Report of the Robust Redhorse Conservation Committee Annual Meeting

Hickory Knob State Park
McCormick, South Carolina
October 13-14, 2004

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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 10th 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. This report summarizes updates on management activities, research findings, and conservation efforts and documents decisions made at the 2004 RRCC Annual Meeting. Below are highlights of the meeting held October 13 – 14, 2004 at Hickory Knob State Resort Park in McCormick, South Carolina.

RRCC chairman Greg Looney passed the crown (and RRCC chairman duties) to Ross Self. Ross and other RRCC members thanked Greg for his many years of hard work and leadership in robust redhorse conservation activities. Ross was selected as RRCC Chair and will serve in this role from 2005 to 2006.

During the past year, the RRCC web page (www.robustredhorse.com) has been updated by the IT TWG. The resulting website is much more visually appealing, and updated contact information for many members has been posted. Additional information and changes will continue to be made on a regular basis. The second project under development by the IT TWG is the creation of a master database of robust redhorse capture records. The current plan is to convert Bob Jenkin's Excel spreadsheet into a MS Access database. This conversion will allow for easier searching of records, and for changes of information to be tracked across multiple fields. The IT TWG is currently soliciting suggesting from RRCC members as to what fields of information are needed.

The Oconee TWG is nearing completion of an Oconee River Management Plan (Figure 52), which will be a comprehensive document covering data collected from 1991 to the present. The plan recognizes that alternative interpretations may exist and that some interpretations or conclusions may need to be modified in the future. Thus far, agency reviews have been mostly positive, however there has been some disagreement on data interpretation and the costs of management. The Oconee TWG will meet soon to resolve the differences, and the Oconee River Management Plan is expected to be completed in the next 6 months.

Research priorities for 2005 in each river basin were discussed by all members. Research will be dependent on funding and personnel but each signatory will make efforts to conduct research in each of their designated basins.

The Oconee River's status and implications was discussed by panel discussion led by Bill Bailey. He gave an overview of the work completed and pending work for the Oconee Basin.

INTRODUCTION

The tenth annual meeting of the Robust Redhorse Conservation Committee was held October 13-14, 2004 at Hickory Knob State Park near McCormick, South Carolina. The RRCC was formed by a MOU signed in 1995 to develop and manage a recovery program for the robust redhorse (*Moxostoma robustum*), previously a Category 2 candidate for federal listing under the Endangered Species Act. The RRCC is committed to the recovery of the imperiled robust redhorse throughout its former range. This report is a summary of the management activities and decisions, research results, conservation efforts, and panel discussion presented at the 2004 RRCC Annual Meeting.

The robust redhorse was re-discovered in the Oconee River of Georgia in 1991, the first scientifically verified sighting since the species was described by the naturalist Edward Drinker Cope in 1869. Since 1991, robust redhorse individuals have been found in the Oconee River between Sinclair Dam and Dublin, GA; in a short upper coastal plain section of the Ocmulgee River, GA; in the Savannah River (the boundary between GA and SC) in the Augusta Shoals area and below New Savannah River Bluff Lock and Dam; and in the Pee Dee River, NC below Blewett's Falls Dam. Robust redhorse living today appear to inhabit specialized areas of large rivers which are difficult to sample. However, small numbers of individuals are occasionally found when targeted surveys are conducted. The historic range of the robust redhorse includes Atlantic slope drainages from the Pee Dee River system in North Carolina to the Altamaha River system in Georgia.

It is believed that river impoundments, predation by nonnative species, and habitat deterioration due to sedimentation and water pollution have contributed to the decline of the robust redhorse. Because of the diversity and complexity of these threats, an interdisciplinary recovery approach is needed which includes the experience, expertise, and authority of many agencies and individuals. Additionally, recovery efforts will be enhanced by a close partnership with private industries and government agencies which potentially impacted by and concerned in robust redhorse conservation.

The tenth annual RRCC annual meeting was attended by approximately 40 representatives (see Attachment) of signatory agencies to the MOU, university research affiliates, and other organizations with interest in the robust redhorse and its recovery. The following signatories include: Georgia Department of Natural Resources, South Carolina Department of Natural Resources, North Carolina Wildlife Resources Commission, Georgia Power Company, U. S. Fish and Wildlife Service, U. S. Geological Survey (Biological Resources Division), U. S. Forest Service, U. S. Army Corps of Engineers, Georgia Wildlife Federation, and Georgia Rivers Network. 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, State University of New York Medical Center, and Roanoke College Department of Biology. In addition, representatives of other concerns with interests in the recovery of the robust redhorse include: South Carolina Electric and Gas Company, Santee Cooper Power Company, South Carolina Aquarium, and Natural

Resource Conservation Service. The success of the recovery effort depend greatly on the willingness of RRCC members and others to participate in the annual meeting and in activities throughout the year.

The RRCC annual meeting satisfies one requirement for the conservation of the species as designated in the MOU. It is also the only scheduled time for all interests to assess progress and to establish management decisions to guide recovery efforts in the coming year and beyond. The annual meeting is also a forum in which to explore and debate the scientific and management implications of new research data and results, to debate philosophical viewpoints, and to bring together the collective expertise of fisheries and environmental management professionals. This dialogue includes the best available scientific data on the robust redhorse, which forms the basis for the RRCC's recovery and policy decisions.

This report includes a summary of the research progress, management activities, and conservation effort decisions and presentations made at the 2004 RRCC annual meeting. The presentations made at this year's meeting were organized into five sections: Collections, Surveys, and Status reports from the past year; Research Updates; reports from each Technical Working Group; a panel discussion of the Oconee River Status and Management Implications; and a discussion of robust redhorse research needs for the coming year and beyond.

Committee Business Notes

Greg Looney, RRCC chair, opened the 2004 annual meeting by welcoming everyone and inviting all participants to introduce themselves to the other attendees. Ross Self, incoming RRCC chair, thanked the sponsors of the meeting: Duke Power, PBS&J, and South Carolina Power. Ross also announced that the South Carolina chapter of the American Fisheries Society had offered to manage funds for the RRCC, and attending members approved this proposal.

Jay Troxel and Jeff Isley, who had offered at the last annual meeting to design and order a 10th Anniversary RRCC t-shirt announced that a shirt has been designed and will be sold via email shortly for an estimated cost of $10.

After the conclusion of presentations and panel discussion on October 14th, RRCC chairman Greg Looney passed the crown (and RRCC chairman duties) to Ross Self. Ross and other RRCC members thanked Greg for his many years of hard work and leadership in robust redhorse conservation activities.

MANAGEMENT ACTIVITIES

OCONEE CAPTURES 2004 – Jimmy Evans, GA DNR

Oconee Broodfish Captures

During the 2004 spawning season, 29 robust redhorse were collected from the Oconee River between Toomsboro and Dublin, GA (Figure 1) in order to provide broodfish for hatchery production of robust redhorse fingerlings. Of the 29 captures, 6 fish were captured 2 or more times, and 6 fish (1 male, 1 female, 2 immatures; 18% of total) were hatchery raised individuals which had been stocked into the river in previous years. The remaining 18 individuals (12 males, 6 females) were wild spawned. Overall, 72% of fish were recaptures from previous sampling efforts, including a 67% recapture rate of wild spawned fish. The total effort for 2004 involved 29.3 hours of electrofishing over 10 days, leading to an efficiency of 0.98 fish captured/hour of effort (0.61 wild spawned fish/hour). Figure 2 shows the declining catch rate of robust redhorse in the Oconee River since intensive surveys were begun in 1993.

Figure 1. Spawning sites on the Oconee River

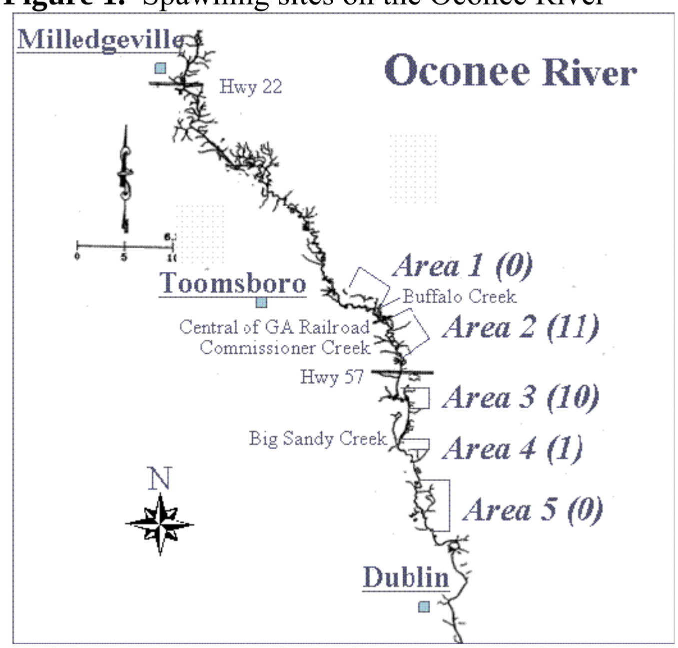


Figure 2. Electrofishing catch rates.

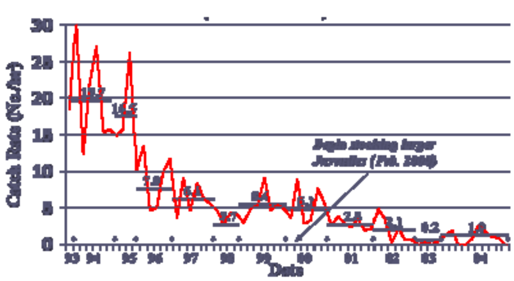
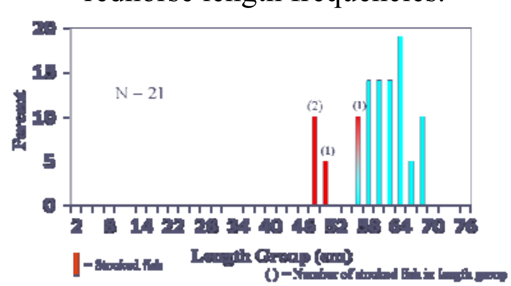


Figure 3. 2004 Oconee River robust redhorse length frequencies.



The captured fish had a length distribution shown in Figure 3, and are compared to captures from previous years in Figure 4. As shown in these two figures, over time there has been a shift toward older, larger fish. However, in 2004 there were a number of smaller fish captured, though they were all recaptured stocked fish.

The small number of individuals captured this year has lead to a slightly lower population size estimates. Figure 5 shows the mark-recapture population estimates over the past decade plotted on the same graph with hourly electrofishing catch rates. For the years 2001-2003, the estimated population size in the Oconee River has been consistently about 100-125 robust redhorse, a reduction from the 300-500 estimated for 1995-2000. A similar reduction in fish caught per hour has been seen during the same time period. The Jolly-Sever demographic population model prepared by Cecil Jennings estimates that a population of about 175 individuals will be maintained over time (mean annual survival for 1995-2003 is 0.7, estimated survival for 2002-2003 is 0.1, mean estimated annual number of new births entering the population for 1995-2003 is 41, estimated number of new births for 2002-2003 is 8). Figure 6 compares estimated population sizes based on data collected up to 1998, 2001, and 2003. Each line represents the average values for 200 model replicates.

Figure 4. Annual length distributions.

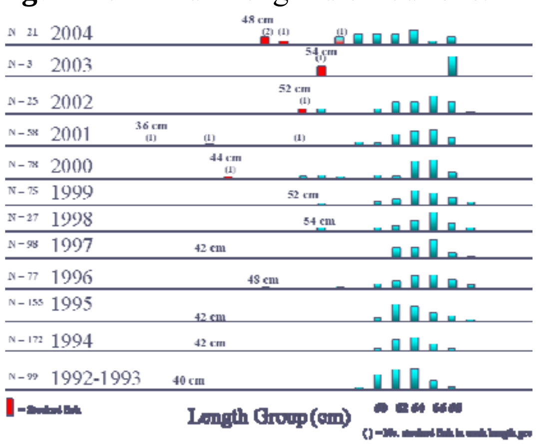


Figure 5. Comparison of population size estimate and electrofishing catch rate.

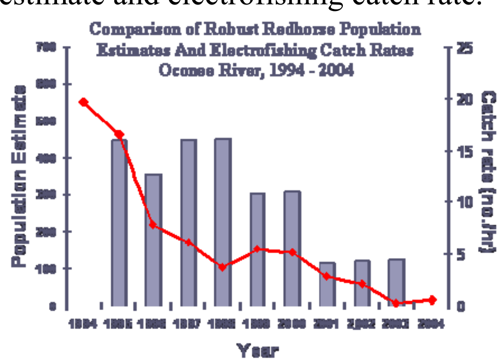
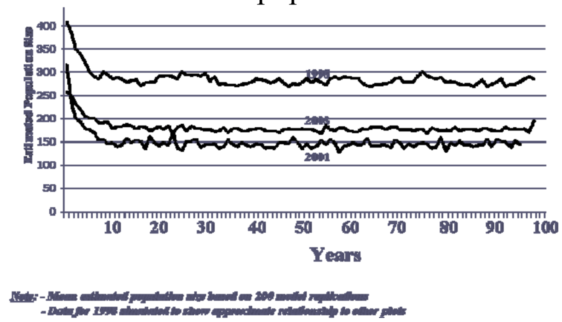


Figure 6. Estimated long term robust redhorse population sizes.



Oconee Status Survey Captures

An intensive robust redhorse scouting survey was carried out from April 12-16, 2004 along the Oconee River from Highway 22 at Milledgeville to Dublin, GA. The objectives of this survey were to assess the abundance and distribution of robust redhorse throughout this range of the Oconee River, to improve broodfish collection efficiency, and to perform a qualitative habitat assessment. Overall, 70 river miles were surveyed, with 8 robust redhorse captured during 22.7 hours (Table 1). All fish were captured in known locations, which may indicate a limited amount of high quality habitat for robust redhorse in the Oconee River. Of the new recruits captured (untagged fish <550mm), 50-60% appear to be stocked. Robust redhorse found in this survey were associated with meander sections of the river near gravel deposits, and they seem to be confined to three small areas of the river. These factors, combined with an extremely low electrofishing catch rate suggests a small, isolated population.

Oconee River Stocking

Between 2000 and 2002, 240 robust redhorse fingerlings (Phase II or older) have been stocked into the Oconee River (Table 2). All stocked fish have PIT tags, and were released in equal numbers at four sites between Milledgeville and Dublin. Ten of the 240 stocked fish have been recaptured between 2000 and 2004 (Table 3), with details of each recapture given in Table 4. Many of the recaptured stocked fish had moved long distances from their stocking sites, and all had shown significant growth.

Table 1. Oconee River status survey results.

