Information Networking and the Conservation of Freshwater Mussels

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Abstract. In the eastern United States, a major and expanding focus of The Nature Conservancy's protection work, in partnership with many other agencies and organizations, is the protection of riverine ecosystems (e.g., Clinch River, Big Darby Creek, Horse Lick Creek, Neversink River, and French Creek), especially their freshwater mussel faunas. The impetus and information needed for the Conservancy to work to protect these places is provided in part by a rapidly expanding body of knowledge stored in the Biological and Conservation Data System files of the Natural Heritage Program Network. But there are still enormous gaps in our knowledge. This paper is a call for help in researching these knowledge gaps and helping to further develop distributed databases of information on freshwater mollusks. Any hope of success in our protection efforts relies upon the collection, management, and exchange of regularly updated information about mussels and their habitats: status and trend information; precise distributions; ecology; protection, management, monitoring, and research needs, programs, and procedures; and local, site-specific information relating to mussel population demographics and viability, threats analysis, and land ownership.

The Nature Conservancy and Its Need for Conservation Information

For more than 40 years The Nature Conservancy has worked to conserve biological diversity. The Conservancy's roots lie with the Ecological Society of America, which in 1917 formed a committee to assess the status of ecosystems and biodiversity in this country. After several transformations, this committee eventually became incorporated as The Nature Conservancy. Along the way, a product of the Committee's work was the Naturalist's Guide to the Americas, an amalgamation of scientists' nominations of the best remaining natural areas in the country.

Early in its history, the Conservancy realized that it needed much more scientifically rigorous information than this report or the natural area nominations of others if it was to efficiently pursue its mission to conserve biological diversity. Conservancy staff then and now wanted to ensure that scarce funds available for the protection of lands and waters were directed to the most critical places, those places harboring the best remaining ecosystems and the highest concentrations or only remaining occurrences of rare and endangered species. Unfortunately, until relatively recently there were no centralized repositories for well-organized, easily accessible, up-to-date information on the locations and condition of species and ecosystems of conservation importance. Many basic questions required answers that weren't readily available, including:

- What are the species and natural communities or ecosystems that constitute biodiversity?
- What is the global, national, and state status of each of these species or ecosystems, the "elements" of biodiversity? In other words, how rare are these elements?
- Where precisely are the best remaining examples of these elements located on the landscape? In other words, where are the "element occurrences"?
- What is the condition of each of these element occurrences? Which occurrences are the best and most viable? Which occurrences should be protected first?
- What are the biological and physical requirements of the individual elements?
- How many areas and which areas of what size and configuration and connectivity are needed to provide long-term protection for a given element?
- How large an area is needed to provide long-term protection for a particular occurrence of a particular element?
- Who owns the land and water where each of these occurrences is located?

- Is the land or water being properly managed to maximize the chances that the elements will not go locally extinct?
- How does one manage a piece of land or water for the elements of biodiversity that are found therein?
- What are the economic uses of that land or buffer to that land or water that are compatible with the conservation of biological diversity?
- What are the threats or stresses on these element occurrences, what are the sources of the stresses, and how does one address these threats?
- How does one best monitor species and communities?
- How does one assess the results of actions undertaken to protect and manage elements of biodiversity?

Without answers to questions such as these, it is difficult to imagine how the loss of biodiversity can be minimized. And, perhaps even more importantly, it is necessary to determine how to track the answers to all these questions and communicate the answers to all who might make use of them to avoid acting in ignorance, avoid redundancy of effort, avoid the misapplication of scarce conservation resources, and avoid misinformed attempts to conserve individual species and communities of species.

