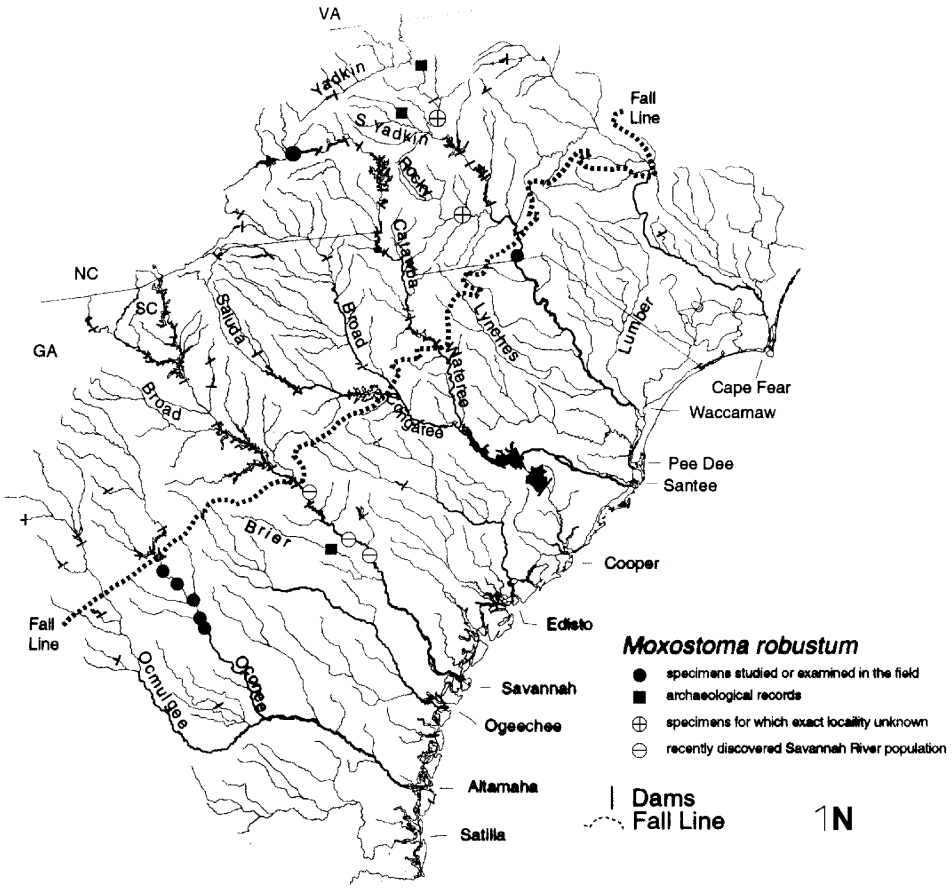
REPORT OF THE

ROBUST REDHORSE CONSERVATION COMMITTEE ANNUAL MEETING

SOCIAL CIRCLE, GEORGIA
OCTOBER 28 - 29, 1998



(The presumed range of the robust redhorse (Moxostoma robustum) on the South Atlantic Slope)

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under contract with the United States Fish and Wildlife Service

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EXECUTIVE SUMMARY

Overall, reports on the robust redhorse recovery effort at the 1998 Annual Meeting of the Robust Redhorse Conservation Committee (RRCC) were mixed, both encouraging and disappointing. A fair amount of positive progress in research, understanding, and management was reported. Yet some areas resulted in discouraging news and many reports led to new questions and additional uncertainty. Recovery efforts are impacted by many variables, some of which, like weather events, are beyond the control of investigators, and of course, funding remains a constraint.

Nevertheless, mixed success may be appropriate to a recovery effort only three (3) years underway. The recovery and management efforts of the RRCC are innovative and the RRCC is attempting something that has never been accomplished anywhere. There is no proven track record for a successful recovery of an imperiled aquatic species. On the Colorado River, efforts to recover similar species are 20 years old and the management activities are still struggling with issues the RRCC are facing. Thus there is no roadmap; the RRCC are helping to build the map and on the way there may be periods when progress is measured in small increments.

The most exciting news this year was the discovery of six (6) robust redhorse in the Savannah River: one (1) in October 1997; four (4) during the June 3-4, 1998 sampling; and one (1) on October 15, 1998. In addition, during 1998, there was an unverified sighting of one (1) adult robust redhorse in the Ogeechee River. The discoveries call for more sampling and increase the challenges by requiring estimates of abundance from the Savannah and Ogeechee rivers. The Savannah finds are particularly important as they relieve a little pressure on the recovery effort since there are now two populations with which to work. Indeed, perhaps the biggest news at this year's meeting involved the results of genetics research that strongly indicate the rivers hold two distinct populations.

Due to the discoveries in the Savannah River and the fact that the Savannah and the Oconee are genetically distinct populations, the most difficult decision accomplished at this year's meeting was the selection of priority stocking sites for fingerlings harvested in 1998. Since genetics considerations loomed large at this year's meeting, uncertainty pervaded the choice of stocking sites. The number of hours the RRCC spent in inquiry and discussion on this issue reflects the high level of integrity with which its members desired to do the right thing as well as the high level of anxiety associated with risk-based decisions.

Nonetheless, the decisions on stocking priorities were arrived at using a consensus process of the signatories of the MOU. On the whole, the group resisted major modification of its prior management approach based on information provided at the meeting. The final selection of stocking site priorities supported most prior short- and long-term management objectives of the RRCC.

The status of the Oconee population supports evidence that it continues to decline, this year's most distressing news. The biggest problem is inability, thus far, to induce the Oconee River population to reproduce and recruit in the wild. The large year classes produced in the late 1970's and early 1980's are declining and new recruitment at present appears insufficient. In the framework of long-lived species, however, recruitment gaps may be normal population dynamics; much remains unknown in this area.

Larger fingerlings are now available for stocking the Oconee, but the larger fingerlings are also needed as a potential source of future broodfish. The RRCC, again this year, decided that a more definitive estimate of the Oconee River population as well as funding a telemetry study of stocked fingerlings are required prior to reintroduction efforts. The task of re-evaluating the necessity and protocol for introductions of

hatchery-reared robust redhorse into the Oconee River below Sinclair Dam has been included in the list of 1999 work items for the Technical Advisory Group. In fact, status surveys of many rivers became a higher priority this year as a result of the new discoveries.

The 1998 harvest (results became available after the RRCC meeting) netted 16,986 Phase I and Phase II fingerlings. From hatcheries in South Carolina 8,655 were harvested (7,849 Phase I and 806 Phase II) and from hatcheries in Georgia 8,331 were harvested (5,180 Phase I and 3,151 Phase II). These numbers are better than were expected from the low egg and fry production that resulted from spring storm events followed by rapidly warming temperatures. The healthy harvest, as well as the good growth and survival rates in adult rearing ponds, indicates progress in fingerling production and pond management techniques.

These successes are accompanied by important research results in many areas: pond monitoring efforts, effects of fine sedimentation on emergence rates, egg and fry tolerance to contaminants, substrate characteristics of spawning habitat, and cryogenic techniques for storing sperm. Of note, research provides strong evidence of the inability of eggs and larvae to successfully emerge in even moderate levels of fine sediment, leading investigators to believe there may be only an 8 percent emergence rate in the wild. Preliminary results of the contaminant research produced good news; eggs and fry are fairly tolerant of exposures to most common contaminants.

Monitoring efforts to evaluate the success of the Broad River stockings were disappointing. After very intensive sampling, none of the stocked robust redhorse were found. Investigators believe the fish maybe surviving but are wily and that a shift in sampling gear is required. It was also concluded that telemetry studies would improve abilities to locate stocked fish and should accompany stocking activities in the future. While there are difficulties connected with the use of telemetry devices on small fingerlings, the technique is workable if funding can be found.

A draft Conservation Agreement has been developed to facilitate introduction of fingerlings into the Ocmulgee River. This process includes the formulation of conservation actions to be taken by major stakeholders as well as assurances that could limit excessive regulation of private sector stakeholders in the event of future listing under the Endangered Species Act. The tool has tremendous potential here and elsewhere.

Even with this year's mixed fortunes progress continues to be made. It is important to remember that if the RRCC had not begun the recovery effort when it did, we would be faced at present with declining abundance in the wild, with no process for initiating recovery activities, little knowledge about the species, and a poor understanding of techniques for artificial propagation. In addition, there would be no refugial population, which may in the end prove to be critical if declines of wild populations cannot be reversed. With few precedents, it is difficult to predict chances of long-term success. As stated, the RRCC are attempting something that has never been accomplished and the recovery of the robust redhorse must be viewed as one of the major new challenges in the fisheries field. However, the recovery process the RRCC has developed, coupled with an adaptive management philosophy, is capable of guiding the effort.

INTRODUCTION

The fourth annual meeting of the Robust Redhorse Conservation Committee (RRCC) was held on the 28th and 29th of October 1998 at the headquarters of the Wildlife Resources Division, the Georgia Department of Natural Resources in Social Circle, Georgia. A Memorandum of Understanding, signed in 1995, established the RRCC to develop and manage a prelisting recovery approach for the robust redhorse (*Moxostoma robustum*), previously a Category 2 candidate for Federal listing under the Endangered Species Act. The annual meeting of the RRCC satisfies partial requirements under the MOU. More importantly, the success of the recovery effort, to a large extent, is dependent upon the willingness of all MOU signatories to continue to support the effort throughout the year and to share progress and chart a direction for the upcoming year by attending the annual meeting.

The focus of this year's meeting was on the big picture, given the current understanding of the species. Objectives included assessing how far the recovery has progressed and determining whether the effort is on the right track. Discussions of significant accomplishments, areas were accelerated improvement is needed, and strategic modifications to the recovery approach supported the meeting's objectives.

On the first day, presentations on recovery efforts and research updates highlighted accomplishments, announced significant new information, and emphasized areas needing additional focus. The findings generated questions and discussion, which have been incorporated as descriptive material at the end of the presentation summaries in this report. Handouts provided by investigators have been noted in the presentation summaries and included as appendices.

The information presented and its implications shaped the discussion on day two of the meeting, which makes up the second portion of this report. The discussions were recorded to flipcharts by the consultant who, using a facilitated method, helped participants prioritize issues, identify changes in strategy, and move toward consensus decisions relative to the management and recovery approach for the upcoming year.

Jimmy Evans, a biologist with the Georgia Wildlife Resources Division and current Chairman of the RRCC, opened the meeting by welcoming those present and thanking participants for their interest and support. He announced that two reports documenting the progress of the recovery efforts are available. The Conservation and Restoration of the Robust Redhorse, *Moxostoma robustum*, Volume 1, June 1998 is a bi-annual report prepared for the Federal Energy Regulatory Commission by A.S. Hendricks of the Georgia Power Company. The Annual Progress Report, Recovery Activities for the Robust Redhorse (*Moxostoma robustum*) April 1, 1996 - March 31, 1997, was prepared for the Robust Redhorse Conservation Committee by James W. Evans of the Georgia Department of Natural Resources, Wildlife Resources Division, July 1998.

Approximately 52 participants were invited to attend representing federal and state agencies, hydroelectric power concerns, researchers and the conservation community actively committed to the restoration of the species throughout its known range. A list of the meeting attendees appears as Appendix 1. After preliminary introductions, participants were invited to submit their one or two highest expectation(s) or desired outcome(s) for this year's meeting. These expectations, shown in Appendix 2, were posted to a flipchart and reviewed periodically. Many of the expectations were met during the course of the research presentations and discussions, while those not met may inform planning for the content or structure of future meetings.

RECOVERY ACTIVITIES

Results of 1998 Spawning Season — Greg Looney

Egg and fry production was low in 1998 due to weather conditions that resulted in a late startup date and early termination of broodfish collecting efforts. The heavy rains attributed to the effects of El Nino delayed getting on the Oconee River; the water temperature (19° c) was lower than optimal and floodwater was 6 inches over the major access road. Although collection and spawning efforts in man-days were just as intense as in 1996 and 1997, all activities occurred during just one week, May 18 - 22, 1998. Weather conditions continued to limit spawning activities as air temperatures rose rapidly. By May 21, 1998, the water temperature was 25° c or higher and most broodfish collected were no longer in spawning condition.

There was difficulty in finding fish during collection efforts. High floodwaters changed the configuration of the river, which made it difficult to locate previous spawning beds. However, fourteen (14) males were captured, six (6) of which were used in spawning. Five (5) of the males were overripe at capture or became overripe before spawning activities occurred. Three (3) others were not in condition to spawn and one (1) was not used due to abrasion stress. Seventeen (17) females were collected, four (4) of which were spawned (2 twice and 2 three times). Two (2) females were lost during the week, probably due to the stress of spawning. The two (2) were brought to Beaver Dam Wildlife Management Area for examination. One had external lesions that were laden with bacterial infections. The other, while dying, was operated on to harvest eggs with no success. Many of the fish that were collected had substantial injuries associated with normal spawning activities. No juveniles were collected during the 1998 spawning activities.

Using the captured broodfish, ten (10) matings were accomplished by crossings with separate males. One mating was split in which eggs were crossed with two (2) males. This compares to previous years when 8 - 10 females were spawned from a selection of up to thirty (30) females on hand. The four (4) females provided 142,000 eggs. Fertilized eggs were shipped to The University of Georgia (UGA) for research (17,000) and the remaining 125,000 were shipped to hatcheries for fingerling production. Survival from egg to stockable fry was about 44 percent, for a total fry production of 55,683.

Four (4) females were caught in the Savannah River on June 3 and 4, 1998 and shipped to McDuffie State Fish Hatchery (McDuffie). The females were examined for spawning potential. All were found to be overripe with an almost total mucus covering. Experience shows that fish should have 1/2 to 1/3 mucus covering for optimal spawning potential. Fin clips were taken from the males and sent to Dr. Ike Wirgin for genetic analysis (see Initial Results of Genetics Investigation of Hatchery-Reared Robust Redhorse Fingerlings; Genetic Characterization of the Savannah River Robust Redhorse Population). The four (4) females were given pit and floy tags and returned to the Savannah River. The Savannah River robust redhorse seemed to be in good condition, with fewer spawning injuries than the Oconee specimens. The Savannah River fish seem to have a bit smaller head than the Oconee, though the body seems the same shape.

During spawning activities, parasitology, bacteriology, and virology examinations were conducted on 20 fish. The United States Department of Interior, U.S. Fish and Wildlife Service, Diagnostic Report on robust redhorse, May 19, 1998 reported negative parasites, pathogens or viral cytopathic effect. The report was distributed to meeting participants and can be found as Appendix 3.

The investigator reported that about 2000 fry have been retained for use in studies on the effect of diet and density on intensive rearing. Warm Springs State Fish Hatchery has 982 of the 1998 year class fry

that are 55.1 millimeters. The 731 fry from the 1997 year class diet and density studies are 1 1/2 year olds, weigh 5.9 grams and are 87.5 millimeters in length.

Fingerling Production and Reintroduction Efforts in 1997; Current Distribution of Hatchery Reared Phase I, Phase II, and Juvenile Robust Redhorse — Jay Shelton

The current distribution of hatchery-reared Phase I (1998 year class), Phase II (1997 year class) and juvenile (1995 year class) robust redhorse appears in Appendix 4 as Table 4. Three year classes of fish are represented in this inventory. The 1996 year class is missing; only 3 fish were harvested, which represents that year's total production. In terms of establishing a refugial population, Table 4 gives a perspective of how many hatchery-reared robust redhorse are located at each of the sites. The inventory of the 1998 year class is an estimate since all ponds containing the 1998 year class have not been harvested. An inventory of individual ponds at each hatchery is provided.

Fingerling production was fairly good in 1997; 182,127 fry were stocked and 34,974 were harvested (see Appendix 5 — Table 1. Summary of Phase I robust redhorse fingerling pond production for 1997). Overall, the survival rate averaged 19 percent. Walton State Fish Hatchery (Walton) had the highest survival rate at 63 percent. Burton's survival rate was good at 43 percent, though the fish were in poor condition at harvest. There was virtually total mortality at the other hatcheries at the time of harvest. It may be that all the hatchery fish experienced the same stressors, but Burton is the furthermost north hatchery and, therefore, has the lowest water temperatures. The lower water temperatures slow the metabolic rate of the fish, which may retard the effects of stressors and improve survival.

This is the first year (1997) that a standardized monitoring routine was followed at all the hatcheries including records of dissolved oxygen and temperature. More rigorous monitoring was conducted in 1998. There were significant temperature events the first week of June 1997. The 1997 Burton harvest showed a bimodal distribution in the size of fingerlings. It seems that those post-larvae fry that did not get up to the next feeding stage had poor growth because they could not take advantage of the available food. These smaller fish were emaciated, due to lower temperatures, and lingered at Burton, whereas at the other hatcheries, these fish would have likely died from starvation. A significant proportion of the Burton fingerlings died during tagging.

Of the 1997 Phase I fingerlings that were harvested (34,974), 7,392 were placed in ponds (see Appendix 6 — Table 2. Pond stocking summary for Phase I robust redhorse fingerling produced in 1997). Some of the ponds were stocked as single species, while others were stocked at low densities with other species such as bluegills at McDuffie. The 1,770 fingerlings that were stocked at the Piedmont National Wildlife Refuge (Piedmont) were added to previous year classes in an attempt to establish a refugial population. Riverine stocking of the 1997 Phase I's totaled 26,018 fingerlings. The majority, 24,256, were released into the Broad River and 1,762 were released into the Ogeechee River, for the first time (see Appendix 7 — Table 3. River stocking summary for Phase I robust redhorse fingerlings produced in 1997). The dates in Appendix 8 — Table 5. Inventory of river-stocked robust redhorse 1995-1997, represent the year the fingerlings were stocked. Again 1998 is not represented in the inventory, however, as the riverine stocking program has progressed since 1995, better distribution of location and number stocked is apparent.

Survival for 1998 year class from egg to stockable fry was about 44 percent. Although only the ponds at Burton containing the 1998 year class had been harvested by the date of the meeting, results support the expectation of a good harvest in 1998.

Status Update on Adult Rearing Ponds at Piedmont National Wildlife Refuge and McDuffie Hatchery — Jimmy Evans presented for Mark Bowers

There has been good growth and survival in the adult rearing ponds at McDuffie and Piedmont. Fingerlings from the 1995 year class were stocked into bluegill and redear ponds at McDuffie in 1997. At stocking, in December 1997, robust redhorse averaged 216 millimeters and 166 grams in length and weight. In March of 1998 at harvest, fish averaged 327 millimeters (11 inches) and 481 grams (1.1 pounds). Over a 27-month period at the hatchery, survival rate has been 87 percent with an average 4.4 inch growth increment.

These results indicate that successful polyculture with sunfish is possible when stocked at low densities. The robust redhorse have been found in places where the feed is deposited and worms colonize. Although it is difficult to determine if the robust redhorse are feeding on the feed or the worms, there is reason to assume that at least some are using the feed. There has been no stomach content evaluation, but it is needed. The bluegill and redear have had no negative impact on the production of robust redhorse. This success support the conclusion that larger juveniles can be reared from stocked fingerlings and increases the likelihood that broodfish can be produced in the future.

Catch rates of about 21 - 53 fish per hour of electrofishing on March 6, 1998 indicate good survival in refugial ponds at Piedmont. Appendix 9 includes six (6) graphs of length and weight data for three (3) ponds at Piedmont: 9A, 7A, and Pippins Lake. Survival and growth in the Piedmont ponds is especially encouraging considering they are not intensively managed. A summary of mean length and weight for the ponds is shown in the table below.