Sampling Area	No. RMs	Sampling Crew	Sampling Dates	Habitat Quality*	EF Effort	Robust redhorse Collected	CPUE (no/hr)
Hwy 22 at Milledg. to begin. of meanders opp. Gin House Lake	9	GA Coop Unit (Jennings/ ___)	12 – 13 April 04	Fair 20% Poor 80%	3.8	0	0
Beginning of meander section opposite Gin House Lake to Avant Kaolin Mine ramp	11	GADNR (Evans, Clark)	15 Apr 04	Excellent 10% Good 20% Fair 30% Poor 30%	2.8	3	1.1
Avant Kaolin Mine ramp to mouth of Big Black Creek	10	GADNR (Evans/Scarbrough)	14 Apr 04	Excellent 80% Good 20	3.2	2	0.6
Mouth of Big Black Creek to beginning of meander section just above Hwy 57	10	Georgia Power Co. (Abney, Broadwell, Estep)	15 Apr 04	Excellent 50% Good 30% Fair 10% Poor 10%	4.2	1	0.2
Hwy 57 to boat ramp on east side below Beaverdam WMA	9	GADNR (Evans, Clark)	13 Apr 04	Excellent 20% Good 10% Fair 10% Poor 60%	3.4	1	0.3
Boat ramp on east side below Beaverdam WMA to Dublin Country Club ramp	11	GADNR (Evans, Clark)	16 Apr 04	Excellent 20% Good 20% Fair 10% Poor 50%	3.1	1	0.3
Dublin Country Club ramp to Dublin Sportsman's Club ramp	10	Georgia Power Co. (Abney, Broadwell, Estep)	16 Apr 04	Fair 20% Poor 80%	2.2	0	0
Totals	**70**	-	-	-	**22.7**	**8**	**0.3**

* **Based on gravel abundance and quality, depth and velocity distributions, and amount and type of woody debris.**

Table 2. Robust redhorse stocked in the Oconee River.

Date Stocked	Location (Oconee R.)	Year Class	Number Stocked	Average Length (mm)	Average Weight (g)
23 Feb. 2000	Hardwick, Balls Ferry, Beaverdam WMA	1995 1997 1998	36 54 2 92	362 (14 in.) 283 (11 in.) 258 (10 in.)	615 (1.4 lbs) 293 (0.6 lbs) 225 (0.5 lbs)
9 Mar. 2001	Hardwick	1997 1999	5 17 22	334 (13 in.) 212 (8 in.)	466 (1.0 lbs) 119 (0.3 lbs)
19 Mar. 2001	Balls Ferry	1995 1997 1999	10 7 1 18	361 (14 in.) 292 (11 in.) 258 (10 in.)	573 (1.3 lbs) 282 (0.6 lbs) 200 (0.4 lbs)
9 Jul. 2001	Avants, Beaverdam WMA	1998 1999	4 41 45	274 (11 in.) 241 (9 in.)	239 (0.5 lbs) 172 (0.4 lbs)
19 Mar. 2002	Avants	2000	26	286 (11 in.)	302 (0.7 lbs)
28 Mar. 2002	Beaverdam WMA	2000	15	215 (8 in.)	130 (0.3 lbs)
17 Dec. 2002	Balls Ferry	2002 1997	21 1 22	268 (11 in.) 435 (17 in.)	238 (0.5 lbs) 885 (1.9 lbs)
Totals	—	1995 1997 1998 1999 2000 2001	46 67 6 59 41 21 240	361 (14 in.) 288 (11 in.) 272 (11 in.) 234 (9 in.) 260 (10 in.) 268 (11 in.)	606 (1.3 lbs) 305 (0.7 lbs) 235 (0.5 lbs) 158 (0.3 lbs) 239 (0.5 lbs) 238 (0.5 lbs)

Table 3. Annual recaptures of stocked fish from the Oconee River.

Year	No. of Stocked RRH (Cumulative)[1]	No. Stocked RRH Captured (No./hr)	Percent Stocked RRH Recaptured	Total No. RRH Captured (No./hr)[2]	Percent of Sample from Stocked Fish	No. New Recruits	No. New Recruits from Stocked Fish	Percent New Recruitment from Stocked Fish
2000	92 (95, 97, 98 yc)	1 (0.06)	1.1	70 (5.1)	1.4	4	1	25
2001	132 (95, 97, 98, 99 yc)	3 (0.14)	2.3	46 (2.8)	6.5	4	3	75
2001, 2002	218 (95, 97, 98, 99, 00 yc)	1 (0.08)	0.5	25 (2.1)	4.0	4	1	25
2003	240 (95, 97, 98, 99, 00, 01 yc)	1 (0.08)	0.4	3 (0.2)	33.3	1	1	100
2004	240 (95, 97, 98, 99, 00, 01 yc)	4 (0.14)	1.7	22 (1.0)	18.2	3	3	100
Totals	240	10	4.2	166	6.0	16	9	56

[1] Prior to sampling in April-May of each year

[2] All sampling conducted during broodfish collection efforts in April-May

Table 4. Recapture details.

Year Class	Date Stocked	Date Collected	Len. at Stocking (mm)	Len. At Recap.(mm)	Growth (mm)	Stocking Wt. (g)	Recap. Wt. (g)	Growth (g)	Distance From stocking site (km)
1995	23 Feb 00	2 May 00	425 (16.7 in)	436 (17.2 in)	11 (0.4 in)	1,120 (2.5 lbs)	1,320 (2.9 lbs)	200 (0.4 lbs)	2.1 (1.3 mi) Up
1995	23 Feb 00	1 May 01[1]	410 (16.1 in)	510 (20.1 in)	100 (3.9 in)	900 (2.0 lbs)	2,500 (5.5 lbs)	1,600 (3.5 lbs)	7.5 (4.7 mi) Up
1997	23 Feb 00	1 May 01	272 (10.7 in)	421 (16.6 in)	149 (5.9 in)	234 (0.5 lbs)	1,160 (2.5 lbs)	926 (2.0 lbs)	61.3 (38.1 mi) Down
1995	NA	7 May 01	NA	360 (14.2 in)	NA	NA	860 (1.9 lbs)	NA	NA
1995	23 Feb 00	1 May 02[1] 7 May 02[1]	410 (16.1 in) 410 (16.1 in)	547 (21.5 in) NA	137 (5.4 in) NA	900 (2.0 lbs) 900 (2.0 lbs)	3,000 (6.6 lbs) NA	2,100 (4.6 lbs) NA	4.0 (2.4 mi) Down 4.0 Down
1997	23 Feb 00	4 June 03	290 (11.4 in)	540 (21.3 in)	250 (9.9 in)	290 (0.6 lbs)	1,400 (3.1 lbs)	1,110 (2.5 lbs)	35.5 (22.1 mi) Down
1995	19 Mar 01	26 Apr 04[1] 5 May 04[1] 10 May 04[1]	371 (14.6 in) - -	503 (19.8 in) - -	132 (5.2 in) - -	620 (1.4 lbs) - -	2020 (5.8 lbs) - -	2000 (4.4 lbs) - -	61 (38 mi) Down 53 (33 mi) Down 61 (38 mi) Down
2000	28 Mar 02	3 May 04	208 (8.2 in)	486 (19.1 in)	278 (10.9 in)	122 (0.3 lbs)	2130 (4.7 lbs)	2008 (4.4 lbs)	6 (4 mi) Up
2000	19 Mar 02	3 May 04	285 (11.2 in)	486 (19.1 in)	201 (7.9 in)	310 (0.7 lbs)	2030 (4.5 lbs)	1720 (3.8 lbs)	47 (29 mi) Down
1995	19 Mar 01	3 May 04	391 (15.4 in)	564 (22.2 in)	173 (6.8 in)	725 (1.6 lbs)	3800 (8.4 lbs)	3075 (6.8 lbs)	53 (33 mi) Down

Questions & Comments

Are stocked and wild juveniles found at the same locations?

- Yes, and they seem to be spawning together.

Describe the hook and line robust redhorse captures.

- There were 2 reported hook and line captures of robust redhorse by anglers this year. The first was caught with a shrimp, was held in a live well, then was turned over to a survey team on the river, was held at the spawning site, and was re-released to the Oconee. The second fish was caught with a worm, and was described to officials as “a carp with plastic in the stomach”.

What is the sampling efficiency on the Oconee?
- Most 2004 captures occurred where there was good habitat. More captures were made in shallow areas, but there were few river sections that were likely to have been too deep to sample this spring due to low river flow rates.

Were stocking or environmental perturbations included in the Jolly-Sever population model?
- No, that model only uses a steady-state environment.

What was the total surveying time for the Oconee this year?
- About 50 hours.

Were any fish captured more than once in 2004?
- Yes, one fish. Perhaps fish aren’t recaptured within the same year more frequently because of behavioral or environmental changes during the spring.

Does the clustering of robust redhorse in certain river sections occur only during the spawning season? In the Savannah River in September and October they spread out.
- Georgia Power crews found robust redhorse in meander sections even during non-spawning times of the year. One problem is that electrofishing is ineffective in 15-20+ feet of water, making some stretched difficult or impossible to survey effectively.

OCONEE RIVER SPAWNING EFFORT–Jaci Zelko, Jay Shelton, and Haile Macurdy USFWS

Fish were captured from the Oconee River and delivered to the riverside spawning facility at the Beaverdam Wildlife Management Area from the week of April 26 to the week of May 10, 2004. Overall, six females and 17 males were captured. Sixteen males gave sperm, and 3 females were crossed with 10 of these males, for a total of 97,048 fertilized eggs. The spawning condition of fish captured during the first two weeks was good, but declined significantly in the third week.

During the week of April 26, 2004, two females and 7 males were captured. The females had soft abdomens, 90-100% mucus loss, and enlarged genital domes. Neither female was injected with Ovaprim, but one naturally spawning female gave 12,064 eggs, which were divided into 3 lots, with each lot fertilized by a different male. The males captured during the first week had hard tubercles, 90-100% mucus loss, flowing milt, and showed evidence of sparring (external lesions and lost scales). Six of the 7 males gave sperm (initial motility 95-100%).

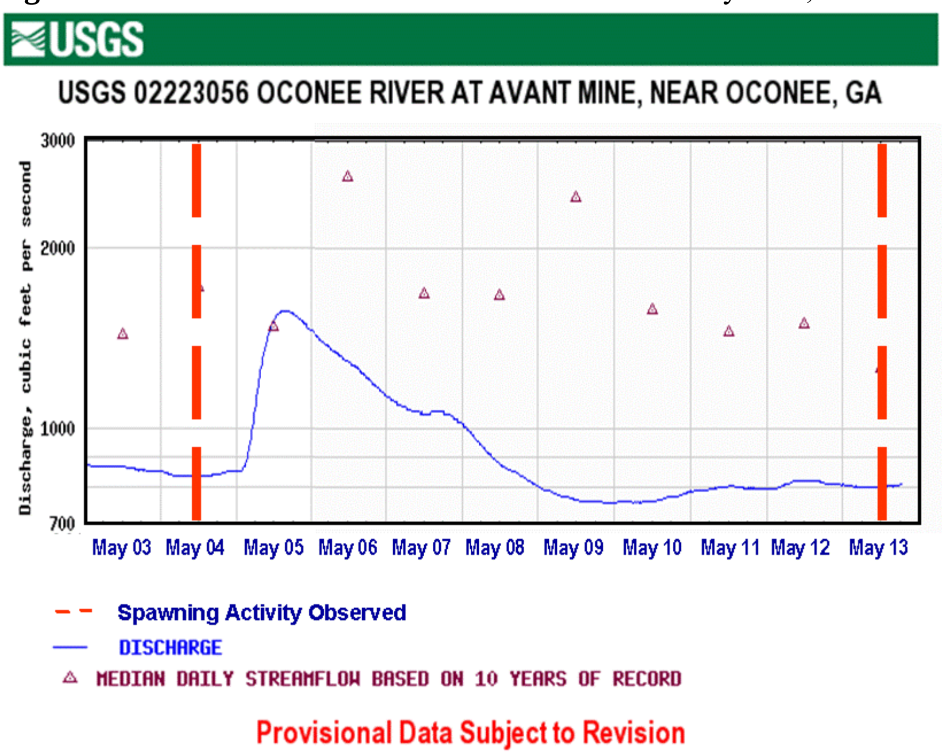
In the week of May 3, 2004, two females and 8 males were captured. The females had hard semi-hard abdomens, 80-100% mucus loss, and no genital dome enlargement. Both females were injected with Ovaprim, which resulted in female #697/698 giving 44,364 eggs over two days, and female #1468/1469 giving 39,960 eggs over two days. Most of

the 8 males had hard tubercles, 10-100% mucus loss, flowing milt, and showed evidence of sparring. All 8 males gave sperm (initial motility 80-100%).

During the week of May 10, 2004, two females and two males were captured. The females had hard abdomens, 10-90% mucus loss, and no genital dome enlargement. Both were injected with Ovaprim, but no eggs were collected. The two males had some tubercles, 10% mucus loss, flowing milt, and less evidence of sparring. Both males gave sperm (initial motility 95-100%).

A spawning aggregation of robust redhorse in the wild was observed at the Avant Mine site on May 4 and 13, 2004. As seen in Figure 7, both dates correspond with reduced flow rates, emphasizing again the importance of low, stable flows to the spawning of robust redhorse in the wild and the disruption caused by sudden changes. The aggregation observed this year was made up of approximately 8-13 fish, down from the 30-40 observed in previous years at the same site.

Figure 7. Oconee River flow rate at Avant Mine for May 3-13, 2004.



Questions & Comments

This year had very good collections (i.e. low stable flow, proper temperatures), yet few fish were found.

No cleaned gravel, fewer mud streaks, and less gravel churning were observed on the gravel beds at the Avant Mine spawning site, which may be indications of lower spawning intensity. However, it is also possible that not enough time was spent at that location observing spawning or that the optimal spawning window was missed by either

the day or time of day. Staging behavior for spawning was definitely observed, with males fighting for territory, males chasing females, and females moving up and down in the spawning area. Additionally, staging further downstream could have been disrupted by collecting activities below Avant (i.e. fish collected on their way to the spawning site might not continue to the spawning site after being collected).

Are gravel bars consistent?

- The quality and size of gravel bars appears to be the same between years, but flood and drought conditions seem to shift their locations somewhat.
- There has been a change in the distribution of spawning sites. In 2001, there were 5 known aggregations; in 2004 only 3 were found.
- Fish seem to stage in a deep pool, the move upstream to a gravel bar to spawn.

CRYOPRESERVATION OF ROBUST REDHORSE SPERM AT WARM SPRINGS– Jaci Zelko, USFWS

During the 2004 spawning season, sperm from 8 new Oconee (Table 5) and 15 new Savannah (Table 6) robust redhorse males were added to the repository at Warm Springs. In total, there are now 1,324 straws of sperm from 39 Oconee males (974 repository, 350 research) and 570 straws of sperm from 25 Savannah males in the repository.

Table 5. 2004 Oconee River cryopreservation records.

