Protocol Development of a Seasonal Survey of Small-Stream Freshwater Mussels

Submitted by G. Dennis Campbell, 29 June 1998

INTRODUCTION

Project Justification

It is generally believed by scientists today that humans are responsible for destroying species and ecosystems faster than nature can create new ones to replace them. Smithsonian Institution biologist Jonathan Coddington calls this running on a "biodiversity deficit."

Freshwater mussels are one of the most endangered groups of animals in North America. Ten percent of North America's native mussel species have gone extinct since 1900. According to the American Fisheries Society, 281 species and 16 subspecies remain, of which more than 72 percent are considered endangered, threatened, or of special concern and 19 percent are on the federal Endangered Species List.

A recent publication by Kevin S. Cummings and Christine A. Mayer (1997; Distributional checklist and status of Illinois freshwater mussels [Mollusca; Unionacea]; in *Conservation and Management of Freshwater Mussels II: Initiatives for the Future*) examined museum collections for records of freshwater mussels from Illinois and revealed that 80 species occur in the state, of with 6 are thought to be extinct, 11 have been extirpated from Illinois, 5 are federally endangered, 7 are former Federal Candidate species, 8 are state endangered, 4 are state threatened, 9 are species of special concern in Illinois, and 3 are considered uncommon or limited in distribution; leaving only 27 species that have relatively stable populations at this time.

The Cummings and Mayer paper lists 47 freshwater mussel species found in the Sangamon River Drainage of Illinois, of which only 34 have been found alive post-1969. A review of the Illinois Natural History Survey Mollusk Collection Database reveals 23 species that have been collected from Sugar Creek of the Sangamon River Drainage and incorporated into this governmental collection. There was no indication of which species were collected alive or which ones are represented by dead shells only.

Freshwater mussels fill an important niche in aquatic ecosystems in Illinois, serving as food for many species of Illinois riparian wildlife and helping to clarify water by concentrating impurities in their shells and soft tissues. Also, because of their filter-feeding habit, they serve as good indicators of water quality in the rivers and streams of the state. Although most of the decline of freshwater mussels can be attributed to a variety of factors acting together, habitat loss and degradation is implicated in the vast majority of the declines, extirpations, and extinctions, according to an American Fisheries Society study.

Freshwater mussels are particularly susceptible to physical changes of stream flow such as caused by barriers, canals, dams and channels, sediment input, and temperature extremes; and to pollution inputs of sewage, agricultural organic enrichments, and chemical toxics from municipalities, agricultural fields, and industries along the course of the streams. Recent reports of the U.S. Environmental Protection Agency identify nonpoint source pollution as the principal water quality problem in the United States. Such pollution is defined as precipitation-driven stormwater runoff generated by land-based activities such as agriculture, construction, mining, and silviculture. Central Illinois is considered by the Soil Conservation Service as having high potential for general agricultural nonpoint source pollution of surface waters, with particular problem areas being in pesticides, nutrients, sediments, and salinity. Despite many years of toxic chemical regulation in the United States, vast quantities of pollutants are still being introduced into the streams every year, and old toxics still remain in eroded sediments.

In addition, introduced, or "exotic," species may compete for food and breeding spaces and also introduce new diseases. Inadvertently introduced in 1987 into the Great Lakes from ship ballast water, the Zebra Mussel has spread to most major rivers and lakes in Central United States and some scientists predict that the mussel species may colonize virtually all freshwater systems in North America within 10 years.

Much of today's streams in the United States differ significantly due to long-term and short-term environmental fluctuations because of the effects of modern development. Some researchers have suggested that many freshwater mussel species very in abundance with changes in stream size, water depth, current velocity, and substrate composition. Both macrohabitat and microhabitat descriptors have been proposed to predict the distributions of freshwater mussels, but for the majority of these studies subjective assessments of mussel habitat use were made rather than more rigorous quantitative measurements.

In the United States, only 2 percent of the country's 8.2 million miles of rivers and streams remain free-flowing and undeveloped. Of the state's 32,190 toal stream miles, less than half are monitored by state agencies for any type of aquatic activity each year. The vast majority of small-stream habitats of Illinois freshwater mussels are under private ownership, with little or no information being made available on the status of and changes to the individual populations of these animals. Partnerships between public and private entities with mutual goals of understanding, protecting and enhancing the quality of small-stream habitats are desperately needed.

Integrated, stream ecosystem management approaches to problem-solving and decision-making are desperately needed in the state. Most previous attempts at ecosytem-based management have focused on specific areas already badly degraded. Although such efforts at "crisis management" are necessary, perhaps there is a greater need for predictive and preventative management rather than reactive management.

Project Historical Perspective

William C. Starrett (1971; A Survey of the Mussels [Unionacea] of the Illinois River: A Polluted Stream; Illinois *Natural History Survey Bulletin* 30(5):267-403) conducted a survey of pearly mussel populations of the entire Illinois River to " formulate a sound basis for managging the mussel resource of this river, and to determine what species and distributional changes had taken place during the past century." Starrett's survey was conducted in 1966 with a total of 429 sampling collections for live mussels. In these collections, live mussels were taken primarily by an exploratory type of crowfoot bar (brail) and a mussel dredge and by hand collecting at specific known former and existing mussel beds and any other habitats appearing to be the best for mussels. This sampling method provided information on species representation (a species list), species richness (number of different species found), relative species abundance (number of individuals collected for each species), relative species density (known dredge width and distance traveled providing the number of individuals within a species per acre), standing crop (known density and live weight providing pounds of live mussels per acre), and site physical and chemical distribution, as well as a station-by-station listing of all mussels collected in the Illinois River by navigation pool and river section. The Starrett study resulted in 4,247 living specimens representing 24 species. The 10 most common living species collected (in order, most common first) were *Amblema plicata* (62.4 perceint), *Quadrula pustulosa*, *Quadrula quadrula*, *Megalonaias gigantea*, *Anodonta (Pyganodon) grandis*, *Arcidens confragosus*, *Quadrula nodulata*, *Leptodea fragilis*, *Lampsilis anodontoides* (*teres*), and *Obliquaria reflexia*. Starrett sought to compare the river's existing mussel populations with those reported by earlier researchers.

For such a comparison, Starrett compiled museum records from 1870-1900 to discover that at least 38 different kinds of mussels were known in the upper river (Starved Rock and Marseilles navigation pools) during that period. He reported that by 1912, pollution had virtually wiped out the mussels in that section with his 1966 survey indicating no living mussels taken there. Further, his study reported that even in the lower river, 21 kinds of mussels had been extirpated in the 75 years preceding 1966.

