NHP,
Please pardon the way this copy has been put together. I lacked the time to organize it. Sorry!

INTERIM REPORT

TO

THE U. S. FISH and WILDLIFE SERVICE

STATE: NORTH CAROLINA PROJECT NO. ES-3

PROJECT TITLE: NORTH CAROLINA ENDANGERED SPECIES

SECTION TITLE: RESEARCH AND SURVEY (SECTION I)

SUBSECTION TITLE: NORTH CAROLINA MUSSELS (SUBSECTION C)

STUDY TITLE: POPULATION STATUS, DISTRIBUTION, AND BIOLOGY OF THE TAR RIVER SPINY MUSSEL, ELLIPTIO (CANTHYRIA) STEINSTANSANA (JOHNSON AND CLARKE), IN NORTH CAROLINA

PREPARED BY

JOHN M. ALDERMAN
Piedmont Project Leader
Nongame & End. Wildlife Prog.
NC Wildlife Res. Comm.

August, 1987

DATE SUBMITTED

INTRODUCTION

This interim report describes survey and distribution activities associated with a research and survey project funded by the U.S. Fish and Wildlife Service to determine the population status, distribution, and biology of the Tar River spiny mussel. Survey activities from September 15, 1986 through August 5, 1987 are described in detail in the appendix section. Laboratory investigations to determine the glochidial fish hosts for the Tar River and James River spiny mussels have been initiated by Dr. Richard Neves, and results of this research will be included in the final report from the North Carolina Wildlife Resources Commission.

PROCEDURE

Seventy-five sites (including some revisited sites) have been surveyed in the Tar River Drainage Basin during the past year for *E. (C.) steinstansana*. These sites were located in the Tar River as well as its major tributary streams and creeks. Most sites could be surveyed either by visually searching while walking a stream segment, snorkeling, using scuba, or canoeing a stream segment. Search time varied depending upon turbidity of water, substrate characteristics, presence or absence of mussels, or mussel diversity seen at the site. Usually low turbidity sites with relatively firm substrates (not silt) and with

high mussel diversity received greater search time.

RESULTS AND DISCUSSION

Four living Tar River spiny mussels have been found at one site near the Tarboro water intake plant during the past year. One shell from a recently dead Tar River spiny mussel was also found at the same site. Approximately two miles downriver from the water intake plant another shell from a recently dead adult E. (C.) steinstansana was found on an extensive sandbar.

On August 4, 1987, a shell from a recently dead E. (C.) steinstansana was discovered in Swift Creek, Nash County. This was the first specimen of a Tar River spiny mussel ever documented from a tributary of the Tar River.

During an earlier survey of the site, several E. masoni were found. Because Johnson (1970) had mentioned that E. masoni and E. (C.) collina were closely associated in the James River, Virginia, I reasoned that there was a possibility that the Tar River spiny mussel might be found at the site in Swift Creek. Therefore, the site was resurveyed on the above date. The first shell picked up was an E. (C.) steinstansana with five spines on the right valve and two spines on the left valve.

The discovery of the Tar River spiny mussel in Swift creek

is extremely important for the species for several reasons.

1. Clarke (1983) was able to find 14 living or recently dead Tar River spiny mussels at nine different sites during his survey of the Tar River. Approximately 900 living mussels other than spiny mussels were found during his survey. During the past year, nearly 1,700 living mussels other than spiny mussels have been found throughout the river basin. Only one site produced live E. (C.) steinstansana. This clearly indicates that the Tar River spiny mussel is becoming much more rare in the Tar River Drainage Basin. Should pollution cause the extinction of the local population of Tar River spiny mussels in the Tarboro area of the Tar River, proper management and conservation of the natural resources in the Swift Creek Drainage Basin may allow this unique species continued survival.

2. To date, no Corbicula have been found in Swift Creek - from its headwaters to its confluence with the Tar River. Swift Creek may offer a haven from Corbicula competition to the Tar River spiny mussel as well as the other mussel species found in the creek. It is important that we discover the cause for Corbicula not being in the creek. If a parasite or other agent eliminates Corbicula from Swift Creek, it may prove useful to help eliminate this introduced species from other bodies of water throughout North America.