Initial Motilities of samples 40-100% with most samples 75-100%

PIT Tag #	Floy Tags	# Straws	Date
403378187B	1531/1529	100 straws	4-29-04
5019753814	1632/1633	100 straws	4-29-04
403366306E	1413/1412	60 straws	4-30-04
4033742B4A	1451/1598	60 straws	4-30-04
442F220B04	1467/1466	100 straws	5-7-04
40340A484E	1542/1382	75 straws	5-9-04
414C526F7C	1462/1463	100 straws	5-9-04
40336F5263	1464/1465	98 straws	5-10-04

Table 6. 2004 Savannah River cryopreservation records.

Initial Motilities of samples 40-90% with most samples 50-100%

PIT Tag #	# Straws	PIT Tag #	# Straws
4034036745	30 straws	45575A3895	30 straws
4557726C18	30 straws	45512C6047	30 straws
4567511071	30 straws	403407020A	30 straws
456747731B	30 straws	40336B081A	30 straws
4567393564	30 straws	4557626D57	30 straws
4567321779	30 straws	45684E012D	30 straws
7F7D1E582F	30 straws	4557773442	30 straws
#15	30 straws		

HATCHING SUCCESS AT WARM SPRINGS AND MCDUFFIE STATE HATCHERY – Haile Macurdy, USFWS

Warm Springs National Fish Hatchery received fertilized eggs from the Oconee River field collecting station between April 27th and May 10th 2004. A total of 61,229 eggs were received, and a total of 24,271 fry hatched (39.6%). Of these, 18,835 fish 18 to 33 days post hatch, were distributed (77.6%), averaging 0.6 to 0.8 inches in length. For details of fry production, see Table 7 below.

Average water quality parameters during egg incubation and fry culture included water temperatures averaging 23°C, pH of 6.9, and hardness of 40ppm. Brine shrimp were hatched and fed to the fry four times daily between May 10th and June 1st. A sample of fry was examined microscopically for external parasites prior to distribution, but none were found.

The 18,835 fry distributed on June 2nd, 2004, totaled 564 grams and averaged 33.4 fish per gram. These fish ranged in age between 18 and 33 days post hatch. The fry were transported to Richmond Hill and Walton State Fish Hatcheries by UGA personnel. Fish were shipped via freight transport boxes (14) with uniform mixing of the crosses into each shipping box. Each pond received a uniform mixing of the crosses.

Table 7. Robust redhorse fry culture at Warm Springs National Fish Hatchery, 2004.

Spawn Date	Female #	Male #	% Hatch	# Fry Produced		#Fry Distributed	Fish /Gram 5/30/04
4/27	WILD	5056	65%	2,588		1,818	
4/27	WILD	306E	58%	2,187		1,537	
4/27	WILD	187E	60%	2,591		1,821	
				-------		-------	
				7,366	70.27%	5,176	25.4
5/7	697/698	1467/1466	100%	760		585	
5/7	697/698	1382/1542	96%	2,223		1,806	
				-------		-------	
				2,983	80.25%	2,391	28.4
5/8	697/698	1462/1463	61%	1,923		1,482	
5/8	697/698	1452/1534	0.6%	20		15	
5/8	697/698	1529/1531	0.6%	20		15	
5/8	697/698	1466/1467	1.1%	30		24	
5/8	697/698	1632/1633	0.7%	20		15	
				-------		-------	
				2,013	77.06%	1,551	32.0
5/9	1468/1469	1632/1633	97%	1,816		1,622	
5/9	1468/1469	1466/1467	65%	1,759		1,572	
5/9 #	1468/1469	1542/1382	100%	2,454		2,192	
5/9	1468/1469	1452/1534	41%	1,168		1,043	
5/9 *	1468/1469	1462/1463	20%	512		457	
				-------		-------	
				7,709	89.33%	6,886	43.9
5/10 #	1468/1469	1542/1382	7.9%	280		188	
5/10	1468/1469	1464/1465	81%	2,800		1,889	
5/10*	1468/1469	1462/1463	3%	280		188	
5/10	1468/1469	1529/1531	44%	840		566	
				-------		------	
				4,200	67.38%	2,831	40.6
				---------	-------	-------	------
		Total for all crosses:		24,271	77.6%	18,835	33.42

notes: #, * Indicates identical brood pairings on separate days.

Distributions to each station and pond from Warm Springs NFH are listed in Table 8. The ponds at Richmond Hill were also stocked with fry hatched at and distributed from McDuffie SFH in the preceding week. Those numbers are not included in Table 8.

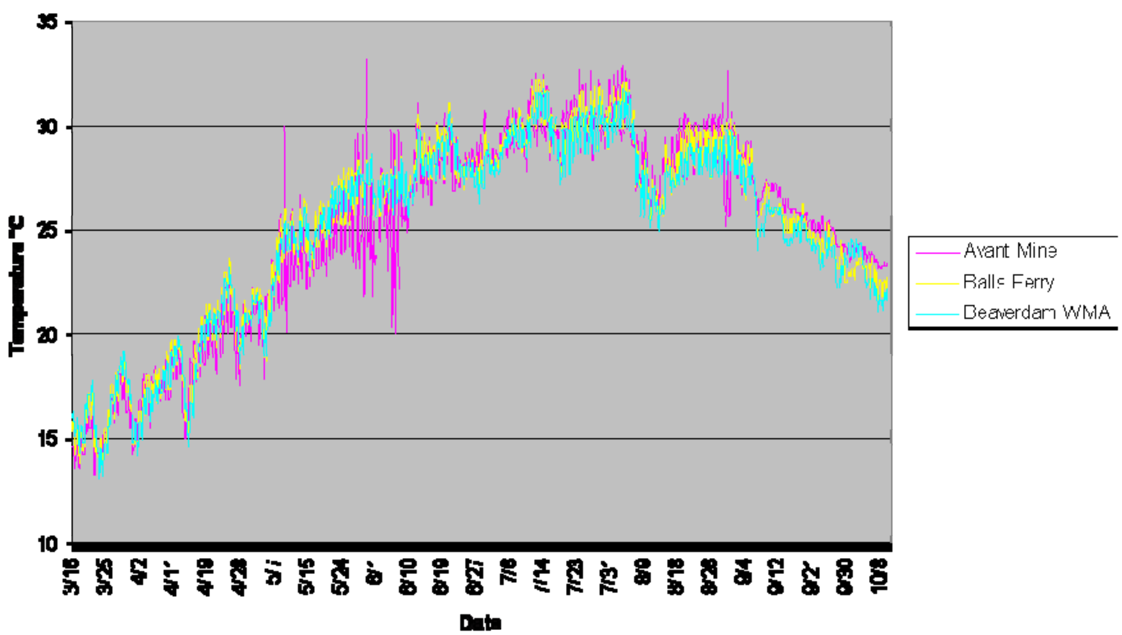
Table 8. Distribution of robust redhorse fry from Warm Springs NFH, 2004.

Location:	Pond Size:	Fry Stocked:	Stocking Rate per Acre
Walton	0.45 acres	8,837 fry	19,638
Rich. C 11	0.20 acres	1,604 fry	8,200
Rich. C 12	0.20 acres	1,814 fry	9,070
Rich. C 13	0.30 acres	2,521 fry	8,403
Rich. C 14	0.30 acres	2.521 fry	8,403
Rich. B-8	0.60 acres	1,538 fry	2,563
	------------	-----------	
	2.05 acres	18,835 fry	

OCONEE AND OCMULGEE RIVER TEMPERATURES FOR 2004 – Mike Abney, GPC

Gauges collected temperature data in 1-hour intervals at three sites in the Oconee River (Figure 8) and 2 sites in the Ocmulgee River. A severe washout on the east side of the Oconee River at Avant below the gravel bar may have affected some readouts.

Figure 8. 2004 Oconee River Temperatures.



GENETICS UPDATE – Beth Dakin, UGA

As in previous years, Anthony Fiumera (Cornell University) has carried out computer simulations which estimate the effective population size (N_e) of the stocked robust redhorse in the Oconee, Ocmulgee, and Ogeechee Rivers. The current status of stocked fish in the Oconee, Ogeechee, and Ocmulgee Rivers is summarized by Table 9, which was distributed at the meeting. Tables 10-12 provide results of simulations assuming that different numbers of phase I individuals from the 2004 crosses are stocked in these three rivers. The maximum average effective population size is highlighted for each river, and the corresponding value in the first column represents the number of 2004 phase I fingerlings that will maximize the genetic diversity of the population. For 2004, the genetically recommended numbers to be stocked are 100 for the Oconee River, 2500 for the Ocmulgee River, and 6000-6500 for the Ogeechee River.

Table 9. Effective population size of each year class, the "ideal" stocking proportion to maximize N_e, and current stocking proportions in each river.

			Current Stocking Proportions[2,3]		
Year Class	N_e	Ideal Stocking[1]	Oconee	Ogeechee	Ocmulgee
1993	2.0	0.02	0.0	0.0	0.0
1994	0.0	0.00	0.0	0.0	0.0
1995	20.7	0.18	0.21	(0.0)	(0.0)
1996	0.0	0.00	0.0	0.0	0.0
1997	19.1	0.17	0.30*	(0.04)	0.20
1998	7.7	0.07	0.03	0.10	0.24*
1999	25.7	0.23	0.27	0.24	0.21
2000	20	0.17	0.13	0.19	(0.11)
2001	3.5	0.03	0.07	0.18*	0.09*
2002	7.3	0.06	(0.0)	0.24*	0.16*
2003	0.0	0.00	0.0	0.0	0.0
2004	6.7	0.06	-	-	-

[1] Ideal stocking proportions assuming all year classes can be stocked at their respective ideal levels

[2] Current stocking proportions assuming phase II and phase III survival are respectively 5 and 7 times higher than phase I survival.

[3] Numbers followed by * indicate that the current stocking proportions for that river are higher than the "ideal levels" by more than 0.05. Numbers in ( ) indicate that the current stocking proportions for that river are lower than the "ideal levels" by more than 0.05. 0.05 is arbitrary.

* The effective population size (N_e) is a measure that indicates the amount of genetic diversity that should be preserved in the population. More genetic diversity will be preserved in populations with higher effective sizes.

Table 10. Effective population size (N_e) for stocked component of the Oconee River population under different stocking scenarios assuming different numbers of phase I individuals from the 2004 year class are stocked. Assuming a relative survival rate of 1, 5, 7 for phase I, phase II and phase III, respectively.

Number phase I 2004 year class stocked	Mean N_e
0	88.1
5	88.3
10	89
25	90.7
50	92.4
100	95.3
150	95.2
200	92.9
250	90.5
300	86.1
400	77.5
500	68.7
1000	38.5
5000	12.4
10000	9.7

Table 11. Effective population size (N_e) for stocked component of the Ocmulgee River population under different stocking scenarios assuming different numbers of phase I individuals from the 2004 year class are stocked. Assuming a relative survival rate of 1, 5, 7 for phase I, phase II and phase III, respectively. All standard deviations are < 1.0.

Number phase I 2004 year class stocked	Mean N_e
0	61.4
5	61.3
10	61.5
25	61.5
50	61.7
100	62.1
150	62.4
200	62.6
250	63
300	63.3
400	63.7
500	64.4
1000	66.5
1500	68
2000	68.7
2250	68.7
2500	68.8
2750	68.3
3000	68.1
5000	61.5
10000	42.4

Table 12. Effective population size (N_e) for stocked component of the Ogeechee River population under different stocking scenarios assuming different numbers of phase I individuals from the 2004 year class are stocked. Assuming a relative survival rate of 1, 5, 7 for phase I, phase II and phase III, respectively. All standard deviations are < 1.0.

Number phase I 2004 year class stocked	Mean N_e
0	49
5	49.1
10	49.1
25	49.1
50	49.2
100	49.3
150	49.5
200	49.5
250	49.6
300	49.8
400	50
500	50.2
1000	51.2
2000	53
3000	54.5
4000	55.5
5000	56.2
5500	56.3
6000	56.4
6500	56.4
7000	56.3
10000	54.5

Another issue which has been brought up in the past few years is the possibility of using stocked fish as broodfish for the production of more fry. To this point, only wild-spawned fish have been used to produce fry, but due to the fact that most new recruits seem to be hatchery-raised, it may become necessary to use stocked fish in the future. Although estimating the effect on genetic diversity of using stocked fish as broodstock is very difficult to estimate precisely, Anthony Fiumera made an initial attempt to evaluate the effect of adding varying numbers of progeny from crosses between 1 male and 1 female, 2 males and 2 females, and 4 males and 4 females. Results shown in Table 13 show that the effective population size is never increased by stocking progeny from broodfish of stocked origin. While stocking fewer than 100 fish from such crosses causes only slight reductions in N_e, larger numbers of fingerlings can result in drastically lower N_e, and the standard error associated with 100 or more fingerlings also increases rapidly, suggesting that even further reductions in N_e could be likely. Due to the fact that genetic diversity is never increased by using stocked fish as broodfish and the potential reduction of N_e, it is the suggestion of the geneticists (Anthony Fiumera, Beth Dakin, Brady Porter) that only wild spawned fish be used for brood fish if at all possible.

A final genetic item of interest to the RRCC is that microsatellite markers have been developed for the copper redhorse. Because the robust redhorse is closely related to the copper, many of these 21 markers (16 polymorphic) should work, reducing the initial cost of many potential genetic studies by several thousand dollars. Microsatellite markers are an appropriate genetic marker to use for the identification of individuals or close relatives (i.e. parentage, comparisons of populations). Full technical details can be found in Lippe *et al.* 2004, Molecular Ecology Notes 4(4):638-641.

Table 13. Effective population size (N_e) for stocked component of the Oconee River population under stocking scenarios assuming different numbers of phase I individuals produced from captive broodstock are used. Assuming a relative survival rate of 1, 5, 7 for phase I, phase II and phase III, respectively.

Number phase I captive broodstock progeny stocked	1Male/1Female		2 Males/2 Females		4 Males/4 Females	
	Mean N_e	Standard Deviation	Mean N_e	Standard Deviation	Mean N_e	Standard Deviation
0	87.9	4.1	88	4.1	88.1	3.6
5	87.9	4	88	4.1	88	3.7
10	87.9	4.3	88	3.7	87.9	3.7
25	87.8	4.2	87.8	4.9	88	4.3
50	86.8	6.2	87.3	5.9	87.8	4.9
100	83	10	84.3	12.4	86	9
150	76.8	16.4	80	23.2	83.5	15.2
200	70.4	19.5	75.2	31.7	79.9	23.4
250	64.4	18.9	70.2	39.4	76.1	34
300	58	19.5	64.7	50.6	72.5	36.3
400	48	16	56	52.9	64.6	49.6
500	40	14.7	48.4	52.3	58	56.9
1000	21.4	3.2	27.8	31.2	37	44

Questions and Comments

Should there be some sort of compromise between effective population size and census size in stocking decisions?
- Yes, but it’s not clear how much.

How did you estimate a relative survival of 1, 5, 7 for the stage I, II, and III fry (Tables 10-12) and what does that mean?
- It’s a best guess estimate, and means that we assume in the model that stocking 1 stage III fingerling is equivalent to stocking 7 stage Is, for example.
- As yet, we don’t have enough data to accurately estimate the survival of stocked stage I vs. stage II.