Biodiversity Data Network

To help meet these information needs, the Conservancy has worked with state governments for almost 20 years to establish permanently operating data centers to continually amass, organize, analyze, and update biodiversity and related conservation data. There are currently 85 of these data centers, typically known as Natural Heritage Programs or Conservation Data Centers, operating in all 50 states, 4 Canadian provinces, and 13 Latin American countries. Most of these data centers are independent of The Nature Conservancy: 84% of the U.S. centers are housed in government natural resource agencies, 12% are housed in public universities, and only 4% are housed and operated by The Nature Conservancy. But all of these programs work in collaboration with the Conservancy so that the benefits of functioning as a network can be realized. The Conservancy serves as the principal network organizer and provides various services to the network's individual data centers, including development of standard methodologies, software development, compilation and dissemination of information, training, technical and financial support, and information exchange. This is accomplished with the aid of the Biological and Conservation Data System, a set of more than 30 interrelated computer files, supported by extensive map and manual files, that is used by almost all data centers.

The primary purpose of these natural heritage or conservation data centers is to compile and make information on biological diversity available for conservation and development planning, impact assesments, natural resource management, and scientific research. Network participants log in over 200,000 data requests annually in response to a myriad of requests, mostly relating to conservation planning and environmental review. The Conservancy's land and water protection agenda derives almost entirely from information available through the Natural Heritage Program Network. The need for reliable, centralized, readily-disseminated, up-to-date information cannot be overemphasized. Without good science that addresses key conservation information needs, and without making that information readily available to all who might make intelligent use of it, conservationists will be inefficient and ineffective in their attempts to conserve biological diversity.

Information Available and Information Needed for Mussel Conservation

So what is known and what needs to be known in order to permit intelligent, informed decisions regarding the conservation of mussels and their habitats? There are at least five basic questions that require answers.

1. What are the species that we are trying to conserve?

If the first precaution of intelligent tinkering is "to keep every cog and wheel" (Leopold 1953), we have to define the cogs and wheels — the species. The taxonomy and nomenclature of mussels is as contentious an area of investigation as any in systematic zoology. The publication by the American Fisheries Society of a standard names list for mollusks four years ago (Turgeon et al. 1988), whether one agrees with its nomenclatural and taxonomic positions or not, at least provides a much-needed standard set of names to which mussels and data about mussels, including synonyms, may be attached. This publication should also be an additional stimulus to do and to fund much-needed taxonomic research. Systematists and museums need to be supported to do the research necessary to define the cogs and wheels—to ensure that mussels are not being lost simply because they are going extinct before they are recognized as distinct taxa. Randy Hoeh's research on the genus *Anodonta* species (Hoeh 1990) and Margaret Mulvey's work (this symposium) on South Carolina

Elliptio are recent examples of the type of research that needs to be encouraged and funded before it's too late.

2. Which species are in greatest need of our attention?

Setting priorities for conservation actions (e.g., "ranking") is a necessary preoccupation of organizations and agencies concerned with the conservation of species and ecosystems. The conservation ranking system used by Biodiversity Data Network participants has evolved over many years, but the basic tenets of the system have essentially remained unchanged for the past 10 years. Network participants assign "element conservation priority ranks" on a 1 to 5 scale to plant and animal species and natural communities alike. These continuously refined and documented ranks are based on the number of occurrences, population size, range, and trends in these factors, as well as threats, fragility, and other considerations that are all documented in regularly updated databases (Master 1991). By way of comparison, the globally imperiled *Alasmidonta heterodon* (dwarf wedge mussel) currently receives a global rank of G1; the globally rare but not yet critically imperiled *Alasmidonta varicosa* (brook floater) currently receives a global rank of G3; and the common and demonstrably secure *Elliptio complanata* (eastern elliptio) currently receives a global rank of G5. Analogous ranks are also assigned at the national and state levels. At the state level, the criteria used to assign state ranks typically include the same criteria that are used to assign official state endangerment status.

It is readily apparent that mussels are in enormous trouble relative to any other group of organisms for which we have comparable data (Table 1). For groups of organisms that are largely land-based, the percentage of the fauna that is extinct or imperiled (rank = GX–G3) is typically 11–14%; for amphibians and fishes, the percentage jumps to 28–34%; and for mussels the percentage jumps to 73%. It is this information that has pushed the Conservancy beyond its historical focus on land conservation to enter the difficult arena of riverine conservation. Clearly, riverine fauna are in trouble in this country, if not around the world. And this loss is accelerating.