Robert W. Schanzle and Kevin S. Cummings (1991; A Survey of the Freshwater Mussels [Bivalvia: Unionidae] of the Sangjamon River Basin, Illinois; *Illinois Natural History Survey Biological Notes* 137) sampled 57 stations in the Sangamon River basin during the summers of 1987-1989 for a total of 228 man-hours for their initial sampling and another 8 man-hours at two additonal locations. They collected mussels by hand for four man-hours at each station, while making an effort to sample all available habitats and substrate types. This sampling method provided species representation, species richness, relative species abundance, abundance ranking, and percent composition of the mussel species collected, as well as a station-by-station listing of all mussels collected in the Sangamon River mainstem and tributaries. The Schanzle and Cummings study resulted in 2,083 living specimens (average of 37 -- range of 0-178 -- at each station) representing 33 species (average of 7 -- range of 0-17 -- at each station). Four additional species were represented by dead specimens only. The 10 most common living species collected (in order, most common first) were *Lampsilis cardium* (11.95%), *Lasmigona complanata*, *Leptodea fragilis*, *Anodonta (Pyganodon) grandis*, *Amblema plicata*, *Lampsilis teres*, *Quadrula pustulosa*, *Potamilus ohiensis*, *Fusconaia flava*, and *Pleurobema sintoxia*. Four of their stations (31, 32, 33, and 34) were found on Sugar Creek "north." Taken as a whole, there were 82 living specimens representing 14 living species and 2 species represented by dead individuals found at these four stations. *Leptodea fragilis* (26.8%) and *Lampsilis teres* were the most common species for these combined stations. None of Illinois' endangered, threatened, or watch list species were found at these stations by Schanzle and Cummings. Schanzle and Cummings' Station 33 (a convenient station to make comparisons with the present study) yielded 24 living specimens representing 10 living species and 3 species represented by dead individuals. *Leptodea fragilis* (37.5%) and *Strophitus undulatus* were the most common species at this station. Schanzle and Cummings' Station 32 (a convenient station to make comparisons with an historical study completed by Matteson [see below]) yielded 34 living specimens representing 10 living species and 2 species represented by dead individuals. *Lampsilis teres* (23.5%), *Lasmigona complanata*, and *Leptodea fragilis* were the most common species at this station. Schanzle and Cummings stated in their report, "It was hoped that this work would accurately gauge the health and distribution of existing mussel populations, as well as any recent increases or decreases in species richness." They sought to compare the river's existing mussel populations with those reported by earlier researchers.

For such a comparison, they reported the unpublished observations of M. R. Matteson who in 1956-1960 sampled many of the same stations. Neither Matteson's sampling methods nor his unit effort of search were reported. His study resulted in 2,989 living specimens (average of 77 -- range of 0-357 -- at each station) representing 32 living species (average of 6 -- range of 0-17 -- at each station). Each of the 32 species collected by Matteson during 1956-1960 was also collected by Schanzle and Cummings in 1987-1989. The 10 most common living species collected in Matteson's study (in order, most common first) were *Quadrula pustulosa* (15.26%), *Amblema plicata*, *Anodontoides ferussacianus*, *Lampsilis cardium*, *Pleurobema sintoxia*, *Leptodea fragilis*, *Lasmigona complanata*, *Fusconaia flava*, *Anodonta (Pyganodon) grandis*, and *Quadrula quadrula*. Matteson's Station (32) was found on Sugar Creek "north" and yielded 210 living specimens representing 12 live species and 1 species represented by dead individual(s) found at this station. *Lampsilis teres* (32.86%), *Lampsilis cardium*, *Amblema plicata*, *Lasmigona complanata*, and *Quadrula pustulosa* were the most common species at this station. None of Illinois' present endangered, threatened, and watch list species were found at this station by Matteson.

Few, if any, of these previous studies have focused on establishing a long-term protocol for monitoring seasonal and yearly changes in the populations of the mussels. The previous studies sited above consisted primarily of qualitative collections by handpicking, shore-line collections of dead shells, and brailing. These methods are adequate in the description of species assemblages and do provide information of relative abundances; however, they are not adequate in the description of productivity, density, recruitment, or quantitative changes in the populations. Sampling studies using linear transects or defined area quadrats do, however, provide data that can

express results as density per unit area, a true quantatative description. Quantitative sampling requires that a defined area quadrat be used and assumes that an adequate number of samples are taken. Studies that provide true quantitative data on small-stream mussel species are virtually nonexistent.

The present project sought to establish and document a protocol of using easily accomplished bank surveys of dead mussel shells and stream bottom grabbing of live mussel shells to establish qualitative information on small-stream populations. In addition, more time-consuming quadrate quantitative sampling was included in the protocol and correlated with the qualitative surveys. The entire protocol was used by volunteer college students under the direction of a college professor and a student intern to document the seasonal occurrence and abundance of freshwater mussel species at a site under private ownership in the Salt Creek-Sangamon River drainage of Logan County. In addition to supplying discrete data for rare and possibly threatened or even endangered species in this particular drainage, it is believed that such a protocol could be used effectively in other small-stream habitats throughout Illinois under public or private ownership.

PROPOSED PROJECT OBJECTIVES

Objective 1

An initial primary objective of the project was to establish two permanent freshwater mussel research study sites on private property owned by Lincoln College and to provide topographical and environmental information that can be used for the present freshwater mussel project and future studies. This information would be utilized in the planned video and written products of the research project.

Objective 2

Another primary objective of the project was to establish and record a protocol for monitoring the qualitative and quantitative composition of freshwater mussel populations in small-streams. This protocol was to be recorded in both a written and videotaped form to be accessible to future researchers.

Objective 3

Another primary objective of the project was to have volunteer college students under the direction of a college professor and student intern use the monitoring protocol to survey the freshwater mussels of research sites on Sugar Creek and Kickapoo Creek of the Salt Creek-Sangamon River drainage system four times during the year to reflect any seasonal changes. Information would be obtained from dead mussel shells on the occurrence and assemblages of specific species along the drainage system and from live specimens on the diversity, relative abundance, distribution, substrate use and preferences, and density of specific species at the two mussel research sites. This information would be compared with previous studies on freshwater mussels in the drainage system to detect any changes that have occurred over the last 10 to 30 years.

The results of the qualitative and quantitative studies will be published in a research journal. It is hoped that information from the use of such a protocol can be used in future years to detect any trends in the status of the drainage system's freshwater mussel populations in the hopes of assessing the potential threat of any internal or external factors on these populations. It is also hoped that the video can be used in enlisting the participation of private landowners in any necessary recovery strategies of threatened or endangered freshwater mussel spec in small-stream habitats on their property in the state.

PROJECT LOCATION

The Illinois River flows more than 800 miles between Chicago on Lake Michigan to the Mississippi River just above St. Louis and has a watershed drainage that includes over half of the state. The major rivers of this watershed include Des Plaines River, Du Page River, Kankakee River, Fox River, Spoon River, and Sangamon River. In the early 1900s the river was one of the most productive mussel streams per mile in the United States, with over 2,600 mussel-fishing boats floating the river in 1910 alone. With the openning of the Sanitary and Ship Canal at Chicago in 1900, a significant volume of water was diverted down the river from Lake Michigan. Through the years, dumping of sewage and industrial wastes, development of drainage and levee districts, building of navigation dams, and increased deposition of sediment have irreversibly diminished the health of the river, its water, and its wildlife.

The Sangamon River Watershed is the largest tributary watershed of the Illinois River. It originates as field tile drainage about one-half mile north of Ellsworth in McLean County and flows more than 240 miles in a broad curve before emptying into the Illinois River near Beardstown. The river has a watershed drainage basin of 5,400 square miles through 16 Illinois counties. Salt Creek and South Fork are the largest tributaries. Among the artificial changes of this river include channelization to reduce speed drainage and reduce the frequent flooding; damming to create community impoundments for water supplies, power plant cooling, and recreational use; and receipt of water effluents generated by industries, municipalities (sewage outputs and urban runoff), agriculture, and oil field drainage.