3. We now know that the spiny mussel can survive in habitat other than the sandy main channel of the Tar River. The

spiny mussel site on Swift Creek is only about 45 feet wide, has an extremely firm substrate composed almost entirely of gravel, cobble, some boulders, and, most significantly, very little sand, and is much cooler than the Tar River. (Trees shade most of Swift Creek.)

E. (C.) STEINSTANSANA SPECIES ASSOCIATES

Clarke (1983) found E. complanata and L. ochracea to be associated with E. (C.) steinstansana. At the water intake plant during July, 1987, E. (C.) steinstansana was found to be associated with E. lanceolata, A. undulata, as well as the other two species. At the Swift Creek site, E. (C.) steinstansana was associated with E. complanata, E. masoni, and V. constricta.

A POSSIBLE FISH HOST?

I feel that it is important to mention the following observation from the site producing the spiny mussel shell on Swift Creek. While snorkeling and looking for additional spiny mussels, I was very impressed with the number of darters (species unknown) seen above the substrate. At least 150 individuals were seen in a 25 x 25 foot area. No other fish species were seen at the site. It may be important to investigate this species as a possible fish host to E. (C.) steinstansana.

ADDITIONAL THREATS TO THE TAR RIVER SPINY MUSSEL

It is apparent that during the past few years local government officials from Rocky Mount have shown wanton disregard for their environment and for fellow citizens living farther down the Tar River. For at least the past 2.5 years, the Rocky Mount wastewater treatment plant has been dumping raw sewage into the Tar River. Its effects upon the native flora and fauna and humans who consume water from the Tar River are unknown. This activity may have significantly reduced the number of E. (C.) steinstansana surviving in the river.

Also extremely troubling is a report (Chapman, 1987) that more and more high density hog farms are being located along Swift Creek, and the farmers are not building lagoons to handle their animal wastes. Hog wastes are reported to be flowing directly into Swift Creek. Hopefully, such farms are rare in the area, and once the State is notified of known polluters, the problem can be quickly corrected to protect any Tar River spiny mussel populations in the area.

A NOTE ABOUT CORBICULA DISTRIBUTION IN THE TAR RIVER

Finally, as predicted by Clarke (1983), Corbicula can now be found throughout the Tar River from Granville to Pitt counties. The effects of this invasion are unknown.

HYPOTHETICAL HISTORY OF THE TAR RIVER SPINY MUSSEL

Scenario One

The following is a product of free thinking, as suggested by Open University (1983), based upon known information concerning the Tar River spiny mussel. Such thinking may help with future management of the Tar River spiny mussel should research substantiate this conjectured scenario.

The Tar River spiny mussel's range in past centuries cannot be determined. It may have ranged throughout the total Tar River Drainage Basin or its range may have always been limited to the lower sections of the basin - the Tar River throughout Nash and Edgecombe counties, and the lower sections of Fishing and Swift Creeks. Based upon our limited knowledge of the species, the latter is the most likely situation. The most healthy local populations could be found in the lower Tar River with some local populations found in Fishing and Swift Creeks. These mussels were associated with swift flowing water flowing over firm substrates - gravel and cobbles with varying amounts of sand.

Historically, the Tar River Drainage Basin has had the highest erosion rate in North Carolina. The sediment load carried by the Tar River and its tributaries caused the extinction of many spiny mussel local populations. Spiny mussels were lost entirely from Fishing Creek, and sediment

problems coupled with reservoir construction on the Tar River caused the extinction of spiny mussels in the Tar River above Rocky Mount. Erosion problems in Swift Creek may not have been as severe as in the other two tributaries thus allowing spiny mussels to survive in Swift Creek.

