phase III-IV. In general terms, the phases are as follows:
***Phase 1*.** After discovery of the Oconee population, a status assessment was initiated which strongly suggested that potential risks existed to the species in the Oconee.
***Phase II*.** An extensive hatchery program was begun that lasted from 1993 until 2008. Refugial ponds and three rivers, the Ocmulgee, Ogeechee, and Broad, were stocked with numerous year classes. Limited stockings were also made in the Oconee River.
***Phase III*.** This is the monitoring phase that consists of an evaluation of the relative success of the stockings in the three rivers and a continuing effort to monitor the status of the Oconee population.
Phase IV consists of efforts to improve the status of the Oconee population and has occurred concurrently with other phases. It has had four general components to date:

> ***1.*** Implementation of altered flow regimes to improve recruitment success as a result of Sinclair Dam relicensing in 1996. Research has been conducted to evaluate changes in reproduction and recruitment in association with these flow changes.
> ***2.*** Limited stockings of fingerlings as well as larger juveniles and adults in the Oconee.
> ***3.*** Habitat improvements, primarily in the form of a large gravel augmentation project, to improve spawning habitat at five locations.
> ***4.*** Currently we are evaluating flathead catfish predation and attempting to determine the nature and magnitude of that threat, and what if anything can be done to reduce it.

The major challenge remaining in Georgia is to improve the status of the Oconee population. Although all the evidence is not in regarding sustainability, the riverine stockings have to date been largely successful. Although we have implemented significant management actions to improve the status of the Oconee population, we cannot document any resulting improvement, and this remains our most significant challenge.

At present, we have no plans to resume the hatchery program. There appears to be no present requirement for hatchery reared robust redhorse in Georgia, although this may change in the future. Any future stockings would likely involve use of adults collected from stocked rivers. If fingerlings were ever produced again in Georgia, fish from stocked rivers would probably serve as the brood source.

Spring 2011 standardized electrofishing survey on the Oconee River.

> One of the major objectives of sampling this spring was to sample the area where most of the relocations of telemetered fish were observed. Since this area was above Black Creek and in the traditional sampling exclusion zone, broodfish sampling may have excluded a significant robust redhorse aggregation area resulting in an underestimation of population size. The other objective was to continue the

standardized robust redhorse monitoring program in the traditional broodfish collection area from the Central of Georgia railroad trestle to the end of the long meander section just above Dublin. These two areas combined represent almost the entire known range of the species in the Oconee River. Sampling was conducted on May 17, 2011 with three crews, one each from the Georgia Department of Natural Resources-Wildlife Resources Division (GADNR-WRD), Georgia Power, and the Georgia Coop Unit. Total distance sampled was about 30 RM and electrofishing effort totaled 10 hrs. Temperature was 22C and sampling conditions were good to excellent. No robust redhorse were observed.

Monitoring of gravel augmentation sites

The Oconee River gravel augmentation project was completed in March 2010 at five sites. Site 1 is located at a traditional spawning area adjacent to the Avant Mine. This site was augmented by placing gravel along the shore above the target site and allowing natural processes to erode the gravel into the channel and onto the target site. This method was marginally successful. Sites 2-5 are located below the Central of Georgia Railroad Trestle and were chosen because hard substrates were present that could anchor the gravel, and they contained the preferred depths and velocities. At sites 2 –5 gravel was loaded onto barges and transported to the sites, then washed off using water pumps. Post-project observations at low flows suggested that suitable sites had been created, varying in quality from fair to excellent, and that the gravel has persisted. Total area augmented was 2.7 acres.

The objective of monitoring was to determine if the augmented sites were being used by robust redhorse as spawning habitat. Bud Freeman and Carrie Straight monitored the traditional gravel spawning site at Avants (Site 1), recently augmented slightly, as well as augmentation sites 2, 3, and 5. The smallest and least accessible Site 4 was not monitored. Monitoring was conducted on May 9, 2011 and methods were visual observations and hydrophone recordings (hydroacoustics). Jimmy Evans also made visual observations at Avants and at 2 of the 4 sites located below the railroad trestle on May 10. Temperature was 23C and conditions for observations good to excellent, however, no robust redhorse were observed.

Implications of monitoring

There are several implications to the absence of any robust redhorse in either the electrofishing survey or in the monitoring of gravel augmentation sites. A thorough discussion of all the implications would require a separate presentation, however it now appears that the population is extremely low throughout the Oconee River from Sinclair Dam to Dublin, and that there are no significant aggregations that have been excluded or overlooked within this area. Within this area the population seems to have declined below the detection point with the resources we have available to sample it. Viable options are to focus sampling on other areas, such as below Dublin or above Lake Sinclair, or to increase sampling effort in the Sinclair Dam to Dublin area, or both. The spring 2012 robust redhorse sampling will focus on the area above Lake Sinclair and in the Oconee River between Lake Oconee and Barnett Shoals Dam.

Other topics

The research being conducted on the Broad, Ogeechee, and Ocmulgee rivers constitutes the majority of the robust redhorse recovery effort in Georgia and these projects have been thoroughly discussed in separate presentations at this meeting. However, several other areas of recovery activity in Georgia should be mentioned as well. First is obviously the recent petition to list the robust redhorse as well as many other species under the ESA. The petition, the U. S. Fish and Wildlife Service (FWS) response, and associated time lines have already been discussed. These developments have implications for all members of the Robust Redhorse Conservation Committee (RRCC). The Georgia Aquarium continues to highlight the recovery project with a display in the Georgia Gallery portion of the facility. We also have robust redhorse displays at the new Go-Fish-Georgia Center in Perry, GA. The juvenile fish that were on display in the jewel tanks died and will have to be replaced with juveniles from the Dennis Wildlife Center, SC. We also have live adult robust redhorse on display with associated species in the Piedmont exhibit, as well as mounted specimens inside the main building.