Mean length and weight data for three (3) ponds at the Piedmont National Wildlife Refuge

Ponds	Length 3/97 (millimeters)	Length 3/98 (millimeters)	Weight 3/97 (grams)	Weight 3/98 (grams)
9A	240	281	179	265
7A	222	276	161	255
Pippins Lake	228	283	181	276

The 28 acres of total pond space at Piedmont is a significant resource, though there are aquatic vegetation problems in some ponds. In February 1997, hydrilla was discovered with a significant *Elodea* infestation in one pond. The Georgia Power Company treated the 11-acre pond for the hydrilla then stocked it with grass carp. It has been left empty for one year and is now ready to be stocked. Hydrilla was discovered in an adjacent pond, which was not treated but stocked with grass carp because it contains robust redhorse fingerlings. A possible connection between vegetation and fingerling growth is under evaluation. The general sense is that hydrilla, an invasive threat, is a detriment to growth. All of the ponds have significant aquatic plants but the species composition is different in each of the ponds.

Regardless of the vegetation issue, the good growth and survival rates indicate that even ponds not managed intensively can be used for juvenile production. Monitoring and sampling will be continued. All fish are tagged with coded-wire tags to distinguish year classes. There is near 100 percent tag retention. Although it is unknown if growth and survival will be sustained, the refugial pond program has been a success thus far.

Status of the Oconee River Population — Jimmy Evans

The collection efforts in 1998 yielded zero immature fish, which can be attributed to several factors. The sample size was smaller than normal and the sampling reach was 1/2 of the species' known extent in the Oconee River. In addition, the known spawning sites had a different pattern than previous years. The change in the distribution may have been the result of two (2) record floods in the spring of 1998. Although there is no direct evidence, it seems likely the usual spawning gravel bar sites were covered with flood sedimentation.

Furthermore, to collect broodfish efficiently, the river must be at low flows, approximately 500 - 700 cfs from Sinclair Dam. The Georgia Power Company could not reduce the river to low flow stage for an extended period due to the flooding. Therefore, collection efforts had to be delayed three (3) weeks, at which time the air temperature rose to 95° Fahrenheit or higher. The high air temperatures caused the water temperature to increase beyond optimal spawning ranges so the flow of the river had to be increased to reduce temperatures. Sampling ended after two (2) days; the low spawning and broodfish collection is the result of the short sampling period.

Mark and capture studies have been the basis of population estimates for the Oconee River. Tag returns indicate significant spawning site fidelity. This year, however, spawning aggregations did exhibit past fidelity patterns. In 1995, the Oconee population was estimated at 2,493, based on tag returns from a small area that are projected over the entire river. In 1996 the population was estimated at 1,746 and in 1997 at 887. This is evidence of population decline, but confidence intervals of the estimate are high. There can be alternative interpretations of the data and sampling biases make the status of the population still unclear.

The modal length of the 1998 sample was 66 centimeters; no juveniles were collected. There is a distinct length distribution that indicates an aging population in which recruitment may not be sufficient to sustain it at the present numbers. The length comparison of 1993 to 1998 reveals a substantial difference and what appears to be a shift to larger size classes. In addition, even though 1998 was an anomaly due to the floods, catch rates over time are declining, which is evidence of a declining population. The present abundance and length distribution are not characteristic of a population crash, yet if trends continue, collection of broodfish could become a problem within five (5) years.

In summary, juveniles of all redhorse species are difficult to collect. The Oconee population consists of year classes produced in the 1970's that are reaching the end of a natural life span. Whether long periods of low recruitment are normal for a long-lived species remains unclear. In long-lived species, individuals may not spawn every year and recruitment gaps may be normal population dynamics. However, the conditions are not the same as the 1970's; the flow regime is different and the flathead catfish are now a factor. It may be most prudent to proceed under the assumption that the declining abundance of adults combined with very low recruitment levels could result in a scarcity of broodfish in 2 - 5 years and perhaps in as little as 2 - 3 years.

Although the extent to which the flathead catfish may be impacting recruitment is uncertain, it is known the species typically alters species composition whenever it is introduced. The literature indicates that when flathead are introduced, suckers, sunfish, and bullhead catfish typically decline. Flathead catfish expanded into the Oconee River during the 1980's, and it appears that bullhead catfishes have been extirpated from the mainstem of the Oconee River. There is little data for the Oconee River prior to the flathead catfish invasion.

PRELIMINARY RESULTS OF RESEARCH

Effects of Sedimentation and Substrate Composition on Robust Redhorse Reproductive Success — Erik Dilts

This research was initiated based on the low density of robust redhorse larvae in the Oconee River. Hypotheses for the causes of the low density include: 1) biosensescence, which has been refuted; 2) unsuitable spawning habitat, which has been proven untrue; and 3) limitations in spawning habitat. This final hypothesis is the basis of the sedimentation and substrate composition research.

Robust redhorse spawning repertoire is similar to salmonids where studies have found that deposition of fine sediments is detrimental. This research tested the effects of fine sediment on larval emergence through a study using various gravel treatments.

Results show peak emergence on day 16 or 17 after fertilization. Data indicate that sediment levels increase egg and fry mortality and result in reduced or early emergence of fry. The percent survival to emergence is significantly lower in fine sediment. A 15 percent fine sediment to gravel mixture, for instance, produces a 50 percent survival rate. Based on this evidence, it is expected that the successful larval emergence rate in the Oconee River study area is about 8 percent.

Research on freshwater mussels, which require a similar substrate, has shown that about 2 - 3 weeks of heavy flows will flush the substrate. Perhaps if the gravel beds can be flushed before spawning it would help increase the larval emergence rate in the wild. The fish, however, may be cleaning the bars sufficiently themselves through natural spawning activity. The spawning sites seem much cleaner than the surrounding areas. Therefore, stable flow events might be the best condition for spawning success in the Oconee River.

Effects of Various Contaminants on Robust Redhorse Eggs and Larvae — Pete Lasier

The contaminants study used a tiered approach under three (3) exposure test conditions to determine the effects of known toxins on eggs and larvae. The conditions included exposure to one (1) contaminant, the effect of a 96-hour exposure, and the effect of cumulative exposures.

Results indicate that robust redhorse eggs and fry are more tolerant of exposures to most common contaminants than some other species. There were no detectable problems with exposure to ammonia. The egg stage was the most sensitive to exposure to cadmium and the effect of cumulative exposure produced similar sensitivity. All three (3) test conditions produced an equal sensitivity to copper in both the egg and larvae stage. Eggs are the least sensitive of the stages to exposure to zinc and to the cumulative effects of zinc.

Tests on fine sediments that bind and carry contaminants and on water quality assessments are currently ongoing at 12 sites of fine sediment deposition. Robust redhorse exposure to in-situ contaminants will be conducted next spring. In addition, robust redhorse tissue samples have been sent to the Georgia Environmental Protection Division (EPD) for contaminant analysis, but results have not been received yet.

Observations of Robust Redhorse Spawning Habitat and Behavior in 1998 — Bud Freeman

Observations were conducted near the Avant Mine site at Oconee River mile 120 below Milledgeville, Georgia. The site has undergone rapid alluvial change over the last five (5) years. The main current is directed to an undercut bank, which feeds a gravel bed in the middle of the channel. New spawning bars were found in the vicinity of the known sites near the kaolin mine. A draft report of findings of this research has been submitted to the Georgia Power Company and the United States Fish and Wildlife Service (FWS).

A lot of data have been collected on direct observation of spawning activities. Visual observations were poor in 1998 in comparison to previous years due to turbid water and fewer low flow windows. The discharge stage data at Milledgeville and the water temperature at the Avant Mine site during April - May of 1997 and 1998 can be found in Appendices 10 and 11. A comparison of 1997 and 1998 Oconee River stage data at Milledgeville can be found in Appendices 12 and 13. In 1998 there were two (2) low flow windows, May 10 and May 16 - 19, when spawning activities were observed. In 1997, low flow windows were April 26 - 28 and, similar to 1998, during May 9 - 14 and May 16 - 20.

The substrate characteristics of the spawning habitat were recorded using a nitrogen freeze coring device. It allows investigators to detect the depth of egg burial and the composition of substrate. The percent of fine sediment (<0.25 millimeters) and the percent of sand (0.25 - 2.0 millimeters) in the freeze-core samples were compared to samples collected in spawning and non-spawning locations for three (3) catostomid fishes during 1997 and 1998. The freeze core techniques were conducted in May and August in the Oconee River. In March 1998 the technique was used in the Broad River for other sucker species where egg burial was found at 8 - 10 centimeters from the surface. Freeze core samples were also collected in the Valley River in North Carolina for river redhorse larvae.

All of the core materials were weighed and the percent of fine sediment and sand was determined. As well, the river temperature and discharges were recorded. A comparison of results indicates a lot of apparent variability in burial depth. The mean depth of burial seems to be greater for the robust redhorse than for other species. Robust redhorse eggs and egg shells were collected but no larvae were found. Strong year classes may occur periodically; larvae should not be expected to be found every year.

In addition to direct observation, hydrophonic instruments were used to record and compare spawning activity. In 1997, noise was much higher than that recorded in 1998 causing uncertainty as to when spawning occurred in 1998. As well, investigators seined for eggs and drift feeding larvae. Although some small shiners were caught in the drift nets, there were many fewer eggs and no larvae found, which also indicates that less spawning occurred in 1998.

Update on the Development of Cryogenics Techniques for Storage of Robust Redhorse Sperm — Greg Looney

There were not sufficient amounts of egg and semen from the 1998 spawning season to conduct fertilization trials. Therefore, the researcher repeated the 1997 experiment to test three (3) freezing techniques. Results confirmed that semen could be used up to one (1) week, which means that males can be released back to the wild sooner. The investigator conducted tests on 1998 stored semen, results of which showed a 30 percent mean motility on thawing compared to the 50 percent mean motility on thawing of the 1997 stored semen.

The researcher has semen from ten (10) different males in storage. Most males produce an over abundance of semen, enough to fertilize existing eggs and to freeze the excess. Healthy male specimens typically produce 20 - 30 milliliters, while 5 milliliters is enough to conduct fertilization. This means researchers can store semen continuously to protect against loss of genetic material.

Early Results of Monitoring Activities on Robust Redhorse Hatchery Ponds — Allen Fitzek

Research on the culture requirements of robust redhorse has been a priority of the recovery effort since 1993. The investigator reported very preliminary but fairly promising results of the first in a five-year monitoring study of hatchery ponds. Researchers were able to sample an entire growing season in 1998 at ponds in South Carolina and Georgia for the first time. Although it is premature to establish a correlation between pond management practices and fingerling survival, sampling effectiveness has been good.

In ponds that have been harvested (only one (1) pond has been harvested at Burton) there was significant variability in where robust redhorse could be found. In ponds that had high mortality rates, growth seemed to stratify before fish died, while in ponds where no death occurred growth was consistent.

The ponds were all on a fertilizer and feeding regime. The researcher will analyze gut samples of fish from each pond to determine feeding patterns, results will be available next spring. Some of the gut contents revealed that commercial feed is definitely being consumed.

Recent Monitoring Efforts to Evaluate Success of Broad River Stockings — Bud Freeman

Twenty-five thousand fingerlings were stocked at numerous sites in the Upper Broad River in 1997 (see Appendix 14). Very intensive sampling in 1997 and 1998 using a variety of gear produced no stocked fingerlings from the main channel. However one (1) flathead catfish, a small number of bass, and many suckers were captured.

Appendix 15 shows a summary of stocking sites for the various year classes and the numbers released in the Broad River system. Backpack and boat electrofishing efforts in the upper Broad River system from December 1996 to early October 1997 also failed to capture any robust redhorse. Nor were any robust redhorse captured in over 1000 hours of pedal time during boat electrofishing surveys conducted from December 1997 through September 1998 on the main stems of the Broad River, Hudson River, North Fork Broad River, and the Middle Fork Broad River.

Low numbers of stocked fingerlings were recaptured from Hannah Creek. Seven (7) robust redhorse stocked in Hannah Creek were found during sampling from mid October to December 1997 and then no more were collected. The smallest captured was 11 centimeters in length. The fingerlings seem to be able to move considerable distances even in a day. Individuals dispersed downstream from the stocking site anywhere from <10 meters to >1600 meters per day, almost to the mouth of the creek.

The typical habitat where the fish were found in Hannah Creek included adjacent to a cut bank or near a pool. Individuals were captured in water depths of 0.54 - 0.67 meters and in velocities of 0.01 - 0.3 meters per second. These areas represent deeper, lower velocity microhabitats in Hannah Creek, typically with sand substrata and often positioned near the channel edge with overhanging cover.

Other species captured during sampling throughout the system include 402 specimens of *Moxostoma* and *Scartomayzon*. The total length of the redhorse and jumprock specimens averaged 32.4 centimeters; the smallest individual was 11.1 centimeters. The size range of captured suckers, including the seven (7) fish captured in Hannah Creek, minimally overlapped with the size range of a sample of robust redhorse taken from hatchery stocking trucks.

Diet studies were conducted on the seven (7) robust redhorse captured in Hannah Creek. Four (4) contained prey items, including: cladocera (45 percent); chironomids (38 percent); plecoptera (7 percent); and odonata, gastropoda, and asiatic clam (30 percent each). Chironomids and *Corbicula* were the dominant prey types of the other suckers examined; caldocerans sporadically occurred. The robust redhorse fingerlings were making the shift to eating items found in the stream.

The habitat of the Hudson River is being mapped using GPS and laser length marking (see Appendix 16). River features were overlaid on an U.S. Geologic Survey quad map to show depth, habitat characteristics, and macrohabitats of pool, run, shoal, or bar. Habitat mapping allows a comparison between characteristics of the Hudson and Broad rivers. The Hudson has 4.5 times more complex habitat than the Broad River (see Appendix 17). There are more flowing pools than shoals and the dominant substrate is coarse sand over gravel.

Researchers do not believe that the Broad River system stocking is a failure. It is believed that the fingerlings are in the system and are feeding. Only 15 miles of a 150-mile river has been sampled. The fifteen miles downstream of the Hudson River release site, which have been sampled, may not include the lowest point of dispersion of the fingerlings.

The sampling problems are thought to be gear related. The key may be the implementation of a telemetry study, but the extent of sampling may also contribute to biased results. Monitoring efforts will be concentrated in the Hudson River where there is more complex shoal habitat. The investigators have been using boat and backpack electrofishing solely to sample, however, there has been better success capturing other species using an electric grid technique. Proposed gear changes for future monitoring efforts will include the use of pre-positioned area grids at night and boat shocking in specific areas.

A telemetry study will be conducted next year, but there are inherent complications with the equipment. It is difficult to quickly follow the species especially at high flows. As well, the 1.5-gram telemetry fin tags have been unsuccessful on trials with small fish. Internal tags do not seem to produce any better results with such a small animal. Sonic tags are 5 millimeters in diameter and 1.5 centimeters long. They may be worth the financial investment, but they have limited range. With all of the telemetry equipment, there is a trade-off between power, range, and the size of fish. Alternate solutions include the use of bigger, Phase II, fingerlings that are more suitable for tagging or the use of a surrogate sucker species.

Assessment of Reproductive and Recruitment Success in the Oconee River— Cecil Jennings

Objectives of this study, in its fifth year, include assessment of the abundance of larval, young-of-year (YOY), and juvenile robust redhorse in the wild. Environmental variables include water temperature, current velocity, dissolved oxygen, and water depth. In the study reach, from the Central Georgia railroad trestle to immediately above Dublin, researchers found evidence of a skewed size distribution indicating very low recruitment levels. Spawning is known to be occurring and based on the assessment, there seems to be at least some recruitment. The investigator is encouraged by the results and believes there is a convergence of data that can direct recovery efforts.

Sampling gear has changed over the last four (4) years. Gear has included push nets, live traps, seines, D-ring nets, and benthic pumps; though the last two (2) are no longer used. The robust redhorse are positively phototactic so protocol involves sampling the top half meter of water. In 1998, sampling occurred between May 11 - September 23. Hoop nets were added in August to sample deeper water, but the technique was abandoned because it was too dangerous. Although the investigators were able to sample a larger area with the hoop nets, efforts did not yield any robust redhorse. Light traps require very bright wattage to attract phototactic fish, particularly in turbid water. The researcher has tried to use these but the draw on the battery reduces a typical 3 - 4 hour sampling time to one (1) hour. Pre-positioned grids may be the best next step in sampling gear.

A total of 3,700 plus larval and juvenile fishes were caught including 23 in the sucker family and 75 in the catfish family. In addition, 48 adult flathead catfish were caught in hoopnets. On analysis of their stomach contents, sunfish, crayfish and small catfish were found. This limited data does not support the theory that flathead catfish are a major predator of the robust redhorse.

Larval fish in samples have increased slightly, six (6) recently emerged robust redhorse larvae, measuring 14 millimeters, were found. No robust redhorse bigger than this, no YOY, were captured. The increase in larval abundance may be a result of sampling bias, but may also be related to better flow conditions following FERC re-licensing of Sinclair Dam. There is no good explanation for the lack of YOY in samples.

The larval and YOY robust redhorse seem to be very elusive, seen to hover at the surface and also to be distributed through the water column. However, when researchers try to capture them, they exhibit escape reflexes indicating a very flight sensitive species.

Density of robust redhorse larvae during Spring 1997 revealed low, high, then low abundance. Apparently, the robust redhorse population includes early, peak, and late spawners.

Density of robust redhorse larvae, Spring 1997

Date	Volume Sampled (cubic meters of water)	Number Collected
May 14	1000 m^3	4
May 26	1000 m^3	5
May 28	1000 m^3	32
June 11	1000 m^3	4

Convergence of the available evidence suggests that adults found in the Oconee River represent strong year classes that are moving through the system, shifting to the right in both size and age distribution. Generally, there seems to be a low level of recruitment in the system; there continues to be a few fish in the 400 - 600 millimeter range.

Maximum density of robust redhorse larvae

Date	Volume Sampled (cubic meters of water)	Number Collected	Comments
1995	1000 m^3	13	Variable flow during spawning season
1996	1000 m^3	3.4	Variable flow during spawning season
1997	1000 m^3	32	First year FERC required stable flow during spawning season

Evidence of unsuccessful recruitment in the wild to 2 - 3 inches supports the conclusion that the Oconee population is in trouble. More definitive results can be gained through a refinement of the sampling techniques to find juveniles. There does seem to be a low level of recruitment evidenced by the 1998 collection. The absence of juveniles may be a sampling bias. A rigorous mark and recapture experiment to determine the population size, individual survivorship, and recruitment is required. The researcher believes that a long-lived species with a high level of survivorship will have a low level of recruitment. A determination of the level of recruitment that is needed to maintain the population must be made.

Results of Savannah River Sampling Conducted in 1998 — Scott Hendricks

During routine sampling in October 1997, an adult robust redhorse was collected in the Savannah River near Plant Vogel. Portions of the Savannah River were surveyed for robust redhorse in 1998. The Georgia Power Company coordinated flows from Clarks Hill Lake with the U.S. Army Corps of Engineers to conduct additional sampling downstream of the 1997 find, between Augusta to Highway 301.

On May 20 and 21, 1998, seven (7) electrofishing boats participated in sampling the Savannah River between the New Savannah Bluff Lock and Dam to Highway 301. Sampling crews included: Georgia Department of Natural Resources, Wildlife Resources Division (WRD); UGA, Institute of Ecology; Coop Fish and Wildlife Research Unit; Georgia Power Company; U.S. Army Corps of Engineers; Tulane University; Kleinschmidt Associates; and Roanoke College, Virginia. Efforts were concentrated in meander bends with snags, areas having similar habitat as the Oconee. Even with the coordinated flows, the river was still high as a result of the spring rain events. After 15 hours of pedal time over two (2) days, no robust redhorse were found.

