Exhibit A

Little Leading Creek Sediment Study

January 1, 2005 through December 31, 2006

Proposal to

Meigs County Soil and Water Conservation District
33101 Hiland Road
Pomeroy, Ohio 45769

R. Guy Riefler, Ph.D., P.E.
Assistant Professor of Civil Engineering

Ben J. Stuart, Ph.D., P.E.
Associate Professor of Civil Engineering

Tiao Chang, Ph.D.
Professor of Civil Engineering

Ohio Research Institute for Transportation and the Environment
Ohio University, Athens, OH 45701

Introduction

Little Leading Creek, a tributary to Leading Creek, drains a twenty-four square mile watershed located primarily in Scipio and Rutland Townships, Meigs County, Ohio. A large portion of the streambed has been inundated with residual sand from hundreds of acres of abandoned strip-mined land, upland erosion from agriculture, and stream bank erosion. Sediment has significantly impacted fish and macro invertebrate habitat and has reduced the flow capacity of the channel, apparently increasing the frequency of road flooding in the area. The lower portion of Little Leading is inundated with up to several feet of sand. The frequency of flooding has increased in Rutland to the point that many homes have been raised or removed through FEMA. Although many residences are now protected, road flooding continues to be an issue.

The Leading Creek Improvement Plan (LCIP), completed in 1999 by Don Cherry *et. al.*, indicates that the most negative environmental impacts in Little Leading Creek are due to past mining and poor agricultural practices, which would include high sediment depth in the channel, intermittent sediment toxicity, and high concentrations of metals. The LCIP ranks Little Leading Creek as the top priority in restoration of the main Leading Creek tributaries. Sedimentation is likely the strongest variable that prevents the stream from attaining Warm Water Habitat level.

The accumulation of sand in Little Leading Creek appears to have had a significant impact on the aquatic life in the creek, particularly fish. Excess sediment in the water column damages delicate gill tissue reducing the amount of oxygen intake into the body and reduces the fish's ability to see and catch food. Settled sediment fills the spaces between gravel and cobbles particles. This may destroy the habitat of bottom dwelling organisms which fish rely on for food, smother spawning gravels which kills eggs and fry in the gravel, and reduce sheltered areas which young fish need to survive. Bed substrate over most of Little Leading Creek is entirely composed of sand providing very poor habitat for macroinvertebrates and fish.

It is unclear where the sands that are constricting the lower portions of Little Leading Creek are originating from. Eroding land in the headwaters impacted from past surface mining may be a continuing source of sand to the creek. However, because mining operations have ceased and several reclamation projects have been completed, sediment sources from the abandoned mine lands (AML) may no longer exist. Rather, sediment in the channel and floodplain accumulated during the active surface mining that occurred in the 1950s may not yet be flushed from the watershed. Accumulation of sediments in the channel may have caused movement of the channel location, spreading sediment widely across the floodplain, raising the ground elevation and reducing the creek gradient. Even though the sediment sources may be eliminated, there are likely erosion and deposition zones within the creek, as the accumulated sediment continues to be redistributed throughout the creek. Further, cattle grazing directly along the creek banks may be adding significant quantities of sediments to the creek. All of these hypotheses will be tested in this study to determine where sediment is currently accumulated, where current erosion and deposition zones exist, what watershed sediment sources exist, and what the original source of accumulated sediment was. These results will be incorporated to understand sediment transport in Little Leading Creek, to predict future sediment movement, to determine sediment impact on flooding and fish habitat degradation, and to propose corrective actions.

One difficultly in understanding the movement of river sediment is the transient, random nature of sediment transport. It is estimated that 70% of sediment transport in rivers occurs during storm events (Yang, 1996), yet sampling during storm events is problematic. Each storm event has different characteristics that affect transport, so generalizations are difficult to make. Further, significant storms are difficult to predict, can be of short enough duration to limit the extent of sampling over an entire watershed, and sediment transport may vary significantly both in total load and particle distribution from the initial first flush of the storm to the time to concentration in the watershed. In this study, samples will be collected both during normal stream flow and several storm events to characterize the sediment sources and transport trends under a variety of flow conditions.

Objectives

In a request for proposal submitted to Ohio University in March 2004, ODNR has identified specific objectives to be fulfilled by this proposal.

- Conduct an assessment to characterize historic and existing watershed drainage conditions that have developed due to pre-1977 mining activities. Include the following:
  - Pre-mining conditions (i.e. channel capacity. channel location, channel substrate).
  - An estimate of the increased flood discharges and elevations due to past mining activities.
  - Location(s) of roads prone to flooding.
  - Percentage of road flooding attributable to past mining.
  - Along with sediment deposition within the channel, determine if sediment deposition within the floodplain has contributed to current flooding conditions.
  - Anecdotal information from residents on historical perceptions.

  Identify current sediment sources. At what rate is sediment entering the system?