OCONEE STOCKING RECOMMENDATIONS – Jimmy Evans, GA DNR

During the past year, Walton and Richmond Hill ponds produced large numbers of robust redhorse fingerlings. Currently, plans call for 3000-4000 to be stocked in the Ocmulgee River and 6000-10000 to be stocked in the Ogeechee. Additionally, 300-500 will be transferred to Piedmont from Richmond Hill. This leaves about 3000 fingerlings which could potentially be stocked into the Oconee River.

Discussion

Is there a specific recommendation from the RRCC as to how many phase I fingerlings should be stocked into the Oconee River, or can the GA DNR interpret the stocking recommendations made by the geneticists on their own?

- Guidelines exist in the RRCC Policies for disagreements between members and the committee. If the GA DNR chooses not to follow the recommendations, they should submit a letter to the Excom explaining their position and what actions were taken.
- Stocking the genetically-recommended 100 fingerlings is not acceptable to the GA DNR, but perhaps a compromise of 400-1000 fish would be okay. Is an effective population size reduction of 20% acceptable?
- The long term effects of such a decision need to be considered: reducing the effective population size in one year makes it more difficult to increase it in years to come. It will also be several years until the effects of this stocking are even seen.
- There is concern over whether broodfish will be available in coming years with which to create fry to stock.
- The implication of the RRCC Policy is to stock the number of fish needed to maximize the effective population size.
- Motion by Mike Nichols: Vote on whether the committee approves the stocking of 250 phase I fish (2004 year class) this fall; seconded by Tim Grabowski.
    - Motion passed: 20 yes, 3 no.

What is the purpose of Anthony Fiumera's tables of stocking scenarios? Are these recommendations or suggestions?

- Some committee members believe that these numbers should be the stocking recommendation of the RRCC, while others note that the numbers provided by geneticists are no more accurate than other sources of data.
  - These numbers represent the best available estimates.

Large numbers of fish have been stocked into the Ocmulgee. Is migration into the Oconee possible?

- No evidence for that has been seen yet.

Motion by Cecil Jennings: Proposal that the ExCom will develop or rewrite RRCC Policy Appendix 2 before the 2005 RRCC Annual Meeting to become an official stocking recommendation policy; seconded by Jaci Zelko. Motion passes with 1 dissent.

SAVANNAH RIVER SPAWNING 2004 – Forrest Sessions, SCDNR

A progress report on South Carolina's recovery effort goals was presented. The first goal, to determine the status of robust redhorse in the Santee River, was addressed by extensive sampling in this river system (Congaree, Wateree, and Broad River below Parr Shoals). Despite good conditions and 0.4 hours of electrofishing time per river mile, no robust redhorse were captured. The Congaree and Wateree have now been sampled over the course of two summers, and gravel bars were targeted during the spring when water temperatures were appropriate for redhorse spawning. This extensive surveying without any robust redhorse sightings strongly suggests that there are no remnant populations in the Santee drainage.

The second goal was to establish a self-sustaining population of robust redhorse in the Broad River of South Carolina. The first objective towards achieving this goal was to build stakeholder interest and support for the project. Thus far, the proposal for reintroducing robust redhorse to the Broad River has been presented to the Wildlife and Freshwater Fisheries Advisory Board, the Heritage Trust Advisory Board, the RRCC, the SC Fishery Workers Association, the Scenic Broad River Committee, SCEG, and SCANA. So far, the proposal has been met with a good response.

The next objective toward reestablishing robust redhorse in the Broad River is to produce the fingerlings to be stocked. In 2002 and 2003, no eggs were collected, but in 2004 6 females and 15 males were crossed (each female was crossed with 3 separate males) to produce 30,000 larvae. The fish are currently growing in DWC rearing ponds, and are scheduled to be harvested and stocked in November 2004. At that time, phase I fish (~80% of total) will be released in 2 areas in the Broad River, SC near Parr Shoals. About 20% will be retained to stock as phase II fingerlings in the fall of 2005. All stocked fish will be differentially marked with coded wire tags in order to later identify their stocking location. In addition, phase II fish will have PIT tags. Sampling in stocked areas to evaluate stocking success will begin in 2005.

Questions and Comments

What are the feelings on stocking Savannah crosses back into the Savannah River?

Why not put some Savannah fingerlings back into the Broad River, GA to swamp the genetics?

That would be supported by the geneticists as an effort to reduce the potential impact of Oconee fish stocked in the Broad GA in the past.

Why not stock Ft. Gordon's refugial pond?

That's a bad pond with low survival, little food, etc.

Stocking back into the Savannah could help offset the natural spawning lost by removing adults for use as broodstock.

What is the population size of the Savannah? Does it need to be augmented?

Where is the population bottleneck? Is it in hatching or juvenile recruitment?

Stocking fingerlings could have a hugely disproportionate effect if the hatch rate of natural spawning is very low.

GADNR has reservations about stocking Savannah fish into the Broad River GA for 3 reasons:

- The risk of escapement downstream into the Savannah River is seen as minimal
- Currently, the source of the Broad GA population is known to be pure Oconee material. If stocked with Savannah fish, this would be changed to an unknown mixture.
- GADNR has doubts as to whether it is possible to swamp out the genetic material of the Oconee founders of this population. This could become a very long-term commitment to stock by GADNR.

BROAD RIVER, SC UPDATE – Ross Self & Scott Lamprecht, SCDNR

Many issues and results pertaining to the Broad River, SC efforts are listed above in the Savannah River spawning section.

Questions and Comments

Does the SC Broad River have a management plan?

Not yet, just a proposal to stock multiple year classes and to continue annual monitoring.

There is a need for more involvement by federal agencies and power companies.

Perhaps the Oconee Management Plan can be used as a template once completed.

Is there a need for a Broad River SC TWG or a Santee-Cooper River Basin TWG?

Not at this time, but more contact between groups working in these areas would be helpful.

PEE DEE RIVER COLLECTIONS – Ryan Heise, NCWRC

During the spring of 2004 (April 28- May 25), two stretches of the Pee Dee River were surveyed weekly for the presence of robust redhorse: Blewett Falls Dam, NC to the NC-SC state line; and Society Hill, SC to below Blues Landing, SC. Radio-tagged fish captured in previous years were used to identify areas that may be used for spawning and to evaluate movement patterns. Overall, 18.6 hours of electrofishing pedal time were expended this year, through the combined efforts of the NCWRC, SCDNR, NCMNS, Progress Energy, and Clemson University. On May 6, 2005 one ripe adult male robust redhorse was collected from shoal habitat 4 miles downstream from Blewett Plant. The water temperature at the capture site was 20.1°C, and the fish was implanted with a radio-transmitter and released one week later near the capture site. No other robust redhorse were captured or relocated using radio transmitters.

A summary of collecting efforts on the Pee Dee River over the past 5 years is given in Table 14. Overall, 6 robust redhorse have been collected from the Pee Dee: 2 mature females, 1 immature female, 1 mature male, and 2 juveniles (details in Table 15).

Table 14. Pee Dee River surveys downstream of Blewett Falls, 2000-2004

Year	Electrofishing Effort (hours)/ Number of river miles covered	Mean Water Temp (°C)	Water Temp (C) at capture	Power Plant Discharge (cfs)
2000	22.5 hours/ 23 miles	17.2 (16.0-18.2)	17.4	9,000
2001	24.2 hours/ 23 miles	20.3 (19.1-21.8)	19.2	7,000
2002	50.1 hours/ 62 miles	24.3 (21.5-26.1)	25.4	4,000-5,000
2003	57.6 hours/ 72 miles	20.4 (19.7-21.0)		3,500-13,000
2004	18.6 hours/ 35 miles	20.9 (19.0-26.0)	20.1	3,300-9,200

Table 15. Robust redhorse captures from the Pee Dee River.

Date	Location (RM) and Habitat	Sex/Status/Age	Total Length (mm)	Weight (g)
26-Apr-00	184.0 NC/Highway 74 shoal	Female, mature 6 yrs	605	3200
2-May-01	177.2 NC/Mill Creek shoal	Female, ripe 11 yrs	692	5600
29-Nov-01	164.7 SC/Cheraw glide	Juvenile female 2+ yrs	413	805
10-May-02	133.0 SC/Blues Landing glide	Juvenile, sex unknown, 3+ yrs	430	1125
08-Oct-02	133.0 SC/Blues Landing glide	Juvenile, sex unknown, 2+ yrs	375	728
06-May-04	182.7 NC/Highway 74 shoal	Male, ripe age unknown	724	6200

WATEREE AND CATAWBA RIVERS – Dave Coughlan, DPC

The Santee-Cooper basin covers approximately 16,000 square miles of North and South Carolina in the center of the historic range of the robust redhorse (Figure 9). As a part of the FERC relicensing process surveying has been carried out on the Wateree and Catawba Rivers, both of which have several impoundments (Figure 10). However, despite the presence of other large Catastomids, no robust redhorse have yet been found in the Wateree and Catawba Rivers. A summary of this year's surveying efforts is given below.

The Wateree River is home to a varied resident fish community as well as a number of diadromous species and several rare Catastomids. In 2004, helicopter overflights of the entire river were made during low flow periods and river surveys were conducted at both high and low flow levels. Potential robust redhorse habitat was assumed to be gravel bars with nearby pools and woody debris, and two of five diadromous fish sampling locations meeting these criteria were surveyed for a total of 14.3 effort hours. The five sampling locations on the Wateree River are shown in Figure 11, and include the Wateree hydro tailrace (76.7 RM above confluence), the most upstream accessible shoal above Hwy. 1 and 601 (74.1 RM above confluence), the gravel bar upstream from I-20 (67.1 RM above confluence), Hwys. 76 and 378 access area and Colonels Creek confluence (25.3 RM above confluence), and Little Rive confluence just upstream from the Congaree River (1.6 RM above confluence). Based on previous years' water temperature data (Figure 12), spawning initiation was estimated to be most likely from April 18-May 17, with cessation from June 3-July 3. This means that there is a potential range of about 11 weeks in which spawning could occur. Rather than carrying out intensive surveys during a few weeks, our biweekly diadromous fish sampling that began in March allowed us to track the rising temperatures and to initiate weekly sampling during appropriate temperatures.

Figure 9. Map of Santee-Cooper basin, including the historic range.

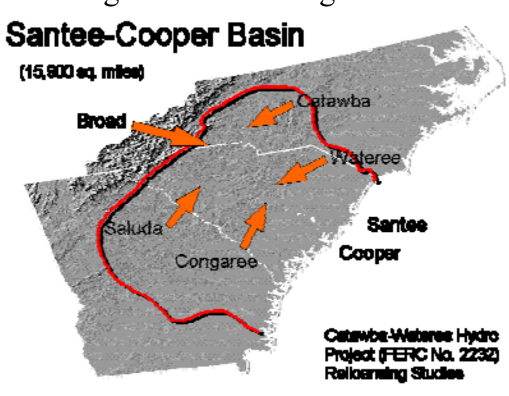
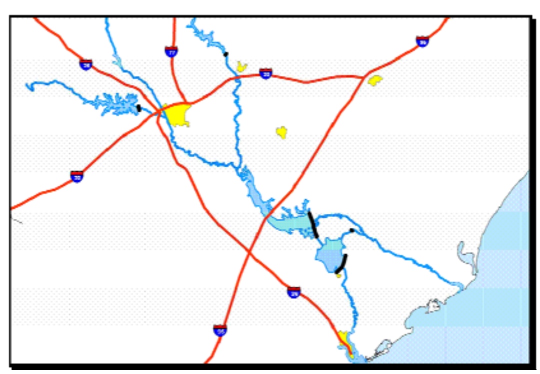


Figure 10. Lower Santee-Cooper Basin.



In 2004, the Wateree River experienced appropriate temperatures for sucker spawning from April 22 to June 9, 2004. A total of 14.3 hours of pedal time was expended at the two shoal locations, with help given by the SCDNR staff at the Eastover Lab. Overall, 54 hours of pedal time were expended on the entire Wateree River in Spring 2004.

Although no robust redhorse, Carolina redhorse, or highfin carpsuckers were captured in the Wateree in 2004, collectors did capture spotted sucker, shorthead redhorse, and quillback throughout the river. In addition, notch-lip redhorse and brassy jumprock were found at the shoal above Hwys 1 and 601, and smallmouth buffalo were found in small numbers.

Additional sampling was also carried out on the Catawba River during the spring of 2004 (Figure 13). As for the Wateree River, a helicopter overflight was followed by a general river survey. In the Catawba River, only one good gravel bar was identified: near the upstream end near Fewell Island. Temperature data was also collected, and smaller river shockers were used in sampling efforts. At the Catawba River below Lake Wylie, water temperatures indicating potential sucker spawning were observed from May 5 to June 10, 2004. A total of 6.6 hours of pedal time were expended during 6 trips to the Fewell Island gravel bar during this time. The species found in the Catawba River were similar to the Wateree: quillback, smallmouth buffalo, notch-lip redhorse, shorthead redhorse, and brassy jumprock were found, while robust redhorse, Carolina redhorse, and highfin carpsucker were not seen. Despite the lack of robust redhorse found in the Wateree and Catawba Rivers, the low abundance and catch rates of this elusive fish in the Pee Dee River over the past decade suggests that it remains possible that a small population persists in the Wateree and Catawba Rivers.

Figure 11. Wateree River sampling locations.

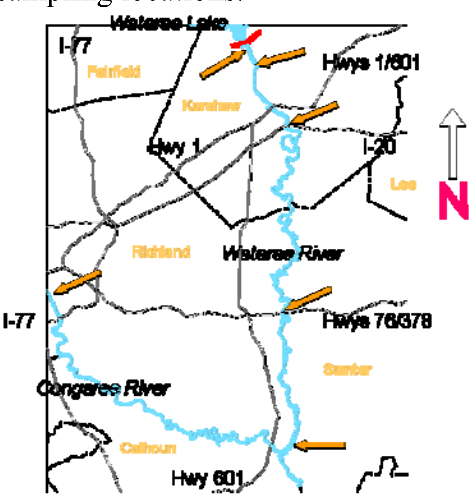


Figure 12. Wateree River temperatures.

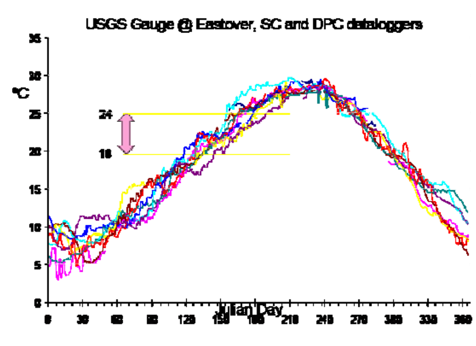
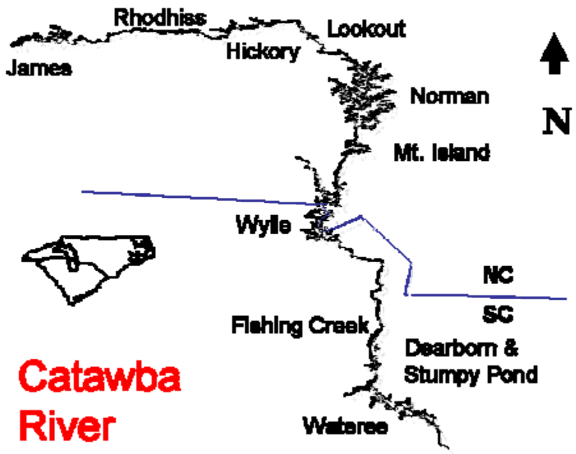


Figure 13. Catawba River geography.