Salt Creek and its tributaries of the Sangamon River Watershed have a total of 651 stream miles and covers a total of 1,840 square miles. The major streams of this watershed include Salt Creek, Sugar Creek, Lake Fork, and Kickapoo Creek. The largest cities in the watershed are Bloomington and Lincoln. The overall resource quality is "good" on 392 stream miles (60%) and "fair" on 259 stream miles. Nutrients from agricultural runoff and muncipal point sources are the primary causes of water quality problems.

Sugar Creek of the Salt Creek Watershed has 61 stream miles, originating in tributaries at and just west of Bloomington in McLean County, passing through Logan County and converging with Salt Creek just in the west boundary of Menard County. The primary cause of pollution is siltation from agriculture. Mussel Research Site Number 1 (SU1 and SU2) consists of an approximately half-mile stretch of Sugar Creek of the Salt Creek-Sangamon River drainage system, adjacent to intensively farmed land owned by Lincoln College, approximately 5 miles north of Lincoln, Illinois, in Logan County (T.21N - R.3W, Section 36).

Kickapoo Creek originates in tributaries just east of Bloomington in McLean County, Illinois, passes near the town of Lincoln, Illinois, and converges with Salt Creek just west of Lincoln in Logan County. Mussel Research Site Number 2 (KI1) consists of an approximately quarter-mile stretch of Kickapoo Creek of the Salt Creek-Sangamon River drainage system, adjacent to moderately-to-intensively farmed land owned by Lincoln College, approximately 4 miles north-northeast of Lincoln, Illinois, in Logan County (T.20N - R.2W, Section 6).

PROPOSED PROJECT METHODOLOGY

Objective 1

Two mussel research sites will be established on property owned by Lincoln College. The sites will be delineated on topographical maps. Aerial color photographs will be taken of each research site in August and compared with the new land cover database of Illinois, already available from satellite imagery, in order to document land usage at and near the sites and to provide a base record of the physical parameters of the sites. Physical, chemi-

cal, and biological water tests will be conducted at the sites at the inception of the project in August and during subsequent visits in order to document environmental habitat changes.

Objective 2

A student intern from Lincoln College will be interviewed and hired to assist in the research project. Mr. Kevin Cummings of the Illinois Natural History Survey and Dr. Robert Warren of the Illinois State Museum will be consulted in the initial development of survey protocols sufficient for the collection of data. Visits in August and September to each institution for personal consultations and collection reference are expected during the project. Shells of freshwater mussel species previously collected in the county will be used to establish a reference collection at Lincoln College for identification purposes. The specimens in the collection will be video taped to illustrate the identifying external and internal shell characteristics of each species likely represented at the site. Using volunteer college students, the preliminary version of the protocol will be conducted and video taped at one of the proposed research sites during one day during the first week in September. This study site will be on Lincoln College property along Sugar Creek with the specific area being chosen that would include diverse substrates. There will be four steps in the day's survey Protocol.

The first step will include documentation of several specific physical, chemical, and biological parameters of the site: including stream width, depth, and velocity; substrate composition using sorting sieves; water color and odor; riparian vegetation; water and air temperatures using thermometers; and dissolved oxygen, pH, alkalinity, nitrates and phosphates using Hach water quality test kits.

The second step will consist of a timed search (4 persons simultaneously searching for 30 minutes each) for dead freshwater mussel shells along the banks and in the gravel and sand bars of the creek at the study site. These shell remains will be collected and later returned to the lab, cleaned, labeled, identified to species level, valves counted, and deposited in the Lincoln College's reference collection. This preliminary search will provide information on probable species representation and species assemblages somewhere above stream or in the general area of the site.

The third step will consist of a timed search (4 persons simultaneously searching for 1 hour each) for live freshwater mussel shells on the bottom of the creek at the lower half end of the study site. The searchers will be asked to wade in the shallow water and to use a viewing bucket to locate live mussels or to grub blindly the bottom substrate with their hands (polywogging), with effort being made to sample all available habitats such as riffles, runs, pools, and areas of differing substrate types. The specimens obtained will be placed in a live bucket, identified to the species level, counted, and returned to the creek bottom that same day. This qualitative search will provide information on mussel diversity and relative abundance at the site.

The fourth step will consist of establishing at least 20, 1-m^2-quadrats at the upper half end of the study site. A portable PVC quadrat frame will be positioned on the creek bottom substrate at randomly selected locations along several transects (a stratified sampling design based on probable habitats and selective areas accessible without danger to collectors). All the contents within that frame for approximately 10 cm in depth will be excavated and placed in a bucket, labeled as to quadrat location, and taken to the shore. The contained material will to be sorted through 1/4-inch and 1/2-inch sieve screens and all freshwater mussels will be removed, measured as to shell length and height with a dial caliper, and identified to species level. All live mussels will be returned, along with the substrate material, to the approximate sampling area that same day. All sampled quadrats will be processed in the identical way. This quantitative sampling will provide information on distribution, substrate use and preferences, species diversity, mussel density, and variance of the density estimate. All four steps of the preliminary Protocol will be videotaped and presented to Mr. Kevin Cummings and Dr. Robert Warren for critique of methodology. Necessary adjustments to the Protocol will be incorporated into the final version of the mussel research sampling Protocol.

Objective 3

The research Protocol will be implemented at eight times during the next year: 2 days in mid-September, 2 days in mid-December, 2 days in mid-March, and 2 days in mid-June. The college professor, student intern and volunteer college students will conduct the four-step research protocol at both mussel research sites during these seasonal sessions. Intra- and inter-site comparisons of the freshwater mussel populations will be made to determine the status of each species. This information will be compared with previous studies for this stream drainage to see if there are any discernible trends in species assemblages, abundance, and recruitment. It is anticipated that the Protocol will be repeated each year in the future by volunteer Lincoln College students in order to document yearly as well as seasonal trends in these freshwater mussel communities. Flooding of the creeks in spring may require delay in implementation of the Protocol at that time of the year.

PROJECT IMPLEMENTATION

Objective 1

Support for Lincoln College's Wildlife Preservation Fund project was approved in July 1997. The proposed Mussel Research Site Number #1 on Sugar Creek (SU1 and SU2) was visited soon afterwards (with permission from the property owners, Lincoln College of Lincoln, Illinois) to make a final conclusion as to its desirability as a study site. The site appeared to be secluded and well-secured, with little or no immediate human disturbance. A visit was also made to the proposed Mussel Research Site Number #2 on Kickapoo (KI1). This site, however, was determined to be too disturbed by local, illegal campers to be of value as a study site. Therefore, the Mussel Research Site Number #1 at Sugar Creek was selected as the target site for the proposed future ongoing seasonal study and implementation of the proposed Protocol and was established as a permanent research site for Lincoln College. A 2,000-foot stream reach of the Mussel Research Site Number #1 on Sugar Creek was plotted on the Lincoln West Quadrangle (Illinois-Logan Co.) 7.5 Minute Series Topographic Map of the United States Geological Survey (1980) as 40°14'02" N Latitude, 89°22'35" W Longitude south to 40°13'38" N Latitude, 89°22'35" W Longitude. One aerial flyover of the site was arranged and accomplished in August 1997 but the air conditions and structural configuration of the plane did not permit adequate aerial color photographs. No other flyovers could be arranged during the project. At the inception of the project in August the U.S. Geological Survey publication *Methods for Characterizing Stream Habitat as Part of the National Water-Quality Assessment Program* by M. R. Meadow, C. R. Hupp, T. F. Cuffney, and M. E. Gurtz (Raleigh, N.C., 1993) was chosen as a model for integrating physical, chemical, and biological data into the characterization of the stream habitat at Sugar Creek, and a wide range of physical, chemical, and biological water tests were perfomed in order to select those that would be used in the Protocol.