- Characterize the sediment within the streambed.
  - Quantify the percentage of sediment attributable to past mining, agriculture, and other sources such as bank erosion, roads, bridges, etc.
  - Is the majority of the sediment old or new?
  - How does the parent geology contribute to the sediment load?
  - Are the sediments toxic to aquatic life?

- Determine sediment load and transport rates. Identify portions of the creek in which the sediment is either moving or static. Project when and where sediment will move and how it will affect future road flooding and habitat issues. Have similar studies been completed?

- Depending on the percentage of road flooding attributable to past mining, identify potential restoration activities that will address this problem.

- Identify potential restoration activities that will re-establish suitable bio-habitat.

Develop a long-term monitoring plan that will evaluate the success of improvement projects and assess sediment movement, refer to Section 15.8 in the LCIP for options.

This proposal has been drafted to meet all of the objectives listed above; however, some objectives have a higher likelihood for success than others. The most difficult objectives to meet involve determining the age and origin of sediments and consequently allocating the percentage of sedimentation and flooding resulting from mining activities. We have proposed methods below to answer those questions; however, reliable clues to the sediments origin may not exist, in which case the questions are essentially unanswerable. All other objectives, we are reasonably confident can be met with the methods described below.

This study will be conducted in concert with two other ongoing sampling programs. A biological assessment of the Leading Creek Watershed and the baseline Federal Creek Watershed is currently underway which includes fish and macroinvertebrate community sampling and Qualitative Habitat Evaluation Index (QHEI) at six stations along the Little Leading Creek and its tributaries. In another study, water quality data continues to be collected by the Leading Creek Watershed Group (LCWG) at several locations in the Leading Creek Watershed. Investigators with both of these programs, Edward Rankin and Cynthia Bauers, have been contacted to collaborate with sampling locations, methodologies, and results. This sediment study will use the same sampling locations selected by these previous studies (in addition to new locations as needed) and incorporate results from those studies in our analyses of mining impacts on fish habitat and restoration alternatives. All aspects of this study will similarly be shared with those investigators.

Methods

Task 1: Analysis of Historical Data

One major thrust of this work is to determine the relative significance that past mining activities have had on current fish habitat and flooding problems in the Little Leading Creek Watershed. This involves attempting to establish flow conditions before significant mining was established in the watershed (believed to have occurred in the 1950s) and compare those with current flow conditions. Although there are likely no data available to address this question in any rigorous sense, we will compile and analyze what information is available. An alternative approach is to identify nearby watersheds with similar characteristics that have not been impacted by mining. Presumably, differences Little Leading Creek and the baseline watershed are due to mining impacts.

Records provided by ODNR and LCWG will be analyzed to determine locations and time periods for significant surface mining and the location of the Little Leading Creek stream channel over different time periods. Records available include a collection of aerial photos dating back to 1939, old USGS 4.5 minute quad maps, mine location maps, and data from ODNR reclamation projects. Further, a literature review of historic documents will be conducted seeking geological surveys and any additional past information on the surface waters, mining activities, and fish abundance in the area. Movement of the stream channel may be indicative of increased deposition of stream sediments, and old channel locations may provide sampling locations for stream sediment from a known historical period which may be useful in Task 2. The records may also indicate the exact locations for AML input into Little Leading Creek to distinguish AML derived sediment from other sources. The historic documents may also give some indication as to the natural or historic streambed character and how fish habitat and abundance has changed following mining activities. Finally, development in the floodplain over time will also be assessed to determine its role in increasing flooding in the watershed.

Several baseline watersheds will be identified where minimal mining occurred. Watersheds will be selected from the baseline watersheds currently being sampled in the biological study and identified in the LCIP within the Federal Creek Watershed and within some of the headwaters and tributaries of the Leading Creek Watershed. Ideally, the baseline watersheds will be in the same geologic unit, with similar watershed size, gradient, and rainfall while at the same time have had a different history of development. We then may distinguish the role that mining or agriculture has had on sedimentation of Little Leading Creek. It is likely that no perfect baseline watersheds can be identified, so interpretations from these comparisons may be qualified.

Several residents along Little Leading Creek will be interviewed for their knowledge of the changes the creek has undergone and resultant flooding and loss of fish in the region. People to interview will be selected based on recommendations from LCWG and residents. This should lead to a better qualitative understanding of mining impacts on the stream and may lead to further lines of inquiry.

Many of these data sources have already been gathered by ODNR, the LCWG, or other investigators. In this work, we will compile additional information as described above; analyze the entire data set in terms of mining impacts, sediment transport, flooding effects, and fish habitat; and provide a comprehensive summary of the data sources and analysis in the final report for this project.

Task 2: Physical and Chemical Characterization of Sediment

We intend to characterize the sediment present in the stream channel and banks so that its origin (AML, agricultural fields, or natural) and age can be ascertained. This will depend on identifying some feature in the sediment to distinguish old sediment from new sediment or to distinguish different sediment sources. Thus, sediments from a number of locations will be analyzed for a variety of chemical and physical properties.