Questions and Comments

The Santee-Cooper Basin TWG suggested that a CCAA may be needed for the Broad River, SC.

Is there a need for a Wateree/Catawba TWG?

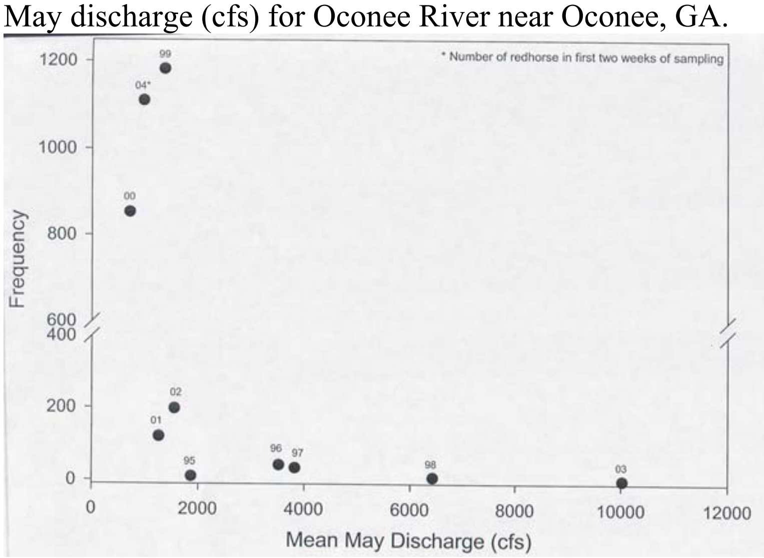
- Not at this time.

RESEARCH UPDATES

OCONEE RECRUITMENT – Cecil Jennings, GA Coop. Fish and Wildlife Research Unit, Warnell School of Forest Resources, UGA

During 2004, efforts continued to be made to document larval redhorse emergence. In 2002, larvae were sent to Ike Wirgin for genetic analysis in order to confirm Stuart Carlton's larval key. Unfortunately, results from this study are not yet available, due in part to a lack of funding for the genetic aspect of this project. Georgia Power Company has recently funded the completion of this project. Based on morphological characteristics, 13 larvae between 13-25mm were identified as robust redhorse, with another 96 identified as silver redhorse. In 2003, no redhorse larvae were found, but in 2004 many sucker larvae were collected. Approximately 1109 redhorse larvae (a combination of robust and notch-lip redhorse) were sampled during the first two weeks of May. According to Stuart Carlton's key for larvae <200mm, about 40% of the larvae were robust redhorse. Other samples will be sent to Ike Wirgin's lab for genetic identification. Sampling was limited during the past year due to hurricanes, but additional sampling will continue through this fall. According to data collected during the past decade (Figure 14), larval abundance seems to be highest in years with low stable flow which are preceded by flooding or high flows in the previous year.

Figure 14. Frequency of robust and notch-lip redhorse larvae (1995-2004) and mean May discharge (cfs) for Oconee River near Oconee, GA.



OCMULGEE HABITAT RESTORATION – Liz Caldwell, USFS

The Wise Creek bank stabilization project (Figures 15 and 16) in the Oconee National Forest was funded by the Georgia Rivers Network and by Georgia Rivers. After hurricane-related flooding in September of 2004, water had covered the entire wall and

parking lot (Figure 17). There was some erosion from behind the cribbing (Figure 18) and newly-planted vegetation was gone, but no structural damage was done (Figure 19).

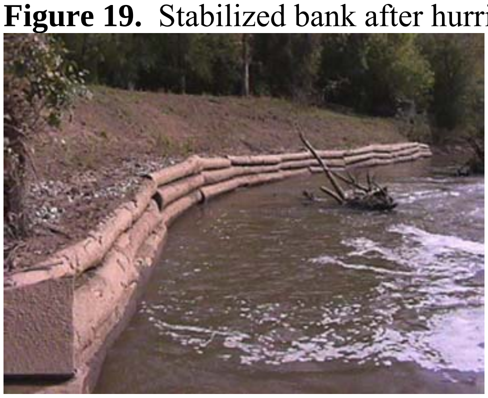
Figure 15. Bank erosion prior to stabilization project.

Figure 16. Stabilized bank before hurricane flooding.

Figure 17. Parking lot (and robust redhorse educational sign) flooded during hurricane.

Figure 18. Erosion from behind cribbing due to hurricane flooding.

Figure 19. Stabilized bank after hurricane flooding.



OCONEE RIVER FLOWS – Mike Nichols, GPC

Several different aspects of Oconee River flows were presented at the 2004 RRCC Annual Meeting, including objectives in setting flows, flow duration curves, and flow data for 1998-2003 at both Milledgeville and Avant. Flow rates for the Oconee and Ocmulgee Rivers are both affected by reservoir operations. Peaking flows are a function of both electrical demand as well as water supply – peaking generation does not occur in periods of low flow (when inflow is less than the designated minimum flow) nor does peaking generation occur during periods of high flow (when inflow is greater than hydraulic capacity). Several proposed actions to change flow regimes were mentioned: increasing minimum flows to 300 cfs, minimizing flow variability through modified ramping, minimizing daily flow variability by generating 7 days per week, and implementing Flow 10 alternative.

Currently, Sinclair Dam's minimum flows are as follows: December-February 500 cfs with normal peaking; March-April 1500 cfs with modified peaking; May- June 10 (if feasible) run of river flows; June-November 700 cfs with normal peaking. These minimum flow specifications are designed to approximate annual hydrological patterns characterized by pre-1954 records (before impoundments). High flows (or flushing flows) are typical prior to robust redhorse spawning season, but do not occur every year.

Shown below (Figures 20-22) are flow durations for the Oconee River. Figure 20 shows average spring flow durations for years with average precipitation as well as wet and dry years. Figures 21 and 22 show average summer flow durations for the Oconee River along with flow durations, demonstrating the extreme patterns seen in recent years. Figures 23-28 show Oconee River daily flow rates at Milledgeville from 1998-2003. Table 16 provides an overall summary of flow rates during the spring and summer for Oconee River at Milledgeville.

Figure 20. Oconee River at Milledgeville average spring flow durations.

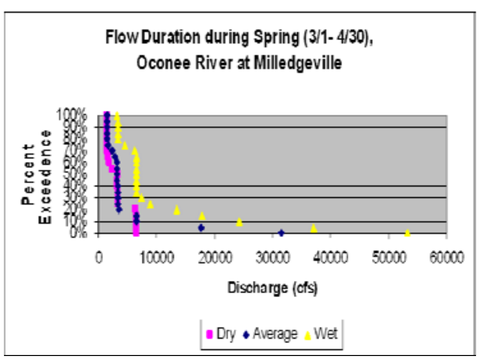


Figure 21. Oconee River at Milledgeville average and summer flow durations.

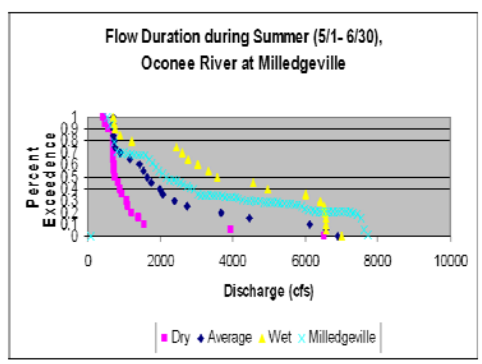


Figure 22. Oconee River at Milledgeville average and summer flow durations.

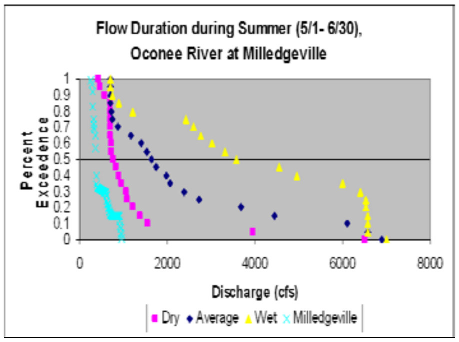


Figure 23. Oconee River daily flow rates – 1998.

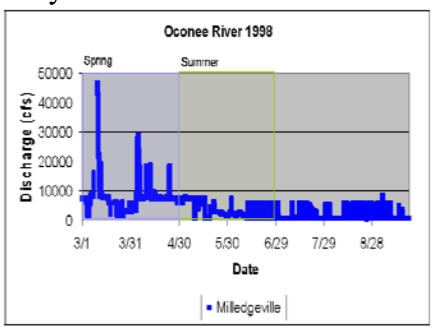


Figure 24. Oconee River daily flow rates – 1999.

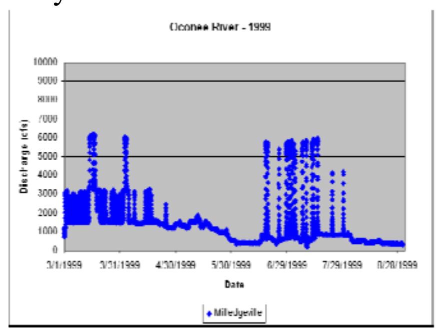


Figure 25. Oconee River daily flow rates – 2000.

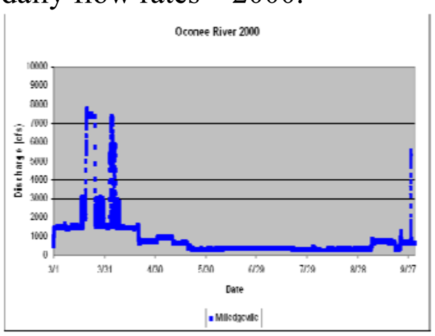


Figure 26. Oconee River daily flow rates – 2001.

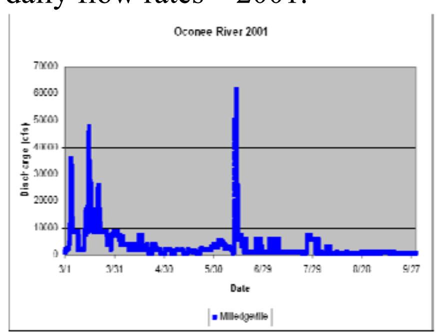


Figure 27. Oconee River daily flow rates – 2002.

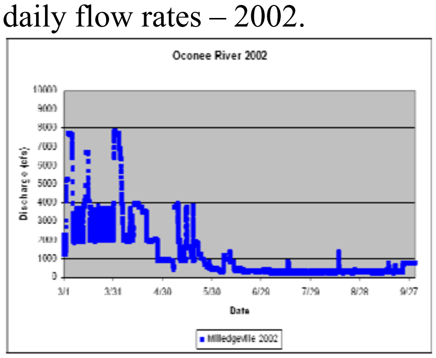


Figure 28. Oconee River daily flow rates – 2003.

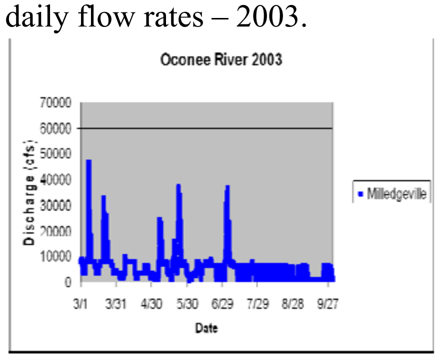


Table 16. Milledgeville flow duration summary.

Year	Flows Exceeding	Number Exceeding	Maximum	Spring	Summer
1998	> 20,000	2	46,000	Wet	Wet
1999	> 8,000	0	-	Dry	Dry
2000	> ▪ 8,000	1	8,000	Dry	Very Dry
2001	> 20,000	4	61,000*	Wet	Average*
2002	> ▪ 8,000	2	-	Dry	Very Dry
2003	> 20,000	5	46,000	Above Avg	Very Wet

SAVANNAH RIVER RESEARCH – Tim Grabowski, Clemson University

At this time, 24 radio-tagged adult robust redhorse have been released into the Savannah River. Three have either died or have dropped their tags, 2 were recaptured in 2004, and 5 new adults were tagged during 2004. As shown in Figure 29, robust redhorse seemed to maintain a somewhat steady position in the river throughout most of the year, but show significant upstream movements concentrated during the spring spawning seasons. Figure 29 shows the furthest upstream and downstream individual for each time point with broken lines, and the average river km position (with standard error bars) with the solid line. Movements of individual fish can be seen in Figure 30, with fish of different size classes and sexes identified by differently colored lines. One fish even managed to swim upstream through a dam.

Figure 29. Average position of tagged robust redhorses in the Savannah River, June 2002- October 2004.

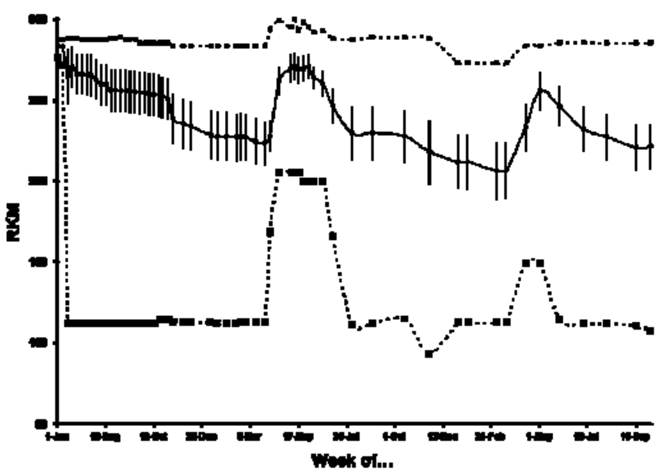
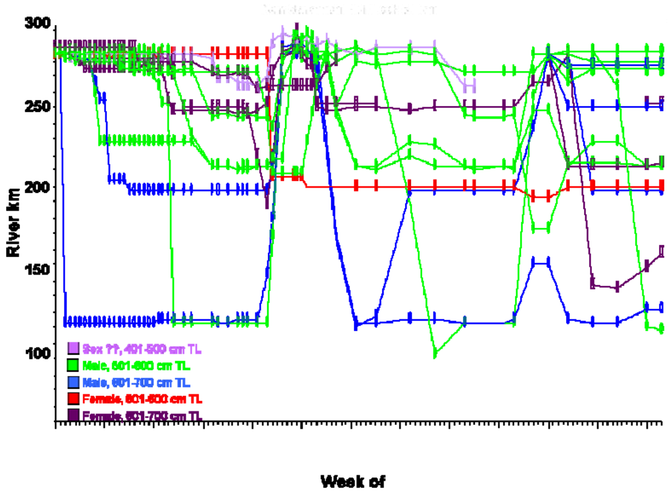


Figure 30. Individual tagged robust redhorse movements in the Savannah River.