Objective 2

A student intern -- Ms. Lena Morris -- was selected in eary August to help coordinate the student volunteers and to curate the freshwater mussel collection. The principal investigator, Dr. G. Dennis Campbell, prepared the first draft of the print version of "Protocol for a Survey of Small-Stream Freshwater Mussels" in early August. A scientific collector's permit and an endangered species permit were obtained on 29 April and 20 May, respectively. A referernce collection of shells of freshwater mussel species previous collected in Logan County was established. The shells were identified to species, and as many representatives of age and gender classes, and both valves, were included as possible. The reference collection was used to instruct Lincoln College students in the specific morphological characteristics used in species idenfication. Dr. Campbell visited Mr. Kevin Cummings of the Department of Biodiversity, Natural History Survey in Champaign, Illinois, on 12 August to seek comments concerning this draft of the Protocol and to use his freshwater mussel collection for clarifications of mussel

identifications. A tentative script for the videotape version of the Protocol was prepared and plans were initiated for the trial study run to be accomplished in early September. A press release was prepared and sent to the local newspaper -- *The Lincoln Courier.*

On 5 and 6 September 1997, Dr. Campbell, Ms. Morris, and 3 student volunteers established Mussel Research Site #1 at Sugar Creek. A trial run of the Protocol was made at SU1 site. Videotaping of the Protocol was begun at that time. Data were collected on a Site Report Form, Live Mussel Visual Encounter Report Form, Live Mussel Quadrate Sample Report Form, and Dead Shell Visual Encounter Report Form. The data and dead and live voucher specimens were returned to the Lincoln College Environmental Laboratory for processing. Another study site (SU2) was established and a study was accomplished at Sugar Creek on 13 September with Dr. Campbell, Ms. Morris, and 5 student volunteers, accompanied by a writer/photographer from *The Lincoln Courier*. a newspaper article concerning the project appeared in *The Lincoln Courier* on 20 September. Videotaping of the Protocol was continued at that time. Data were collected on a Site Report Form, Live Quadrate Sample Report Form, and Dead Shell Visual Encounter Report Form. The data and voucher specimens were returned to the Lincoln College Environmental Laboratory for processing. Videotaping of the Protocol was completed with the recording of the processing of the live voucher specimens in the Laboratory. Dr. Campbell completed the second draft of the print version of the Protocol. Dr. Campbell revisited Mr. Kevin Cummings of the Natural History Survey in February 1998 for help with problem identifications and to deposit processed voucher specimens, and Mr. Kevin Cummings visited the Lincoln College Environmental Laboratory that same month.

Objective 3

An initial review of the data from both SU1 and SU2 indicated that the SU1 study site would be the best site (primarily because of its proximity of vehicle access and greater level of accessibility to the entire stream reach). Thus, the SU1 study site of the Freshwater Mussel Research Site #1 was selected as the target site for the ongoing seasonal study and implementation of the Protocol. Because of the success of the trial run of the Protocol at SU1 on 6 September 1997, it was decided that the data obtained during that time would be used as part of the initial seasonal sampling (Summer) for the yearly study and that additional information would be obtained at a near date to complete the 4-part Protocol. Dr. Campbell, Ms. Morris, and 4 student volunteers returned to SU1 on 20 September 1997 to obtain more data on the Live Mussel Quadrat Sample Report Form which would complete the Protocol for the Summer sample. The data and live voucher specimens were returned to the Lincoln College Environmental Laboratory for processing.

The Fall sampling was accomplished at SU1 study site of the Freshwater Mussel Research Site #1 on 13 December 1997 by Dr. Campbell and Ms. Morris. A light rain and an early frost had raised the level of the stream by about 8 inches and had settled a thin layer of snow and ice onto the site which tended to discourage full implementation of the Protocol. A number of protective measures such as shoulder-length gloves and extra thermal undergarments allowed for data to be collected for the Site Report Form, Dead Shell Visual Encounter Report Form, and Live Mussel Visual Encounter Report Form. The Mussel Quadrat Sample Report could not be completed because of the high water levels and the danger from prolonged submersion in freezing water. The data and dead and live voucher specimens were returned to the Lincoln College Environmental Laboratory for processing. All voucher specimens were turned over to Mr. Kevin Cummings of the Department of Biodiversity, Natural History Survey in Champaign, IL.

The Winter (March 1998) and Spring (June 1998) samplings could not be completed due to extremely high water conditions on Sugar Creek. On the initial project proposal, It was stated that "flood of the creeks in spring may require delay in implementation of the protocol at that time of the year." Because of the severity of the flooding during late winter1998 into early summer 1998, cancellation of these samples for the Protocol was deemed appropriate.

RESULTS and DISCUSSION

Initial review of the data from the timed visual survey of live freshwater mussels suggests that Sugar Creek is rather diverse with respect to freshwater mussel species that are presently living at the SU1 site. During the Summer study at SU1 of Sugar Creek, 12 species of freshwater mussels were represented by 41 living individuals found during the visual encounter survey, with *Lampsilis cardium* (31.7%), *Quadrula quadrula* (22%), *Lasmigona complanata* (9.8%), *Leptodea fragilis* (7.3%), and *Strophitus undulatus* (7.3%) the most abundant. During the Fall study, 14 species of freshwater mussels were represented by 76 living individuals, with *Lampsilis cardium* (38.2%), *Lasmigona complanata* (21.1%), *Leptodea fragilis* (9.2%), *Pleurobema sintoxia* (6.6%), *Quadrula pustulosa* (5.3%), and *Lampsilis teres* (5.3%) the most abundant. None of Illinois' present endangered, threatened, and watch list species were found during these surveys.When the two collections are combined, there were 17 species represented by 117 living individuals during the timed viusal encounters. That is 3 more species than recorded in Schanzle and Cummings (1991) for all four of their Sugar Creek "north" sites, and is 5 more species than found by Matteson (1956-1960) at his single Sugar Creek "north" site.

Initial review of the live mussel quadrat data suggests a rather high density of live mussels occupying the site in summer. The 29 1-m^2 sampled quadrats revealed 13 species with 67 living individuals, providing a density of 0.2 species /m^2 and 2.31 individuals/m^2, with *Lampsilis cardium* (0.69/m^2), *Quadrula pustulosa* (0.31/m^2), *Leptodea fragilis* (0.28/m^2), *Lasmigona complanata* (0.17/m^2), and *Pleurobema sintoxia* (0.17/m^2) having the highest densities. None of Illinois' present endangered, threatened, and watch list species were found during the quadrat study.

