

Reviewing the Status of Your State's Molluscan Fauna: The Case for a Systematic Approach

William F. Adams and John M. Alderman

*U.S. Army Corps of Engineers, Wilmington, North Carolina
North Carolina Wildlife Resources Commission, Raleigh*

Abstract. Prior to passage of North Carolina's Endangered Species Act in 1987, the state did not have an acceptable list of threatened mollusks because previous unofficial lists had relied only on cursory reviews of the fauna. After passage of the Act, a Scientific Council on Freshwater and Terrestrial Mollusks was established to determine which species should be listed. The Council used a systematic approach, developing a checklist of every species of freshwater and terrestrial mollusk known to occur in the state and reviewing the status of each. Through this process, the known species of concern increased markedly, and additional attention was easily focused on species of undetermined status. Widespread application of this type of process would be valuable in directing future conservation efforts.

Introduction

Many state legislatures have passed state endangered species acts within recent years. Species are supposedly placed on these lists based on the best available information. In reality, they are usually listed after contacting knowledgeable individuals who give their opinions or impressions as to what has become rare in recent years. The net effect of such an approach is that species which are not being studied or sought by these investigators will never get listed because nobody will notice ongoing population declines.

Recognizing the potential for this to happen in North Carolina, we approached the listing process in a systematic manner. A Scientific Council on Freshwater and Terrestrial Mollusks was established and was composed of persons actively involved with the study of mollusks in the state. The Council first developed a checklist of all the freshwater and terrestrial mollusks ever known to occur in North Carolina. A status evaluation was then focused on each species on the list. The State of North Carolina has responded to the efforts of the Council by officially listing all species that have been recommended. This listing process has been followed by a concerted effort to acquire more information on species distribution and status and to put quality control measures into place for future survey work. An improved database should increase the accuracy of future status assessments.

Methods

Creating the North Carolina Checklist

Given the desire for a thorough assessment of North Carolina's freshwater and terrestrial mollusks, the first task was to create a checklist of species known to occur, or to have once occurred, in the state. For vertebrates, such lists have been common for decades, but, as is typical for invertebrates, we had catching-up to do. Without such a list, certain species probably would have been overlooked, with the result that some species in need of institutional protection would not have received it. In addition, there was a desire on the part of the Council to make information on the mollusks as available to the public as it is for the vertebrates. Indeed, we knew that mollusk conservation efforts would never succeed unless this goal was met.

Compilation of the state checklist was the most difficult and time-consuming task faced by the Council, spanning about 18 months and requiring countless interlibrary loans, phone calls, and letters. The major information sources used fall into the following categories.

Literature review—A thorough review of the literature proved to be quite productive and interesting because some taxa that we had never seen in North Carolina were found to have been recorded from the state historically. Additionally, data on trends can be obtained from the literature; in many cases, evidence is given that some taxa were far more widespread and abundant in the past than they are today.

Museum records—Museum records were sought only from institutions with major holdings of North Carolina material. Gathering records from every museum with holdings from North Carolina would be a major undertaking and was not possible under the time frame in which we were operating. However, we believe that such a task would be an extremely interesting and profitable exercise and have placed it on our list of things to do.

Records of committee members—Personal collection records proved to be very valuable, providing our only records for some taxa.

Correspondence with other researchers—Certain groups are poorly published due to their taxonomic difficulty (e.g., Sphaeriidae) and, for the same reason, are frequently under-represented in museum collections. Through necessity, outside help was sought for these groups.

Throughout the list formulation process, a continual effort was required to stay taxonomically current. Much of the historical literature uses names now considered junior synonyms, making nomenclature a major concern and problem in the list making process. It was not unusual to find reference to a species being collected in the state and have only the vaguest idea using current names which species was actually found. Fortunately, for the south Atlantic slope Unionidae, Johnson (1970) provided a fairly complete listing of junior synonyms for each species, making the task fairly easy for that group.

Status Assessment

Since the Council was composed only of persons doing active research in North Carolina, we were assured that current data on stream conditions, land use, and population response would be available for consideration. Although many other researchers have worked in portions of the state in the past, conditions for mollusks have changed so rapidly that we believe only a recent working knowledge is reliable in assessing status. For information on assessing historic populations and possible causes for observed trends, outside experts were consulted as necessary.

The Council met for two days in May 1989, with each member bringing the state checklist and whatever data and reports they believed would be useful in making status determinations. Agreement on our status definitions was necessary because each person's concept of the meaning of the listing categories varied slightly. The final definitions agreed upon were as follows:

Endangered—Species in danger of extirpation from North Carolina.

Threatened—Species likely to become endangered in North Carolina in the near future.