Collections targeting large catastomids on the Savannah River were very successful during the spring of 2004, with many notch-lip redhorse (Figure 31), spotted sucker (Figure 32), and robust redhorse (Figure 33 and Table 17) captured. In addition, a growth curve and regression for spotted sucker were presented (Figure 34).

Figure 31. Length-frequency distribution of notch-lip redhorse captured in the Savannah River, 2004.

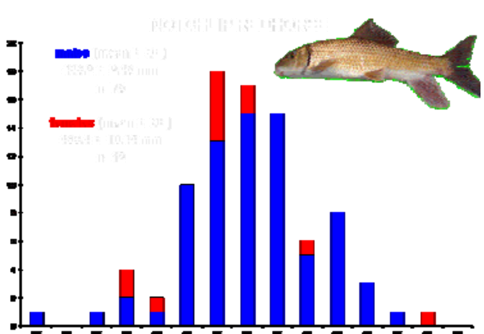


Figure 32. Length-frequency distribution of spotted sucker captured in the Savannah River, 2004.

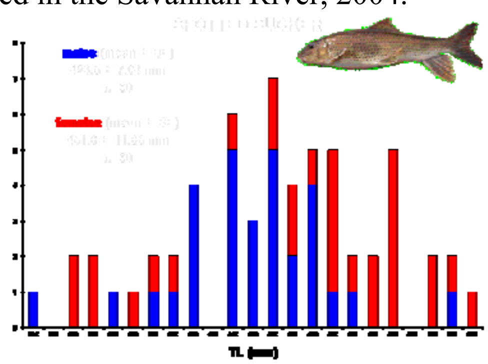


Figure 33. Length-frequency distribution of robust redhorse captured in the Savannah River, 2004.

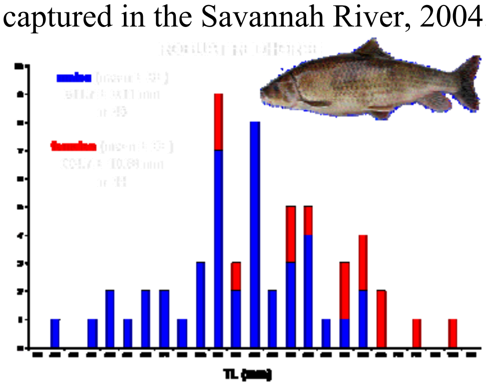


Figure 34. Spotted sucker growth curve.

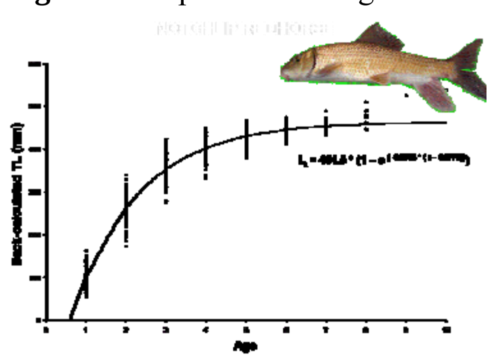


Table 17. Capture records of robust redhorse on the Savannah River, 2004.

	Sex	PIT tag	Capture date	TLcapture	Recapture date	Lrecaptur
robust redhorse	M	40330F780D	20-May-02	600	6-May-04	610
robust redhorse	M	40337E7430	20-May-02	640	10-May-04	672
robust redhorse	M	4033717700	21-May-02	600	14-May-04	604
robust redhorse	M	4034030740	21-May-02	640	4-May-04	613
robust redhorse	M	7F7D1E302F	21-May-02	673	4-May-04	620
robust redhorse	M	0A00004342	11-Jun-02	600	6-May-04	600
robust redhorse	M	40330E001A	11-Jun-02	602	4-May-04	600
robust redhorse	F	4033787E13	?	?	4-May-04	647
robust redhorse	M	40337F3024	?	?	6-May-04	602
robust redhorse	M	4034040F00	?	?	2-May-04	620
robust redhorse	M	4034000C78	?	?	14-May-04	600
robust redhorse	M	403407020A	?	?	4-May-04	600
robust redhorse	M	4057020D67	?	?	4-May-04	600
robust redhorse	M	4000000C03	?	?	6-May-04	610

The other aspect of research being pursued on the Savannah River is spawning habitat selection by robust redhorse and other large catastomids. At the 2004 RRCC Annual Meeting, information was presented on the effort to document temporal and spatial partitioning of gravel bar habitat and the effects of microhabitat selection on the survival and hatching success of robust redhorse. The study sites used during 2004 were two gravel bars downstream from New Savannah Bluff Lock and Dam on the Savannah River (Figure 35). Although robust redhorse were abundant at the upstream gravel bar in previous years, very few were seen there this year, but many were observed at the lower gravel bar. Overall, 57 robust redhorse were captured, including 14 males, 43 females, and 14 recaptures (some of which had unidentifiable PIT tags).

During the spawning season, fish were observed from above, and were also videotaped underwater before and during spawning. From these videos, the preferred spawning substrates of robust redhorse can be determined. Videos also revealed that there was significant predation on robust redhorse eggs by spottail shiners, blackbanded darters, and northern hogsuckers. Grid shockers were used in order to capture fish observed in particular positions on the gravel bar, and eggs floating downstream were collected in plankton nets.

Figure 35. Map of robust redhorse spawning habitat selection study.

Figure 36 shows the temporal partitioning of the gravel bar used as a spawning site by notch-lip redhorse, spotted sucker, northern hogsucker, and robust redhorse. While there is significant temporal overlap by the notch-lip redhorse and the spotted sucker and the northern hogsucker was present during the entire time surveyed, the robust redhorse had a fairly distinct spawning season. Microhabitat preferences of the robust redhorse are shown in Figure 37, along with a 3-D depiction of the gravel bar and direction of water flow. Figure 38 compares the microhabitat preferences of spotted sucker, northern hogsucker, notch-lip redhorse, and robust redhorse. Based on these preliminary results, there is no appreciable spatial partitioning of gravel bar habitat. However, spawning suckers seem to partition the habitat through time. Future research will focus on identifying and aging larvae to determine whether there is any overlap in spawning seasons, determining the impact of flow on survivorship and cohort structure, identifying any interannual or spatial variability in the observed patterns, analyzing habitat preferences earlier in the spring, and assessing which particular factors make these gravel bars desirable for spawning.

Figure 36. Temporal spawning partitioning of catastomids on the Savannah River.

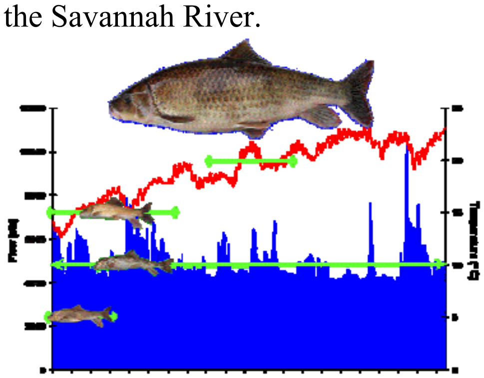


Figure 37. Microhabitat preferences of the robust redhorse, Savannah River.

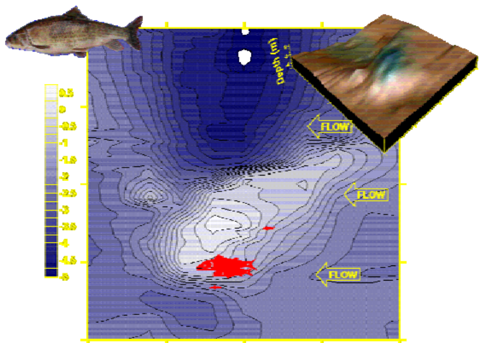
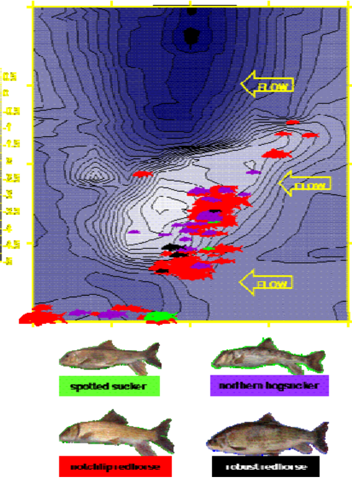


Figure 38. Microhabitat preferences of catastomids, Savannah River.



The final area of research done on the Savannah River gravel bar involved using artificial incubators (Figure 39) to determine the effects of microhabitat selection on the survival and hatching success of robust redhorse. A total of 18 incubators were deployed, with 3 replicates for each combination of two flow rates (high [chosen] or low [not chosen]) and three substrates (gravel/sand [chosen], sand/silt [not chosen], or no substrate [control]). Unfortunately, water levels surrounding the Savannah River gravel bar being studied fluctuated by several feet during the ten days in which the incubators were deployed (Figure 40), causing many incubators to experience flow regimes much different than were intended (most were above water) and all incubators became filled with silt and mud (Figure 41). Although these experiments will need to be repeated in order to determine the relative importances of flow and substrate selection, it appears that substrate may be less important than having a consistent flow so that eggs will be deposited and develop in the same microhabitat. In terms of river regulation, the exact flow rate may not be as important as maintaining a consistent flow throughout the spawning season of the robust redhorse.

In conclusion, the limited availability of spawning habitat may render the Savannah River robust redhorse population vulnerable to stochastic and density dependent effects.

Figure 39. Incubators used in Savannah River, spring 2004.

Figure 40. Fluctuation in Savannah River gravel bar size, spring 2004.

Figure 41. Silt and rocks in incubator.

Questions and Comments

Did you dig up gravel to find or count eggs?
- No, but we plan to next year. In the Oconee, eggs have been found to be about 5cm below the surface. Quivering during spawning clears the silt from the gravel.

Are there indications of any other Savannah spawning sites?
- None as good or large as the two gravel bars right below NSBL&D.

Is there a population size estimate for the Savannah River?
- Recapture and telemetry estimates are both around 400 fish.

Could fish be tagged down river in order to see if they come all the way upstream to spawn?
- If there was money to support that study, yes.

How far downstream do eggs drift?
- None made it as far as nets placed 10m downstream from spawning sites. Little drift of eggs was seen on the Oconee.

2004 was a low flow year overall, and the upstream monitoring site had less than 6 inches change in water level during the whole spawning. This is in contrast to more than 1 meter fluctuation in water levels observed at the spawning gravel bar.

FINAL VERSION OF LARVAL REDHORSE IDENTIFICATION KEY – Stuart Carlton, GA Coop. Fish and Wildlife Research Unit, Warnell School of Forest Resources, UGA

A key has been developed in order to distinguish between larval robust redhorse and notch-lip redhorse. In "normal" years (Figure 42), there is a bimodal size distribution between larvae of these two species, but in drought years (Figure 43), there is a much higher abundance of redhorse larvae, and a unimodal size distribution, which makes it impossible to correctly identify the abundances of these two species. Several years ago Ike Wirgin developed a genetic test to distinguish between these species (described in Wirgin *et al.*, 2000, "Development and use of a simple DNA test to distinguish larval redhorse species in the Oconee River, Georgia". North American Journal of Fisheries Management 24(1): 293-298). Although the genetic test is very accurate, it is also expensive and time-consuming. Therefore, a binomial key using morphometric and descriptive features has been developed for use in studies of larval ecology. Additionally, a taxonomic reference collection of *M. collapsum* larvae has been established.

Figure 42. Larval redhorse size distribution in a "normal" rain year.

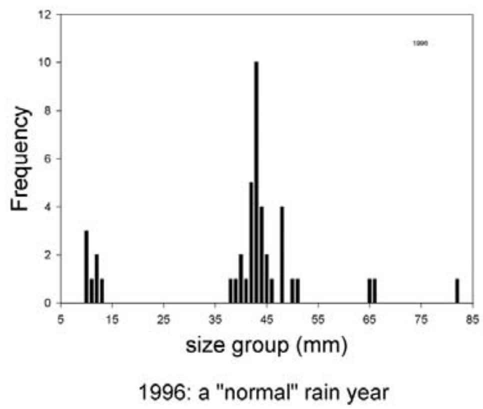
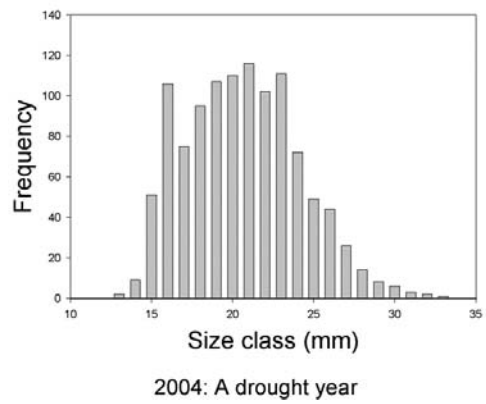


Figure 43. Larval redhorse size distribution in a drought year.



The first step to create a larval key was to obtain the fry to be studied. A total of 29 notch-lip redhorse were collected from various sites in the Oconee and Broad Rivers. Two fish were strip-spawned in the field, yielding about 2000 fertilized eggs. The other 27 fish were taken to the Whitehall for artificial spawning, yielding 5000 fertilized eggs. A number of morphological measurements were then carried out on larvae (Figures 44 and 45). A total of 59 qualitative characters were measured, with 13 selected for classification tree analysis. Descriptive characters were subjected to a χ^2 test of association, and the morphometric and descriptive characters were then assimilated to form a binomial key (Table 18). The key is currently undergoing crossvalidation by both genetic testing of larvae provisionally identified by the key and by second party testing. So far, the success rate has been approximately 95%. Further research will focus on improving the accuracy of the key, testing whether Savannah River redhorses can be categorized by the existing key, and expanding the size range to larvae in the 25-50mm range.

Figure 44. Morphological measurements of redhorse larvae.

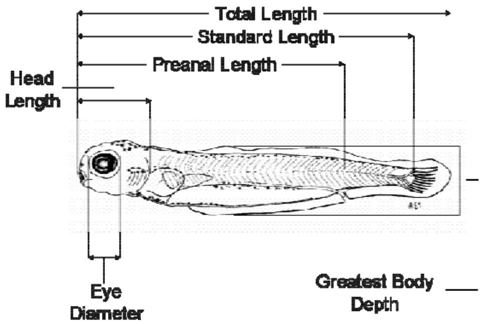


Figure 45. Morphological data used in key construction.