We are currently engaged in environmental reviews at four projects that have the potential to affect robust redhorse populations in the Ocmulgee, Broad, and Savannah rivers in Georgia. One of these projects is the expansion of a water intake structure at the Macon Water Authority (MWA) water treatment plant just above Macon and downstream of a known robust redhorse spawning site. The natural resource agencies are working with the MWA and the U. S. Army Corps of Engineers (ACOE) to assure that the structure will not cause entrainment/impingement of larval or young-of-the-year robust redhorse. We are also in the final stages of negotiations on the design of a Denil fish ladder at the Juliette Dam between Macon and Lake Jackson. Robust redhorse were stocked above the dam but apparently large numbers passed over and at least two spawning sites exist below the dam. The fish ladder would probably result in some passage of robust redhorse, but the magnitude or significance of passage is unclear and there is some skepticism that the facility will ever be completed. Also, the FWS and the GADNR-WRD are reviewing a wastewater treatment facility in the Broad River drainage and a Savannah River drought flow operations plan. The proposed Plant Washington water intake on the Oconee River at the Avant site remains an important issue as well. The proposed coal-fired power plant is to be located in Sandersville, GA. Water permits have been issued that include various mitigation measures to reduce entrainment/impingement of robust redhorse larvae as well as other species at the water intake structure. The air permits have still not been issued and the project is now far behind schedule, but all indications suggest that the plant will eventually be built.

In the conservation arena, a 90–100 acre ACOE trust fund preservation site has been created on the South Fork of the Broad River near Watson Mill State Park. This preservation site should help improve water quality in the area. Of particular significance is a 7,000 ac wetlands mitigation site that has been created on the Oconee River immediately across and generally downstream of the Avant site. A 500 ac future state park tract on the Oconee River at Balls Ferry has also been purchased, although funds are not now available to develop the area. These efforts combined with gravel augmentation

projects on Oconee River demonstrate significant progress in the area of habitat protection and enhancement.

South Carolina 2011 Update – Scott Lamprecht

Carolina Santee Basin Robust Redhorse (RRH) restoration efforts experienced its first production failure in 2010. While fry production was ~25,000, only 200 individuals were harvested in November and all of these were retained for further grow-out. Entering 2011 we have stocked a total of 50,500 phase I fingerlings in our two Broad River restoration sites. The Wateree River site has received 12,601 phase I fingerlings, 2,400 phase II juveniles (age 1+), and 400 phase III juveniles (age 2+). At the beginning of 2011, our goal of using the progeny of 100 parental crossings to restore or re-establish RRH to the Santee Basin had yet to be achieved and remained at 95.

Our 8th annual RRH spawning trip to the Savannah River gravel bar located below Augusta at RK 173.3 (~14.5 Km below Augusta Shoals Lock and Dam), took place on May 12th. Twenty three adults were collected, but only one female. Her meager supply of eggs were divided into 3 parts and fertilized with three different males. Seven of the fish had been previously PIT tagged, with two males having been tagged way back in 2002 (1 floy tag still present, but unreadable). One of these two males has been collected a total of 5 times (02, 04, 05, 06, 11) and the other 3 times (02, 07, 11). Approximately 2,500 fry were stocked out in production ponds that will be harvested in November 2011. Provided survival to harvest is adequate, a total of 98 unique parental crosses have been used to stock fingerlings out in the Santee Drainage restoration sites, indicating a need to continue our spawning effort in 2012.

In addition to the two sonic transmittered RRH initially collected and release in the Wateree Dam Tailwater in 2009, 6 more individuals were similarly equipped in May of 2011. The seasonal movement pattern of the newer study animals corresponded to that of the older specimens. All the study fish occupied the Wateree Tailrace during spawning season, which is not surprising since all were initially collected there in the spring. The two 2009 tagged fish have returned to the Tailrace between 3/26 and 4/15 in both 2010 and 2011. During the three springs these two fish have been monitored, both departed the Tailrace area between 5/14 and 6/13. In 2011, six of the eight study fish ascended the Congaree River between 5/25 and 6/21. Long distance movement of these fish can occur relatively quickly; one fished moved downstream 124 km in 2.6 days and there are numerous instances of fish moving more than 30 km/day.

The number of RRH observed using the Columbia Diversion Dam Fishway (Broad River) continues to grow. The number observed by Jennifer Hand (Kleinschmidt) doubled this year to 26. Extrapolating this number produces a rough estimate of 207 individuals potentially using the ladder during the spring of 2011. Upstream passage was observed from March 22 thru May 17 with temperatures ranging from 16.5 to 24^{o} C. This corresponds to temperatures and timing of adult RRH use of the Wateree Dam Tailrace, which enforces the assumption of the availability of more than one spawning area in the system.

North Carolina 2011 Update – Ryan Heise

The objective of the 2011 field study by the Yadkin-Pee Dee technical working group (TWG) was to continue looking for any additional Robust Redhorse spawning shoals. TWG members tracked radio-tagged robust redhorse in April and May and individuals were only relocated in previously documented spawning areas (Jones Creek and Hitchcock Creek shoals). This highlights the importance of these sensitive areas and we are happy to report that these locations are receiving some protection by ownership of the adjacent riparian lands by RRCC members (NC Wildlife Resources Commission and Progress Energy). Much has been learned about the Pee Dee river population (e.g. habitat use/suitability, migration patterns) since the formation of the TWG (see pervious RRCC annual reports). Currently, robust redhorse are only found downstream from Blewett Falls dam and the TWG is studying the possible reintroduction of robust redhorse upstream of the dam. North Carolina Wildlife Resources Commission with help from Progress Energy has funded a study at North Carolina State University to model the suitable upstream habitats (located downstream of Tillery Dam). In addition, a separate project at NCSU will look at water quality in Pee Dee River. The results of these studies will help determine our reintroduction options for Robust Redhorse.