Special concern—Species that have significantly declined or have restricted ranges in North Carolina but do not yet warrant a more restrictive status.

Status undetermined—Species that cannot be adequately assessed due to insufficient information.

Common—Species that have wide-ranging habitat in the state and that can be easily found in that habitat.

Extinct—Species no longer found in North Carolina or any other locale.

Extirpated—Species no longer found in North Carolina but still found in other areas.

Probable—Species with ranges that encompass North Carolina but not yet recorded for the state.

Possible—Species with ranges that approach North Carolina and may extend into it but not recorded in the state.

Introduced—Species imported into North Carolina that may or may not be permanently established as a part of the state's fauna.

Subcategories

Two subcategories, "restricted" and "peripheral," were established by the Council. When appropriate, these subcategories were used in conjunction with major categories to explain the placement of the taxon in that category. "Restricted" (R) refers to a species that was determined to be of concern solely because it has a very restricted range, part of which occurs in North Carolina. In instances in which additional threats to the species were identified, this subcategory was not used. "Peripheral" (P) refers to a species with a large range that occurs primarily outside of North Carolina but with a small portion of its range extending into the state. When this subcategory is used, the major category (e.g., special concern) applies only to the North Carolina portion of its range.

Once the status assessment process was completed, Council members prepared species accounts for each species listed as endangered, threatened, or of special concern, explaining the reasons for its listing. In addition, abbreviated accounts were prepared for species of undetermined status.

Results

Prior to the effort of the Council, the 1975 mollusk committee convened by the North Carolina State Museum of Natural Sciences determined that 28 species of freshwater or terrestrial mollusks were either endangered, threatened, of special concern, or of undetermined status. At the time that number seemed high, equaling roughly 10% of the state's known fauna (Fuller 1977). Today, we know that that number was, in actuality, too low. The number of species recommended for listing by the Council, excluding species of undetermined status, was 71, equaling almost one-fourth of the state's 301 known species. Breakouts for the major groups were as follows: 53% of the Unionidae, none of the Sphaeriidae, 11% of the freshwater gastropods, and 17% of the land snails. If the species of undetermined status were included in this tally, the species of concern would swell to over one-half of the state's fauna.

The following freshwater species were recommended for listing by the Council. For species of undetermined status and our assessment of the land snails, see Adams et al. (1990).

Endangered (2 snails, 11 mussels)

Gastropoda

Pleuroceridae

Goniobasis (= *Elimia*) *interrupta* (Haldeman, 1840)
— knotty elimia

Planorbidae

Planorbella *magnifica* (Pilsbry, 1903)
— magnificent rams-horn

Bivalvia — Unionidae

Ambleminae

Fusconaia *barnesiana* (I. Lea, 1838) — Tennessee pigtoe

Tritigonia *verrucosa* (Rafinesque, 1820) — pistolgrip

Elliptio *judithae* Clarke, 1986 — Neuse slabshell

Elliptio *steinstansana* Johnson & Clarke, 1983 — tar spinymussel

Anodontinae

Lasmigona *decorata* (I. Lea, 1852) — Carolina heelsplitter

Lasmigona *holstonia* (I. Lea, 1838) — Tennessee heelsplitter

Lasmigona *subviridus* (Conrad, 1835) — green floater

Alasmidonta *heterodon* (I. Lea, 1829) — dwarf wedgemussel

Alasmidonta *raveneliana* (I. Lea, 1834) —

Appalachian elktoe

Alasmidonta *viridis* (Rafinesque, 1820) — slippershell mussel

Anodonta *couperiana* I. Lea, 1840 — barrel floater

Threatened (1 snail, 12 mussels)

Gastropoda — Pleuroceridae

Leptoxis *dilatata* (Conrad, 1835) — seep mudalia

Bivalvia — Unionidae

Ambleminae

Fusconaia *masoni* (Conrad, 1834) — Atlantic pigtoe

Elliptio *lanceolata* (I. Lea, 1828) — yellow lance

Elliptio *marsupiobesa* Fuller, 1972 — Cape Fear spike

Elliptio *roanokensis* (I. Lea, 1836) — Roanoke slabshell

Elliptio *waccamawensis* (I. Lea, 1863) — Waccamaw spike

Anodontinae

Alasmidonta *undulata* (Say, 1817) — triangle floater

Alasmidonta *varicosa* (Lamarck, 1819) — brook floater

Strophitus *undulatus* (Say, 1817) — squawfoot

Lampsilinae

Toxolasma *pullus* (Conrad, 1838) — Savannah lilliput

Villosa *vanuxemensis* (I. Lea, 1838) — mountain creekshell

Lampsilis *cariosa* (Say, 1817) — yellow lampmussel

Lampsilis *fullerkati* R. I. Johnson, 1984 — Waccamaw fatmucket

Special Concern (3 snails, 10 mussels)