On June 3 and 4, 1998, sampling was conducted in the Augusta shoals area, about one (1) mile upstream of Interstate 20 downstream to about the 5th Street Marina. Again flows were coordinated with the U.S. Army Corps of Engineers. Sampling crews included: WRD; South Carolina Department of Natural Resources; UGA, Institute of Ecology; EDAW, Inc.; City of Augusta/Richmond County, Georgia; Georgia Power Company; Duke Power Company; Roanoke College, Virginia; and North Carolina State University, Museum of Natural History.

The sampling efforts concentrated on shallow, swift, rocky shoals, and shallow pools between rock ledge habitats. Five (5) electrofishing boats accumulating over 12.3 hours of pedal time captured four (4) adult robust redhorse, two (2) each day, and several more were observed. All four (4) fish were females, measuring between 620 - 675 millimeters in total length with a mean of 645 millimeters (25.4 inches). They weighed between 3.66 - 5.11 kilograms with a mean of 4.13 kilograms (9.1 pounds). Fin and egg tissue was collected and the females were given pit and floy tags. These fish did not exhibit severe scale loss and abrasions, presumably from spawning activity, as do fish from the Oconee River. They were transported to McDuffie (see Greg Looney's report, Results of 1998 Spawning Season) and then returned in good condition to the Savannah River near the capture site on June 8, 1998.

On October 15, 1998, one (1) robust redhorse was collected in deep water from a straight stretch of the Savannah River 11 miles downstream of Highway 301. This find, measuring 575 millimeters (22.6 inches) and weighing 2.9 kilograms (6.4 pounds), was 42 river miles downstream of the 1997 capture and 98 river miles downstream of the Augusta shoals catch.

The status of a Savannah River population remains entirely unknown. The Savannah, a large deep river, is difficult to sample making an estimate of the population hard and its potential as a reliable broodfish source unlikely. Furthermore, the Savannah River is one of the most heavily sampled rivers in the Southeast United States and until recently there were only two (2) known records. Efforts to estimate a population must target just robust redhorse; they will rarely be found while looking for other species.

The investigator recommends sampling the Ogeechee River for robust redhorse. While sampling for stocked fish in the Ogeechee, Tim Barrett who caught the Savannah River robust redhorse in October 1998, saw one (1) fish that could have been an adult robust redhorse. This sighting has not been verified but merits an intensive sampling focus.

Initial Results of Genetics Investigation of Hatchery-Reared Robust Redhorse Fingerlings; Genetic Characterization of the Savannah River Robust Redhorse Population — Ike Wirgin

Objectives of the genetics investigation of robust redhorse include: 1) to determine if there are multiple stocks of robust redhorse in the Oconee River; 2) to evaluate the genetic similarities in the Oconee and Savannah rivers; and 3) to compare the genetic diversity of the hatchery population to the adult Oconee River population. The focus of genetic research this year has been on the fin clip tissue collected from the four (4) robust redhorse captured in the Savannah River on June 3 - 4, 1998 and the one (1) captured in October 1997. Techniques typically used in genetic sequencing research involve: 1) allozyme proteins, which detect low levels of bi-parent genetic variability; 2) mitochondrial DNA, which detects moderate levels of maternal genetic variability; and 3) microsatellite DNA, which detects high levels of bi-parent genetic variability.

The five (5) Savannah River specimens were compared to Oconee River specimens using the microchondial DNA sequencing technique. Results showed genetic sequencing at 9 of 10 sites. Six (6) of the sites are polymorphic, which differ among individuals. Four (4) of those revealed fixed differences between the Oconee and Savannah river specimens indicating significant genetic divergence. The microsatellite analysis to compare the hatchery-reared to the Oconee River population is ongoing. Other results indicate no difference in the individual spawning aggregates in the Oconee River, but the testing has not been completed. The same analysis was conducted between the Savannah and the Oconee specimens; three (3) of the four (4) Savannah individuals demonstrated different alleles to the Oconee River specimens.

Preliminary conclusions argue that the Oconee River contains a single population of robust redhorse. The fixed differences between the Oconee and the Savannah specimens suggest that the two populations are genetically distinct. The researcher informed the RRCC to assume that the Oconee and Savannah rivers contain two different populations and cautioned against the mix of hatchery-reared robust redhorse between the two rivers.

Progress on Development of a Conservation Agreement to Facilitate Reintroductions of Robust Redhorse in Georgia — Mike Nichols

A draft of a Conservation Agreement with an associated Conservation Strategy designed to facilitate a stocking of the Ocmulgee River has been developed. The approach is a tool that can be used in managing the recovery of the robust redhorse. The RRCC MOU is flexible and addresses needs throughout the historic range. The Conservation Agreement deals specifically with the Ocmulgee River. It is more

structured than an MOU and specifically addresses the FWS requirements for five (5) Endangered Species Act criteria applied to listed species.

The Conservation Agreement evaluates specific sites, identifying characteristics, conservation measures, specific actions to be implemented, and monitoring and reporting requirements. It outlines conservation actions the stakeholder signatories must take in exchange for assurances that if a future listing occurs, stakeholders will not be unduly penalized. The Conservation Strategy outlines the recovery strategy for the species throughout its historic range. Other states may attach specific Conservation Agreements for other rivers to the Conservation Strategy.

At this time assurances provided relative to the Ocmulgee River will apply only to the Georgia Power Company, unless there are future signatories. Immediate signatories will be the FWS, Georgia Power Company, WRD, and perhaps the Georgia Wildlife Federation and the U.S. Forest Service as well.

The draft documents are undergoing review by the signatory agencies. Unresolved issues connected with the proposed Ocmulgee River Conservation Agreement include: determination of the stocking rate needed for the approximately 19 mile reach, definition of "viable population", and a final rule on Conservation Agreements (proposed changes to 50 CFR 17) expected by the beginning of 1999.

South Carolina Perspective on the Robust Redhorse Recovery Effort — Ross Self

Reintroduction in South Carolina is a critical issue. The state has devoted many hours of manpower and committed significant resources, including hatchery space, to the recovery effort. However, South Carolina Department of Natural Resources is not prepared to go forward with reintroduction at this time.

There are unresolved issues that impel South Carolina to delay reintroduction. A better definition of an "experimental population" must be developed. The effectiveness of stocking in sites with flathead catfish must be demonstrated. The results of genetic comparisons between the Oconee and Savannah river populations should be more definitive. Finally, questions that relate to species interaction resulting from stocking in rivers with endangered mussels must be resolved.

In addition to these unresolved issues, a potential funding avenue could be complicated by the status of the robust redhorse. Federal legislation is ready to be presented that would dedicate 10 percent of offshore drilling royalties to nongame species. Potentially, $350 million per year could be allocated to the state, but it cannot be used on a species that is already listed.

South Carolina will be conducting more sampling of the native mussel species. It will also be watching the results of genetics investigations of the Savannah River. If any fish are found in the Pee Dee River system, it is likely they are at least as different as the Savannah and Oconee rivers are from each other. The hesitancy to re-introduce does not preclude South Carolina from helping with Savannah River sampling and broodfish collection efforts.

The following comments, made by RRCC members, resulted from the previous presentation on the South Carolina perspective.

- Investigators have found that robust redhorse pick-up and pass through corbicula. It seems to be easily handled and not an issue.

- Essential and nonessential experimental populations have a narrow distinction for a listed species. It would be hard to conclude that an introduced species is anything but an experimental nonessential population.
- If consensus is reached on a Conservation Agreement and Strategy for the Ocmulgee River, it may address some of South Carolina's concerns.
- Through a candidate Conservation Agreement, major stakeholders in the area agree to undertake specific conservation measures in exchange for assurances that sever penalties will not result from a future listing under the Endangered Species Act. Experimental nonessential population designation states that nothing more will be required of land users under the Endangered Species Act.
- The Pee Dee and the South Carolina Broad rivers are potential stocking sites.
- At some point, the recovery effort must move to another river system. All stakeholders will never have all of the assurances desired. Meanwhile the gamble remains, how long do we let the parent stock decline while assurances are evaluated?
- Investigators are unsure of the stocking density needed to establish a new population. With current hatchery production potential, reintroductions need to be concentrated in the few systems already identified.

DISCUSSION _____

RECOVERY ACTIVITIES AND RESULTS OF RESEARCH

The group discussed the major, take-home, messages from the presentations and findings. The following comments reiterate surprising findings or areas where the data are beginning to converge into fuller understandings. They have been organized by topic theme, which is slightly different than what occurred during the actual flow of discussion.

Recruitment Considerations

- There is improved understanding of habitat impairments associated with recruitment failure for robust redhorse including: temperature, sedimentation, contaminants, and flow variation.
- Steady flows have the potential to help recovery of native populations but we need to look at hydrographs associated with recruitment of present Oconee River year classes.
- There is an eight (8) percent emergence survival rate in the wild, based on results of lab studies.
- A 15 percent fine sediment to gravel composition is the break for developing successful emergence. This implies that watershed initiatives have a major impact on recovery efforts.
- The flathead catfish question remains to be answered. What is its impact beyond inference? What is its impact relative to length of time in the system?

Genetics Findings

- The populations in the Oconee and Savannah rivers have separate genetic makeup and, therefore, are genetically distinct populations. It is unknown whether this is also a functional distinction.

Sampling

- Given the results of the Savannah sampling, the RRCC must be proactive in sampling the Ocmulgee, Ogeechee, Pee Dee, and several other rivers for remnant robust redhorse populations.
- The sampling efforts reveal a definite absence of robust redhorse less than 42 centimeters. Where are the fish of this size? What part does sampling bias play in observed length distribution?
- Telemetry protocol and research is needed especially for stocked fingerlings.

Status of Oconee Population

- There was a lot of evidence to support efforts to understand the population dynamics of the Oconee River.
- Serious effort must be made to refine knowledge of the dynamics of the population.
- Evidence of continued declines in the Oconee River population is a critical issue that should impact research and stocking prioritization as well as how to factor the Savannah River population into future recovery plans.

The Big Picture - Where We Go From Here

- There is a convergence of information now informing decisions regarding how to implement management strategies. The RRCC is moving toward a position beyond research to be able to make informed policy recommendations.
- The preliminary contaminant work is exciting and might connect point source issues to recovery success that could be developed into recommendations from the RRCC to the EPD.

Progress on Work Items Assignedat the 1997 Meeting of the RRCC - Report by Technical Advisory Group — Jay Shelton

Eight (8) priority work items were identified during the 1997 RRCC Annual Meeting. A Technical Advisory Group (TAG) was formed to accomplish or to coordinate the accomplishment of these work items during 1998. Some of the work items assigned to the TAG have been the focus of research efforts or activities by members of the RRCC. In general, there has been excellent progress in some areas, moderate progress in others, and no progress in a few areas.

Savannah River Sampling
The report of Scott Hendricks, see Results of Savannah River Sampling Conducted in 1998**,** details the activities relative to the determination of the extent, if any, of a native robust redhorse population in the Savannah River.

Reintroduction and the "Experimental" Status
This is another area that was an activity focus of several RRCC members. Mike Nichols reported Progress on the Development of a Conservation Agreement to Facilitate Reintroductions of Robust Redhorse in Georgia, see above.

Impact of Predation as an Impediment for Recovery
Two (2) of the updates to recent research results provide some information toward assessing the degree flathead catfish predation impacts the robust redhorse. See the report of Bud Freeman, Recent Monitoring Efforts to Evaluate Success of Broad River Stocking, and of Cecil Jennings, Assessment of Reproductive and Recruitment Success in the Oconee River.

Overall there is little evidence predation is as large an issue as believed. In researching current studies of other species, the TAG found conflicting information to substantiate predation as a significant issue. As well, there are definite differences between the systems of the robust and other redhorse species researched, such as turbidity.

Habitat Degradation, Availability of Spawning Sites and Life History Requirements
Three (3) research areas have added to the available information relative to this topic. See the research Erik Dilts has completed, Effects of Sedimentation and Substrate Composition on Robust Redhorse Reproductive Success and the ongoing research of Bud Freeman, Recent Monitoring Efforts to Evaluate Success of Broad River Stockings and Observations of Robust Redhorse Spawning Habitat and Behavior in 1998.

Based on this research, the RRCC can begin to develop a descriptive model of the limiting factors posed by habitat degradation, availability of spawning sites, and life history requirements. The development of a descriptive model is a potential research item for consideration in 1999.

Fingerling Culture Requirements Influencing Phase I Production
This is another work item that has been developed into a research agenda, which is fortunate to have received $55,000 per year for its implementation. In 1998, the proceeds for sale of nongame and endangered species license plates were made available for competitive research grants. The RRCC members submitted 8 - 10 research proposals. The fingerling culture research project, a five-year intensive study, was the only proposal awarded.

The objective of the project is to define the most critical factors influencing Phase I production. It will systematically monitor what is happening in hatchery ponds regarding fingerling mortality. It involves two (2) short-term studies: the feeding behavior of swim-up fry (laboratory research), and hatchery monitoring. The study employs one (1) technician and two (2) student research assistants. At some point the project manager may decide to shift the focus of this research to requirements of Phase II fingerling production.

Characterize and Compare Genetic Diversity
The TAG ensured the collection and shipment of fin clip material from the Oconee and Savannah river individuals and from the hatcheries to Ike Wirgin. Dr. Wirgin reported on his genetic research, see Initial Results of Genetics Investigation of Hatchery-Reared Robust Redhorse Fingerlings; Genetic Characterization of the Savannah River Robust Redhorse Population.

It was noted that several year classes and more Savannah River fish are needed to conduct conclusive genetics research. The TAG should continue to oversee the collection and shipment of fin clip material for ongoing genetic investigations.

Develop Oconee River Population Estimates and Introduction Protocol
The TAG failed to complete this work item. However, there has been sampling on the Savannah and Ogeechee rivers to determine the extent of robust redhorse presence. Scheduled Fall 1998 Oconee River sampling to develop improved population estimates was canceled due to hurricane threat. However, preliminary estimates have been developed from mark-recapture investigations during spring broodfish sampling.

Create a Listserv on an E-Mail System to Enhance Communication
The network administrator at the UGA School of Forest Resources has developed a listserv and a small group has registered successfully. All RRCC Annual Meeting participants who add their e-mail address to the sign-in sheet (Appendix 1) will receive a message with instructions to join the listserv by the end of November. Those interested in more information can contact Jay at jshelton@uga.cc.uga.edu.

Postings on the listserv will be archived by the administrator, but the listserv is not set up to allow members to query the archive. However, recipients can download postings of interest and establish their own archives. Les Ager volunteered to manage an archive for one year, 1999, at which time the RRCC can re-evaluate the necessity of an archive.

In closing, it was noted that staffing the TAG's 1997 accomplishments was relatively minor. The TAG, however, did not direct research items, which would have required a larger investment of time and effort. It should be mentioned that staffing the recovery effort was identified as an impediment during the 1997 meeting and is a continuing problem. There are never enough people to do the work required. Therefore, prioritization is critical to accomplishing the most pressing tasks, realizing that it is never possible to accomplish all that needs to done.

Reevaluation of the Rationale and Protocol for Broad River Reintroduction Effort, Based on Results of Recent Monitoring

The reintroduction protocol used for the Broad River in 1997 - 1998 was reviewed and the time of stocking, size of fingerlings at stocking, stocking locations, and numbers stocked were summarized (see table below). The RRCC members discussed the possible causes of the poor results of monitoring efforts.

Discussion then focused on ways in which reintroduction and sampling protocol should be changed in 1998 - 1999. There is a strong sense that the poor monitoring results were caused by biases in the sampling protocol.

This examination led the group to agree to continue the Broad River as a high priority release site. Additionally, the group decided to retain the same stocking protocol but make changes to sampling in terms of the gear used, the locations monitored, and the amount of resources dedicated to the effort. The group agreed that the use of telemetry techniques is probably the single most important change in sampling protocol. The time of stocking can occur in November 1998, but given enough pond space, June 1999 stocking is preferred. Both Phase I (2 – 4 inch) and Phase II (5 – 8 inch) fingerlings will be stocked in 1998; the locations and amounts will be decided in the priority stocking sites discussion.

Broad River Reintroduction

Re- introduction Protocol	Protocol used in 1997	Protocol to use in 1998-1999
Time of stocking	10/10 - 11/25	11/98 but 6/99 is preferred
Size of fingerlings	Phase I (2 – 4 inch)	Phase I (2 – 4 inch) and Phase II (5 – 8 inch
Stocking locations and amounts	Hudson 10,000	To be decided
	N. Fork 9,800	
	Middle Fork 3,000	
	Hannah Creek 1,300	

Possible Causes of Poor Monitoring Results

- Selectivity of gear.
- Excessive flows.
- Survivorship was low.
- Fish migrated beyond monitoring area.
- Electro-shocked fish go to the bottom of the water course rather than float.

Possible Changes to Sampling Protocol

- Increase sampling:
    - increase intensity with more manpower; and
    - increase area sampled up to 20 miles from release site.
- Target appropriate habitats.
- Shock into seine nets.
- Use standardized electric grid gear.
- Use tow barge/pram shocking.
- Use telemetry methods.
- Bracket sampling around release site, upstream and downstream, up to 3 weeks after release.

Reintroduction Protocol Discussion

- There is no basis for changing the protocol, due to uncertainty over survival and sampling biases.
- We can expect good flow windows this year during stocking in the fall. Let's use the same protocol, but overwinter fish and release in June to improve ability to sample.
- There is no pond space to overwinter.
- An estimated 8000-9000 fingerlings will be harvested this year.

- We could tag the summer releases with different tags than the winter releases to distinguish differences in survival rates.
- The Broad River is in the Savannah River Basin. Should we continue to stock the Oconee River fingerlings into the Broad considering what we now know about the genetic differences between the populations?
- Clark's Hill, Stevens Creek, and City of Augusta dams are potential barriers between the Broad and Savannah rivers that may prevent genetic mixing.
- Are the fish still alive in the Broad River? These fish may require large rivers. The Broad releases may have instinctively gone down river into Clarks Hill Reservoir or perished in the smaller waterways of the Broad.
- We should focus on releases to the Altamaha River Basin and determine what happened in the Broad before additional releases are made.
- If we do not release to the Oconee River, augmenting the existing population, we might lose it.
- It comes down to the management philosophy of the RRCC. Should we engage in a proactive versus a reactive recovery approach?
- The Broad River was selected as a release site because, at the time, it was believed that the risk of mixing with a wild population was minimal (records indicated extirpation of Savannah population had occurred or was near).
- Future stocking in the Broad River should be with Savannah broodfish.
- The objective of releasing fish in the Broad River was to establish a refugial population. If that remains the objective and there is relatively little likelihood of genetic mixing, the Broad should continue to be stocked.

Stocking Sites for Phase I and II Fingerlings to be Harvested in Fall 1998

A series of handouts, developed by Jimmy Evans, provided important background information to the discussion of this topic. Appendix 18 shows a map of areas where fish have already been stocked, a table of where fry were distributed in 1998, and a table of scheduled dates for harvesting ponds in November - December, 1998. Also included are a list of stocking priorities for the 1998 harvest and tables indicating stocking scenarios for various production rates of Phase I and Phase II fingerlings. Finally, a table of the present distribution of all year classes of fingerlings at all hatcheries and a table that shows where fingerlings will be stocked from each individual hatchery, given several projected levels of production, and who will do the transporting are included in Appendix 18.

The early results of the genetic comparisons of the Oconee and the Savannah river populations influenced the stocking site discussion. It seems clear that the two rivers contain distinct populations. Beyond the generally accepted genetic research that cautions the mixing of different populations, the practical implications of this finding on the Broad River reintroductions remain to a large extent unknown. The stocking site decision was greatly complicated by the additional level of uncertainty.

The RRCC members invested hours of thoughtful discussion on the issues and implications of stocking and the merits of each potential stocking site. A greater emphasis on rearing broodfish in captivity was considered but major change in emphasis was rejected because neither the pond space nor a clear understanding of hatchery management methods exist. The group worked hard to come to a consensus decision on stocking the Broad, Ogeechee, Ocmulgee (must await the acceptance and signing of the Conservation Agreement), and Oconee rivers. Although the decision reached has levels of inherent risk, it remains the best consensus decision the group was able to accept given the known information weighed against unknown factors.