Wateree River Collections – Dave Coughlan

The Santee Cooper River Basin is 15, 900 m^2 and include the Santee, Cooper, Wateree, Catawba, Congaree, Saluda, and Broad rivers. Phase II fish were first PIT tagged and stocked into the Wateree River in 2005. Additional stockings have taken place in 2006 and 2008 – 2011. Robust redhorse have been collected since then at the base of the Wateree Hydro Tailrace in 2006, 2008 – 2011.

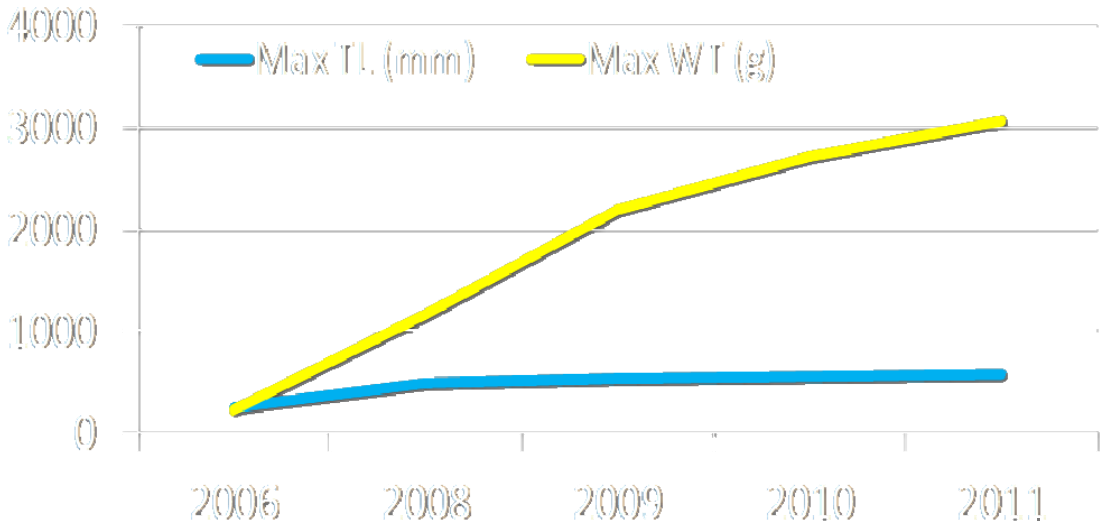

Figure 1. Maximum length and weight of robust redhorse captured in Wateree River from 2006 – 2011.

R E S E A R C H U P D A T E S

Use of hierarchical occupancy models to estimate seasonal distribution of stocked robust redhorse in the upper reaches of the Ocmulgee River, GA – Will Pruitt

Previous studies on the Ocmulgee population revealed capture probability is very low (0.031) and other approaches (e.g., occupancy models) must be explored. To determine habitat use of robust redhorse, we assessed physical underwater habitat (e.g., woody debris and substrate composition) using side-scanning sonar imagery in combination with fish capture data. To account for the imperfect detection of robust redhorse, the current study employs hierarchical occupancy models to determine detection probability, estimate site occupancy and seasonal habitat use of the Ocmulgee River population. Using this new approach, our preliminary results indicated that water temperature and quantity of woody debris have a negative relationship on site occupancy. However, the most influential factors include water velocity and the proportion of the streambed occupied by coarse substrates (i.e., gravel, cobble, boulder, and bedrock), both of which have a positive relationship with site occupancy. Contrary to previous findings, our best-approximating model revealed robust redhorse had an average conditional detection probability of 0.315 (±0.19). While detection for the species is higher than expected, the low number of robust redhorse captures during this study may be contributed to the extremely low occupancy rates, where the average conditional occupancy was only 0.134 (±0.15). We conclude that robust redhorse may not be as difficult to detect as previously thought, and rather than having a high affinity towards woody structure like their Oconee and Ogeechee River counterparts, the Ocmulgee River robust redhorse may reside only in the inaccessible or difficult-to-sample shoal portions of the river year-round.

Abundance, size structure, and spawning locations of robust redhorse stocked in the Ogeechee River, Georgia. – Patrick Ely & Cecil Jennings

Between November 2010 and March 2011, we conducted 10 electrofishing trips to the Ogeechee River and have collected, tagged, and released 19 robust redhorse. One robust redhorse was captured on 01 December 2010, three were captured on 23 February 2011, seven were captured on 02 March 2011, and eight were caught on 09 March 2011. We will continue electrofishing for robust redhorse until we have a total of thirty radio tagged individuals. The radio-tagged fish will be tracked weekly during the spring spawning season. These data should help identify where in the system robust redhorse are spawning and allow for habitat characterization and protection of spawning site(s). After the spawning season, 10 sampling stations will be established and sampled during the summer and fall to ascertain the abundance of juvenile robust redhorse in the system.

Broad River, Georgia, 2011 Review – Carrie Straight and Bud Freeman

Our current research in the Broad River watershed includes movements of tagged fish spawning behavior, and juvenile sampling.