Gastropoda

Hydrobiidae

Cincinnatia *sp.* (Lake Waccamaw endemic)

Amnicola *sp.* (Lake Waccamaw endemic)

Ancylidae

Ferrissia *hendersoni* (Walker, 1908) — blackwater ancylid

Bivalvia — Unionidae

Ambleminae

Elliptio *dilatata* (Rafinesque, 1820) — spike

Elliptio *folliculata* (I. Lea, 1838) — pod lance

Anodontinae

Anodonta *implicata* Say, 1829 — alewife floater

Lampsilinae

Villosa nebulosa (Conrad, 1834) — Alabama rainbow

Villosa vaughaniana (I. Lea, 1838) — mountain creekshell

Ligumia nasuta (Say, 1817) — eastern pondmussel

Leptodea crocata (I. Lea, 1841) — Waccamaw lampmussel

Leptodea ochracea (Say, 1817) — tidewater mucket

Lampsilis fasciola Rafinesque, 1820 — wavy-rayed lampmussel

Lampsilis radiata (Gmelin, 1791) — eastern lampmussel

Discussion

At the end of our review process, every Council member was surprised at the number of species that ended up on the list; everyone had known the situation for our mollusks was bad but no holistic view had been available. Moreover, it became apparent for the first time that, in large measure, the mussel species of North Carolina were disappearing by genus, with *Lasmigona* and *Alasmidonta* going first, being closely followed by *Lampsilis*.

It was clear to the Council that basic population monitoring for virtually all of our species was neglected prior to 1988. Moreover, most researchers have not looked for "missing" taxa, those found in the state many years ago but which have since been unreported. The systematic process that the Council followed focused attention on these species that we otherwise would not have considered or even known to have once occurred in the state. In most cases, we were left with little choice but to list these species as status "undetermined" until more detailed surveys can be done. We expect our list of species to increase as focused research answers some of the status questions raised during our analysis. The undetermined status category alone provides enough research questions for many careers and will very likely produce most of our new listings in coming years.

During the course of the Council's deliberations, discussions migrated with great frequency to the theme of what needed to be done to make similar evaluations easier in the future. The following recommendations were made to the state as a result of these deliberations. Few have been implemented to date, primarily for budgetary reasons. However, they are offered here in the hope that they will be of use to others.

1. A comprehensive statewide mollusk survey should be performed and the habitat niches of

rare species defined. Such surveys should be performed in a systematic manner and, for terrestrial species, should be systematically directed to habitat types, defined on the basis of soils, hydrology, vegetation, elevation, etc. In addition, habitat and population monitoring that specifically targets mollusks should be undertaken. Without it, the cryptic nature of mollusks almost assures that deterioration of their habitats will go largely undetected. This monitoring should occur on four fronts: systematics, distribution, habitat quality, and population vigor. All data should be entered into a central database.

2. All surveys should be performed by experienced personnel, should address clearly defined goals and objectives, and should be designed so that results can be published. Voucher specimens should be placed in an institution where they will be properly catalogued and curated. Arrangements for curation of material should be made prior to collections.
3. A reference collection of all species of mollusks known from a state should be established and maintained within that state for the benefit of current and future researchers. This collection should include both specimens of shells and properly narcotized and preserved soft parts. Many species are taxonomically difficult, and good reference collections are greatly needed for verification of identifications. Topotypic specimens should be sought for these collections and used in the standardization of species concepts amongst investigators.
4. Future surveys of taxa with uncertain taxonomic position should require the use of molecular data as an additional character for interpretation. This information is extremely valuable as a diagnostic tool, and for some taxa, the opportunity to obtain it may last only a few more decades. Standardized techniques should be followed. Such information should be published and copies of raw data catalogued and curated with the specimens.
5. When conducting molluscan surveys for target species, collection of other nonlisted species and field notation of other listed species should be required whenever possible. This is the only way existing data gaps on species of undetermined status can be addressed in a cost-effective manner.

6. The status of every species known from the state should be periodically reevaluated. A suggested interval is once every three years.
7. When defensible data are available to show that a species has been seriously depleted, this information should be transferred to the U.S. Fish and Wildlife Service to facilitate listing on the federal endangered and threatened species list. Federal listing could provide additional protection and, potentially, additional funding for research and conservation efforts.

Implications for Future Action

Temporal patterns of human settlement and activity are frequently neglected in assessing the long-term viability of endangered species populations. It is an undeniable fact that ownership of all privately owned property will eventually change, if for no other reason than that the existing property owners will eventually die. New property owners have their own goals for their newly acquired land, and these may vary dramatically from those of the previous owner for both personal and economic reasons. The changes wrought on the presettlement landscape by the cumulative effects of such simple property transfers has been profound.