The ranking information for mussels derives from 150 years of data stored in museum collections and the more recent efforts of many field workers. Over the past 10 years, a number of malacologists have generously given of their time, sometimes aided by some modest funding from the Conservancy, to help prioritize mussel species. However, there are still enormous gaps in the collective knowledge base of the status of these species. Assistance is sought to help refine this status information.

3. How do we identify and prioritize those areas where we should be focusing our efforts to conserve mussels and associated riverine biota?

The Conservancy and the Biodiversity Data Network take what has been characterized as a coarse filter–fine filter approach to identifying and conserving biological diversity. The coarse filter consists of the best examples of every community or ecosystem type, the protection of which has been estimated to potentially protect, in the absence of global climate change and zebra mussels, 80–90% of an area's (e.g., state's) natural biological diversity. But rare species aren't always reliably found in the habitats or communities where one might expect to find them—they're just too rare. So Network participants inventory separately for rare species and work to protect them as well. This is the fine filter. Unfortunately, there is not currently a good national classification and inventory of the best examples of riverine systems in this country, and so only the fine filter is available to help identify streams that should be protected. Knowledge of the fine filter, the rare biota, in riverine systems is confined largely to

Table 1. Status of selected animal groups in the United States (taken from Master 1990).

Status	Mammals	Birds	Reptiles	Amphibians	Fishes	Crayfishes	Unionid mussels
GX	1	20	0	3	18	1	12
GH	0	2	0	1	1	2	17
G1	8	25	6	23	78	62	88
G2	23	9	10	17	72	49	49
G3	19	23	25	26	110	84	35
G4-G5	330	628	251	153	549	106	73
G?	62	55	9	3	24	9	26
Total	443	762	301	226	852	313	300
% of total = GX–G3	13	11	14	28	34	65	73

GX = extinct; GH = historical (may be extinct); G1 = critically imperiled; G2 = imperiled; G3 = rare; G4, G5 = relatively secure; G? = unranked.

mussels, crayfishes, and fishes. Consequently, these groups must serve as the primary surrogates for the biodiversity of riverine systems. The Natural Heritage Network is incrementally developing comprehensive information on other groups such as aquatic gastropods and insects such as Plecoptera.

To begin to conserve mussels, one must know where they are located. The obvious informational need is to conduct prioritized surveys and to ensure that the results of those surveys are incorporated into databases that are available for and conducive to conservation planning. Maintaining such continuously updated and incrementally refined data files and map or GIS files that track this "occurrence" information, and related information about threats and land ownership at the sites of these occurrences, is the bulk of what natural heritage programs do. As previously discussed, the purpose of this activity is to make the information widely available for conservation planning, environmental assessment, research, and iterative reconsideration and updating of the global, national, and state priority ranks.

The information on occurrences of rare mussels that is currently stored in natural heritage data files in state agencies has led the Conservancy to develop a national riverine conservation program that targets those riverine systems that are currently known by the Conservancy to have the greatest diversity of rare species and for which there is some reasonable chance of success. Riverine systems that the Conservancy is currently working to protect, in concert with many partner organizations and agencies, include the Clinch River in Virginia and Tennessee, Big Darby Creek in Ohio, Fish Creek in Indiana and Ohio, Horselick Creek in Kentucky, French Creek in Pennsylvania and New York, the Neversink River in New York, and Sideling Hill Creek in Maryland and Pennsylvania. These are all good projects and each represents a significant segment of the biological diversity of riverine systems, but they are certainly not the only systems that the Conservancy should be working with others to try to protect.