Movements. In early spring of 2010, we tagged six robust redhorse (2 female and 4 male) with sonic transmitters. We tracked these six fish from their tagging location at

Anthony Shoals upstream to two spawning shoals (approximately 81-88 river km from the tagging location). One individual visited, and presumably spawned, at two different gravel bars approximately 6.5 river km apart on the Hudson and Broad Rivers. Tagged individuals moved downstream after the spawning season was completed and five of the sixed tagged fish entered the Clark's Hill Reservoir by mid-August. One individual has not been detected since late-May 2010 during its downstream migration. The remaining five fish were recorded moving 10 – 13 km into the reservoir (downstream of the original tagging location).

In early spring of 2011, we captured and tagged an additional 14 fish (3 female, 11 males) with sonic transmitters. Tagged males had an average weight of 2775 g (range 1890-4330 g) and an average standard length of 471 mm (range 439-555 mm). Tagged females had an average weight of 3163 g (range 2800-3350 g) and an average standard length of 491 mm (range 467-510 mm). The first tagged fish was recorded moving upstream on the 2nd of March and the first fish was recorded in the vicinity of the one of the documented spawning shoals on 26 April 2011. Five tagged fish were recorded at a known spawning location on the Hudson River, three fish were recorded at one spawning location on the Broad River, and two fish were recorded at both of those spawning locations during the 2011 spawning season.

Spawning Behavior. The 2011 spawning season for robust redhorse in the Broad River system was first documented on 3 May at two different locations, one on the Hudson River and the main site on the Broad River (see table below). On the Hudson River, spawning was documented from 3 May until 12 May 2011. At the main location documented on the Broad River, spawning was documented from 3 May until 23 May 2011. At the secondary site documented on the Broad River (upstream site), spawning was documented from 7 May until 21 May 2011. The site with the highest estimated number of fish was located on the Broad River and was the main documented site used in 2010. At the main site, robust redhorse used six distinct spawning areas within a 150 m reach of river and covered approximately 185 m^2 of habitat. Spawning depths in 2011 averaged 0.53 m (0.3 - 0.88 m). Spawning velocities averaged 0.81 m/s (0.42 - 1.4 m/s) at 60% depth and 0.36 m/s (-0.01 - 0.85 m/s) on the bottom. These water velocities are range and average higher than those recorded previously on the Savannah and Oconee River spawning locations.

Spawning information for the three spawning locations used during spring 2011

Location	Temperature °C	Maximum Number of Fish*
Hudson River	15-23	10 (no estimate of males/females; on 5/9)
Broad River (main)	16.5 – 21.5	73 (12 female; 61 male; on 5/12)
Broad River (upstream)	16.5-22	24 (2 female; 22 males; on 5/12)

*(estimated number of females and males and date of occurrence)

Juvenile Sampling. In fall of 2009, we conducted juvenile robust redhorse sampling. We chose 21 random localities from upstream of the spawning shoals downstream to the reservoir. We collected suckers at 16 of the 21 locations, including M*oxostoma collapsum*, *Moxostoma* sp. (brassy jumprock), and *Minytrema melanops*. No robust

redhorse were collected during these samples. Our 2011 juvenile sampling is not yet complete.

In the fall of 2011, we will continue to conduct juvenile sampling, focusing our efforts in upstream reaches closer to the spawning shoals. We also plan to continue tracking fish within the reservoir and any spring movements of fish tagged in spring 2011. During the spring of 2012, we will conduct a study of flow pulses in relation to spawning behavior in the Savannah River using a hydrophone to record spawning sounds in relation to discharges from Thurmond Dam.

Modeling Suitable Habitat for Robust Redhorse: An Assessment for Reintroduction – Michael Fisk

A remnant population of robust redhorse persists downstream of Blewett Falls Dam, the terminating hydroelectric dam in the Pee Dee River, North Carolina. Due to anthropogenic processes, including habitat fragmentation and alteration from dams, the species has been extirpated from upstream reaches. Tillery hydro-facility is the next dam upstream of Blewett Falls and contains a lotic reach 30 rkm long upstream of Blewett Falls Lake. The implementation of a new minimum flow regime at the Blewett Falls Hydro-facility will create more suitable available habitat for the Blewett Falls reach but has not been quantified for the lotic reach upstream of Blewett Lake where flows are controlled by the Tillery Hydro-facility. Habitat suitability indices (spawning site and non-spawning period) based on field microhabitat measurements from downstream of Blewett Falls Hydro-facility were applied to model weighted usable area (suitable available habitat) for the proposed minimum flows. The objectives of this study were to (1) quantify suitable available habitat in the Tillery reach based on these suitability indices and compare the current and proposed minimum flows between the Tillery and Blewett Falls reaches and (2) identify limiting microhabitat variables.

Modeled suitable available habitat was found for both spawning sites and non-spawning period with spawning sites being affected more by flows. There was little to no increase in suitable available habitat for both periods between the current and proposed minimum flows although proposed minimum flows will inundate gravel bars throughout the reach. Modeled suitable available habitat for spawning in the Tillery reach was higher than the Blewett Falls reach while modeled non-spawning suitable available habitats were similar between reaches throughout the flow range. Substrate and depth were the most limiting microhabitat variables for spawning sites and depth was the most limiting for the non-spawning period.

Our results will help managers make informed decisions about flow manipulations during critical time periods for species of concern and guide research for a potential reintroduction for the robust redhorse in the Tillery reach.