Stocking Sites Discussion
Asterisks indicate the facilitator's summary of critical information. Also discussion points have been organized by theme and lumped under a subheading.

Critical Dates
- *Fingerlings are going to be harvested next week.

Management Strategy Considerations
- The RRCC's mid- to long-term management objectives include:
  - to establish viable reproducing populations in three rivers in addition to the Oconee River;
  - to establish refugial populations in ponds containing multiple year classes; and
  - to prevent the decline of the existing Oconee River population.
- The RRCC, in past years, has decided to take an aggressive hatchery reintroduction approach. Should we shift our recovery philosophy toward watershed management and habitat rehabilitation to boost the survivability of the existing fish?
- Perhaps improving the aquatic habitat where the species currently exists (Oconee and Savannah rivers) is a better management strategy than stocking for a successful recovery. Examples include working with the Army Corps of Engineers to expand the Savannah River population through the installation of fish ladders to remove dam obstacles, reduction of cold water discharges, and habitat enhancements such as providing additional spawning substrate in addition to erosion and sedimentation control measures, and water quality enhancements on both the Oconee and Savannah rivers.

Genetics Considerations
- * Potential genetic issues pertain to all stocking sites.
- Disruption of genetic adaptability of a wild population may result from mixing genetically distinct populations.
- Reduction in genetic diversity may result from restocking the Oconee River.
- No genes at all, if the wild population vanishes because they were not augmented.
- The genetics research indicates that stocking with the nearest geographic source is the best strategy for augmenting/establishing populations.

Ocmulgee River Stocking Considerations
- The objective of stocking the Ocmulgee between Lloyd Shoals and Juliette dams is to establish a viable population. If a viable population is not established, the area could still serve as a new source of broodfish.
- *The goal is to implement the Ocmulgee Conservation Agreement. This Conservation Agreement should be signed by major stakeholders before stocking occurs. We should survey the Ocmulgee before stocking. Fingerlings from the 1998 year class should be held back for stocking the Ocmulgee next fall.
- The target reach for the Ocmulgee stocking involves a 19 mile section between Lloyd Shoals and Juliette dams that has the following issues:
  - sedimentation;
  - predation; and
  - habitat considerations.

  These issues are common to most stocking sites but the habitat and predation (i.e., flathead catfish) considerations place this reach at the top of a list of potential stocking sites in Georgia.

Ogeechee River Stocking Considerations

- The objective of stocking the Ogeechee is reintroduction of the species for the establishment of a viable population to ensure the species survival.
- Factors favoring an Ogeechee River stocking include:
    - little or no flathead catfish, yet;
    - little riverine disturbance;
    - relatively good habitat; and
    - no hydropower.
- There are unknowns about the existence of a wild population. However, if there is a significant wild population in the Ogeechee River, stocking with fingerlings from the Oconee River should not occur.
- *There was an unverified siting of a robust redhorse in the Ogeechee in 1998.

Broad River Stocking Considerations

- The objectives of stocking the Broad River is: 1) to establish a viable reproducing population, and 2) to establish a refugial population, genetically isolated from wild populations, that can serve as a source of broodfish in the future.
- Broad River stocking factors include:
    - 120 river miles;
    - genetic isolation now, but maybe not forever, due to recent discovery of a Savannah River population downstream from Augusta;
    - minor threat of predation;
    - no hydropower flow disruptions;
    - local conservation group support;
    - good habitat; and
    - no known wild population.
- It is difficult to establish a riverine population. Just because we have stocked the Broad River, we do not have to continue. We should attempt to prevent genetic mixing with the Savannah fish, the problem is to assess probability of genetic mixing versus benefits of establishing a new population in the Upper Broad River.

Piedmont National Wildlife Refuge Stocking Considerations

- The objective of stocking at Piedmont is to establish a refugial population.

Oconee River Stocking Considerations

- Stocking the Oconee River is not supported by the genetics research in the sense that stocking is needed to enhance genetic diversity (and may be additionally complicated by hatchery borne diseases).
- Augmenting the Oconee River may actually imperil it more if conducted without a consideration for genetics.
- The hatchery borne disease issue cannot be considered a threat in this situation.
- A hatchery reintroduction approach versus watershed management is not an either or proposition. We can manage the Oconee River to improve its habitat and also achieve a reintroduction management objective.

Hatchery Pond Considerations

- If the harvest only nets 9,000 fingerlings, can we hold them to produce Phase II with good success?
- The previous success rate related to attempting Phase II production is 7 percent, but at low densities we can expect good or better survival rates.

Use of Telemetry

- *Telemetry cannot be used on Phase I fingerlings released this year or in the Fall of 1999 because the fingerlings will not be big enough to carry the device even if funding is found to pay for the research.
- Fingerlings need to be about 120 grams, at a minimum, to be able to carry a 60-day telemetry tag.

Research Considerations

- The bulk of the research dollars has gone to the study of the Oconee population. Boosting its survivability has not been overlooked as a management objective.
- Research on assessing the Savannah population is also ongoing.
- Monitoring and sampling the Ogeechee is happening now.

At this point in the discussion, the group ranked stocking site preferences to get a preliminary sense of the degree of consensus among the RRCC members.

First Cut on a Phase I and Phase II Stocking Site Priority Preference

Stocking Site	Ranked Preference
Piedmont National Wildlife Refuge	18
Hatchery ponds for Phase II production and release into the Ocmulgee after the Conservation Agreement is signed	17
Upper Broad River	13
Upper Ogeechee	4
Oconee River	5

Stocking Sites Discussion Continuation

Hatchery Pond Considerations

- Phase II will have to go to other ponds.
- What ponds exist that could take Phase II?

Phase II Production Ponds

Location	Number of Ponds	Acres
Dennis Center	1	1
McDuffie	2	.5 and .4
Walton	1	.5
Burton - maybe	1	.3
Total	5	2.7

- Experience has shown that stocking at higher densities will reduce growth.
- Can we delay the decision of where to stock by placing all Phase I and Phase II that will be harvested in ponds over the winter?
- Over wintering the fish will grow bigger fish to release and perhaps increase their chance of surviving in the wild.
- *By waiting until next November to stock, we might get better survival of the released fingerlings or we might experience substantial mortality in ponds.

- *Unless there is a compelling reason to wait until November 1999, do not.
- Can we hold the Ocmulgee fingerlings until the river has been monitored for an existing population and for a telemetry study of the released fingerlings?
- Hold fingerlings in the ponds only if we can stock them in the Ocmulgee.
- Where do we put the fish in the meantime?

Carrying Capacity of Pond Sites and Anticipated Harvest

Pond Sites	Carrying Capacity	Anticipated Harvest
Piedmont (to build 5 year classes)	1500 (for 1998 year class)	Phase I 8,000
Phase II production ponds (only until March)	12,000	Phase II 1000-4000
Phase II pond space	~12,000	

Viable Population Considerations

- We should not stock any river if its existing population is stable. This leads to the question of the definition of a viable population.
- Genetics literature suggests 100 - 1000 fish with good sex ratios and good age distribution could make a viable population.
- *The RRCC must decide on a definition of a viable population for the robust redhorse. This discussion item was tabled for the duration of the meeting and will be assigned as a 1999 Work Item for the TAG to accomplish.

Summary of Critical Information from the Stocking Site Discussion So Far

- Phase I and Phase II fingerling harvest will occur on November 3, 1998.
- Telemetry cannot be used on either Phase I or II this year.
- Monitoring is not extensive enough on the Ocmulgee to definitively determine the existence of a wild population at present.
- There are issues associated with all stocking sites. The exact implication of all the issues are not known. Determining a priority preference of sites involves a trade-off decision.
- There are genetics issues associated with all stocking sites.
- The definition of a viable population might help determine the priority of stocking the Oconee River. However, defining a viable population is a 1999 Work Item and not part of this discussion.
- If the RRCC wait until next November to harvest, survival rates will probably be lower.
- Whether or not the RRCC stocks this fall, it must stock November 1999.
- Unless there is a good reason to wait, do not.
- Based on the ranked stocking priorities, there is a clear preference from the group that a percentage of the harvest will go to the Piedmont adult rearing ponds.
- Based on the ranked stocking priorities and the discussion of the Broad River Reintroduction Protocol, there is a clear preference of the group that a percentage of the harvest will go to release in the Broad River for continued research and monitoring.

At this point in the discussion, the group ranked stocking site by least preferred to try to continue to move toward a sense of consensus.

Second Cut on Ranking Phase I and Phase II Stocking Sites by Least Preferred Site

Sites	Least Preferred	Amounts/Comments
Ocmulgee (held somewhere)	2	
Upper Ogeechee	Decision to remove from ranking	Site was least preferred on first cut
Oconee River	7	
Broad River	3	
Piedmont	Not Ranked- already selected	1500

Suggested Stocking Site Decisions Points

- Do not stock new sites until the robust redhorse is listed as an endangered species and is protected under the Endangered Species Act.
- Consider existence of a wild population.
- Put all Phase II in the Broad except those going to Piedmont.
- Fingerlings for the Ocmulgee releases should be held for one (1) additional year.
- The suggested Phase II pond stocking rate is 2000 fish per acre.
- Put some Phase I (1998 year class) in the Broad River from what is left over after holding back a portion for the Ocmulgee release.

Decision on Stocking Sites for Phase I and Phase II Fingerlings

- Max the stocking rate in Phase II ponds up to 5400 fish total. Phase I will be allocated on a 50-50 percentage between the Broad River and Piedmont.
- The RRCC should make the decision regarding where (i.e., which portion of specific drainages) to stock each year but future specific allocations should be left to the smaller group of folks involved in the reintroduction efforts and the project manager.
- The Oconee River stocking remains a controversial issue with the RRCC. The facilitator advises that re-evaluating the necessity or protocol for introductions of hatchery-reared robust redhorse into the Oconee River below Sinclair Dam become a 1999 work item for the TAG to bring as much information and clarity to the issue as possible.

South Carolina Aquarium Project Update – Ross Self

Charleston, South Carolina is in the process of constructing a state aquarium. A select group of RRCC members have discussed the merits of placing robust redhorse at the South Carolina Aquarium, a proposal that the aquarium folks are interested in pursuing. The group met in July 1998 to outline considerations such as exhibit options, roles of the various participants, research and educational opportunities, and potential avenues for funding. A proposal was developed and sent to the natural resource agencies in both Georgia and South Carolina. Georgia has given approval of the proposal and stands ready to participate. South Carolina is still reviewing consideration of the proposal, but its approval seems likely.

When both states agree to support the project, next steps include a possible meeting with the Aquarium executive staff to begin to develop project details and contacts with potential funding organizations. Ross Self is heading up the project's course in South Carolina and will continue to shepherd the project through the approval process. If robust redhorse can be established at the South Carolina Aquarium, the

fish could potentially be a source of broodfish to guard against species' extinction as well as an education tool. It is a very exciting project, having great of potential for research and education.

Status Surveys on Other Rivers

Given the recent Savannah River discoveries and the genetic distinction between the Oconee and Savannah river systems, the RRCC discussed status surveys on other rivers. Evidence is increasing that the species may remain in more river systems that previously believed, but apparently in such low numbers that it is escaping detection. Therefore, additional status surveys are an important task and the group developed a list of rivers/reaches to target in 1999. Also, prioritization and allocation of personnel and resources for sampling each site was discussed.

Potential Rivers/Reaches Where Status Surveys Should Be Undertaken

- Ogeechee
- Ocmulgee
- Altamaha
- Lower Oconee
- Ohopee
- Savannah above Stephens Creek Dam
- Upper Broad in North Carolina
- Lynches River in South Carolina
- Pee Dee River around Society Hill in South Carolina (John Crutchfield is surveying the Pee Dee River system).

After brief a discussion, the group decided that the further development of status survey priorities should be a 1999 Work Item for the TAG. Once developed the status survey priorities should be distributed to each state fisheries agency that would then allocate the resources for sampling, thereby, establishing state priorities. The RRCC members strongly suggest that status survey sampling on all rivers should be conducted at the time of spawning.

Research Activities for 1999

A list Research and Survey Activities for 1999 - 2000 appears as Appendix 19. Also included is the master list of research priorities developed at previous meetings. In reviewing research and survey activities for 1999 - 2000, it was noted that the first subset of activities indicate active projects that will continue through the year. The second subset shows active research projects that are terminating in 1999 and the third subset lists those that are funded and scheduled to begin in 1999. No action was required regarding these three (3) subsets of research activities. The fourth subset, below, lists proposed research priorities for 1999 - 2000 that were reviewed and approved by the RRCC members. Note, research activity number one (1) was modified slightly from the way it appears in Appendix 19 by eliminating the word "stocked" and research activities five - eight were added to the list by the RRCC. No proposed research projects were removed from the original list. The following are not in priority order; the group did not work on prioritizing research activities at the meeting.

Proposed Research Activities for 1999 - 2000

1. Telemetry investigations of movement and habitat utilization of robust redhorse in the Oconee, Broad, and possibly Ocmulgee rivers.

2. Development of mortality, survival, and population estimates for the Oconee River population and modeling of population dynamics.
3. Evaluation of possible correlation between historical flow regimes and year class strength in the Oconee River.
4. Development of husbandry techniques in an aquarium environment (South Carolina Aquarium).
5. Surveys on the Pee Dee River System in North Carolina and South Carolina.
6. Continue genetics research.
7. Continue Effects of Sedimentation on Emergence Success Research.
8. Create additional spawning sites in the Oconee River through habitat restoration.
9. Develop a descriptive model of the limiting factors relative to habitat degradation, availability of spawning sites, and life history requirements.

Effective Use of Conservation Agreements to Facilitate Recovery

Conservation Agreements are cumbersome for riverine species with large numbers of stakeholders. The FWS has stated that these agreements, although difficult, can be utilized with the robust redhorse and the initial Ocmulgee Agreement could serve as a model for others. The RRCC believe that a Conservation Agreement can be effective in facilitating these types of reintroductions by providing a reasonable level of stakeholder assurances in exchange for specific conservation actions.

Conservation Agreements are typically site specific and limited in scope but are often accompanied by a Conservation Strategy which states that implementation of similar agreements throughout the range should be adequate to remove the threat of the species' extinction. In addition, the Conservation Agreement can address the concerns of individual stakeholders.

The revisit to this topic is an extension of the presentation made by Mike Nichols. It included the opportunity for RRCC members to discuss proceeding with the Conservation Agreement process for facilitating reintroductions into drainages where major water development projects exist. In particular, the perspective of South Carolina and North Carolina stakeholders on whether a Conservation Agreement is a workable arrangement for rivers in those states was sought.

Discussion and Concerns Related to the Ocmulgee River Conservation Agreement Process
The final rule on using Conservation Agreements from the FWS is expected by January 1999. The Ocmulgee River Conservation Agreement is in its fourth draft and looks good. Many folks have contributed to its development; Mike Nichols, in particular, has put a lot of work into it. The WRD must indicate their comfort level with the proposed Conservation Agreement, which is currently under their review. Then it goes to the FWS for approval, publication in the Federal Register, and out for public comment. The RRCC will wait until the public comment period is closed and signatures from major stakeholders are obtained before any fish are released to the Ocmulgee River.

Any future stocking of robust redhorse in North Carolina will probably have to follow a state-developed process, with cooperation from the FWS, granting certain assurances against potential impacts of future Federal listing. A letter from the RRCC chairman to the State of North Carolina describing the recovery efforts to augment and reintroduce the species can assist the process of developing this state initiative. In any case, it can be expected that the state process will take at least one (1) year to develop.

A change in the wording to the Endangered Species Act, which is undergoing reauthorization, could include the ability to allow "experimental status" designation for non-listed species such as the robust

redhorse. This would greatly facilitate reintroduction efforts throughout the historical range. A champion in Washington D.C. to oversee and move this wording change to the Endangered Species Act through the legislative process would help its accomplishment. In addition, letters from the RRCC and from each of the state natural resource agencies making the same request would help.

Report by Search Committee on the New Chairman of the RRCC, Selection of Chairman-elect, and Establishment of a Project Manager

During the 1997 RRCC Annual Meeting a Search Committee was created and given the authority to identify and select a new committee chairman. It was further charged with developing a process to identify a new chair-elect position and to develop job descriptions of both positions.

The Search Committee reported that it developed three (3) leadership positions and drafted very generalized job descriptions for each position. The positions of chairman, chair-elect, and project manager were created because the duties and responsibilities have grown too large for one person. Even with the creation of a project manager position, the responsibilities of the chairman remain considerable.

In searching for a chairman, the committee looked for a person who was qualified in a number of areas, had flexibility to revise their workload to handle the job, and was willing to accept the position. The Search Committee considered several candidates for chairman, though the list of candidates with these characteristics was obviously small. After discussing the requirements of the position with candidates, the search committee decided that although there were several qualified to do the job, Scott Hendricks was in a good position to carry out the responsibilities of chairman and would do an excellent job.

In accepting the appointment to Chairman of the RRCC, Scott thanked the members for their confidence in his ability to direct the work of the recovery efforts. He intends to continue along the same administrative path that Jimmy Evans has set for the recovery of the robust redhorse. Scott's term begins immediately and ends November 2000.

The new project manager position has been conceived with no term limit and shifting responsibilities based on overseeing the management activities and research efforts of any given year. The Search Committee believes that initially the project manager must be WRD Fisheries staff considering the coordination that must take place with the state's hatcheries and other personnel. It further believes that Jimmy Evans should continue taking a major role in the management of the robust redhorse recovery effort by assuming the project manager position. It is conceivable that a South Carolina or North Carolina or other Wildlife Resources Division staff could be designated as project manager in the future.

The chair-elect, a two-year term, will assist the chairman and the project manager in preparation of assuming the chair position. Since the chair-elect will eventually be chairman, the Search Committee recommended further that consideration be given to locating a person to fill this position by early next year. The Search Committee will select and recommend a chair-elect candidate to the RRCC. The RRCC signatory representatives can either vote on the candidate by mail or wait until the next RRCC Annual Meeting for a voice vote.

Work Items for 1999

After discussion, the following tasks were identified as specific work to be accomplished before the next RRCC Annual Meeting. They are not listed in a priority order.

- Establish the protocol for actions to take if a robust redhorse is collected from any drainage outside of the Oconee. This includes types of photographic documentation required.
- Establish a robust redhorse web page on the Internet.
- Define "viable population" including minimum numbers of individuals required, age structure, sex ratio, and required evidence for reproduction/recruitment; also genetics considerations.
- Establish the Oconee River introduction protocol.
- Develop, and distribute for prioritization, a list of rivers in each state for status surveys.
- Develop a protocol for status surveys regarding when to sample, what information to collect, and what to do if a robust redhorse is collected.
- Develop a letter from the RRCC to the FWS requesting a change in provisions of the Endangered Species Act to allow "experimental population" status for introductions of non-listed species.
- Support Search Committee's efforts to interview and select a chair-elect candidate.
- Complete the listserv by sending membership information to RRCC annual meeting participants.
- Establish a proposed stocking rate range in the Ocmulgee River for the Conservation Agreement. How many should be stocked to establish a population?
- Determine if there is significant or just apparent difference, in morphometric characteristics of Savannah and Oconee river robust redhorse, particularly the head dimension.
- Create a task force, in coordination with South Carolina Department of Natural Resources, to work through the logistics of how to factor the discovery of additional evidence of a Savannah River population into the recovery effort.
    - Determine who will do what in terms of broodfish collection, spawning, etc.
    - Decide if the RRCC will attempt to collect broodfish in 1999.