Presently, spiny mussels are found in the Tar River near Tarboro and in Swift Creek in Nash County. The population near Tarboro has been spiralling toward extinction at a rapid rate. Even before the introduction of Corbicula and the building of reservoirs, the Tar River spiny mussel was not a common species in the Tar River. However, sedimentation of the river has always been present historically, and according to elderly local citizens near Tarboro, the filling of the Tar River with sand has been accelerating during recent decades. They indicate that the Tar River once had a distinct channel and sand was not nearly as abundant when they were younger. I cannot glean information concerning the characteristics of the substrate; however, undoubtedly gravel and cobble areas could be found in the Tar River near Tarboro and in other areas throughout the river in Edgecombe and Nash counties. In these areas, E. (C.) steinstansana was most abundant. Gravel and cobble areas are now largely nonexistent in the Tarboro area, and spiny mussels are becoming more and more rare there.

Although a sandy environment may ultimately cause the extinction of the Tar River spiny mussel in the Tarboro area

of the Tar River, it is ironic that certain characteristics of this habitat have allowed the species to persist there.

First, as described by Hynes (1970), river beds usually enlarge when river velocities exceed 200 cm/sec. Since the Tar River near Tarboro shows few signs of river bed enlargement, the river velocity probably rarely exceeds 200 cm/sec. even during high water periods during the winter when the river may be 20 or more feet deeper than during summer periods. However, during high water periods when the river is turbid, the river velocity near the substrate probably is within the range of 30 to 70 cm/sec. which can easily move fine to coarse sand (Schmitz, 1961). Also, any mussels less than 10 cm. long living in this sandy environment should be carried along with the sediment load (Nielsen (1950). In straight lengths of the river where the gradient decreases, river velocity decreases and the sediment load should be dropped - at first along the left shore facing downriver because of the Coriolis force's effects on the flowing water and sediment load. Any mussels in the sediment load should be dropped with the sand. This effect should tend to concentrate smaller mussels in these sandy areas along the left shore facing downriver. Interestingly, five of the seven site ecology maps produced by Clarke (1983) for Tar River spiny mussels found during his survey indicate that spiny mussels were found at sites like those described above. The other two sites appear to be at sandbar

locations along the right shore facing downriver. Such sandbars can be expected at river bends or where obstructions are found in the river. Also, the site where five spiny mussels (one as a fresh shell) were discovered during July, 1987 was located along the left shore. Additionally, the site producing Tar River spiny mussels at Riverfront Park, Tarboro, is a sandbar along the left shore of the river facing downriver.

Finally, the interaction of the Coriolis force, sand characteristics, and river flow off the river bank on the left shore often creates a distinct channel between the river bank and the sandbar. During July and August, I have found these channels to be small compared with the total river width. Where the river is 200 feet wide, the channel between the sandbar and river bank may be 25 feet wide or less. All four living spiny mussels found during July, 1987 were located in the channel - three in the exact center of the deepest part of the channel with the fastest flow. Apparently, the river physically concentrates these mussels at these sandbar locations. Then during June and July, I believe that the spiny mussels move to the areas with the greatest water velocity to feed or reproduce. This is extremely convenient for a species which is very rare. Without such natural concentration of spiny mussel individuals, successful reproduction would be very unusual, and Tar River spiny mussels would probably become extinct in less than a decade.

SCENARIO TWO

Background Information

Length, height, and width data have been collected for all mussels found during the past year. Using data from the ongoing study and from data supplied by Johnson and Clarke (1983), some basic E. (C.) steinstansana population shell characteristics are derived as seen in Table One.

TABLE ONE

Length, Height, and Width Shell Ratios
and 95 % Population Confidence Intervals
for These Parameters Based Upon the
Characteristics of 10 E. (C.) steinstansana
Specimens

Parameter	Sample Mean (Standard Dev.)	95% Confidence Interval for the Population Mean
L/H ratio	1.603 (0.033)	1.579 (= U (= 1.627
L/W ratio	2.460 (0.201)	2.316 (= U (= 2.604
H/W ratio	1.535 (0.128)	1.443 (= U (= 1.627

Because Clarke (1983) accidentally collected and preserved an E. (C.) steinstansana adult during his survey (I assume because it looked like an unusual E. complanata), and because E. complanata specimens are extremely varied in form in Edgecombe County, it may be that some specimens thought to be E. complanata in the field are actually Tar River

spiny mussels. By searching the data generated during the most recent survey of the Tar River, it may be possible to determine the probability that certain individual specimens thought to be E. complanata are actually Tar River spiny mussels.