When the live visual encounter surveys are compared with the quadrat study, there is an indication of a bias toward larger-sized species over smaller-sized species during the visual encounters, and a bias toward more common species over less common species during the quadrat studies. The timed visual encounters provide an opportunity to check out all possible mussel microhabitats and encourages a variety of methods to detect living species. There are several drawbacks to using this method, however; among them is the training required for volunteer students to utilize their time most effectively when searching for mussels, the possible dangers involved with walking thoughout the stream and "blindly" searching the stream banks and bottoms, and the abovementioned bias for larger-sized species while smaller-sized individuals go undetected. There are also some drawbacks inherent in a quadrate study; among them is the specialized equipment (quadrat frame, scoops, sieve screen boxes) required, the heavy back-breaking work of hauling and sorting buckets of substrate, and the extra time it takes to process the substrate to find shells. Certainly, the acquisition of data that provides for more rigorous quantitative analysis makes the quadrat sampling attractive. A comparison of the results obtained from these two sampling methods during this study suggests that future studies incorporating <u>both</u> types of sampling would be preferential over any studies utilizing only one type of sampling.

Initial review of the data from the survey of dead freshwater mussel shells suggests that Sugar Creek is extremely diverse with respect to freshwater mussel species that are presently living at the SU1 site or upstream from the site or have been living at the site or upstream from the site in the past. Although easiest to find, dead shells tend not to be the most reliable indicators of the specific species presently living in a particular area. They likely drift downstream for an unknown distance after death (or, more rarely, be carried upstream by predators) or could have just recently been eroded out of a stream bank after being dead for an unknown period of time. During the Summer study at SU1 of Sugar Creek, 18 species of freshwater mussels were represented by 526 dead shell valves. The supplemental encounter search revealed 1 additional species making 19 total species. The top 5 in order of abundance ranking (beginning with the most abundant) and percent composition of the total dead shells are *Lampsilis teres* (20.7%), *Lampsilis cardium* (17.5%), *Leptodea fragilis* (11.2%), *Pleurobema sintoxia* (7.2%), and *Quadrula pustulosa* (7.0%). During the Fall study at SU1 of Sugar Creek, 19 species of freshwater mussels were represented by 514 dead shell valves. The top 5 in order of abundance ranking and

percent composition of the total dead shells are *Lampsilis teres* (18.1%), *Leptodea fragilis* (14.2%), *Pleuobema sintoxia* (11.3%), *Lampsilis cardium* (10.1%), and *Lasmigona complanata* (9.9%). None of Illinois' present endangered, threatened, and watch list species were found during these surveys. When the two collections (Summer and Fall) are combined, there were in fact 21 species represented by dead shells. That is 5 more species than recorded in Schanzle and Cummings (1991) for all four of their Sugar Creek "north" sites, and is 8 more than found by Matteson (1956-1960) at his single Sugar Creek "north" site. Another interesting feature of the survey of dead freshwater mussel shells is the quantity of dead shells found at SU1 in Fall just 3 months after all visible dead shells were removed with timed and supplemental searches in Summer. Recruitment of dead shells during that time kept the total amount of shells constant. It will be particularly interesting to see the recruitment following this year's heavy winter, spring and early summer rains.

CONCLUSION

The Protocol developed during this project has been found to be of particular value in surveying small-stream freshwater mussels. While being perhaps time- and labor-intensive, such a protocol will likely provide future researchers with the tools necessary to monitor the seasonal and yearly changes in small-stream freshwater mussel populations while encouraging for predictive and preventative management of our state's freshwater resources. It is anticipated that the Protocol will be repeated each year in the future at this and other sites in the Sangamon River Watershed by volunteer Lincoln College students in order to document yearly as well as seasonal trends in freshwater mussel communites.

Submitted by

Dr. G. Dennis Campbell
Lincoln College
300 Keokuk St.
Lincoln, IL 62656

217-698-9647 (summer phone number)

29 June 1998

INITIAL ILLINOIS PRESERVATION FUNDS REQUESTED

Labor: College Student Intern: 80 hours (5 protocols of 8 hours of field work and 8 hours of lab work) @ $5/hour = $400

Equipment: 35mm camera film: 4 rolls of color film @ $16/roll = $64
videotape: 5 tapes @ $5/tape = $25
Hach Water Test Kit replacement reagents

Alkalinity	$24
Nitrogen	$13
pH	$9
Phosphate	$14
D. Oxygen	$36

Contractual: Small plane rental: 5 flights @ $50/flight = $250

Travel: 2 trips to Champaign, IL @ 110 miles roundtrip/trip x $.31 = $68
2 trips to Springfield, IL @ 70 miles roundtrip/trip x $.31 = $43
5 trips to Sugar Creek Site @ 10 miles roundtrip/trip x $.31 = $15
4 trips to Kickapoo Creek Site @ 8 miles roundtrip/trip x $.31 = $9

FUNDS PROVIDED BY GRANT RECIPIENT

Labor: College Professor as volunteer labor for 80 hours
4 college students as volunteer labor for 216 hours
College Professor as volunteer pilot for 5 hours

Equipment: 35mm camera: $300
video camera: $800
thermometers: 2 @ $12/each = $24
dial calipers: 2 @ $42/each = $84
water testing kits: 5 @ $65/each = $325
hip boots: 5 @ $70/each = $350

Equipment to be constructed by Lincoln College:
- 5 viewing buckets
- 5 PVC quadrat frames
- 3 box screen sieves
- 1 water flowmeter

PRESENT ILLINOIS PRESERVATION FUNDS REQUESTED

The following expenses were incurred during the project and it is these funds that Lincoln College is requesting to be paid by the Illinois Preservation Fund:

Labor: College Student Intern: 80 hours (20 hours field work and 60 hours lab work) @ $5/hour = $400

Equipment: videotapes: 5 tapes @ $5/tape = $25
Hach Water Test Kit replacement reagents = $96

Contractual: Small plane rental: 1 flight = $50

Travel: 2 trips to Champaign, Il @ 110 miles roundtrip/trip x $0.31 = $68
5 trips to Sugar Creek Site @ 10 miles roundtrip/trip x $0.31 = $15

TOTAL = **$654**

A Protocol for the Survey of Small-Stream Freshwater Mussels

Retrospective Analysis -- to provide an historical perspective on freshwater mussel distribution in the river drainage system.

Consult scientific literature.

Visit collections at local museums, universities, or governmental agencies.

Consult with scientific authorities.

Reconnaissance -- to evaluate candidate stream study site locations and to familiarize project participants with resident freshwater mussel species and survey procedures.

Obtain scientific collection permits.

Make arrangements for final deposition of voucher specimens at a permanent institution.

Obtain property access permission.

Visit prospective stream study site.

Install semipermanent markers to delineate stream study site boundaries of 1,000 feet in stream reach length.

Conduct preliminary surveys by collecting dead shells of representative freshwater mussel species just outside (above and below) study site boundaries.

Construct and curate a reference collection of representative freshwater mussel species.