Closing Business

The final discussion item before the meeting adjourned was the date of next year's meeting. It was determined that the date should be moved forward as much as possible to provide more time between the meeting date, when stocking decisions are made, and actual pond harvest in the fall. The first choice for the 1999 RRCC Annual Meeting is October 13 and 14, 1999. These are final dates, please commit them to your calendars.

Appendix 1
RRCC Annual Meeting Participants

Name & Agency	Address & E-mail	Voice & Fax
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Pete Lasier USGS - PWRC		
Kurt Bogenrieder School of Forest Resources University of Georgia	Athens, GA 30602	706/546-2186 V 706/546-2109 F
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APPENDIX 2
EXPECTATIONS

- Resolve Oconee River stocking problem.
- Resolve Broad River prioritization.
- Status update.
- Guidance on consensus of research priorities for genetic investigations.
- Good overview of the whole project.
- Latest robust redhorse results from spawning, research and search expeditions.
- Comment of future research directions.
- Review of previous year's activities and results.
- Resolve Oconee River reintroduction issue.
- Clarify issue of assurances for landowners/agencies when stocking (reintroducing) robust redhorse.
- Where do we want to be in 2-3 years?
    - Is it time to move beyond the MOU to written Conservation Agreements?
    - Agree on proposed stocking rates for the Oconee and Ocmulgee Rivers.
    - Define "viable population" for the robust redhorse.
- Clear idea from group regarding the highest priority management direction for the committee.
- Direction for research spending.
- Synthesis of existing information.
- Research needs based on that synthesis.
- Prioritization of those research needs.
- Research objectives for coming year.
- Definitive stocking sites and densities for coming year.
- Plan to address Savannah River robust redhorse population.
- Update on robust redhorse recovery.
- Status of spawning and hatchery production (success, failures, etc.).
    - What do we know?
    - Where do we go from here?
- Expand areas of research.
    - Juvenile food habitats.
    - Interactions with native mussels.
    - Interactions with flathead catfish.
- Identify additional funding sources.
- Is monitoring in Broad River adequate?
- Discuss and evaluate current stocking regime.
    - What about the Oconee River?
    - Should refugial stocking be continued?
- Should stocking augment the known populations in the Oconee and Savannah Rivers?
- Should some larger "refugial" fish be stocked in rivers?
- Prioritize egg uses.
- Future research needs.
- Agenda for investigating effects of possible toxicants in the Oconee River on survival of eggs and larvae and juveniles.
- Justify distribution of eggs/larvae for research.
    - Should some research have higher significance than hatchery production?
- Needs:
    - Flowchart of who is doing what and when. Could use Microsoft project or other software.
    - Maps of where projects occur.
    - ARC View project file and associated dBase file, kept up-to-date and distributed to cooperators with latitudes and longitudes for all project sites.

United States Department of the Interior

U. S. Fish and Wildlife Service
Warm Springs Regional Fisheries Center
Fish Health Laboratory
5151 Spring Street
Warm Springs, GA 31830-9712

IN REPLY REFER TO:

DIAGNOSTIC REPORT

DATE: September 16, 1998

CASE NUMBER: 98-64

Facility: Beaver Dam Wildlife Management Area-Balls Ferry Landing
Owner/Manager: Georgia Dept. Natural Resources
Address: Oconee River
Allentown, Ga
Phone: NA
Sample submitted by: Brian Hickson

Species submitted: Robust Redhorse Sucker, *Moxostoma robustum*
Date submitted: May 19, 1998

BACKGROUND: On site river spawning-holding area to check suckers for infectious disease using non - lethal techniques. Ovarian fluids and vent swab samples were taken. This sampling will contribute to the Wild Fish Health Survey. Fish were identified via Pit tag. 20 fish were sampled.

GPS coordinates : N 32° 42' 29" W 83° 57' 26"

Results:

Parasitology: No samples taken. Visual observations of gills, skin, and fins. Negative.

Bacteriology: Vent swabs were streaked onto BHIA slants. 20 fish sampled. Samples were negative for reportable pathogens.

Virology: 20 vent and 1 ovarian sample were processed and inoculated at 1:100 dilution onto EPC (Epithelioma papillosum cyprini), CHSE(Chinook Salmon Embryo) cell lines to screen for possible virus infection or carrier state. Viral assays were performed in 96 well microtiter plates. No viral CPE(cytopathic effect) was observed.

Norman P. Heil
Fish Health Biologist
706-655-3382

APPENDIX 4

Table 4. Current inventory of pond-stocked robust redhorse from 1995, 1997 and 1998 year classes.

Location	1995 year class	1997 year class	1998 year class
McDuffie SFH, GA	164	1988	0*
Walton SFH, GA	0	3180	9857
Burton SFH, GA	0	0	885
Richmond Hill SFH, GA	0	0	2666
Dennis Center, SC	0	2571	6758
Campbell SFH, SC	0	0	8217
Cheraw SFH, SC	0	0	4950
Shirey SFH, SC	0	0	1980
Piedmont NWR, GA	1377	1770	0
Grand Total	1541	9509	35313

* 5,448 Phase I (98 year class) fry were stocked, but pond experienced complete mortality in early summer.

APPENDIX 5

Table 1. Summary of Phase I robust redhorse fingerling pond production for 1997.*

Hatchery	# Ponds	Ave. Stocking rate (no/ac)	Ave. % Survival	Ave. Length (mm)	Ave. Weight (g)
Burton SFH, GA**	1	29,343	43	81.1	5.6
Dennis Wildlife Center, SC	3	14,033	< 1	142.0	31.0
Campbell SFH, SC	1	17,040	3	NA	30.3
McDuffie SFH, GA	3	24,544	< 1	175.5	31.9
Walton SFH,GA	3	22,646	62.0	118.1	17.3
Richmond Hill SFH, GA	1	20,295	7	90.4	7.0
Overall	**12** (9.13 ac)	19,948	**19*** **	110.3	15.2

* Fry stocked 5/29 - 6/3; fingerling harvest 10/8 - 12/3.

** Mortality during harvest and tagging was 28% at Burton, less than 1% at all other hatcheries.

*** 182,127 fry stocked, 34,974 Phase I fingerlings harvested.

APPENDIX 6

Table 2. Pond stocking summary for Phase I robust redhorse fingerlings produced in 1997.

Location	Pond	Pond Size (ac)	Number stocked	No./ac
Piedmont NWR	9A	7.3	710	97
	11A	4.5	660	147
	Pippin	3.5	400	114
(Piedmont subtotal)			**1770**	
McDuffie SFH (GA)	11A	0.5	500	1000
	10A	0.48	81	169
	5W	0.28	47	168
	8W	0.58	98	168
	9W	0.56	95	170
	12W	0.29	49	170
	15W	0.76	129	170
(McDuffie subtotal)			**999**	
Burton SFH (GA)	-	0.3	**660**	2200
Walton SFH (GA)	5	0.45	**2582**	5738
Dennis Wildlife Center (SC)	-	1.0	**1381**	1381
Grand Total			**7392**	

APPENDIX 7

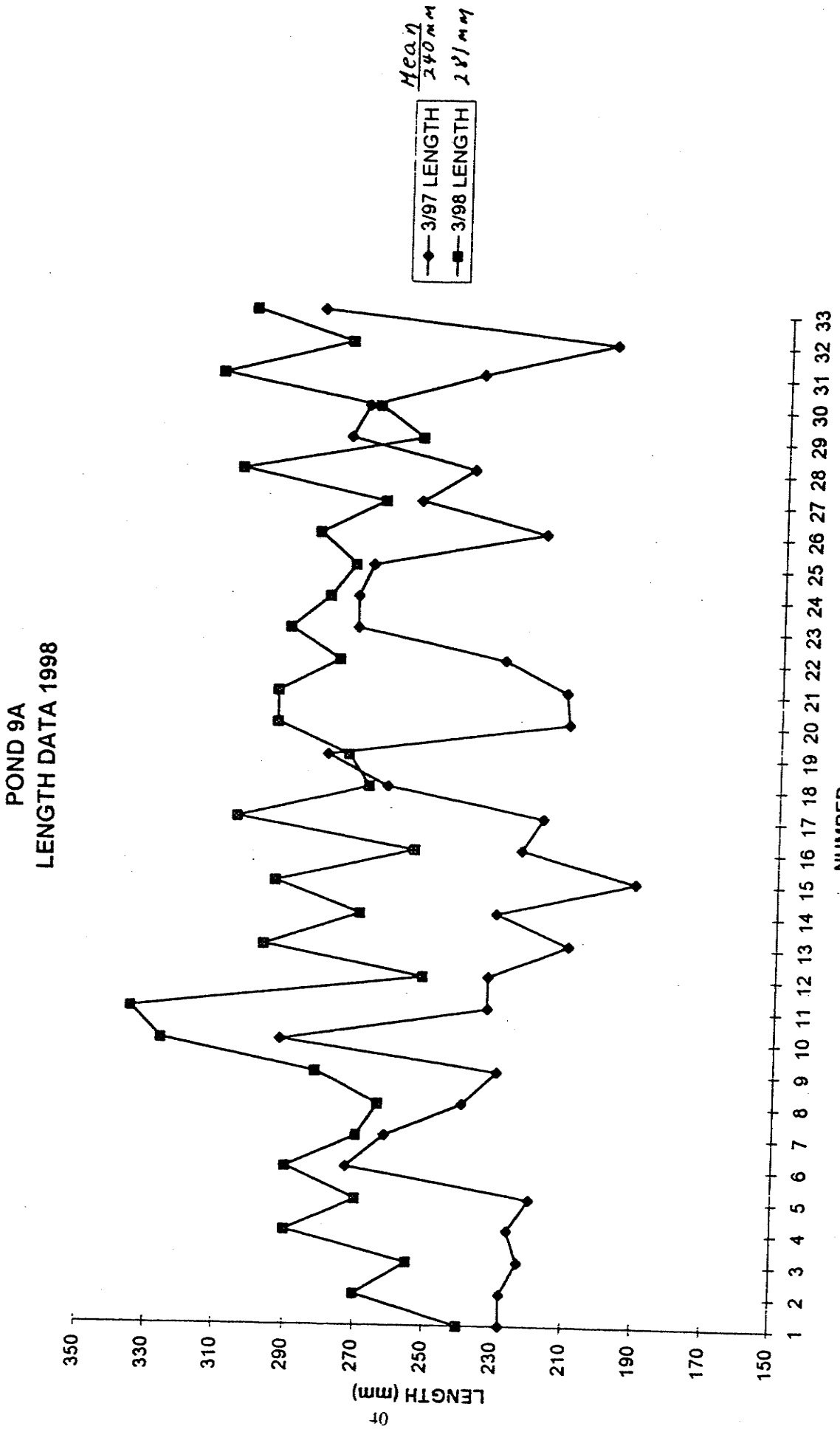
Table 3. River stocking summary for Phase I robust redhorse fingerlings produced in 1997.

	Stocking Site	Number Stocked
Broad River	North Fork below Franklin Springs	9028
	North Fork at Highway 51	826
	Hudson River at Highway 106	4330
	Hudson River at Highway 29	5781
	Hannah Creek	1291
	Middle Fork, Atkinson Bridge Road	3000
(Broad subtotal)		24256
Ogeechee River	Mayfield	850
	Jewell Mill	912
(Ogeechee subtotal)		1762
Total River Stocking		26018

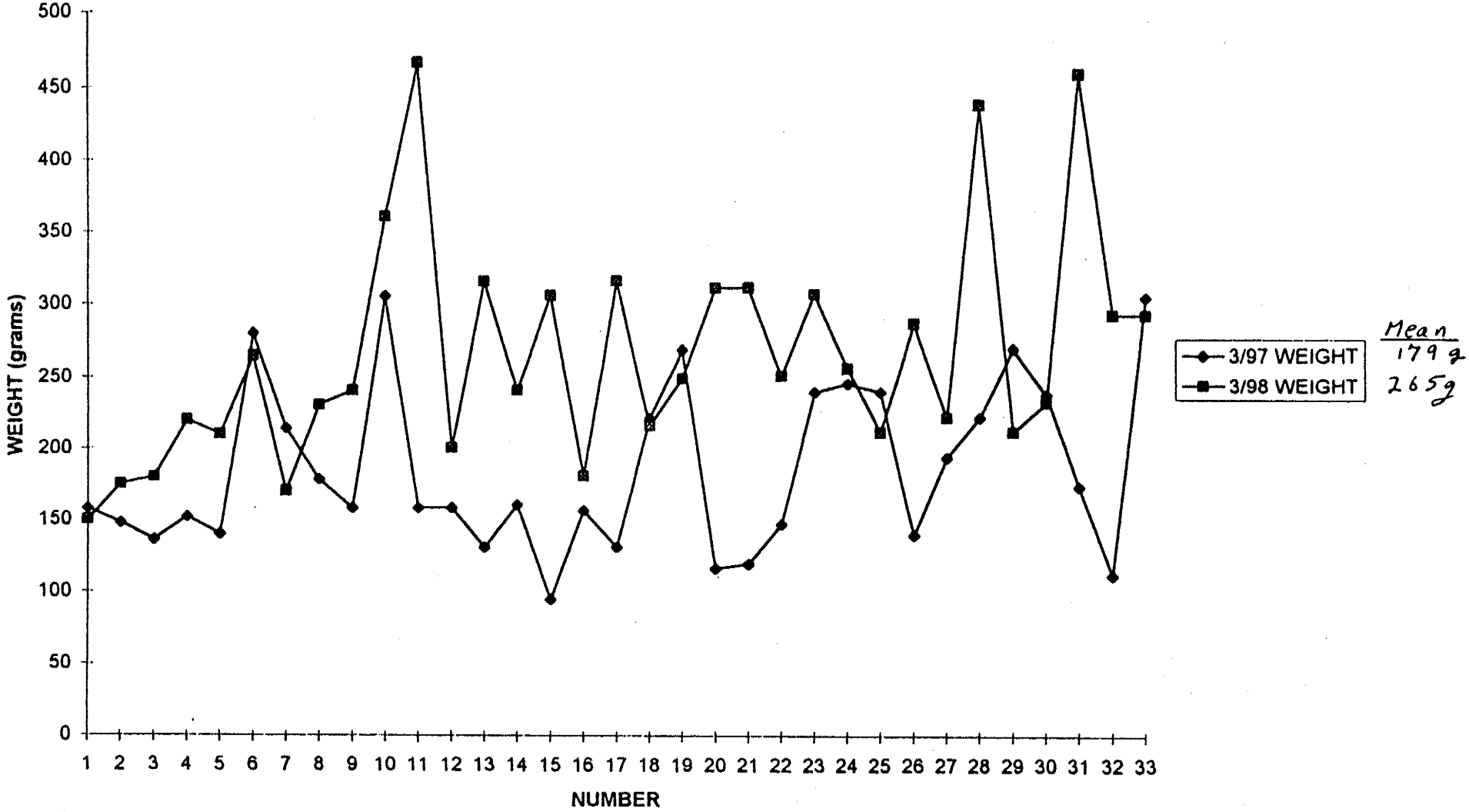
APPENDIX 8

Table 5. Inventory of river-stocked robust redhorse 1995-1997.

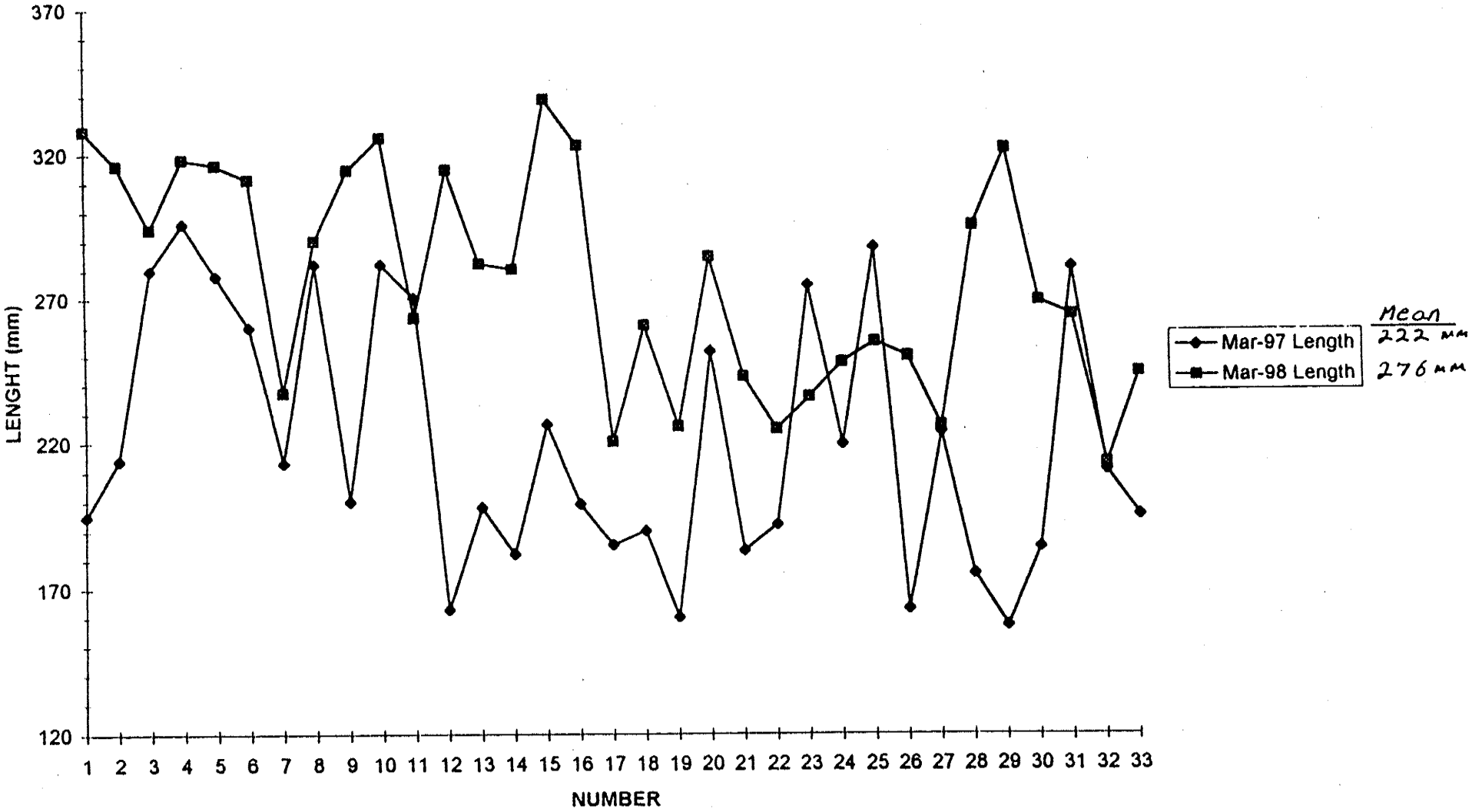
Broad River	1995	1996	1997
N. Fork below Franklin Springs	0	0	9028
N. Fork at Highway 51	195	150	826
South Fork above Watson Mill	350	150	0
Hudson River at Highway 106	0	0	4330
Hudson River at Highway 29	0	1124	5781
Hannah Creek	0	0	1291
Middle Fork, Atkinson Bridge	0	0	3000
Broad River Total	545	1424	24256
Ogeechee River			
Mayfield	0	0	850
Jewell Mill	0	0	912
Ogeechee River Total	0	0	1762


POND 9A
LENGTH DATA 1998
3/97 LENGTH
3/98 LENGTH
Mean
240mm
211mm
LENGTH (mm)
350
330
310
290
270
250
230
210
190
170
150
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
NUMBER