Population Genetic Characterization of Savannah and Pee Dee River Robust Redhorse – Tanya Darden and Carolyn Tarpey

Overall, our genetic evaluation indicates substantial levels of genetic structure between the Savannah and Pee Dee rivers as indicated by the high R_{ST} value and distinct allele

frequency distributions, with a high number of private alleles in each system. The detection of significant genetic differentiation between the Savannah and Pee Dee rivers is congruent with both Wirgin's estimation that genetic divergence between these systems occurred 1.5 million years ago (DeMeo 2001) based on mitochondrial control region sequence data and his unpublished preliminary microsatellite evaluation of these systems (Wirgin et al. 2001). Collectively, these results support the current management of rivers as distinct population segments and should be continued, as suggested by Wirgin et al. (2004), due to the importance of genetic composition for future evolutionary growth of the species.

Both the Pee Dee and Savannah populations show high within-population diversity (>0.79) as well as low levels of inbreeding as compared to the average genetic diversity measured for freshwater fishes (0.54, DeWoody and Avise 2000). Additionally, *M. robustum* population diversity estimates from both rivers are in the upper range of those reported for other *Moxostoma* species (0.63 in black redhorse, *M. duquesnei*, Reid et al. 2008a; 0.72 in river redhorse, *M. carinatum*, Reid et al. 2008b; 0.76 in shorthead redhorse, *M. macrolepidotum*, Reid et al. 2008b; 0.77 in copper redhorse, *M. hubbsi*, Lippe et al. 2006; 0.85 in sicklefin redhorse, *M. sp.*, Moyer et al. 2009).

All estimates of N_e differed between rivers with consistently lower estimates in the Pee Dee River, which is consistent with the suggestion of a smaller population size in the Pee Dee River (Wirgin et al. 2004). However, even the higher contemporary N_{eb} estimates for the Savannah River were lower than those estimated for the endangered *M. hubbsi* ($N_{eb(LD)}$=480, Lippe et al. 2006). Additionally, the estimates of contemporary N_{eb} are well below the goals identified in the conservation strategy for *M. robustum* (Nichols 2003). Similar evolutionary population trends were detected in the Pee Dee and Savannah Rivers. As no recent population bottlenecks were detected in either system, the substantial reduction from long-term to contemporary estimates likely indicates gradual population decreases over very long time periods for both *M. robustum* populations. Bottleneck detection capability is dependent on the severity of the event; however, the tests utilized here are highly robust with population reductions to N_e<10 (Luikart and Cornuet 1998); therefore, a recent bottleneck would have certainly been detected in Pee Dee River had one occurred recently. Although interpretation of genetic data suggested a similar long term trend for *M. hubbsi* (Lippe et al. 2006), it is interesting that the long term estimates of N_e were higher in both the Pee Dee and Savannah populations of *M. robustum* (*M. hubbsi* N_e: 4,476).

Similar to other *Moxostoma* species, *M. robustum*'s life history strategy is characterized by both a long life span and overlapping generations. The maximum age reported for *M. robustum* is 27 years with reproductive maturity occurring at 4-5 years in males and 5-6 years for females, leaving approximately a 22 year reproductive window for each individual (Robust Redhorse Conservation Committee 2002). Therefore, although the very low N_{eb} estimate in the Pee Dee River population is concerning from a genetic management standpoint, their long life span and overlapping generations appear to result in a high potential for across-year class spawning and is likely contributing to the maintenance of high genetic diversity in light of their low effective population sizes. Although the high genetic diversity and lack of inbreeding indicators observed within both the Pee Dee and Savannah river populations of *M. robustum* would normally be

indicative of populations in good genetic health with sufficient adaptive potential, it is unknown if *M. robustum*'s life history characteristics and current high genetic diversity will be capable of overcoming the negative effects of low effective population sizes in the long term. Long-term simulation modeling supports this concern with results indicating more rapid declines in allelic richness with higher maintenance of heterozygosity. Therefore, conservative management approaches and continued monitoring of the populations are recommended as Kuo and Janzen (2004) have suggested that long life and overlapping generations could potentially mask accelerated rates of drift in small populations. The lack of demographic population history for robust redhorse makes it challenging to ground truth interpretation of genetic results and monitoring and management recommendations would greatly benefit from current demographic population estimates (particularly in the case of simulating diversity retention). The contemporary LD-based estimates of N_e for two robust redhorse populations provide an important benchmark for future detection of bottlenecks as it has recently been shown that LD-based estimates have the sensitivity to comparatively detect population reductions within a single generation (Antao et al. 2011). A substantial level of knowledge and intensive effort is necessary for successful recovery of protected species, and the genetic data generated during this study provide information on an important aspect of *M. robustum* biology that will be valuable in the continued monitoring and management of this species.

The microsatellites used to evaluate *M. robustum* were initially developed for other Catostomids, but have proved to be an excellent genetic tool for *M. robustum* as well. In addition to genetic characterization and monitoring of these populations, the marker suite provides a statistically robust mechanism of parentage analysis and individual identification in both rivers. Evaluation of the success of any restoration effort is dependent on the ability to identify stocked individuals, which necessitates the use of a tag or mark to distinguish hatchery from wild produced fish (Blakenship and Leber 1995). The use of molecular markers as genetic tags avoids some of the constraints and pitfalls associated with conventional tags, in that molecular markers require no additional tagging, the mark is never lost, and tag recovery is non-lethal. The archiving of all South Carolina *M. robustum* production and genetic information will allow for offspring identification of future recaptures within the Santee River during re-establishment efforts. As genotyping of Santee River offspring progresses, genetic characterization of the new population can be assessed and compared to the Pee Dee and Savannah river populations.