Gather and/or construct project equipment.

Select and train project participants. Discuss safety precautions in and around the stream study site: including, deep water hazards and currents; underwater branch debris, glass and metal; and obnoxious plants (stinging nettle, sticker vines, poison ivy) and animals (insects, reptiles) around the shores and in the water.

Study Site Characterization -- to describe the environmental settings of a study site and to evaluate the stream habitats in a geographic, spatial hierarchy (basin, stream segment, stream reach, microhabitat).

Characterize the stream basin that includes the study site using USGS 1:250,000-scale resolution topographic and bedrock geology maps; National Weather Service temperature and precipitation information; and GIS soil, natural vegetation, and land-use data bases.

Consult aerial photographs of site location.

Characterize the stream segment that includes the study site using recent aerial photographs and Township/Range/Section and USGS 7.5' maps.

Establish and temporarily stake out 6 transects across the stream, equidistant along the stream reach study site (2 of which are established at the boundaries to the study site; the other 4 at 200-foot intervals).

Characterize the stream reach along each transect by estimating channel, bank, and flood-plain width, stream depth, water velocity, bed substrate, bank erosion, canopy coverage, aquatic and riparian vegetation, and habitat features.

Draw a schematic or representative map of the stream reach (including a plan view and 6 profiles at the transects) to include approximate locations of transects, habitat features, and bank and flood-plain land use, and delineate approximate locations of 4 to 6 specific substrate microhabitats (e.g., sand or gravel bars; sand or gravel riffles; swift or sluggish, sand/gravel-bottomed run; deep or shallow, mud-bottomed or sand/gravel-bottomed pool; mud or sand/gravel bank; log jam; tree-root snags; area of large boulders) on the map.

Prepare a Study Site Report Form (which includes the representative map) of the study site.

Documentation of Physical, Chemical, and Biological Study Site Parameters -- to provide specific environmental data of the study site microhabitats on the date of freshwater mussel survey.

Record the present local weather and the local weather during the previous 48 hours of the time of the mussel survey on Study Site Report Form..

Describe water color and odor, measure the Secchi depth (water transparency) of any deep areas of the stream using a Secchi disc, and record on Study Site Report Form.

Measure air (shaded), ground (shaded), water surface (shaded), and water bottom temperatures with a hand-held thermometer. Estimate cloud cover (% of sky) and canopy shade cover pattern (% of stream shaded; draw extent on map); and precipitation conditions every hour at the study site, and record on Study Site Report Form

Measure stream width, depth, and water velocity at multiple points (L, LM, M, RM, R - looking downstream) along each transect using measuring tape, depth stick, and timed floats, and record on Study Site Report Form.

Sample and estimate stream substrate composition at multiple points (L, LM, M, RM, R - looking downstream) along each transect using sorting sieves, and record on Study Site Report Form.

Note on the Study Site Report Form and representative map any changes to aquatic (submerged, emergent, floating) or riparian (herbaceous, woody) vegetation, bank erosion, bank or flood-plain land use, or habitat features.

Measure pH, dissolved oxygen, alkalinity, nitrates, and phosphates of the water at several representative points in the stream using Hach water quality test kits, and record on Study Site Report Form.

Take a water sample at a representative point in the stream to be analyzed by the Environmental Protection Agency or other governmental agency for pH, total suspended solids, volatile suspended solids, dissolved phosphorus, turbidity, total alkalinity, phenolphthalein alkalinity, nitrate/nitrite-nitrogen, ammonia/ammonium-nitrogen, total Kjeldahl nitrogen, conductivity, and chlorophyll A and B.

Take a plankton sample at a representative point in the stream using a hand-held plankton net, to be microscopically analyzed for species composition back in the laboratory, and record on Study Site Report Form.

Take a kick-seine macroinvertebrate sample at a representative point in the stream using a hand-held D-net, to be analyzed for species composition back in the laboratory, and record on Study Site Report Form.

Record on the Study Site Report Form any sightings or other evidence of the recent presence of vertebrates at the study site.

Make a color photographic record of each transect of the study site.

Visual Encounter Survey of Dead Freshwater Mussel Shells -- to provide information on probable freshwater mussel species representation (a species list) and species richness (number of different species) somewhere above stream or in the general area of the study site at sometime in the recent(?) past by recording the presence of paired or single dead shells along the banks and in the sand and gravel bars of the stream during a time-constrained (2 person-hours) systematic survey of the study site.

Prepare a Dead Shell Visual Encounter Survey Report Form.

Assemble searchers along both shorelines at the downstream boundary of the study site and discuss the systematic search strategy for efficiently locating both large and small dead shells

of freshwater mussels on both sides of the stream throughout the study site.

Provide each searcher with a 5-gallon plastic pail, a gardening spade, and a large supply of rubber bands.

Initiate a 2 person-hour search.

Request that each searcher look for dead mussel shells on the banks and sand and gravel bars and just into the shallow water along both shorelines of the stream, extricate the shells from any substrate materials using the spade, quickly rinse off any contained or adhering substrate, place a rubber band around any paired valves, and put all shells into the pail.

Announce when the timed search is over.

Gather all pails, combine all contained shells into one or more buckets, and label these buckets as "Dead Timed Search."

Have searchers switch stream sides, search the study site again for approximately 15 minutes for any missed dead shells, and place any collected shells into another bucket labeled as "Dead Supplemental Search."

Take labeled buckets back to the laboratory. For all collected shells, wash in warm soapy water with a small scrub brush or toothbrush and let dry. Attempt to pair up all unpaired valves; denote as to S (single dead valve, normal wear), FS (single dead valve, fresh tissue adhering), WS (single dead valve, extremely weathered), P (paired dead valves, articulated or disarticulated, normal wear), FP (paired dead valves, articulated, fresh tissue adhering), and WP (paired dead valves, disarticulated, extremely weathered); identify to species level; and label. Record information on the Dead Shell Visual Encounter Survey Report Form, and incorporate specimens into a curated reference collection.

Quadrat Sampling of Live Freshwater Mussels -- to provide information on representation (a species list), species richness (number of different species), relative species abundance (the number of individuals within a species), relative species density (the number of individuals within a species per unit area) and variance of the density estimate, and species microhabitat substrate distribution and preference of freshwater mussel species at the study site at the present time by recording the presence of individual mussels found living in the stream reach at randomly selected quadrats delineated in a stratified sampling design at the study site.

Prepare a Mussel Voucher Report Form.

Prepare a Live Mussel Quadrate Sample Report Form.

Use the representative map to delineate 4 to 6 different substrate microhabitats and randomly select, using a random numbers table to generate a set of coordinates, 5-7 quadrats between each transect marker making an effort to position a quadrat over each of the substrate microhabitats. This would provide from 25 to 35, 1-m^2 quadrats for sampling.

Visually locate the 25 to 35 stratified randomly selected quadrats to be sampled at the site.

Assemble a 2-person team to sample each quadrat and discuss the strategy necessary to sample the preselected substrate area with as little of disturbance to the surrounding area as possible.

Provide each team with gloves, waders (if needed because of cold water), a portable 1-m^2 PVC frame, 2 grain-scoops, and a 5-gallon pail (with attached expended flags in order to locate pail beneath the water).