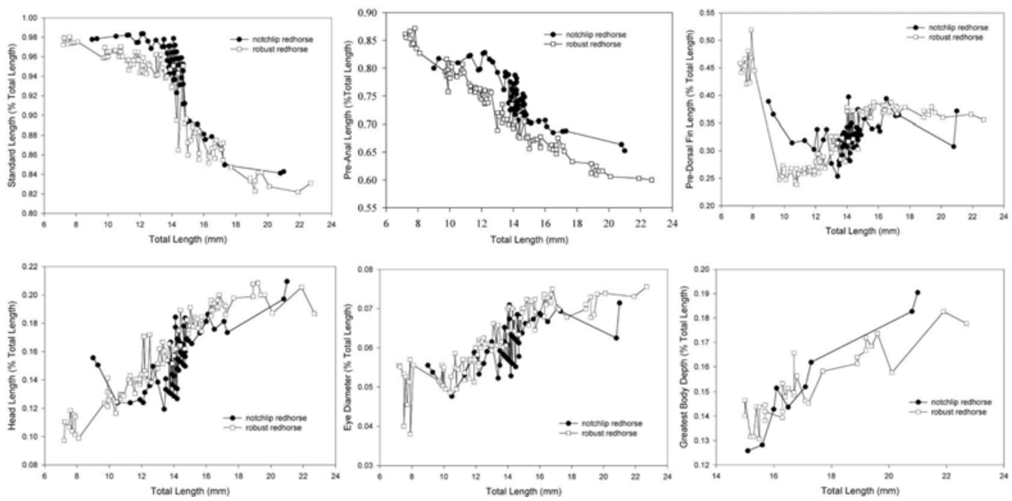


Table 18. Key to larval robust and notch-lip redhorses.

1) TL<13.5mm……………………………………..2
   TL>13.5mm……………………………………..3

2) Head lifted away from yolk sac…………..4
   Head curved around yolk sac…….notchlip

3) Digestive tract fully developed…… robust
   Digestive tract not developed…….notchlip

4) TL<12.0mm…………………………………robust
   TL>12.0mm……………………………………..5

Questions and Comments
How much time does it take?
It depends on the experience level of the user, but about 50 larvae can be identified in a day.
When will the key be completed?
When the second party testing is finished in a few weeks.

BACKWATER HOLDING AREAS – Diarra Mosley, GA Coop. Fish and Wildlife Research Unit, Warnell School of Forest Resources, UGA

One of the greatest remaining mysteries surrounding the robust redhorse is what sort of habitat the juveniles inhabit. Despite intensive studies over the past decade, no fish between 30mm and 410mm have been found in the wild, leaving a gap of 4-5 years worth of natural history unknown. Several theories as to why no one has yet found juvenile robust redhorse include habitat selection, sampling efficiency, and actual abundance. We have used an artificial racetrack mesocosm to determine if juvenile suckers use available habitat in proportion to its availability, or if they selectively use only certain portions of the habitat. Performing racetrack experiments in order to observe the habitat preferences of juvenile redhorses will help direct the sampling efforts on the Oconee River, and in turn help evaluate the status of the Oconee River population.

On the Oconee River, adult robust redhorse are most frequently found in meander areas (Figure 46), with few individuals captured in straight-aways. Another potential habitat for larval redhorses are the backwaters areas adjacent to the main channel of the river. In the Oconee River, straight-away habitat is about 49% of the available habitat, while bend habitat makes up another 38% of habitat. In the mesocosm, straight-aways made up 65% of the available habitat, with bend habitat making up 20%, and the backwaters 13% (Figures 47-49).

Figure 46. Oconee River habitat types: straight-aways (black), meanders (red), and backwaters (blue).

Figure 47. Bend and straight-away habitat in mesocosm.

Circulation of water in the raceway was performed by two MinnKota 40-lb thrust trolling motors. Flows varied between -10 and 80-cm/s. A velocity map of the entire mesocosm (Figure 50) was made using velocity readings at 3 depths (Marsh McBurney Flowmate model 2000).

Two preliminary trials using the raceway setup described above have already been carried out using spotted suckers and notch-lip redhorse as surrogates for robust redhorse. Each trial lasted five days, and six fish were used in each trial with replacement of fish between trials. Fish were observed for the first ten minutes out of every hour between 0800 and 1700. For each observation period, the position of each fish was recorded (aerial and lateral views), and water and ambient temperatures were also recorded hourly. In analyzing the data, habitat in the raceway was divided into a number of categories (Figure 51). Overall, notch-lip redhorse prefer outside meander habitat, while spotted suckers prefer backwater habitat. No difference was seen between different size classes, and only spotted suckers used the backwater areas. This is consistent with the preferred habitats of notch-lip redhorse and spotted suckers in the wild. Another observation from this experiment was that fish were significantly more active during the first trial, in which the water temperature was higher.

Figure 48. Backwater habitat in mesocosm.

Figure 49. Entrance to backwater habitat.

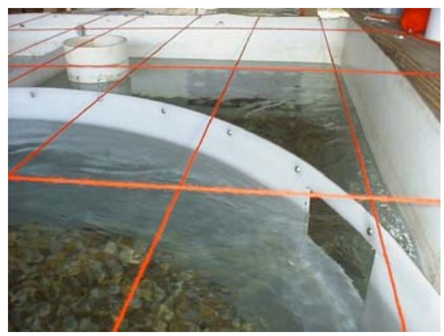


Figure 50. Velocity map of raceway.

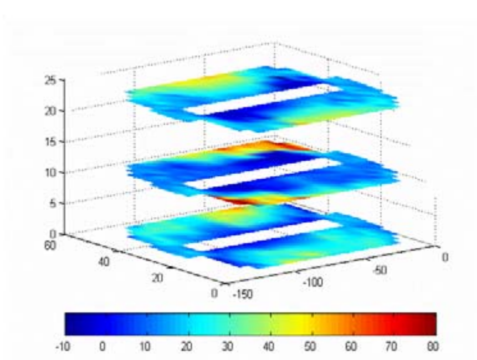
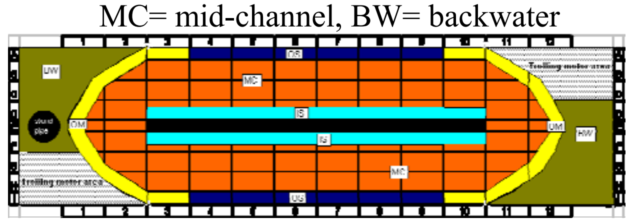


Figure 51. Habitat map of raceway. OS= outside straight-away, IS= inside straight-away, OM= outside meander, MC= mid-channel, BW= backwater



These preliminary results suggest that this mesocosm design can be used to determine the habitat preferences of juvenile robust redhorse. Slight changes to be implemented in upcoming trials include the following: four 10-day trials will be carried out, two tanks will be used, 8 fish will be used in each trial, and smaller fish (100-130mm TL) will be used.

Questions and Comments

How are the motors run?
- Motors are run continually during the trial, fish have 2 days to acclimate to the racetrack before the observations are begun. No artificial cover is used because the racetrack is too small for it.

How are the fish fed?
- They are fed bloodworms daily after the observation period. The current scatters the food across the tank, but the fish don't seem to eat much, perhaps due to the low water temperature.

How jumpy are the fish?
- Six foot tall curtains keep them from seeing much outside the tank. They are observed either from above or through one-way mirrors.

How was the gravel distributed, and did it shift?
- Little movement of gravel was noted. The gravel was made a bit deeper on the inside of the track than the outside.

TECHNICAL WORKING GROUP REPORTS

HABITAT TWG – Bill Bailey, US Army Corps of Engineers

A revised version of the Habitat TWG's Habitat Restoration Management Plan was distributed at the RRCC 2004 Annual Meeting. The latest version of this document includes an updated appendix with a list of potential projects that the Habitat TWG would like to see completed in the future. Also included are an assessment of potential habitat restoration projects on the Oconee River, a timeline of historic deforestation and sedimentation, and information on a study of gravel cleaning and augmentation. The Habitat TWG is also in the process of developing a public information flyer, which will be available on the robust redhorse web site (www.robustredhorse.com).

IT TWG – Jaci Zelko, USFWS

During the past year, the RRCC web page (www.robustredhorse.com) has been updated. The resulting website is much more visually appealing, and updated contact information for many members has been posted. Additional information and changes will continue to be made on a regular basis.

The second project under development by the IT TWG is the creation of a master database of robust redhorse capture records. The current plan is to convert Bob Jenkin's Excel spreadsheet into a MS Access database. This conversion will allow for easier searching of records, and for changes of information to be tracked across multiple fields. The IT TWG is soliciting suggesting from RRCC members as to what fields of information are needed.

OCONEE TWG – Jimmy Evans, GA DNR

The Oconee TWG is nearing completion of an Oconee River Management Plan (Figure 52), which will be a comprehensive document covering data collected from 1991 to the present. So far the draft is approximately 150 pages long, and includes three main elements: a summary and analysis of available data, interpretation based on "weight of evidence", and management recommendations. The plan recognizes that alternative interpretations may exist and that some interpretations or conclusions may need to be modified in the future. The plan also includes guidance for future research areas, culture studies, and making management decisions. Thus far, agency reviews have been mostly positive, however there has been some disagreement on data interpretation and the costs of management. The Oconee TWG will meet soon to resolve the differences, and the Oconee River Management Plan is expected to be completed in the next 6 months.

Figure 52. Outline of Oconee River Management Plan.

Introduction
Purpose
Problems facing species
Conservation goals
Status of Oconee population
Background

- Discovery in Oconee
- Initial responses
- Recovery under an MOU

Population status and recommendations

- Elements in assessment
- Monitoring
    - Length distributions (recom - Box 1)
    - Electrofishing catch rates (recom – Box 2)
    - Population dynamics (recom – Box 3)
    - Reproduction and recruitment (recom – Box 4)
- Monitoring summary
- Habitat availability (recom – Box 5)
- Contaminant effects, physiol tol., parasites and diseases (recom - Box 6)
- Predation (recom – Box 7)
- Genetics and stocking (recom – Box 8)

Summary of management recommendations
Appendix A – Tables
Appendix B - Figures

YADKIN-PEE DEE TWG – Ryan Heise, NCWRC

First, Ryan Heise was introduced as the new chair of the Yadkin/Pee Dee TWG, replacing John Crutchfield after several years of service as chair. The short-term goals of this group are to have consistent collection of robust redhorse and to determine the range of robust redhorse in the Yadkin and Pee Dee drainages. The long term goal is to have a sustainable population of robust redhorse in the region. In 2005, the members will try to find and track the one radio-tagged fish, and hope that this will lead them to additional robust redhorse.

PANEL DISCUSSION OF OCONEE RIVER STATUS AND MANAGEMENT IMPLICATIONS

Leader: Bill Bailey (USACOE)
Panelists: Jimmy Evans (GADNR), Cecil Jennings (UGA Coop Unit), Bud Freeman (UGA), Mike Nichols (GPC), Jeff Isely (Clemson University)

INTRODUCTION – Bill Bailey

The discussion of the Oconee River's status and implications can be broken down into four basic questions:

Where have we come from?
Where are we?
Where do we want to go?
What should we do to get there?

Below is a brief comment on each of these questions, which will be followed by comments from the panel members and the other attendees of the RRCC 2004 Annual Meeting.

Where have we come from? The robust redhorse has been called a "mystery fish". First discovered in 1869 in North Carolina and historically believed to have been abundant in North Carolina, South Carolina, and Georgia, the robust redhorse disappeared in the late 1800s. The rediscovery of robust redhorse in the Oconee River in 1991 led to a public/private cooperative effort to the restore the species as early as 1992, and the formation of the RRCC in 1995.

Where are we? What we know. Thus far, members of the RRCC and affiliates have conducted substantial basic fishery research on the robust redhorse. Juveniles have been stocked in four river systems (Oconee, Ocmulgee, Ogeechee, and Broad Rivers), and stocked fish have grown well. Additionally, four refugial populations have been established – 3 ponds at Piedmont NWR and 1 at Fort Stewart. Genetic research on robust redhorse has identified three evolutionary significant units (ESUs) corresponding to the Altamaha, Savannah, and Pee Dee drainages. A second population of robust redhorse has been found in the Savannah River, and individual fish have been found in the Ocmulgee and Pee Dee Rivers. In total, robust redhorse are currently known to exist in four rivers and five ponds. Indeed, the presence of apparently healthy adults indicates that the source of food for adults is okay and there is no major disease problem at this time. Growth of stocked fish shows that there is also adequate food for juveniles. The fact that viable progeny have been found from spawning indicates that pesticides are not a major problem, and at least some suitable spawning habitat is present in the Oconee River. Robust redhorse are now found in several river basins, which means that problems affecting this fish are not localized. Much of the information detailed above has been developed into public information resources in order to publicize the "mystery fish".

Where are we? What we don't know. However, much still remains unknown about the Oconee River population of robust redhorse. For example, the size and structure of the population, the stability of the population, whether there was or is a critical population bottleneck, and details of present and future threats to the population are all topics which need much more study before conclusions will be reached. These questions also remain unanswered in other robust redhorse populations. Other questions concern the species as a whole. Where do the young go? What is the effect of predation by catfish? What is the sampling efficiency for adults, juveniles, and larvae? What are the seasonal habitats of adults?

Where do we want to go? Goals previously stated by the RRCC aim to have self-sustaining populations in at least six river systems throughout the historic range. Another important goal is to have the robust redhorse no longer be at risk and in need of special management and protection.

What <u>could</u> we do to get there? Possible actions to achieve the above goals include the following: stocking, biological research, behavioral research, field surveys, habitat restoration, government policies, government priorities, and public involvement.

What <u>should</u> we do to get there? Suggestions considered recently (and to be discussed later in the panel discussion) include biological research, behavioral research, field surveys, habitat management (including restricting flows below dams), and habitat restoration.

Remaining questions and actions. Items on which the panel may wish to comment include the following questions and issues:

Is spawning habitat a limiting factor?
How much good habitat is available in each river?
- Survey and compare to other species

Is habitat restoration necessary?
- Clean existing gravel beds
- Augment by depositing new gravel
- Reduce bank erosion to lower sedimentation
- Other activities to reduce turbidity

Are hydropower operations adversely affecting spawning activities or emerging redhorse?
Is there a recruitment problem?
Do juveniles between 5 and 35 cm exist?
Where do the young go?
- Options: Telemetry & Sampling

Chemically marking larvae
Is nursery or juvenile habitat the limiting factor?
Are hydropower operations adversely affecting juvenile redhorse?
- Should we continue to spawn from the Oconee River?
  - Why -- For what purpose(s)?

- Should we continue to rear juveniles in ponds?
    - Why -- For what purpose(s)?
- Should we continue to stock?
    - Why -- For what purpose(s)?
    - If so, where and what?

COMMENTS BY PANELISTS

JEFF ISELY

So far, we have only scraped the surface on the problems facing the robust redhorse. There is limited funding, no concerted effort, and therefore researchers are unable to take on exhaustive studies – we need more money to do more work. Probably the most important issues to look at are issues pertaining to habitat and temperature, for example thermal regimes from dams. Another priority should be the use of a multi-species approach because many other species in the Oconee River may be imperiled due to the same factors. Additionally, an important question to address is whether the robust redhorse is actually that rare or whether low capture efficiency has obscured its presence. Comparisons to the better understood copper redhorse could be useful.