Using the maximum and minimum values for the population means (Table One) for each parameter, plus or minus the standard deviation for each parameter, a computer search for E. complanata specimens with L/H, L/W, and H/W ratios simultaneously within these ranges produces a list of seventy-two specimens as seen in Table Two. Table Three shows the exact computer search. These mussels were found from Person County to Pitt County within the Tar River. However, sixty-four of the seventy-two mussels were found in the Tar River in Edgecombe County - from Tarboro to the Pitt County line. Within the Tar River from Tarboro to Pitt County, 931 E. complanata have been found and measured. Using data from the present survey, the probability of any given E. complanata within this area simultaneously having L/H, L/W, and H/W ratios within the values stipulated above is 0.0337. Therefore, from probability theory, 31 (931 x .0337) of the E. complanata from this area should have had their length, height, and width ratios simultaneously within the above ranges. Therefore, thirty-three (64 - 31) of the mussels thought to be E. complanata have an increased probability of being E. (C.) steinstansana.

The data generated and listed in Table Two can be analyzed in another way. First, assume that all 72 specimens listed in Table Two are *E. complanata* - a pollution tolerant mussel species. Based upon this assumption, there should be no change in the percent of *E. complanata* with length, height, and width ratios within the above ranges for the areas above versus below the Tarboro wastewater treatment plant. As seen from Table Four, there is a difference. From this data, it can be assumed tentatively that the original assumption - all mussels listed in Table Two are *E. complanata* - is incorrect. Therefore, we may assume that some of the mussels listed in Table Two are *E. (C.) steinstansana*. There is a need for further research to verify this assumption. Electrophoretic research is greatly needed to determine if this hypothesis is correct.

Table Four

Percent of *E. complanata* with Length, Height, and Width Ratios Within the Ranges Specified for *E. (C.) steinstansana* in the Tar River from the Water Intake Plant to Four miles Below the Tarboro Wastewater Treatment Plant

Site	% *E. complanata* With Shell Dimensions Within the Population Ranges for *E. (C.) steinstansana*
Water Intake Plant, Tarboro	12.07 %
Riverfront Park, Tarboro	6.99 %
One mile below Wastewater Treatment Plant for Tarboro	2.94 %
Three miles below Wastewater Treatment Plant for Tarboro	3.26 %
Four miles below Wastewater Treatment Plant for Tarboro	8.00 %

Table Two possibly indicates that spineless Tar River spiny mussels may be present from Pitt County to the headwaters in Person County. Interestingly, three *E. complanata* were found with dimensions like those for *E. (C.) steinstansana* at a site in Granville County (860925.1). The listing of these specimens as *E. complanata* becomes suspicious when one realizes that the site's substrate and current characteristics are very similar to

those found at the site on Swift Creek which produced a Tar River spiny mussel shell. At the site in Granville County, a very rare mussel, A. heterodon, was found along with E. complanata and V. constricta (both associated with the Tar River spiny mussel at the Swift Creek site), and S. undulatus.

In scenario two, all conditions were the same as in scenario one except isolated smaller populations of spiny mussels were found in appropriate habitat farther up each of the major Tar River tributaries. Sedimentation eliminated many of these local populations. Other forms of pollution (such as discharges from municipal wastewater treatment plants as indicated in Table Four) are rapidly eliminating the remaining populations. Even urban runoff may significantly affect the Tar River spiny mussel. Notice from Table Four that the percentage of questionable E. complanata at Riverfront Park is almost half the percentage found at the water intake plant. The major difference between the two sites is that there is urban runoff occurring between the two sites. If other forms of pollution are responsible for the rapid decline of E. (C.) steinstansana in the recent past, the extinction of the species can only be expected to accelerate as cities grow and discharge more and more wastes throughout the Tar River Drainage Basin.