Have a team wade out into the stream, position a portable PVC quadrat frame on the creek bottom substrate at the visually preselected point, and while holding the frame in place, remove all bottom substrate contents within that frame for approximately 10 cm in depth with grain scoops and place in the pail. Larger rocks can be removed from the quadrat area and placed back into the stream nearby. Have the team make note of estimates of stream velocity (still, slow, fast) and depth (in inches) of each quadrat.

Carry the pail with contents to the shore and label as to quadrat location number.

Sort the material contained in the pail by washing through 1/4-inch and 1/2-inch stacked rectangular box sieve screens using pails of nearby stream water. Search for and remove by hand all live freshwater mussels. While sorting, make an estimate of dominant stream substrate composition (cobble, gravel, sand, silt, or combinations of these).

Record on the Live Mussel Quadrate Sample Report Form any presence of the Asian clam in the substrate material.

Make a color photographic record of the live freshwater mussels from each quadrat.

Place each mussel in an individual zip-lock plastic bag with fresh stream water. Label using a permanent marker each plastic bag with a consecutive specimen number, the relevant quadrat number, and estimates of stream velocity, depth, and dominant stream substrate composition. Place each bag in a bucket marked as "Live Quadrat Sample."

Continue the sorting procedure until all preselected substrate quadrats have been sampled, sieved for mussels and the mussels photographed, bagged, and labeled.

For each Live Quadrat Sample bucket, remove and open plastic bags; identify each specimen as to species; measure shell length and height of each with a dial caliper; and record this information along with mussel number, quadrat number, and estimates of the stream velocity, depth, and substrate composition on the Live Mussel Quadrate Sample Report Form.

Return most of the live mussels to the approximate area in which they were collected, ensuring that they are gently deposited into the substrate with posterior end sticking out of the substrate.

Retain one or two voucher specimens of each species and any specimens with questioned

identification for shell and tissue preparation and ultimate deposition in the permanent collection of an appropriate governmental agency.

For all live specimens retained (vouchers and unidentified mussels), pour out water from the plastic bags, zip-lock, ensure label is readable, place on ice in a cooler, and return them to the laboratory where they will be cleaned, preserved, identified, and transferred to the permanent collection.

At the laboratory, collate all individual plastic bags into a single larger bag and place in freezer. After about 5 days in freezer, remove the larger bag from the freezer and place in tap water to thaw slowly. Prepare a label of heavy cotton rag paper and write on the label, using permanent ink or a pencil, the date of collection, stream name, county and state, and study site code with a consecutive individual mussel voucher number. Transfer the mussel voucher number to the appropriate place on the Live Mussel Quadrate Sample Report Form. Using a spatula, slice the adductor muscles of each specimen to remove the soft parts from the mussel shells, wrap the soft parts in cheese cloth with the label, tie with a cotton thread, and place in a jar of 70% ethanol. Make note of the dominant color of the soft parts of each mussel specimen and record on the Live Mussel Quadrate Sample Report Form. Contain as many wrapped soft-part specimens as the jar can hold without stuffing. Place in the jar a label with date of collection, stream name, county and state, and study site code, and secure with a proper lid (not metal). Wash the shells of the mussels with soap and warm water and label each shell with study site code and individual mussel voucher number. Register all voucher specimens on the Mussel Voucher Report Form. Deliver the soft-part specimen jars and labeled shells to the permanent collection of an appropriate governmental agency.

Visual Encounter Survey of Live Freshwater Mussels -- to provide information on representation (a species list), species richness (number of different species), relative species abundance (the number of individuals within a species), as well as an indication of species microhabitat substrate distribution of freshwater mussel species at the study site at the present time by recording the presence of individual mussels found living in the stream reach during a time-constrained (4 person-hours) systematic survey of the study site.

Prepare a Live Mussel Visual Encounter Survey Report Form.

Assemble searchers at the downstream boundary of the study site and discuss the systematic search strategy for efficiently locating both large and small living freshwater mussels in all available reach microhabitats while wading in the stream, viewing down with the naked eye (best in slow current, shallow water, with full sun), using a viewing bucket, or blindly grubbing the bottom substrate with their hands (polywogging).

Provide each searcher with a 5-gallon plastic pail, gloves, waders (if needed because of cold water), a viewing bucket (if desired), and a gardening spade.

Initiate a 4 person-hour search.

Request that each searcher look for live mussels (often with some portion, if not most, of their shells buried in the stream's bottom substrate), extricate the shells from any substrate

materials using the spade, quickly rinse off any contained or adhering substrate, and announce to the recorder the acquisition of living mussel.

The recorder should place the specimen in a zip-lock bag with fresh stream water; label using a permanent marker each plastic bag with a consecutive specimen number, the number of the nearest transect, and estimates of stream velocity (still, slow, fast), depth (in inches), and dominant stream substrate composition (cobble, gravel, sand, silt, or combinations of these); and place each bag in buckets marked as "Live Timed Search."

Announce when the timed search is over.

Carry the buckets with contents to the shore. For each Live Timed Search bucket, remove and open plastic bags; identify each specimen as to species; measure shell length and height of each with dial caliper; and record this information along with mussel number, nearest transect, and estimates of the stream velocity, depth, and substrate composition on the Live Mussel Visual Encounter Survey Report Form.

Make a color photographic record of the live mussels from the timed search.

Return most of the live mussels to the approximate area in which they were collected, ensuring that they are gently deposited into the substrate with posterior end sticking out of the substrate.

Retain one or two voucher specimens of each species and any specimens with questioned identification for shell and tissue preparation and ultimate deposition in the permanent collection of an appropriate governmental agency.

For all live specimens retained (vouchers and unidentified mussels), pour out water from the plastic bags, zip-lock, ensure label is readable, place on ice in a cooler, and return them to the laboratory where they will be cleaned, preserved, identified, and transferred to the permanent collection.

At the laboratory, collate all individual plastic bags into a single larger bag and place in freezer. After about 5 days in freezer, remove the larger bag from the freezer and place in tap water to thaw slowly. Prepare a label of heavy cotton rag paper and write on the label, using permanent ink or a pencil, the date of collection, stream name, county and state, and study site code with a consecutive individual mussel voucher number. Transfer the mussel voucher number to the appropriate place on the Live Mussel Visual Encounter Survey Report Form. Using a spatula, slice the adductor muscles of each specimen to remove the soft parts from the mussel shells, wrap the soft parts in cheese cloth with the label, tie with a cotton thread, and place in a jar of 70% ethanol. Make note of the dominant color of the soft parts of each mussel specimen and record on the Live Mussel Visual Encounter Survey Report Form. Contain as many wrapped soft-part specimens as the jar can hold without stuffing. Place in the jar a label with date of collection, stream name, county and state, and study site code, and secure with a proper lid (not metal). Wash the shells of the mussels with soap and warm water and label each shell with study site code and individual mussel voucher number. Register all voucher specimens on the Mussel Voucher Report Form. Deliver the soft-part specimen jars and labeled shells to the permanent collection of an appropriate governmental agency.