Potential impacts of non-native flathead catfish on the Oconee River robust redhorse population – Jimmy Evans

Robust redhorse were collected from the Oconee River during 1993–2008 to supply broodfish for an artificial propagation program that eventually resulted in the stocking of several refugial ponds, as well as the Broad, Ocmulgee, Ogeechee, and Oconee rivers in Georgia. Broodfish sampling was generally conducted from below Sinclair Dam near the Central of Georgia railroad trestle downriver for about 20 RM to the end of a long meander section above Dublin. Electrofishing catch rates during broodfish sampling in this area began to decline in about 1996–1997 and have continued to decline from a high of 15–20 fish per hour in 1993-1995 to 0.5 fish per hour in 2008. Population monitoring

in the Sinclair Dam to Dublin area in 2009–2011 has failed to capture any robust redhorse.

The possibility of a future demographic decline was recognized in the early–mid 1990s through an evaluation of annual length distributions that indicated an aging population with limited recruitment, and this was one of the reasons for implementing the artificial propagation program. The flow regime at Sinclair Dam was altered in 1996 as a result of FERC relicensing, partially in response to limited robust redhorse recruitment, and in 2008 five gravel spawning sites were augmented to improve spawning habitat quality. However, these measures have not resulted in any documented improvement in recruitment success to date and no strong year classes have been produced.

Several causes have been proposed for the decline of the Oconee River robust redhorse population, but one of the first to be recognized was the introduction of flathead catfish into the Ocmulgee River in the mid-1970s, followed by their appearance in the Oconee River in about 1980. The flathead catfish is a large voracious, ambush-type piscivore with a particularly large gape. Indigenous fishes in rivers such as the Oconee have evolved no well-developed defenses against this non-native predator. Negative effects of non-native flathead catfish on indigenous fishes are well documented, including the alteration of entire native fish communities. Some species are more affected by flathead catfish predation than others and several lines of evidence suggest that robust redhorse may be especially vulnerable, but conclusive proof is lacking.

The first line of evidence is the correlation between the appearance of flathead catfish in the Oconee River in the early 1980s and the apparent decline in robust redhorse recruitment. Length distributions of robust redhorse from the early-mid 1990s are unusual because of the low numbers of juveniles but also because the length/age distribution is shifted to near the maximum known length/age for the species. These length distributions strongly predicted the demographic decline that occurred and has continued to the present. An age and growth study using opercles conducted by Dr. Robert Jenkins indicated that this large group of fish, composing most of the population, was 10–25 years of age and was therefore produced primarily in the 1970s before flathead catfish appeared in the Oconee. After the appearance of flathead catfish in the early 1980s, recruitment appears to have been much lower and the population has aged, eventually declining dramatically.

A second line of evidence that implicates flathead catfish predation in the decline of the Oconee River robust redhorse population comes from the Ocmulgee River in the late 1980s. A comprehensive fish population study of the Ocmulgee River (Evans 1991) found that flathead catfish did not at the time exist above the Juliette Dam, the first barrier to fish migration on the Ocmulgee. Although robust redhorse were not found in this section, notchlip redhorse were common and up to ten times more abundant above the Juliette Dam where flathead catfish were absent than below the dam where they were present. The implication from these data is that sucker species abundance may be reduced by flathead catfish predation. However, the results of this analysis is complicated

by natural habitat alterations associated with the fall line and other factors that may also have influenced observed longitudinal changes in notchlip redhorse abundance.

Finally, a third line of evidence implicating flathead catfish predation in the decline of the Oconee River population is the apparent significant overlap in habitat utilization of the two species observed from radio telemetry studies. In principal, greater exposure of prey species to predators through habitat overlap will increase opportunities for predation and therefore elevate predation pressures. Habitat overlap has been used to explain the virtual disappearance of bullheads from numerous rivers following the introduction of flathead catfish. In general, telemetry studies conducted in coastal plain areas such at the Oconee River between Sinclair Dam and Dublin indicate that non-spawning adult robust redhorse prefer deeper portions of meander sections with concentrations of woody debris. Preference of adult robust redhorse for this habitat type has been observed in the Oconee, Ocmulgee, and Savannah rivers. Telemetry studies of flathead catfish in several rivers also indicate a preference for these habitat types. Dr. Tom Kwak will review these studies and expand on habitat preferences for the two species in the following presentation. Following Dr. Kwak's presentation Joey Slaughter will further discuss the relationship of habitat overlap to predation as it applies to flathead catfish and razorback suckers in western rivers.

The questions we are exploring in these three presentations are: Can the two species coexist? Can they coexist in some areas and not others? What is the cumulative evidence in support of the suggestion that flathead catfish predation has played a major role in the decline of the Oconee River robust redhorse population. Is there other evidence indicating that flathead catfish predation might not have played a significant role in the decline? Do we have enough data to answer these questions?

Interaction of Nonnative Flathead Catfish with Imperiled Redhorses - Thomas J. Kwak, J. Michael Fisk, and Ryan J. Heise

The flathead catfish, *Pylodictis olivaris*, has been widely introduced in the United States beyond its native range. This domestic invasive species receives less scientific and media attention relative to exotic fish introductions, but its ecological impacts may be equally or more severe. It has been implicated for the decline of sport and imperiled fishes and can restructure fish communities. It is an aggressive obligate carnivore with great potential to alter native fish assemblages. Since the 1950s, it has been introduced into Atlantic Slope rivers from Florida to Pennsylvania, established by releases of few individuals, and its distribution overlaps that of the robust redhorse, *Moxostoma robustum*. The flathead catfish has been considered easily collected by electrofishing, of low densities, with sedentary behavior, restricted to freshwater, and feasible to manage in restricted river units, but recent research suggests that electrofishing is an inefficient gear, it occurs in dense populations, individuals migrate throughout a drainage, it tolerates brackish waters, and populations must be managed at the basin scale (see relate publications below). Microhabitat suitability analyses suggest substantial habitat overlap between flathead catfish and robust redhorse, and fluvial restricted redhorses, such as the robust redhorse are more vulnerable to flathead catfish predation than fluvial specialist fishes. Management of introduced catfish focuses on limiting dispersal among basins, public

education, and encouraging harvest. Additional research is needed to elucidate the effects on native fishes and develop and assess alternative population control measures.