As long as our society persists in property transfers, yet does not modify its views of property rights to include mandated ecosystem rights or landscape habitat goals, fragmentation of the landscape will almost certainly continue and with it resources of concern will certainly decline. That our human population continues to increase only exacerbates this situation as the landscape will be further dissected to satisfy the demands of more people. Given this statistical inevitability, only two viable conservation avenues are left open to us today—either acquire important lands to cease the cycle of property transfer or change our uniquely western view of property rights to include ecosystem rights.

To date, only one significant attempt has been made to limit property rights for the benefit of wildlife—Section 9 of the Endangered Species Act. This section of the Act, which prohibits the taking or harming of a listed species or its habitat, has met with substantial opposition from property owners who believe that their right to manage their property as they desire has been impaired. This is currently a contentious issue, and a political resolution that restores lost rights to property owners is not out of the question. Indeed, this may well be one of the most important conservation debates leading into the next century. Because there are no prospects for

any other legislation restricting property rights for the benefit of natural ecosystems on the horizon, we are left with the inescapable conclusion that, for the time being, our legal concepts of property rights will remain unchanged. Recognizing that many species will not survive long enough for our views of property rights to evolve to a more earth-friendly plane, we are left with only one viable option today—land acquisition. Unfortunately, for lotic ecosystems this is not an easily implementable option because entire watersheds might have to be acquired. Therefore, for the present, we will have to continue our reliance on increasingly complex and piecemeal regulation, a situation abhorrent to almost everyone.

This is not an encouraging prospect. Since passage of the National Environmental Policy Act of 1969, the Clean Water Act of 1972, and the Endangered Species Act of 1973, one would believe that we have sufficient tools available to protect our molluscan fauna. Sadly, for our molluscan fauna these laws have created a barren tree—lots of wood but little fruit. Most of this fauna has continued to decline. Clearly, our current protection efforts and management systems are not working on a landscape scale and radical changes in approach are needed. However it is accomplished, sound, comprehensive inventories of species with reliable documentation of population changes will almost certainly be necessary to overcome the legislative and bureaucratic inertia we have inherited and unwittingly fostered.

A systematic approach to species assessment provides our best chance of truly conveying to those in power what has happened to our freshwater ecosystems. Indeed, this concept should be expanded beyond the mollusca to include crustaceans, rotifers, poriferans, bryozoans, and all of the other freshwater invertebrates. Prejudices against doing this will abound, particularly for parasitic species, a group important in contributing many of the selective pressures which steer the course of evolution. As scientists, we cannot afford to wear any shrouds of bias; to do so will be certain to raise ethical questions which we will find ourselves ill-equipped to answer.

In protecting and managing our molluscan fauna and other aquatic species, influencing the actions of our fellow citizens will be our most difficult conservation challenge. Evidence indicates that our society and political hierarchy are fickle partners in conservation efforts, supporting those efforts with obvious and quick benefits while hedging when the fruits of such labors are hidden, silent, or too-long in the making. Conservation of freshwater mussels, which bear all of these unfortunate attributes, will almost certainly continue to be a

low priority item on the social agenda of our nation.

For the conservation of freshwater mussels and other invertebrates to ever become ingrained in our social will, a higher reach from our public educators and a greater dose of fervor on the part of those who understand its importance will be required. Yen and Butcher (1992) provide a good summary of the issues and needs for invertebrate conservation in today's political climate and stress action on four fronts: education, legislation, research, and administration. Our generation can ill-afford to wait any longer for decisive action on all four. The potential fruits of our labors slip away with the time — with each passing year we are working for less and less. "Progress" has claimed many species already, and the cost of their passing to us and our children can never be known.

Literature Cited

- Adams, W.F., J.M. Alderman, R.G. Biggins, A.G. Gerberich, E.P. Keferl, H.J. Porter, and A.S. Van Devender. 1990. A report on the conservation status of North Carolina's freshwater and terrestrial molluscan fauna. North Carolina Wildlife Resources Commission, Raleigh. 251 pp. + appendix.
- Fuller, S.L.H. 1977. Freshwater and terrestrial mollusks. Pages 143–194 *in* Cooper, J.E., S.S. Robinson, and J.B. Funderburg, eds. Endangered and threatened plants and animals of North Carolina. North Carolina State Museum of Natural History, Raleigh. 460 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* 140(6):263–449.
- Yen, A.L., and R.J. Butcher. 1992. Practical conservation of non-marine invertebrates. *Search* 23(3):103–105.