BUD FREEMAN

The Oconee River as it exists today has a long history of impacts due to European settlers. Significant changes have been made in Atlantic slope drainages in the fall zone due to impoundments which break up this very productive zone. One important result has been that the gravel beds required by robust redhorse for spawning have been reduced in the coastal plain region. In addition to changes in thermal regimes and flow rates, fish are no longer able to get to the upper reaches of rivers where there are lower, more consistent flows during the spawning season. Despite the problems that have been observed, the Ogeechee River appears to have the potential for good recruitment and spawning. Overall, there are no simple answers – for example, the invasive Asiatic clams have turned out to be a good source of food for robust redhorse.

JEFF ISELY

What do juvenile robust redhorse eat? Copper redhorse eat small snails, maybe robust redhorse do as well. It is possible that *Corbicula* species might be important to adults but not juveniles. So far no one has caught any juveniles. The Broad River (GA) population appears to be thriving, but why were robust redhorse not already there before being stocked?

MIKE NICHOLS

Most of the information that we have so far indicates that the Savannah and Oconee Rivers are very similar – there are few gravel bars, unknown population size, and we can't find juveniles. We do know that there is at least some evidence for recruitment. So far, we have answered the easy questions, such as culturing and genetics. We now need to continue to work on juvenile habitat and flow requirements (with the emphasis on juvenile habitat over hydrology) and to pull together all the information that we have accumulated. We need to expand the range of the Savannah River strain, perhaps by stocking into the Broad River of Georgia. Flow rates on the Oconee River already approximate average historic flow, and hydrographs are being developed.

JIMMY EVANS

We need to look at changes in the channel structure over the past 15 years. Although the abundance and location of gravel and spawning aggregations may have changed, management options may still be able to reverse damage done in the past. However, habitat management may prove to be difficult and expensive. The long term sustainability of robust redhorse in the Oconee River is the most important goal. To reach this goal, we will need habitat enhancement and restoration (perhaps including flow, sediment, temperature, and substrate augmentation) as well as stock augmentation and supplementing.

Question (Mike Nichols): What flows are desired?

Answer: We don't know yet.

(Mike Nichols): It's possible that flow changes won't have any effect. We believe that gravel distribution is important, but it still does not address the gap in juvenile habitat. Many changes in gravel seen in recent years were due to floods – see the hydrogeological survey done for relicensing.

(Jimmy Evans): We have temperature data from the late 1960s to the present from Dublin to Milledgeville. During the 1980s, the temperatures in the tailwaters increased. Deformities are known to increase when eggs are incubated at 25°C or higher. Is higher water temperature reducing larval recruitment?

(Mike Nichols): The dam used before the 1980s discharge the lower layer of a stratified lake. The newer dam design reduces stratification and discharges water from a wider range of depths, so the water being discharged in recent years is much more similar to surface water temperatures. Data on discharged water temperatures is available in the relicensing report.

CECIL JENNINGS

This is all an uncontrolled experiment. We don't know much about the history of the robust redhorse. What was its abundance? Was it always rare? The current environment is a given – what else are we able to change? Why should the public care about the robust redhorse? Some important things we don't know include capture efficiency, predation pressure by flathead catfish and humans, sucker taxonomy, and historical abundance. We need to not overinterpret the data we have and recognize limitations. This is a long-lived species, so we need a long term approach. They may only need a good recruiting year once in five to ten years, or perhaps each individual spawns successfully once in a lifetime.

GENERAL DISCUSSION

(with attributions where possible)

(Bud Freeman): We probably all agree that current observed robust redhorse habitat is only one quarter to one third of the potential habitat available in historic records.

(Dave Coughlin): They might be in the best remaining habitat. Why aren't they found further upstream?
(Wayne Starnes): The presence of gravel bars is not the only limiting factor for robust redhorse in the Oconee. For example, the lower Pee Dee River has plenty of gravel bars, but very few robust redhorse. Are they unable to access this habitat? Are there post-spawning factors?
(Jeff Isely): Gravel is necessary, but not sufficient habitat.
(Jimmy Evans): A combination of appropriate flow, velocity, and gravel means that the suitable habitat in the Altamaha system is restricted to a 50 mile reach in the region from the fall line to the end of fall hills. Robust redhorse require very specific habitat, and not much of it is available.
(Scott Lamprecht): The gravel bar in from the Savannah Dam near the wing wall is a man-made area for spawning.
(Bud Freeman): Channel maintenance has affected these rivers. Gravel bars used to be removed so that barges could pass through more easily.
(Jimmy Evans): Dams may actually have increased the gravel bars.
(Rebecca Cull): Does anyone have opinions about gravel augmentation or cleaning?
(Jimmy Evans): Entrex has an ongoing gravel augmentation study in North Carolina using modeling and mapping.
(Bud Freeman): Robust redhorse activity during spawning cleans silt sufficiently, but depth and flow velocity are important. Would we even know where to dump gravel?
(Jeff Isely): Short term changes in flow can change conditions rapidly, so cleaning probably isn't the answer. We don't yet know enough about microhabitat preferences. We don't know how often individuals spawn, however the same individual fish were seen spawning at two separate gravel bars in the Savannah River. Another concern is that the upstream source of new gravel may have been cut off due to dams.
(Wayne Starnes): Is there natal homing in robust redhorse? This could be a problem in stocking fish.
(Jeff Isely): There are several potential problems associated with stock augmentation. Stocking large numbers of larvae can be dangerous because we don't know where the population bottleneck is and we may dilute the genetic diversity of the natural population. The phase of individuals stocked could make a big difference if the problem is recruitment from phase I to phase II versus hatch rate. Is there natal homing? Will individuals try to leave the river they were stocked in? Before stocking rivers that do not current have any robust redhorse in them, we should ask ourselves: Why aren't they there? These could end up being population sinks that we keep stocking forever.
(Jimmy Evans): The ultimate goal is self-sustainability for refugial populations. Georgia DNR is willing to keep stocking the Oconee River forever if needed.
(Dave Wilkins): On the subject of robust redhorse diet, it is interesting to note that in captivity they will eat a lot of different foods. Maybe they're more generalists than we had thought.
(Bud Freeman): Probably all redhorses eat mainly the same things – there's no reason to think that the robust is different in that respect. Pollution has affected native mussels in the past, but Unionids are now present, indicating that the water quality is okay for mussels. Spotted suckers and notch-lip use the same spots in the Broad River every year, indicating that it should be a good habitat for suckers. Perhaps it would be a good

location for an experimental population of robust redhorse. No robust redhorse were collected at Anthony Shoals in 2004, however they were found in the Hudson and the main channel of the Broad River. They were found in complex habitat (boulders and woody debris), but not in "sea of sand" stretches. We don't know yet whether the stocked Broad River (GA) population is reproducing yet. In the past, 200-400 individuals from the 1995 year class and 23000 individuals from the 1997 year class were stocked from the Oconee River into the Broad (GA), but not many have been recaptured recently.
(Jeff Isely): In the Savannah River, two tagged fish led to an aggregation of about 50 fish. One fish swam upstream through a dam. There could be another major spawning area in Augusta Shoals, but there's not a lot of funding to survey that area. The robust redhorse is a hard fish to survey for.
(Jimmy Evans): What is the status of the fish passage at the New Savannah Bluff Lock and Dam?
(Bill Bailey): We're waiting for funding from Congress.
(Jeff Isely): Leveling flow has been used for shad passage. Lock operation is getting trickier – they may be unable to close the lock once it opens. Copper redhorse are able to use fish ladders.

MANAGEMENT PRIORITIES FOR THE OCONEE RIVER

The list below shows issues that attendees of the 2004 RRCC Annual Meeting raised that they believe managers should focus on for management implications and improving the status of the species in the Oconee River. Each participant was asked to vote for what they felt were the top three priorities. Results are shown in order of number of votes received with the number of votes in parentheses.

Juvenile habitat quality (32)
Recruitment (17)
Quality of spawning habitat (13)
Status of populations (12)
Quantity of spawning habitat (7)
Capture efficiency (6)
Genetic diversity of wild & stocked populations (4)
Sediment reduction (3)
Stocking (1)
Flows (1)
Predation (0)
Temperature (0)

Questions and Comments on management priorities

- How important is natal homing? Behavioral, imprinting, and genetic components are all possible.
- Are these research needs of management issues? The management issue in the Oconee is recruitment. This list is research priorities.

- No suckers were found in an analysis of 57 flathead catfish stomachs, but more work is needed.
- What is the capture efficiency? Could it be tested using the Fort Gordon ponds?

RESEARCH PRIORITIES FOR 2005

OCONEE RIVER

Juvenile habitat quality

- The bottleneck may be in early life stages. Could Diarra Moseley's study on flow preferences of juvenile redhorse be expanded to include fish smaller than 100mm long? Not at this time, as smaller fish can't be seen to record data.
- Are there other sampling methods to try to catch juvenile robust redhorse in the wild? Gill nets and backpack shockers have been used in slackwaters. Hoop nets caught mainly flathead catfish. Dropnets are being tried now. The Oconee River is not comparable to the habitat of the razorback sucker.
- Are there any more ideas for studies that should be done? Perhaps we should wait and see what current studies reveal and then make new suggestions.
- Warm Springs has the capability and facilities for captive propagation of robust redhorse eggs and fry for research needs.
- The critical stage is probably hatching or the early larval stage. Consider Eric Diltz's study in which 15% silting led to greatly reduced hatch rates. Cecil Jennings has proposed a mesocosm study on eggs and fry hatching and habitat preference. Preliminary data from a 10 gallon tank showed a preference for slackwater habitat during high flow times. However, more data is needed in order to ask more appropriate questions.
- Should we try to collect juveniles from the Ogeechee River? It might be possible to collect there and look at their habitat preferences. Some robust redhorse ~200mm long have been collected from the Ogeechee. Perhaps the Ogeechee River group can provide some information.
- Can we estimate the importance and prevalence of egg predation? How many survive to swim up? Based on the voting results shown above, predation is a lower priority, and would also be much more difficult to realistically address.
- Tailrace temperature pre- and post-1980 and Sinclair Dam generations and their effect on area downstream from Balls Ferry to Dublin.

SAVANNAH RIVER

- Extra fish were produced from the Savannah River this year and are available to stock. SCDNR proposes to stock ~500 phase I fish in the Savannah River, and most of the remaining ~12,000 will be stocked into two sites in the Broad River SC. Some fish may be held back for future stocking or research.
- No juveniles have been seen on the Savannah River, leading to concerns over the status of the population. However, since none have been found in the other drainages either, this may not be a cause for concern.
- Smaller fish have been seen spawning in the Savannah than in other populations. Juveniles as small as ~450mm have been seen holding territories. Perhaps the Oconee is an older population with less recruitment.
- We need to know the range and status of the Savannah River population. Suggestions for a "robust roundup" – a concerted sampling effort like that done in the Pee Dee River in order to find juveniles in the Savannah River. Population estimates, dynamics, and models would all be very useful. Sampling done during all times of the year would

provide useful information. More mark-recapture is needed in the Savannah. Currently ~75 adults are tagged, plus individuals from Demery Creek.
- A concerted effort is needed to get funding for this effort. Perhaps the Coop units can help?

Broad River GA

- Is there spawning success? Young, untagged fish have been seen at Clark's Hill, but is that definite evidence of recruitment?
- We need to sample the upstream reaches more completely and determine the distribution of stocked fish over the entire range as well as what habitats they are using.
- One running ripe male was seen at the dam.
- Could funding be secured to survey from Hudson/North Fork Dam? It could be done, and might allow documentation of habitat preference.

Pee Dee River

- Sentinel fish work may be funded by Progress Energy, and a request was made for the committee to support and give priority to sterilizing and releasing sentinel fish.
- Warm Springs can help with the sterilization, but the bottleneck is in the availability of fish to sacrifice in order to conduct internal examinations. Could notch-lip redhorse be used as a surrogate? They might still find the appropriate spawning grounds, but probably occupy different habitats during the rest of the year.
- We don't know if there are good habitats for robust redhorse in the Pee Dee River. The Yadkin-Pee Dee TWG should evaluate their needs with the USFWS and bring the results back to the ExCom.
- The sterilization procedure could be practiced now using notch-lip as a surrogate for robust. Structures are very similar between these species, but suckers are much more difficult to sterilize than sturgeon.
- Are there any objections to the use of sentinel fish? Be sure not to remove too many fish from the Broad River to use as sentinels. Consider using surrogates instead. Perhaps robust redhorse could be grown at Warm Springs for use as sentinels, but that would require several years of waiting until they reach maturity. Could triploid fish be used instead of surgical sterilization?
- How much effort should be expended? The amount of funding specified for robust redhorse research is very low – the major need is to find money, not discuss research priorities. However, money is available to work with robust redhorse in the Pee Dee River, but first we need to be able to find them reliably.
- A list of granting agencies is included in the Habitat TWG report, but those funds are almost all tied to doing habitat augmentation and watershed assessments. We need commitments from the USFWS, NPS, COE, state DNRs, NSF, private foundations, and power companies to do other sorts of studies. The GADNR thinks that the robust redhorse gets enough support from other groups. Funding opportunities are available through FWS state funds.

Ogeechee River

- Need for larval habitat preference study.

REVISIONS TO MOU

The RRCC was formed in 1995 by the signing of a MOU by approximately 14 agencies. According to Section VII of the MOU, the agreement will expire on December 31, 2004 unless renewed. Thus, revisions were solicited during the 2003 RRCC Annual Meeting, and further revisions were discussed and finalized during the 2004 RRCC Annual Meeting. The new MOU will be renewed on December 31, 2004, and will remain in effect until December 31, 2009, as part of the FERC relicensing process.

The first change to be implemented is that the South Carolina Wildlife Federation has expressed interest in becoming a signatory member.

A second area of discussion centered on the definition of a “population”. In section II, several mentions are made of the historic and present range of robust redhorse, and there was some discussion as to whether groups of stocked fish should be referred to in the same manner as naturally occurring fish. The main concern centered whether or not the Broad River of Georgia should be considered a population, with most members agreeing that the stocking there appears to have been successful. A proposed change of MOU section II, 2nd paragraph, 3rd sentence to read “Fingerlings from the Oconee River population have been introduced in the Broad River (GA) and Ogeechee River” was put forward by Jeff Isely and passed by committee members with no dissent.

A second discussion topic was whether competition by non-native introduced species should also be addressed in the MOU as a potential threat to robust redhorse. Wayne Starnes proposed the following changes to MOU section II, 2nd paragraph, 4th sentence: “Impoundments, impacts by introduced non-native species, and general deterioration of habitat quality due to sedimentation and water pollution are believed to have contributed to the decline of the robust redhorse and are seen as continued threats to the survival of the species.” The motion to accept these changes was passed with no dissent.

The motion to accept the MOU with the addition of all of the above changes passed with no dissent. The revised MOU will now be sent to all signatories for renewal by December 31, 2004.

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