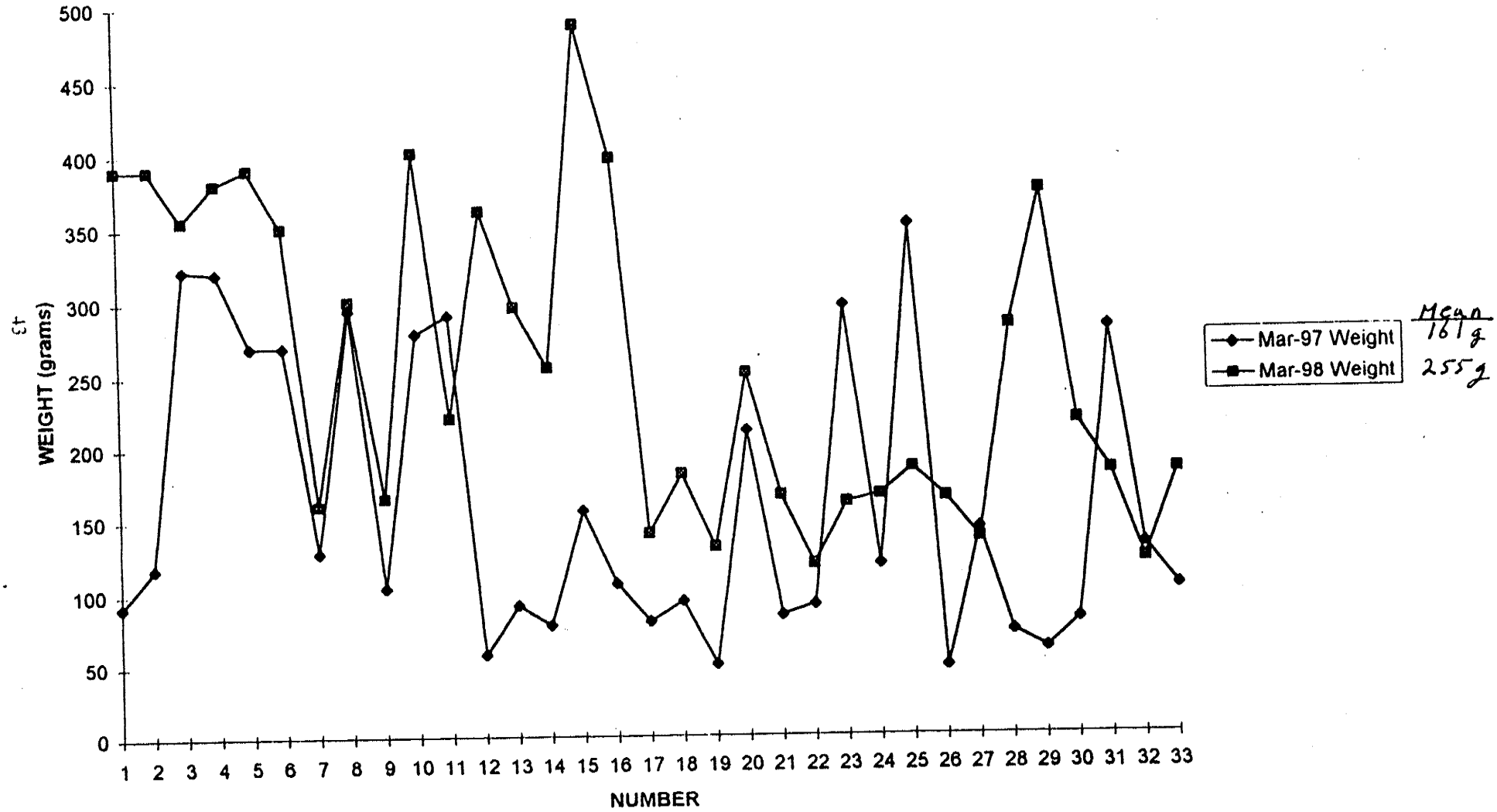
POND 9A 1998
WEIGHT DATA



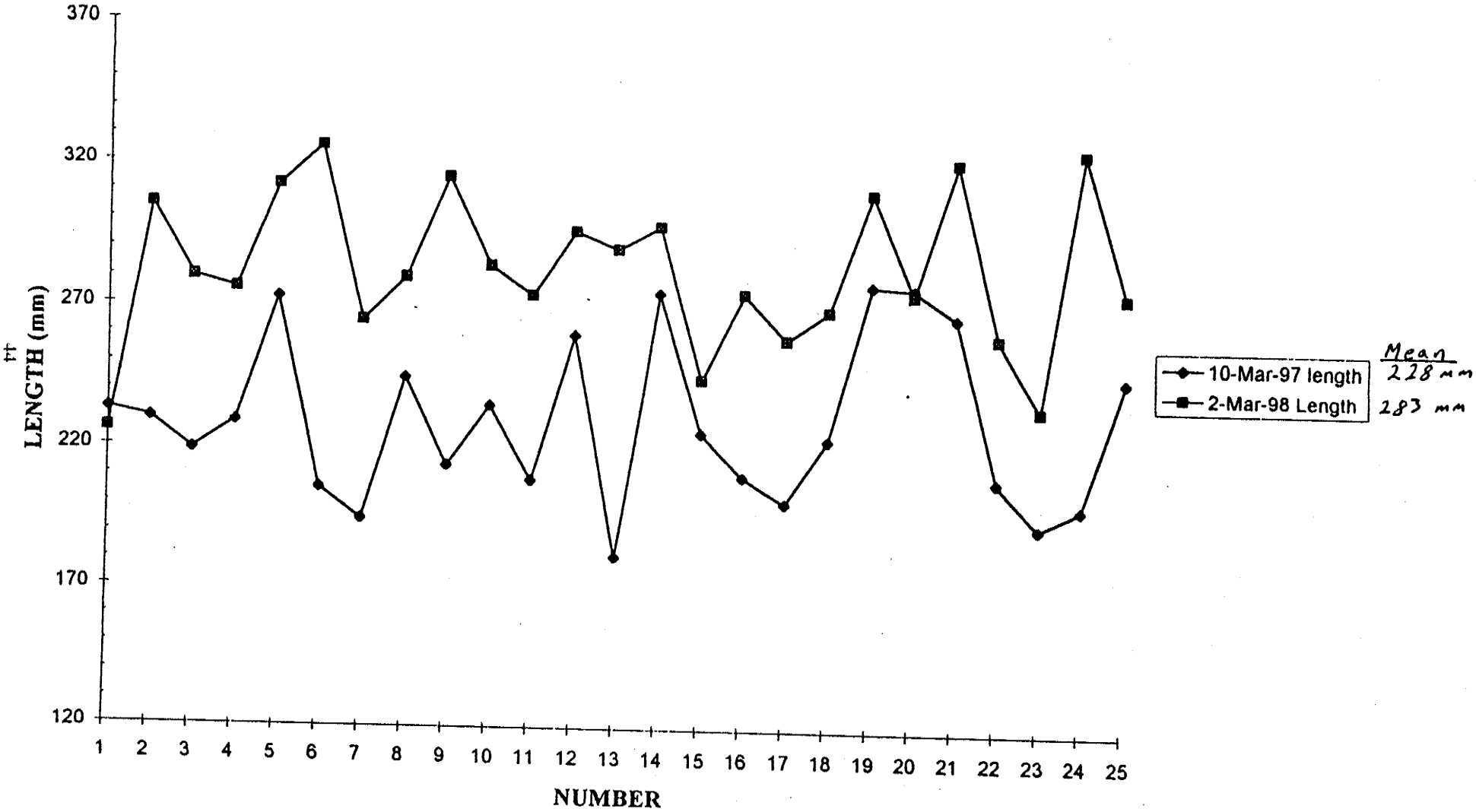
POND 7A
LENGTH DATA 1998



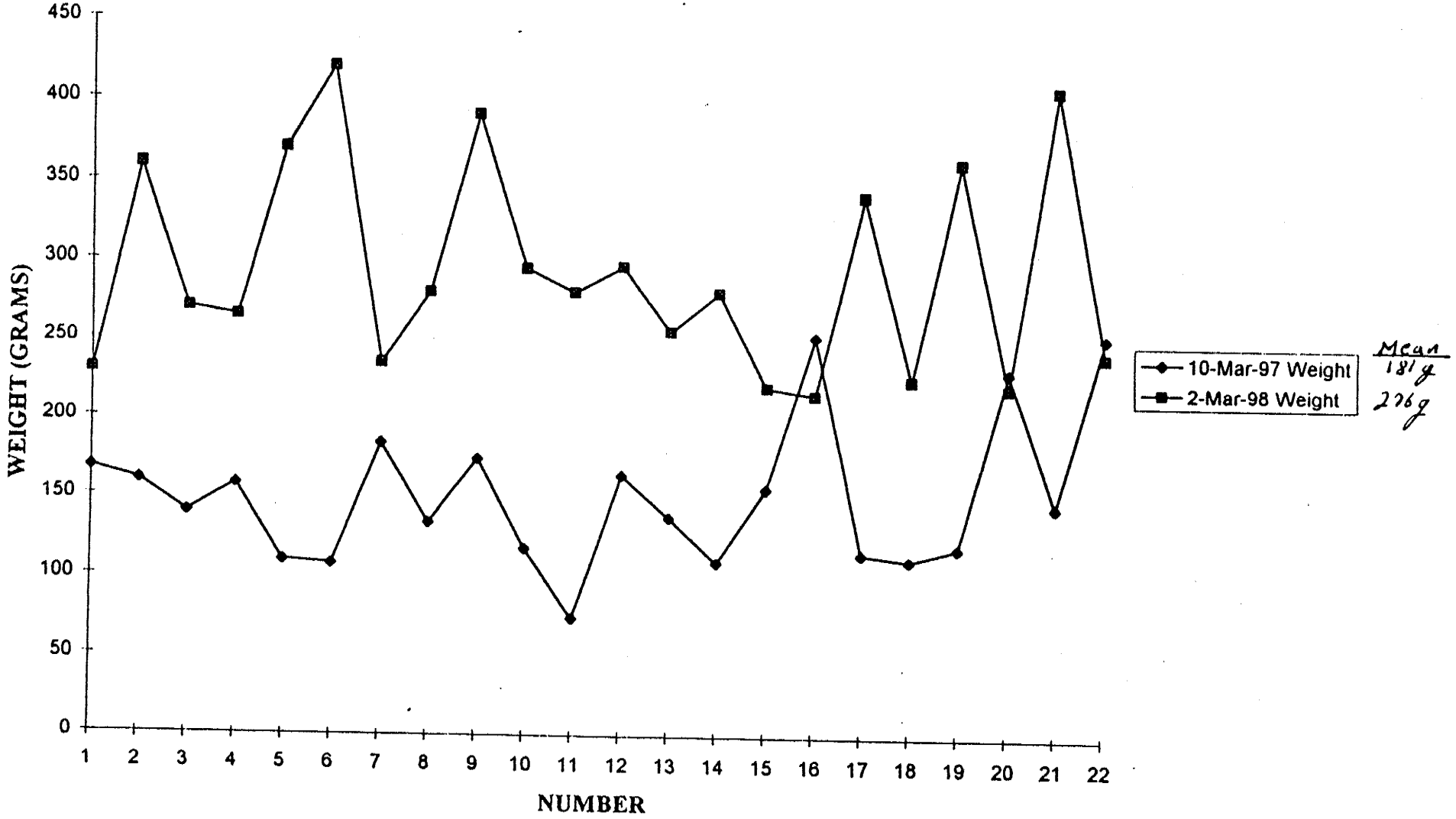
POND 7A
WEIGHT DATA 1998

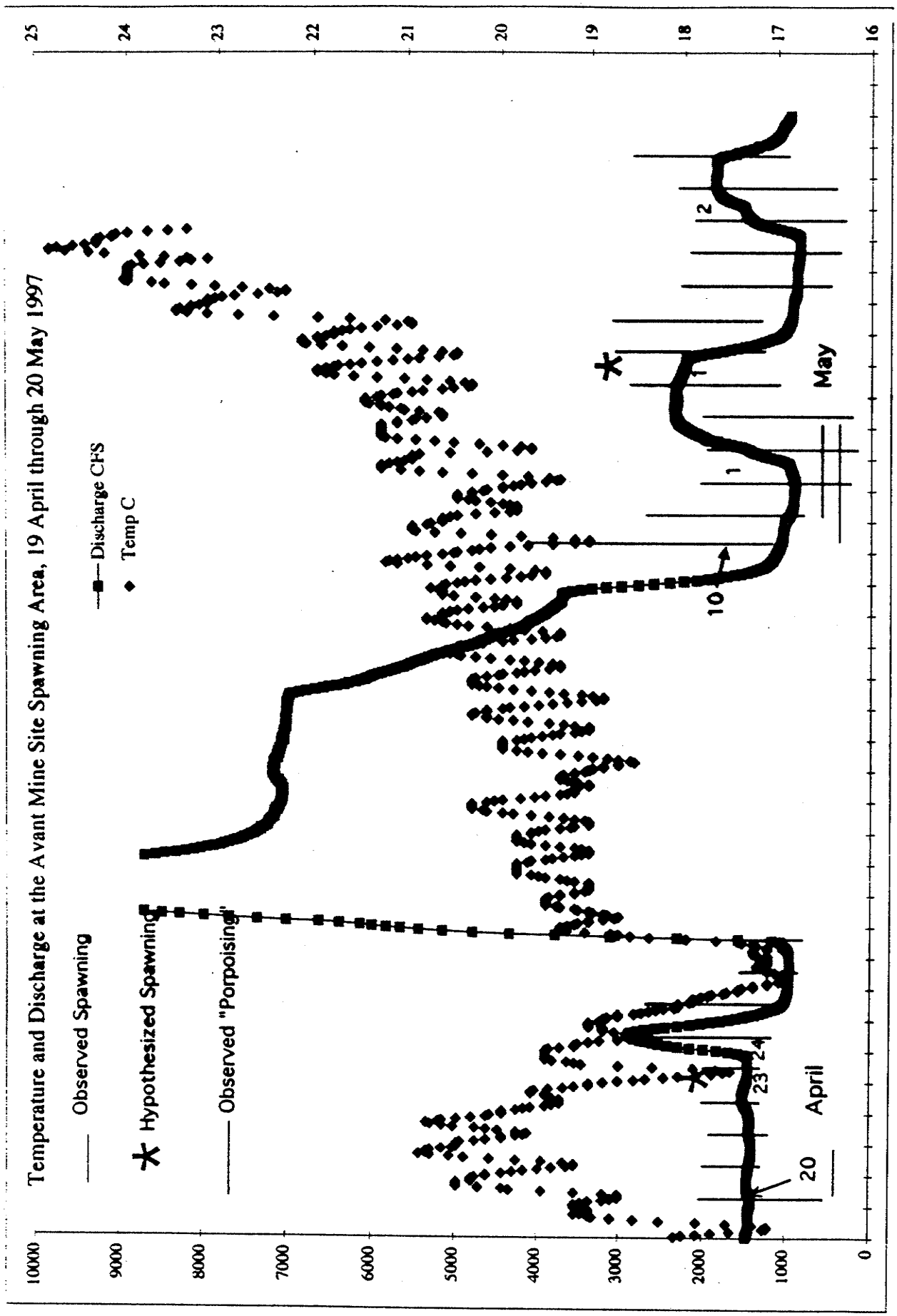


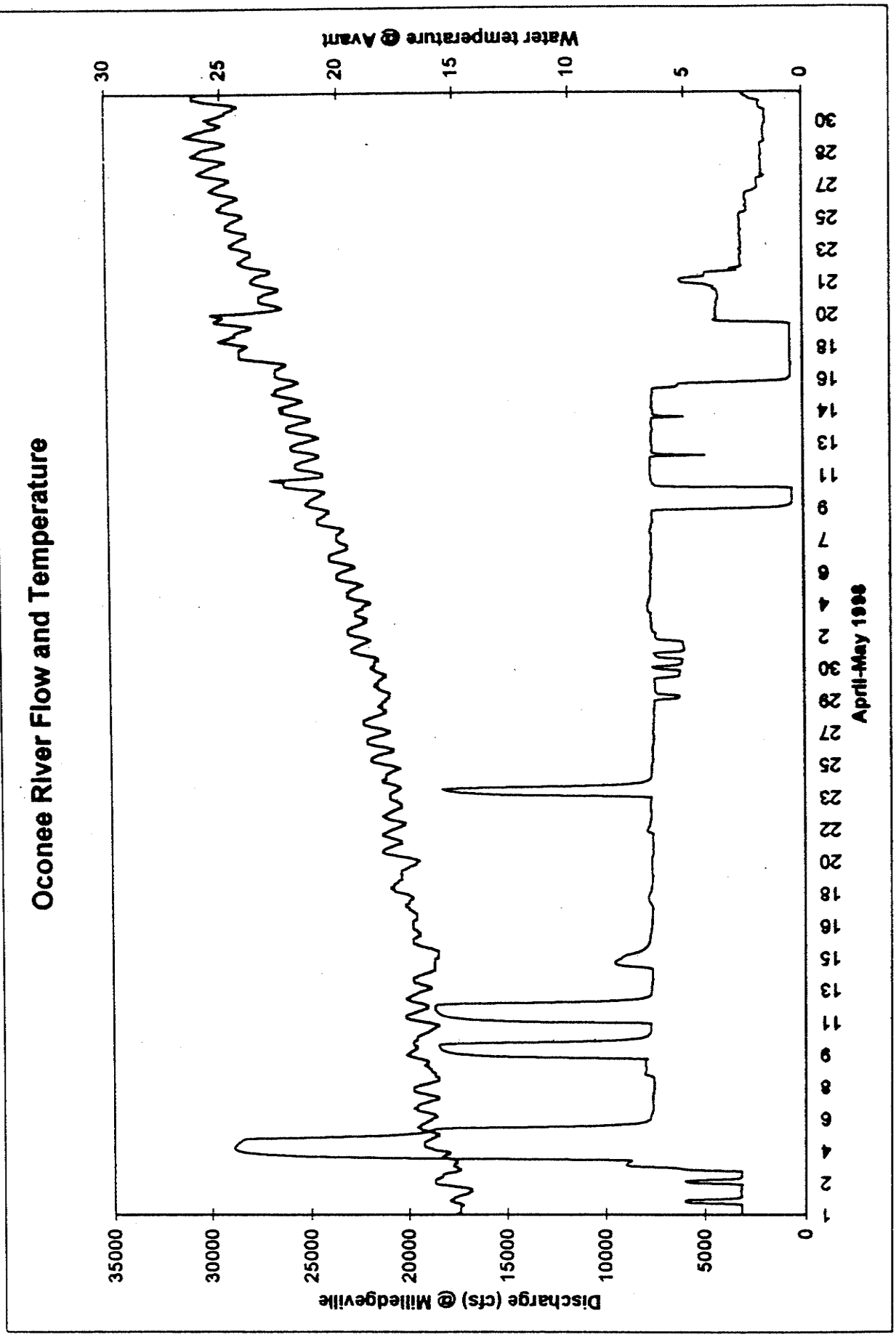
PIPPINS LAKE
1998 ROBUST REDHORSE LENGTH DATA