Mussel Study SITE REPORT FORM

Site ID: _____

Date: _____

Stream: _____

County/State: _____

Names of Investigators: _____

Start Time: _____ **End Time:** _____

Present Weather:
- Clear/Sunny
- Overcast
- Showers (intermittent rain)
- Rain (steady rain)
- Storm (heavy rain)
- Other condition _____

Weather in Past 48 Hours:
- Clear/Sunny
- Overcast
- Showers (intermittent rain)
- Rain (steady rain)
- Storm (heavy rain)
- Other condition _____

Water Appearance:
- Clear
- Turbid
- Other: _____

Water Odor:
- None
- Sewage
- Chlorine
- Fishy
- Rotten Eggs
- Petroleum
- Other _____

Water Color:
- Light Brown
- Dark Brown
- Green
- Reddish
- Other: _____

Forel Color Number: _____

Notes:

_____
_____
_____
_____
_____

Secchi Readings:

Location (transect)	Depth (ft/in.)

Hourly Readings:

Time:								
Air Temp °C								
Ground Temp °C								
Wat Sur Temp °C								
Wat Bot Temp °C								
Cloud Cover %								
Shade Cover %								
Precip condition								

Riparian Vegetation Condition (also note on map):

Aquatic Vegetation Condition (also note on map)

Transects:	**Stream width** (ft/in.)	**Depth** (inches)(looking downstream) L	LM	M	RM	R	**Water Velocity** (secs/10 ft.) L	M	R
Transect 1:									
Transect 2:									
Transect 3:									
Transect 4:									
Transect 5:									
Transect 6:									

Bottom Substrate (%):		**silt**	**sand**	**gravel**	**cobble**	**boulder**	**bedrock**	other
Transect 1	L							
	LM							
	M							
	RM							
	R							
Transect 2	L							
	LM							
	M							
	RM							
	R							
Transect 3	L							
	LM							
	M							
	RM							
	R							
Transect 4	L							
	LM							
	M							
	RM							
	R							

Bottom Substrate (%) (Cont.):		**silt**	**sand**	**gravel**	**cobble**	**boulder**	**bedrock**	other
Transect 5	L							
	LM							
	M							
	RM							
	R							
Transect 6	L							
	LM							
	M							
	RM							
	R							

Chemical Measurements:

Location	DO_2	Nitrates	Phosphates	Alakalinity	pH

Sightings or Evidence of Vertebrates:

Changes to bank erosion, bank or flood-plain use:

Water Sample taken for IEPA? no yes Location_____

Plankton Sample taken? no yes Location_____

Kick Sample taken? no yes Location_____

Photographs taken? no yes Location_____

Mussel Study DEAD SHELL VISUAL ENCOUNTER REPORT FORM

Site ID: ______________________

Date: ______________________

Stream: ______________________

County/State: ______________________

Names of Investigators: ____

Start Time: __________ **End Time:** __________ **Total Elapsed Time:** __________

Total Person-hours: __________

Dead Timed Visual Encounter Results

Species Found	WS	S	FS	WP	P	FP	TOTAL
	(for S, # valves; for P, # individuals; for TOTAL, # valves)						

Dead Supplemental Visual Encounter Results

(for S, # valves; for P, # individuals; for TOTAL, # valves)

Species Found	WS	S	FS	WP	P	FP	TOTAL

Date Shells Were Incoporated into
Lincoln College's Freshwater Mussel Reference Collection ____________

Code Numbers Written on Shells ____________

Mussel Study LIVE MUSSEL VISUAL ENCOUNTER REPORT FORM

Site ID: ______________________

Date: ______________________

Stream: ______________________

County/State: ______________________

Names of Investigators:____

Start Time:____________ **End Time:**____________ **Total Elapsed Time:**____________

Total Person-hours:____________

Live Timed Visual Encounter Results

Individuals Found (species)	ID #	Nearest Trans.	Sub-strate	Depth (in.)	Water Velocity	Voucher Collected?	Voucher Number

Live Timed Visual Encounter Results (Cont.)

Individuals Found (species)	ID #	Nearest Trans.	Sub-strate	Depth (in.)	Water Velocity	Voucher Collected?	Voucher Number

Live Timed Visual Encounter Summary

Species	Number	Habitat Remarks

TOTAL Number of Individuals _____

TOTAL Number of Species _____

Date Vouchers Shells and Soft Parts Were Preserved _____

Code Numbers Written on Voucher Shells and Soft Part Labels _____

Disposition Date and Collection Location of Vouchers

Mussel Study LIVE MUSSEL QUADRAT SAMPLING REPORT FORM

Site ID: _____

Date: _____

Stream: _____

County/State: _____

Names of Investigators: _____

Start Time: _____ **End Time:** _____

Quadrat #____ Transect_____ Substrate_____ Depth_____ Water Velocity_____

Individuals Found (species)	ID #	Length / Height (mm)	Voucher Collected?	Voucher Number

Quadrat #____ Transect_____ Substrate_____ Depth_____ Water Velocity_____

Individuals Found (species)	ID #	Length / Height (mm)	Voucher Collected?	Voucher Number

Quadrat #____ Transect_____ Substrate_____ Depth_____ Water Velocity_____

Individuals Found (species)	ID #	Length / Height (mm)	Voucher Collected?	Voucher Number

Quadrat #_____ Transect______ Substrate______________ Depth_________ Water Velocity_______________

Individuals Found (species)	ID #	Length / Height (mm)	Voucher Collected?	Voucher Number
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________

Quadrat #_____ Transect______ Substrate______________ Depth_________ Water Velocity_______________

Individuals Found (species)	ID #	Length / Height (mm)	Voucher Collected?	Voucher Number
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________

Quadrat #_____ Transect______ Substrate______________ Depth_________ Water Velocity_______________

Individuals Found (species)	ID #	Length / Height (mm)	Voucher Collected?	Voucher Number
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________

Quadrat #_____ Transect______ Substrate______________ Depth_________ Water Velocity_______________

Individuals Found (species)	ID #	Length / Height (mm)	Voucher Collected?	Voucher Number
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________
____________________	_____	_______________	______	__________

Live Quadrat Sampling Summary

Species	Number	Density (number/m^2)	Habitat Remarks

TOTAL Number of Individuals _____

TOTAL Number of Species _____

TOTAL Number of Quadrats (m^2) _____

DENSITY

Number of Individuals/m^2 _____

Number of Species/m^2 _____

Date Vouchers Shells and Soft Parts Were Preserved _____

Code Numbers Written on Voucher Shells and Soft Part Labels _____

Disposition Date and Collection Location of Vouchers _____

Mussel Study VOUCHER SPECIMENS FORM

Species	Site ID	Collection Date	Voucher Number	Shells? (Y,N)	Soft Parts? (Y,N) (Color)

Voucher Specimens Form Page Number _____

Species	Site ID	Collection Date	Voucher Number	Shells? (Y,N)	Soft Parts? (Y,N) (Color)

Balmy for bivalves but less so for humans, the oozing mud and chilly currents of Sugar Creek greet Lincoln College students Sara Curran, left, and Lyndi Otte as they wade into a research project. The study, developed by professor Dennis Campbell, at left, tracks the variety and number of mollusks in the creek. Otte and Jason Toft, other photo, encounter an empty shell.

— Ann Klose photos