APPENDIX

All data sheets are arranged numerically by date/sites. For example the first date/site is 860915.1. Broken down, the 86 represents the year 1986; 09 represents September; 15 represents the 15th. day of the month; and .1 represents the first site surveyed that day. Each data sheet contains a more detailed description of the site together with length, height, and width data for each mussel found at that site. All shell measurements are in millimeters. This data will prove valuable when comparing the results of future mussel surveys at these sites. Although age data cannot be determined from this data, relative community health can be obtained. For example, if a site produced mussels of many different species with a wide range of sizes one year, and in a future year only small individuals of a pollution tolerant species such as E. complanata could be found, it would be very likely that some catastrophe such as toxic substance poisoning had passed through that area at some time in the recent past. On the other hand, if a site produced only small E. complanata one year, and in the future, E. complanata of many different sizes were found along with young from other species, it could be concluded that the habitat quality is improving.

REFERENCES

Biggins, R.G. 1982. Endangered and Threatened Wildlife and Plants; Review of Status - Tar River Spiny Mussel (Canthyria sp.). Federal Register, Vol. 47, No. 4, pp. 9484-9485.

Biggins, R.G. 1985. Endangered and Threatened Wildlife and Plants; Final rule listing the Tar River Spiny Mussel (Elliptio (Canthyria) steinstansana) as an Endangered Species. Federal Register, Vol. 50, No. 124, pp. 26572-26575.

Chapman, J.H. (Director of Public Works, Tarboro), 1987. Personal communication.

Clarke, A.H. 1983. Status Survey of the Tar River Spiny Mussel. Final Report to U.S. Fish and Wildlife Service with Supplement. 63pp.

Clarke, A.H., and R.J. Neves. 1984. Status Survey of the James River Spiny Mussel, Canthyria collina, in the James River, Virginia. Final Report to U.S. Fish and Wildlife Service. 105 pp.

Dawley, Charlotte. 1965. Checklist of Freshwater Mollusks of North Carolina. Sterkiana, No. 19, pp. 35-39.

Fuller, S.L.H. 1977. Freshwater and Terrestrial Mollusks, pp. 143-144 in Cooper, J.E., S.S. Robinson, and J.B. Funderburg, (editors). Endangered and Threatened Plants and Animals of North Carolina. Raleigh: North Carolina State Museum of Natural History.

Hynes, H.B.N. 1970. The Ecology of Running Water. University of Toronto Press. 555 pp.

Johnson, R.I. 1970. The Systematics and Zoogeography of the Unionidae (Mollusca: Bivalvia) of the Southern Atlantic Slope Region. Bulletin of the Museum of Comparative Zoology, Vol. 140, No. 6, pp. 263-449, plates 1-22.

Johnson, R.I. and A.H. Clarke. 1983. A New Spiny Mussel, Elliptio (Canthyria) steinstansana (Bivalvia: Unionidae), from the Tar River, North Carolina. Occasional Papers on Mollusks, Vol. 4, No. 61, pp. 289-298. Museum of Comparative Zoology, Harvard University.

Nielsen, A. 1950. The torrential invertebrate fauna. Oikos, 2, 177-96. 8, 11, 134, 137, 146, 156, 178.

Open University. 1983. Open Business School P670 Course Book I. Milton Keynes: Open University.

Schmitz, W. 1961. Fliesswasserforschung-Hydrographie und Botanik. Verh. int. Verein. theor. angew. Limnol. 14, 541-86, I, 7, 11, 26, 29, 34, 43, 50, 60, 73, 85, 88, 411.

Shelly, R.M. 1972. In Defense of Naiades. Wildlife in North Carolina, Vol. 36, pp. 4-8, 26-27.

Widlak, J.C. 1986. Technical Review Draft Recovery Plan for Tar River Spiny Mussel (Elliptio (Canthyria) steinstansana) Johnson and Clarke. U.S. Fish and Wildlife Service. Asheville, NC. 35 pp.

Zale, A.V., and R.J. Neves. 1982. Fish hosts of four species of lampsiline mussels (Mollusca: Unionidae) in Big Moccasin Creek, Virginia. Can. J. Zool. 60: 2535-2542.