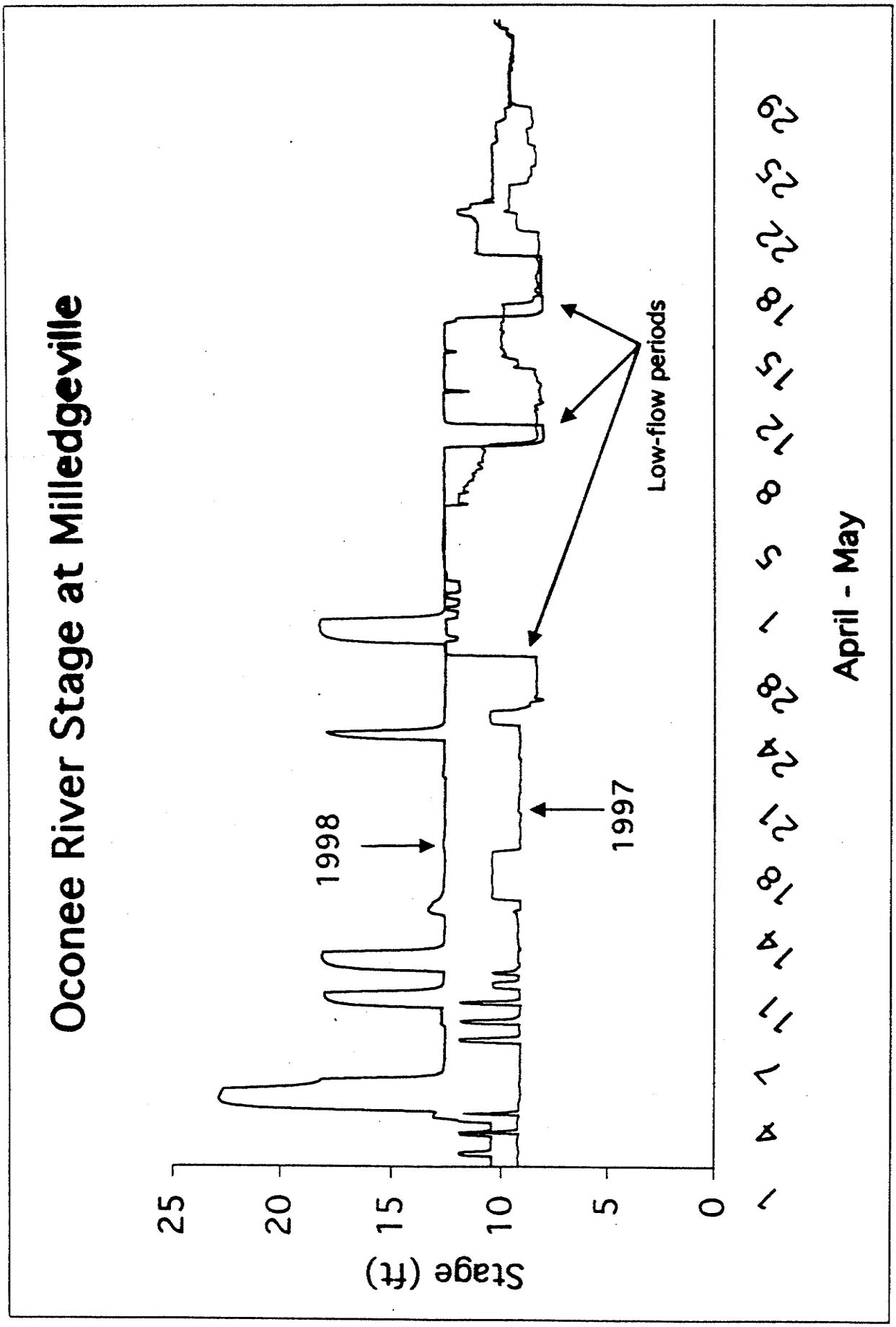


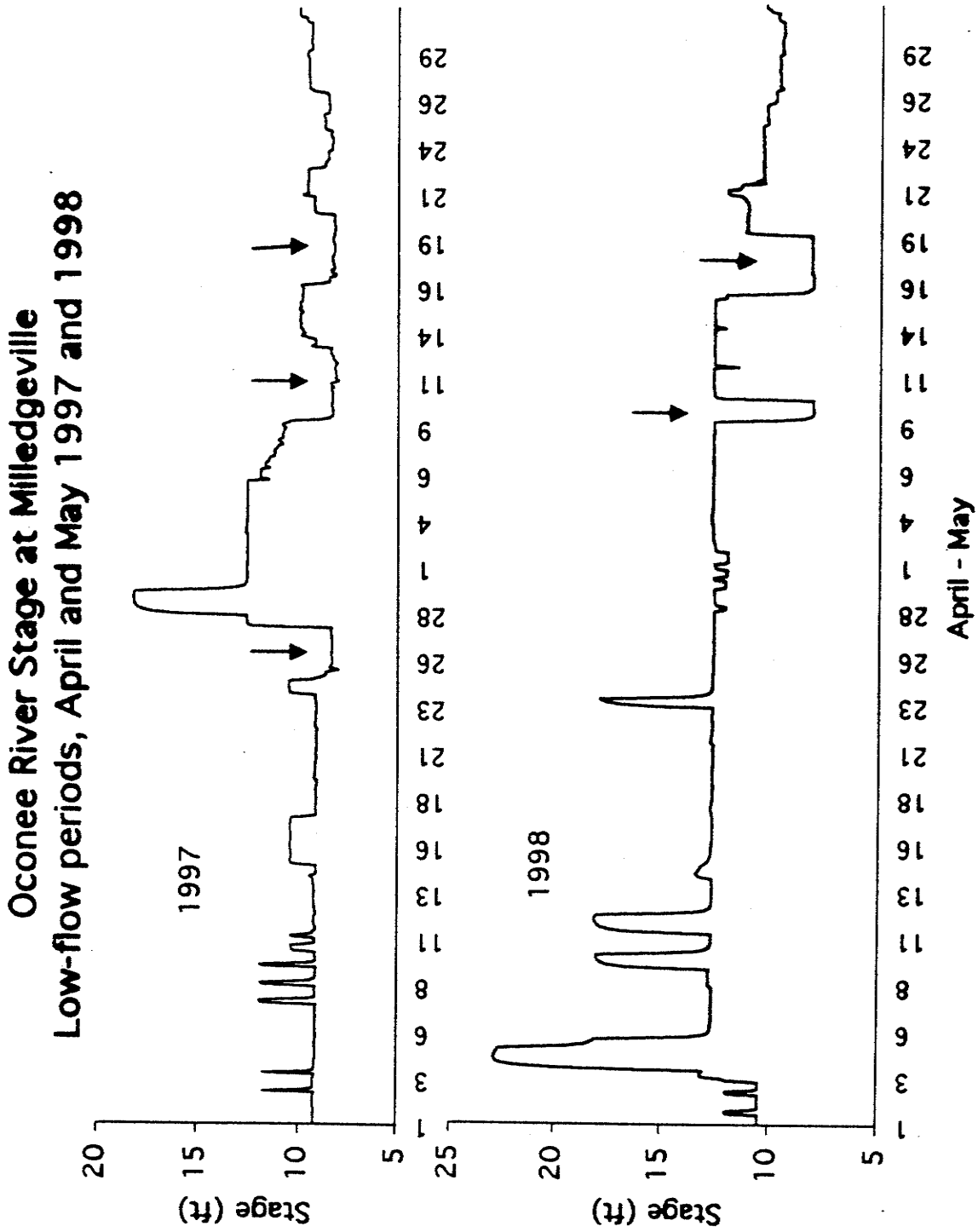
PIPPINS LAKE
1998 ROBUST REDHORSE WEIGHT DATA




Temperature and Discharge at the Avant Mine Site Spawning Area, 19 April through 20 May 1997
Discharge CFS
Temp C
Observed Spawning
Hypothesized Spawning
Observed "Porpoising"
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
25
24
23
22
21
20
19
18
17
16
20
April
23
24
May
1
2
10


Oconee River Flow and Temperature
Discharge (cfs) @ Milledgeville
Water temperature @ Avant
April-May 1998
35000
30000
25000
20000
15000
10000
5000
0
30
25
20
15
10
5
0
1 2 4 6 8 9 11 13 15 16 18 20 22 23 25 27 29 30 2 4 6 7 9 11 13 14 16 18 20 21 23 25 27 28 30


Oconee River Stage at Milledgeville
Stage (ft)
25
20
15
10
5
0
1998
1997
Low-flow periods
April - May
1 4 7 11 14 18 21 24 28 1 5 8 12 15 18 22 25 29


Oconee River Stage at Milledgeville
Low-flow periods, April and May 1997 and 1998
1997
1998
Stage (ft)
Stage (ft)
April - May

APPENDIX 14

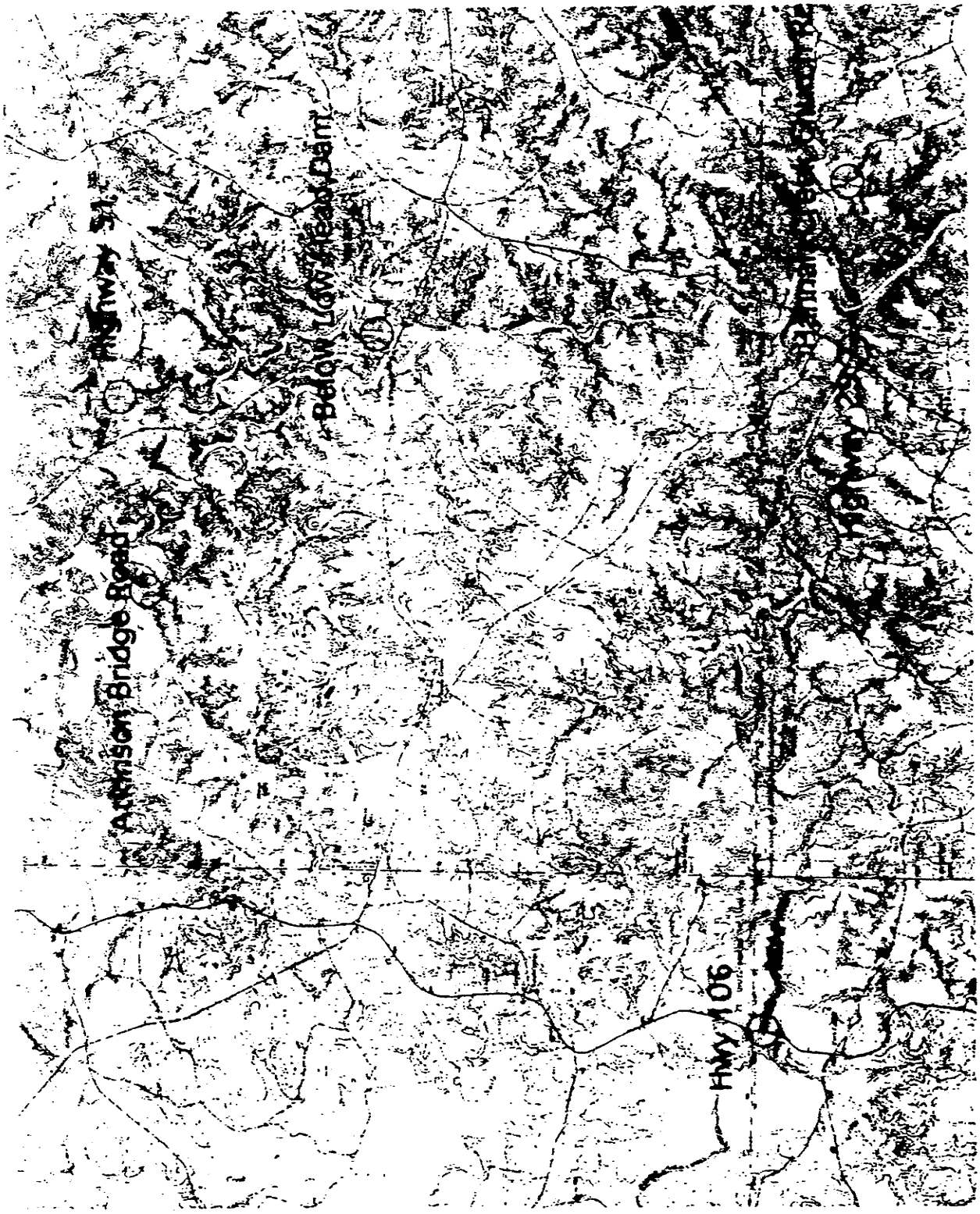
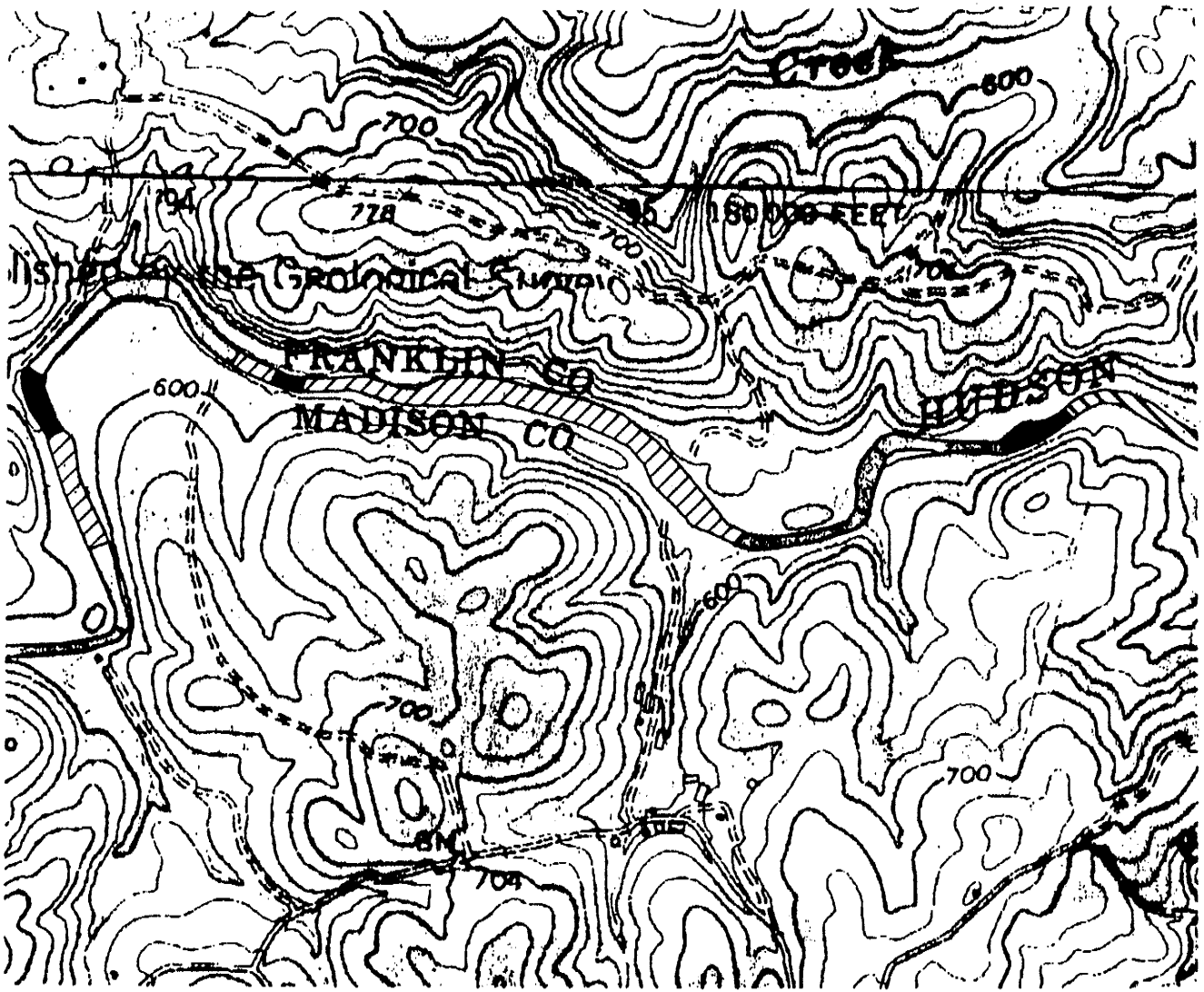

N
Stocking Sites in Upper Broad River System 1997
Highway 11
Below Lake Wateree Dam
Attaway Bridge Road
Hwy 901
Hwy 901
0 1 2 3 4 5 Kilometers

Table 1. Summary of stocking locales, year class, and numbers of robust redhorse released in the Broad River System, GA.

Year Class	Number Released	Date	Locale
1993	195	3/9/95	North Fork Broad River at Highway 51
1993	250	3/9/95	South Fork Broad River at Highway 22
1993	100	8/9/95	South Fork Broad River at Watson Mill State Park(above dam)
1995	1124	11/21/96	Hudson River at Highway 29
1995	150	11/21/96	South Fork Broad River at Watson Mill State Park(above dam)
1997	300	10/10/97	Hannah Creek at Hannah Creek Church Rd.
1997	1800	11/10/97	North Fork Broad River at Highway 145 (below dam)
1997	2200	11/19/97	North Fork Broad River at Highway 145 (below dam)
1997	300	11/20/97	Hannah Creek at Hannah Creek Church Rd.
1997	1300	11/20/97	Hudson River at Highway 106
1997	926	11/20/97	North Fork Broad River at Highway 51
1997	1930	11/21/97	Hudson River at Highway 29
1997	801	11/21/97	Hudson River at Highway 29
1997	1900	11/21/97	North Fork Broad River at Highway 145 (below dam)
1997	1000	11/21/97	North Fork Broad River at Highway 145 (below dam)
1997	1000	11/21/97	North Fork Broad River at Highway 145 (below dam)
1997	2000	11/21/97	North Fork Broad River at Highway 145 (below dam)
1997	3000	11/24/97	Middle Fork at Atkinson Bridge Rd.
1997	750	11/25/97	Hannah Creek at Hannah Creek Church Rd.
1997	3000	11/25/97	Hudson River at Highway 106
1997	3000	11/25/97	Hudson River at Highway 29

Hudson River Habitat Map C



Habitat Classes

- Flowing Pool
- Shoal
- Exposed Bar
- Run

Complex Habitat

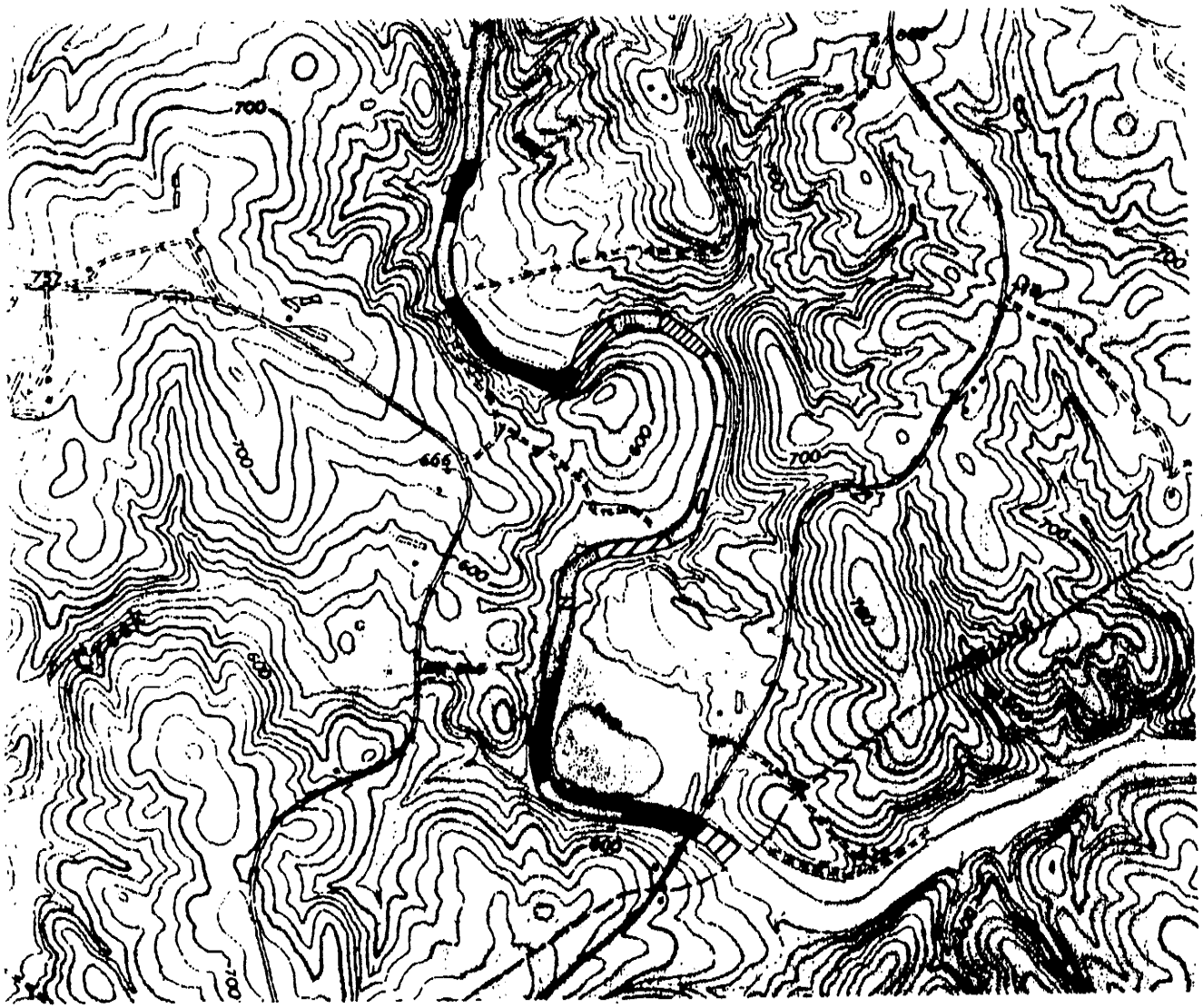
- Pool
- Shoal
- Run

- Shallow sediment

N

0.6 0 0.6 Kilometers

Broad River Habitat Map A



Habitat Classes

- Flowing Pool
- Shoal
- Exposed Bar
- Run

Complex Habitat

- Pool
- Shoal

- Shallow sediment

N

1 0 1 Kilometers

APPENDIX 17

APPENDIX 18

Stocking Locations for Hatchery Reared Phase I, Phase II, and Juvenile Robust Redhorse Fingerlings (1993, 1995, 1997 year classes) March 9, 1995 - December 6, 1997