There is an obvious need to ensure that as much as possible of the full array of biotic diversity in riverine systems is being protected. The Conservancy is currently pooling range-wide heritage occurrence data for rare mussels, crayfishes, fishes, and other riverine animals to try to identify other areas where the Conservancy and others should be focusing resources. The Conservancy is also conducting a "gap analysis," in cooperation with the U.S. Fish and Wildlife Service and the Environmental Protection Agency, in which the known *and* probable occurrences of mussels will be assembled into a GIS for analysis. But there will be many gaps in the results of these analyses because, for whatever reasons, mussel occurrence information is not getting into natural heritage databases in some states. Persons conducting inventory work on mussels need to correct this situation by providing survey information to natural heritage databases and encouraging them to process the information and to help fund or to seek funding for additional surveys.

4. Once we know what they are, how rare they are, and where they are, how do we conserve mussels? What do we know and what do we need to know about mussels and the systems they inhabit in order to preserve them?

There is an obvious need to know a lot more than is currently known—about individual species' life histories and sensitivities to various pollutants and water flow regimes, about sources of stress to riverine systems, etc.

But ignorance can't be a bar to action, and so The Nature Conservancy has recently undertaken strategic planning exercises for each of the riverine and other landscape-level conservation projects like that for the Clinch River. The assistance of mussel and other experts is needed in this process—both to help ask the right questions and to research the answers.

The plight of native mussels needs to be publicized—not only what is happening to mussels but also reasons why it matters. To quote Harvard biologist Edward O. Wilson:

> The truth is that we need invertebrates but they don't need us. If human beings were to disappear tomorrow, the world would go on with little change. . . . But if invertebrates were to disappear, I doubt that the human species could last more than a few months. Most of the fishes, amphibians, birds and mammals would crash to extinction about the same time . . . [followed by] the flowering plants . . . and the world would return to the state of a billion years ago (Wilson 1987).

The loss of freshwater mussels is itself sufficient reason for widespread alarm. But as was pointed out in a recent issue of *The Amicus Journal*, the numbers of imperiled mussels point to a hazard broader than the loss of any one species: "a widespread decay in the health of the streams, rivers, lakes, and wetlands that sustain the ecology of this continent" (Natural Resources Defense Council 1992).

5. How do we efficiently gather and exchange information to facilitate the conservation of mussels?

Can information be efficiently gathered and exchanged so that all can benefit from an accumulated knowledge base that tracks information and information gaps on topics such as species' life histories, including host fishes; monitoring, management, and research needs, procedures, and programs; sensitivity of different species to different pollutants resulting from chemical and agricultural runoff; sensitivities to sediment loading and other perturbations; protection tools; model state riverine and endangered species protection legislation; and government programs that can aid in conserving riverine systems?

Part of the answer is certainly to hold more forums like this one for information exchange. In a similar vein, some 30 persons convened in Washington last November to discuss the status of freshwater mussels of the Atlantic slope. And in three months (January 1993), Conservancy and U.S. Fish and Wildlife Service staff and others involved in the conservation of the half-dozen or so previously listed riverine systems will gather in Lexington to exchange ideas and share experiences related to protecting riverine systems.

Another part of the answer, although a widely unappreciated part of the answer, is the necessity to incrementally develop an accessible and widely distributed base of knowledge about the taxonomy, status, trends, locations, conditions, and biological and physical requirements of mussels; about threats to mussels; and about management, monitoring, and research needs, procedures, and programs for mussels. If the collective mussel knowledge base, including all of the mostly gray literature and reports, could be efficiently assembled and abstracted, scarce resources could more efficiently and effectively be directed to the conservation of freshwater mussels.

The Biodiversity Data (Natural Heritage) Network has come a long way in developing just such an information base, thanks in part to the collective efforts to date of 50 state agencies and their respective conservation data centers, and cooperating agencies, organizations, and individuals. But there is a long way to go. Contributing to the Natural Heritage Network's databases will facilitate the incremental development and exchange of information pertinent to and necessary for the conservation of mussels.

Finally, given that failure is likely in the near-term conservation of some mussel species, research must be supported that will permit the propagation and maintainance of mussels in captivity so that they can be eventually reintroduced or introduced into areas when and where pollution, habitat destruction, zebra mussels, and global warming are less significant threats.

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