A physiological evaluation of predation potential of flathead catfish on razorback suckers – Joey Slaughter

Flathead catfish are well established in the Colorado River below Parker Dam. This section of river is also within the native range of razorback suckers and is the site of ongoing recovery efforts. Previous studies have shown that flathead catfish actively feed on razorback suckers when they coexist within a given area, and recent work suggests that mortality of stocked razorbacks is very high. Razorback body size was compared to flathead gape size to determine at what size catfish were able to ingest a given size of razorback sucker. The size distribution of flathead catfish present below Parker Dam was then analyzed to determine the abundance of catfish by size within the river. Proportions of flathead catfish available to prey upon various sizes of razorback suckers were calculated and compared to mortality curves estimated for various stocking sizes of razorbacks. This information was used to determine at what size razorbacks could or should be stocked to minimize mortality induced by flathead predation. Ultimately, all razorbacks of any size are vulnerable to predation by the largest flathead catfish within the system, but increased stocking size could lead to higher survival by decreasing the proportion of flatheads large enough to feed upon stocked razorbacks.

TECHNICAL WORKING GROUP REPORTS

Oconee River Technical Working Group – Alice Lawrence
The tasks in the management plan that were addressed during the past year and tasks that the Oconee TWG is considering as our top priorities for the upcoming year were summarized:

Task: Continue to document spawning activity at known sites and identify any additional sites, and
Task: Continue evaluation of habitat augmentation and identify augmentation strategies to address habitat bottlenecks.

Georgia DNR visually monitored gravel augmentation sites over a two-day period this spring and the Oconee TWG conducted the annual standardized spring electrofishing event. No robust redhorse were detected. More recently, acoustic monitoring equipment was purchased by Georgia ES (FWS) for UGA to monitor robust redhorse spawning activity. This equipment will be used in the Broad and Savannah Rivers, GA, but because there are multiples of the equipment available, we are hoping to use some of the equipment in the Oconee to continuously monitor for spawning activity. The Oconee TWG deemed monitoring of the gravel augmentation sites as one of the top three priorities for 2012. The Oconee TWG feels that it is important to monitor these sites not only for robust redhorse use, but also for use by the other native fishes in the Oconee River because this is a habitat restoration method that is not commonly used, especially in the southeastern United States.

Task: Survey areas not specifically targeted in the past, sampled only sporadically, or outside the management unit, and
Task: Evaluate the need for establishing additional refugial populations.

Manpower was not available this spring to survey these extra areas, but the Oconee TWG has deemed exploring if a remnant population exists above Sinclair Dam as one of the top three priorities for 2012. This is a necessary step before the group considers introducing robust redhorse above Sinclair Dam. The group will be sampling areas above Sinclair Dam this spring instead of conducting the spring standardized sampling event in the Oconee River below Sinclair Dam. Reconnaissance surveys above Sinclair Dam are already underway, with more work planned for this winter. Springtime survey work will consist of electrofishing in riverine reaches and gill-netting in Lakes Oconee and Sinclair.

Task: Review existing data on habitat quality and quantity to develop a more accurate estimate of available habitat.

A sub-task in the management plan specifically mentions updating the flow regime at Sinclair Dam. Since the FERC license was issued for the project in the

mid-1990's, we now have more information including robust redhorse population estimates, catch-per-unit-effort data, and now Jennings et al. 2008 that correlates abundance of larval and age-0 redhorse with April-June flow parameters. Because the Jennings et al. 2008 results include parameters that are slightly different than the current flow regime, the Oconee TWG deemed providing Georgia Power with a formal flow tweak recommendation as one of the top three priorities for 2012. The mechanism for doing this will be a Flow Advisory Team meeting, which will translate the data results into a management recommendation for Georgia Power.

Task: Expand public outreach and outreach efforts.

In addition to the SC Aquarium and the GA Aquarium, now there is also the newly-opened Go Fish Education Center in Perry, Georgia operated by GDNR. The RRCC website has been updated with the Oconee TWG Management Plan and is being updated with the past RRCC Annual Meeting summaries.

Task: Actively participate in the environmental review process, as appropriate.

There were no projects on the mainstem Oconee in the robust redhorse range that the Service or GDNR is aware of this past year. However, there are some riparian lands in this area that are permanently protected, including a 6700+ acre wetland mitigation bank in Wilkinson County that encompasses one bank of the river at the only known robust redhorse spawning site. Other protected lands along the mainstem Oconee River in Baldwin, Wilkinson, Washington, Johnson, and Laurens counties, that the Service is aware of, include protected public lands such as the Berry Farm Conservation Area, a State Parks property, Beaverdam WMA, as well as mitigation properties such as the Wilkinson/Oconee Mitigation Bank, the Engelhard Corporation Mitigation Site, Imery's Clay Mitigation Site, and a proposed Commissioner Creek Mitigation Bank.