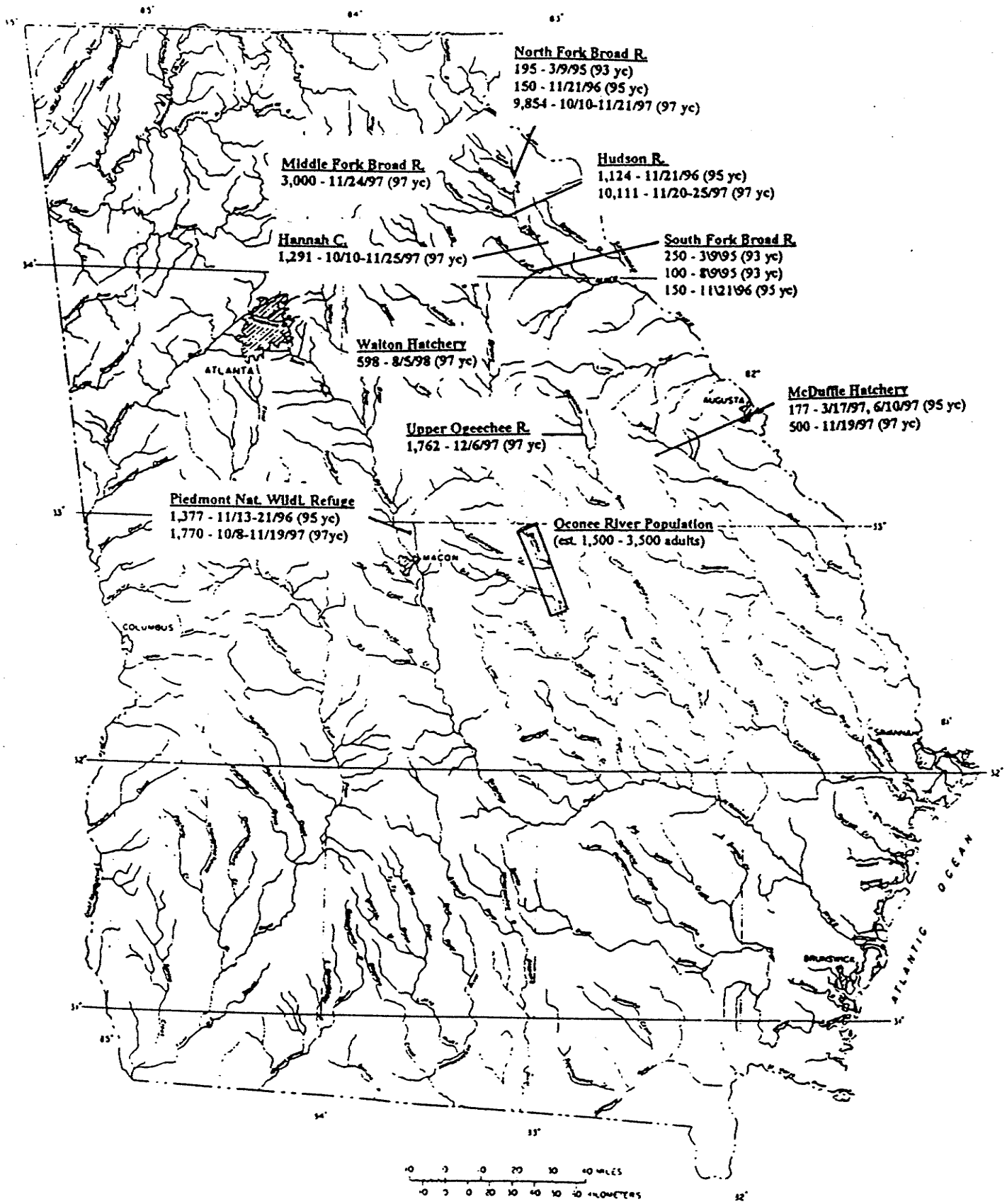


Table 1. Robust redhorse fry distribution in 1998.

Receiving Hatchery	Number Stocked	Dates Shipped	Fry Source
SOUTH CAROLINA			
Cheraw	4,950	6/9/98	Dennis Center
Shirey	1,980	6/10/98	Dennis Center
Dennis Center	13,403	6/10/98 6/10/98	Dennis Center McDuffie
Campbell	8,217	6/9/98, 6/15/98	Warm Springs
Subtotal	28,550		
GEORGIA			
McDuffie	9,786	6/6/98, 6/7/98 6/9/98	McDuffie Warm Springs
Burton	2,753	6/9/98	Warm Springs
Walton	9,857	6/9/98	Warm Springs
Richmond Hill	2,666	6/9/98	Warm Springs
Warm Springs	2,071	6/15/98	Warm Springs
Subtotal	27,133		
Grand Total	55,683		

Table 2. Dates scheduled for harvesting robust redhorse fingerling rearing ponds in 1998 (includes both Phase I and Phase II rearing ponds).

Hatchery	Scheduled Harvest Dates (1998)
Burton	October 20
Cheraw, Shirey, Dennis Center, Campbell	November 2 - 6
McDuffie	November 9
Walton	Week of Nov. 17 - 19
Richmond Hill	December 1

Table 3. Stocking priorities for Phase I and Phase II robust redhorse fingerling production in 1998.

1. Adult rearing ponds at Piedmont National Wildlife Refuge
2. Phase II production/hold for stocking in Ocmulgee R. in 1999
3. Upper Ogeechee R.
4. Upper Broad R.

Table 4. Stocking scenarios for various production rates of Phase I (1998 yc) robust redhorse fingerlings in 1998.

Estimated Number of Phase I (1998 yc) Fingerlings Harvested	Piedmont Refuge	Broad River	Ogeechee River	Phase II Production/Hold for Ocmulgee R.
1,000	500	-	-	500
5,000	1,000	1,000	1,250	1,750
10,000	1,500	2,000	3,000	3,500
15,000	1,500	3,000	4,500	6,000
25,000	1,500	4,500	7,000	12,000

Table 5. Stocking scenarios for various production rates of Phase II (1997 yc) robust redhorse fingerlings in 1998.

Estimated Number of Phase II (1997 yc) Fingerlings Harvested	Broad R.	Ogeechee R.	Phase II Production/Hold for Ocmulgee R.
1,000	-	500	500
2,000	500	500	1,000
4,000	1,000	1,500	1,500

Table 2. Hatchery pond space available for rearing Phase II (fall 1998) and Phase I (spring 1999) robust redhorse fingerlings, 1998 - 1999. Current status and designated use are indicated.

Hatchery	Pond no.	Size (ac)	Current Status	Designated Use
McDuffie, GA	11A 16W 6A bg ponds	0.50 0.78 0.44 -	500 (Phase II, 97 yc, pond reared) 988 (Phase II, 97 yc, tank reared)* Empty** 164 (95 yc), 500 (97 yc)	Fry, Phase II Fry Fry, Phase II juv., adults
Walton, GA	6 12 5 bg ponds	0.45 1.00 0.45 0.6 (ave.)	3,375 (Phase I,98 yc) 6,482 (Phase I,98 yc) 2,582 (Phase II,97 yc) 598 (Phase II,97 yc, tank reared)	Fry Fry Phase II juv., adults
Burton, GA	- -	0.45 0.30	885 (Phase II,98 yc) Empty	Fry, Phase II Fry, Phase II
Richmond Hill, GA	A1 or A2 or C2	1.25, 0.6 0.20	Other species 2,666 (Phase I,98 yc)	Fry Fry
Dennis Center, SC	- - - -	1.00 1.00 1.00 1.00	6,758 (Phase I, 98 yc) 1,381 (Phase II, 97 yc, pond reared) 595 (Phase II, 97 yc, tank reared) 595 (Phase II, 97 yc, tank reared)	Fry Phase II Fry Fry
Campbell, SC	- -	0.8 0.4	(Phase I, 98 yc) (Phase I, 98 yc) Note: Total for both ponds = 8,217	Fry Fry
Cheraw, SC	-	0.75	4,950 (Phase I, 98 yc)	Fry
Shirey, SC	-	0.40	1,980 (Phase I, 98 yc)	Fry
Subtotal	-	**12.0 (excluding bg ponds)**	**164 (95 yc), 7,739 (97 yc), 35,313 (98 yc)**	-
Piedmont NWR, GA	11B 9A 11A Pippin 7A	11.0 7.3 4.5 3.5 2.1	Empty*** 1,071 (95, 97 yc)*** 1,114 (95, 97 yc) 753 (95, 97 yc) 209 (95, 97 yc)***	Juv., adults Juv., adults Juv., adults Juv., adults Juv., adults
Subtotal	-	**28.4**	**1,377 (95 yc) 1,770 (97 yc)**	-
Grand Total	-	**40.4**	**1,541 (95 yc) 9,509 (97 yc) 35,313 (98 yc)**	-

* Originally stocked with 5,448 Phase I (98 yc), pond experienced complete mortality early summer 98.
** Total mortality of 2,904 Phase I (98 yc), mid summer 1998.
*** Highest priority for stocking with 1998 yc.

Table 1A. Harvest of robust redhorse hatchery ponds in South Carolina.

Phase I Harvest

No Harvested	Piedmont	Broad R.	Ogeechee R.	Phase II/Hold for Ocmulgee
1,000	500*	-	-	500 (stk. DC)
5,000	1,000*	500**	1,500***	2,000 (1,000 stk. Wal*, 1,000 stk. DC)
10,000	1,500*	2,000**	2,500***	4,000 (1,500 stk. DC, 1,500 stk.Wal*,1,000stk.McD.***)

*FT. Valley haul
**UGA haul
***Thomson haul

Table 1B.

Phase II Harvest

No Harvested	Broad R.	Ogeechee R.	Phase II/Hold for Ocmulgee
1,000	-	500*	500 (McD, 2nd pond)*
2,000	500**	500*	1000 (McD, 2nd pond)*

*Thomson haul
**UGA haul

Note: Following this harvest, following ponds will be available at SC hatcheries for fry stocking in 1999: Dennis Center (3 ponds, 3 ac.), Campbell (2 ponds, 1.2 ac.), Cheraw (1 pond, 0.25 ac.), Shirey (1 pond 0.4 ac).

Table 2. Harvest of Phase II robust redhorse ponds at McDuffie SFH.

No Harvested	Broad R.	Ogeechee R.	Phase II/Hold for Ocmulgee
500	-	250**	250 (McD, 2nd pond)
1,000	250*	250**	500 (McD, 2nd pond)

*UGA haul
**Ft. Valley haul

Note: Following this harvest, following ponds will be available at McDuffie for fry stocking in 1999: 1 pond (0.78 ac)

Table 3A. Harvest of robust redhorse Phase I and II hatchery ponds at Walton SFH.

Phase I Harvest

No Harvested	Piedmont	Broad R.	Ogeechee R.	Phase II/Hold for Ocmulgee
1,000	-	250*	250**	500 (Walton)
3,000	-	500*	1,500**	500 (Wal), 500(McD)***
5,000	-	1,500*	2,500**	500 (Wal), 500(McD)***

*UGA haul
**Ft Valley haul
***Thomson haul

Table 3B.

Phase II Harvest

No Harvested	Broad R.	Ogeechee R.	Phase II/Hold for Ocmulgee
1,000	250*	250**	500 (Wal,2nd pond)***
2,000	250*	500**	1,250 (Wal, 2nd pond)***

*UGA haul
**Ft. Valley haul
***This 2nd pond must be harvested before March 1999 (stock in Ocmulgee or elsewhere).

Note: Following this harvest, following ponds will be available at Walton for fry stocking in 1999: 2 ponds totaling 1.45 ac.

Table 4. Harvest of Phase I robust redhorse hatchery ponds at Richmond Hill SFH.

No Harvested	Broad R.	Ogeechee R.	Phase II/Hold for Ocmulgee
1,000	500*	500**	-
2,000	750*	1,250**	-

*UGA haul
**Ft. Valley haul

Note: Following this harvest, following ponds will be available at Richmond Hill for fry stocking in 1999: 1 pond totaling 1.25 or 0.6 ac.

APPENDIX 19

Research and Survey Activities for 1999 - 2000
(Funding Sources in Parenthesis)

A. Active Research Projects, continuing into 1999 - 2000 period
   1. Robust redhorse culture studies (GaDNR, non-game license plate funds)
   2. Monitoring of survival and growth of fingerlings reintroduced into the Broad River (FWS)
   3. Evaluations of reproductive and recruitment success in the Oconee River (GPC)
   4. Genetics evaluations of the Oconee and Savannah river populations (Duke, CP&L, EPRI)
   5. Development of cryopreservation techniques for robust redhorse sperm (FWS)
   6. Spawning site delineation, description of spawning behavior in Oconee River (GPC, FWS)
   7. Age and growth evaluations of adult robust redhorse from the Oconee River (GPC)
   8. Status surveys on the Savannah River below New Savannah River Bluff Lock and Dam and on the Ogeechee River downstream of Louisville (GaDNR, in conjunction with annual standardized river surveys, Demeries Creek Regional Office)

B. Active Research Projects, terminating in 1999
   1. Effects of sedimentation and substrate composition on reproductive success (GPC)
   2. Impacts of contaminants on robust redhorse eggs and larvae (USGS)
   3. Effects of temperature and flows on robust redhorse eggs and larvae (GPC)

C. Research activities funded and scheduled to begin in 1999
   1. Evaluation of flow/habitat relationships for robust redhorse spawning and rearing stages in the Augusta Shoals area of the Savannah River (Augusta and Richmond counties, in conjunction with FERC relicensing of the Augusta Canal)

D. Research activities proposed for the 1999 - 2000 period
   1. Telemetry investigations of movement and habitat utilization of robust redhorse stocked into the Oconee, Broad, and possibly Ocmulgee rivers
   2. Development of mortality, survival and population estimates for the Oconee River population; modeling of population dynamics
   3. Evaluation of possible correlations between historical flow regimes and year class strength in the Oconee River
   4. Development of husbandry techniques in an aquarium environment (South Carolina Aquarium)

Prioritized Research Needs
Robust Redhorse Recovery

I. Culture Techniques

A. Propagation

- Use of hormones to induce ovulation.
- Incubation techniques.
- Water quality requirements, temperature sensitivity.
- Egg and fry handling techniques.
- Fry dietary requirements, growth trials.
- Maximizing genetic diversity.

B. Rearing

- Dietary requirements of Age-0 and Age-1 fingerlings.
- Growth trials on various diets in ponds.
- Growth and survival at various stocking rates in ponds.
- Food habits\preference of fingerlings in ponds.
- Intensive culture in raceways, tanks, and cages.
- Pond preparation.
- Rearing techniques for larger juveniles and adults.

II. Early Life History Habitat Requirements

A. Egg viability in redds, substrate characteristics necessary for viability. Impacts of turbulence and rapid changes in current velocities.

B. Depth, current velocity, substrate, and cover preferences (larval to advanced fingerling stage). Impacts of turbulence and rapid changes in current velocities.

C. Swim-up survival and fry disposition.

D. Juvenile habitat requirements.

III. Monitoring the Oconee River Population

A. Annual electrofishing catch rate comparisons.

B. Age and growth studies.

C. Population estimation.

D. Adult spawning and non-spawning habitat requirements.

E. Spawning site delineation and characterization.

F. Long-term migration patterns.

G. Daily, monthly, and seasonal movement patterns.

H. Larval and YOY sampling.

IV. Monitoring Stocked Populations

Evaluation of sampling methods. Determination of growth, survival, reproductive success; relationships between predator types\densities and survival.

V. Post-Stocking Behavior

Telemetry investigations of Age-1 and, if possible, Age-0 fingerling behavior for a several week or month period immediately after stocking. Important in identifying suitable stocking sites and potential for migration out of stocking sites.

VI. **Tagging Studies**

Coded-wire tag retention for Age-0 and Age-1 fingerlings at various tag insertion locations. Suitable tag length, diameter, etc. Effectiveness of various field detection techniques. Evaluation of tagging methods for identification of individual fish.

VII. **Predator Control**

Techniques for reducing flathead catfish densities. Focus on the Oconee River, but applicable to stocked rivers.

VIII. **Population Genetics**

Genetic heterogeneity (MDNA and electrophoretic techniques); Oconee River population as well as populations or individuals which might be collected from other drainages in the future.

IX. **Distributional History**

A. Additional surveys to determine if other populations or isolated individuals exist in Georgia, South Carolina, or North Carolina.
B. Investigations into historical occurrence and distribution.
C. Correlation between changing land and water use patterns and species decline.

X. **Behavioral Studies of Adults.**

Focus on spawning and feeding behavior, behavioral responses to rapidly changing flows.

XI. **Evolutionary Biology**

Establish phylogenetic relationships.

XII. **Physiology**

Thermal biology, endocrinology, reproductive biology, etc.

PROPOSED CONSERVATION ACTIONS
(Bold indicates short term (6-8 yr.) needs)

a. Propagation and culture studies
   i. **Culture techniques**
   ii. Development
   iii. Growth
   iv. Nutrition Tagging
   v. Water quality
   vi. Disease

b. **Reintroduction assessment for experimental populations**
   i. **Habitat suitability**
   ii. **Accessibility**
   iii. **Watershed development**
   iv. **Predator densities**
   v. **Water quality**

c. Habitat Restoration

d. Life History Research **(early life history research is a short term goal)**
   i. **Egg viability**
   ii. **Swim-up survival and fry disposition**
   iii. **Behavior**
   iv. Food habits

e. Riparian Zone Management

f. Environmental Requirements
   i. Habitat assessments **(early life history stages)**
   ii. Instream flow requirements **(early life history stages)**

g. Applied Research
   i. **Population genetics**
   ii. Distributional history
   iii. Physiology
   iv. Evolutionary biology and zoogeography

h. Predator Control Measures

i. **Monitoring Populations**

Cost estimates for all short term research needs range from $400-600 thousand.