Yadkin-Pee Dee Technical Work Group Activities – Ryan Heise

The objective of the 2011 field study by the Yadkin-Pee Dee technical working group (TWG) was to continue looking for any additional Robust Redhorse spawning shoals. TWG members tracked radio-tagged robust redhorse in April and May and individuals were only relocated in previously documented spawning areas (Jones Creek and Hitchcock Creek shoals). This highlights the importance of these sensitive areas and we are happy to report that these locations are receiving some protection by ownership of the adjacent riparian lands by RRCC members (NC Wildlife Resources Commission and Progress Energy). Much has been learned about the Pee Dee river population (e.g. habitat use/suitability, migration patterns) since the formation of the TWG (see pervious RRCC annual reports). Currently, robust redhorse are only found downstream from Blewett Falls dam and the TWG is studying the possible reintroduction of robust redhorse upstream of the dam. North Carolina Wildlife Resources Commission with help from Progress Energy has funded a study at North Carolina State University to model the

suitable upstream habitats (located downstream of Tillery Dam). In addition, a separate project at NCSU will look at water quality in Pee Dee River. The results of these studies will help determine our reintroduction options for Robust Redhorse.

Information Technology Technical Working Group – Jaci Zelko

The status of the annual reports, website, and database was relayed to the meeting participants. Jaci asked all participants to check on their latest dataset and send updated copies to be included in the master spreadsheet.

Jaci relayed that the new protocol of each presenter submitting an abstract has greatly streamlined the annual report process. As of this meeting she has completed the 2003, 2004, 2005, 2009 reports and is drafting the 2010 report. These documents need to be uploaded to the RRCC as well as many other pictures and documents. Jaci will work with Ryan to get this accomplished by the next annual meeting.

Habitat Technical Working Group – Alice Lawrence

Alice reported that the group is currently looking for funding options to monitor the gravel augmentation project on the Oconee River.

B U S I N E S S

Research Topics and Resource Needs
A general discussion was held concerning research needs. The following list includes these topics.

- A larval source may be needed in the future for the following projects (carried over from the 2010 Annual Meeting):
    - Determining bottlenecks in certain populations
    - Fish cage experiments concerning inter-sex fish (Produce fingerlings from Pee Dee fish for tag retention and toxicology studies)
    - Larval research concerning Plant Washington
    - Fingerlings to replenish Aquarium stocks
    - Preserved series for Georgia and North Carolina Museums.
    - .
- Genetic characterization of the Georgia population.
- Estimate demographic sizes from all populations.
- Evaluate Yadkin River for additional spawning habitats.
- Continue to monitor the gravel augmentation sites in Oconee River.
- Cryopreservation samples from Savannah and Pee Dee males for repository.
- How to monitor stocked populations to determine sustainability in Georgia when funding runs out?

Update on the 404 Species Petition – Alice Lawrence
The Service received a petition to list 404 southeastern aquatic, riparian, and wetland species from the Center for Biological Diversity in April 2010. Separate settlement agreements with WildEarth Guardians and the Center for Biological Diversity were filed in federal court in May 2011 and July 2011, respectively, requiring the Service to make listing decisions for 700+ species by 2018. The judge ruled on September 9, 2011, approving those settlement agreements. Subsequently, the Service filed a partial 90-day finding addressing the CBD petition on September 27, 2011.

Per the settlement agreements which include a scheduled work plan, the Service agreed to make listing decisions on 251 species that are currently candidates (per the Service's 2010 Candidate Notice of Review), along with other select species, within the next 6 years. Eighteen of the 404 species in the CBD petition are already candidates, so they will be addressed within the next six years. One of the 404 species will be handled by NMFS, because it is under NMFS' jurisdiction. Eleven of the 404 species have not been addressed yet. The Service's 90-day finding states that for the remaining 374 species, the petition presents substantial scientific or commercial information indicating that listing may be warranted. Therefore, the Service is initiating a status review of these species and is soliciting scientific and commercial information regarding these species. The 60-day comment period is now open and ends November 28, 2011. However, 12-month findings on these 374 species, including the robust redhorse, are not scheduled to be

completed within the next 6 years; they will likely follow completion of the court-approved work plan that schedules listing decisions over the next 6 years.

The Service will use information obtained during the public comment period, as well as information contained in the Service's files, for the status review. The RRCC website needs to be updated with a comprehensive list of journal articles, and any gray literature needs to be linked to the website. If someone decides to submit information as part of the public comment period, then it needs to be substantiated with accompanying data, gray literature (or citations to gray literature if it is linked to the RRCC website), and journal articles (or citations to journal articles).

A T T A C H M E N T S

Attendees of the 2010 Meeting:

Last Name	First Name	Organization
Williams	David	S.C. Aquarium
Heise	Ryan	NC WRC
Zelko	Jaclyn	U.S. FWS
~~Eugene~~ Starnes	Wayne	NC Museum Nat. Sci.
Fisk	Michael	NC State
Bowles	Tom	SCE&G
Hailey	Rebecca	NCWRC
Tarpley	Carolyn	SCDNR
Darden	Tanya	SCDNR
Ewing	Todd	NCWRC
Swing	Mike	Progress Energy
Straight	Charlie	UGA
Brown	Jason	Progress Energy
Lawrence	Rick	USFWS
Sessions	Forrest	SCDNR
Rodgers	Angie	NC NHP
Quattlebaum	Milton	SCANA/SCE&G
~~Cecil~~ Jennings	Cecil	USGS
Zimpfer	Steve	UGA
Pruitt	Will	Georgia Coop. / UGA
Jones	Brena	NCWRC
Ely	Patrick	UGA
Deaton	Shannon	WRC
Kwak	Tom	NCSU/USGS
Evans	Jimmy	GADNR/GWRD
Slaughter	Joey	GA Power
Abney	Michael	Duke Energy
Lamprecht	Scott	SCDNR