First sediment in Little Leading Creek will be characterized. Hand advanced cores that collect vertical profiles into sleeves will be collected at several locations in the stream channel and banks with recent deposition. The deposits will be logged in the field as deep as possible (expected 5 feet) and samples collected from significant strata for analysis. For comparison, representative sediments will be collected and analyzed from various possible initial sources, including exposed surface mines, pasture, and several tributaries. Third, sediment from baseline watersheds identified in Task 1 will be collected as representative of sediments from the same general geology yet not impacted by mining. Fourth, at several locations in the lower reaches of the watershed, detailed soil boring will be performed to determine if the pre-mining floodplain can be identified. A truck mounted drilling rig available from ODNR Division of Mineral Resources Management (DMRM) will be used to conduct continuous split spoon sampling up to a depth of 20 feet. Sediments will be logged and samples collected from significant strata for analysis. Finally, if old river channels can be identified and aged with aerial photos they will be sampled using hand advanced cores to identify sediments typical of a specific time period.

Sediment characteristics that distinguish mining impacted sediment from agriculture impacted sediment and non-impacted sediments may be obvious, such as a color difference or the presence of coal fines. Additional increasingly sophisticated analyses will be performed to improve distinction. All analyses will be performed on triplicate samples to assess variability within the deposit as well as from among different sources. Sediments will be acid extracted and analyzed for mine impacted metals such as Fe, Al, Mn, Zn, and Cu. Total organic carbon may also be performed to measure either organic matter or coal fines. Particle size distribution analysis may also prove useful for identification, although deposition events tend to sort particles, so a strong correlation between source particle size and deposit particle size may not exist. Particle size distribution comparison with the baseline watersheds may be fruitful however. Finally, powder x-ray diffraction is capable of identifying mineral content on the surface of sand particles, and may be useful to distinguish sediment sources. In addition, a comprehensive literature search will be conducted to identify other state-of-the-art techniques for sediment aging. All of these methods will be screened for their usefulness on selected samples.

River substrate collected from these sampling events will also be assessed for its suitability as macroinvertebrate and fish habitat. Sediment depth, substrate embeddedness, particle size distribution, sediment chemical analysis results, and mineral type may all be considered as indicators for poor habitat. Macroinvertebrate and fish survey results will be compared with substrate indicators to look for correlations in the data.

Task 3: Sampling of Sediment Depth and Movement

Generally 75-95%, of sediment transport occurs as suspended sediments, although a greater proportion of the large sediment fraction is moved by bed-load transport (Yang, 1996). Total transport by both transport mechanisms predominantly occurs during storm events (typically 70%). As a result, samples will be collected from the water column and analyzed for suspended solids from a number of locations on a monthly basis during normal flow periods (no rain in 4 days preceding sampling). Stream flow velocities and water depth will be measured at intervals across the creek at these locations to determine flow rate, which will allow calculation of sediment load. These locations will also be sampled semiannually during heavy storm events. Second, bed load transport will be estimated using constructed sediment traps, sunk in the creek beds at several locations. Sediment accumulating in the traps will be emptied and weighed after several hours or several days, depending on how quickly the traps fill. Bed load transport rates will be measured monthly at a number of fixed locations, as well as semiannually during storm events. A comprehensive literature review will be conducted and several sediment trap systems will be tested for usefulness in this study.

Sediment depth in the channel and bank will be surveyed at a number of locations along the creek on a monthly basis. Several rapid techniques for measuring sediment depths will be tested including hand borings, hand dropping hammer penetrometers (as described by the LCIP), and remote sensors. Ideal locations, measuring technique, and frequency will be recommended in the final report for further sampling as part of a long-term monitoring plan.

Task 4: Development of HEC Models

In order to predict locations of future flooding risk and estimate rates of sediment scour, deposition, and transport within the creek, two models will be developed of Little Leading Creek. HEC RAS v. 3.1.1 is a state-of-the-art modeling package for water analysis of river systems and is capable of predicting water surface profiles throughout the river for a variety of flow conditions. Once calibrated, the HEC RAS model will allow predictions of flooding risks as Little Leading Creek is altered by further sedimentation or planned restorations. The model will also be useful to apportion the percentage of flooding due to residual mining impacts. First, river cross-sections and slopes will be collected using Total Station surveying equipment. Locations will be selected based on model requirements and corresponding to previously surveyed locations. Select locations will be surveyed semiannually in this study to observe changes in the channel. Stream flow velocities and water depths will also be measured at these locations to determine creek discharge and pebble counts will be conducted to determine the particle size distribution of creek sediment. During these sampling events all stream crossings will be inspected to determine if they are of adequate size and the role they play in flooding. This data will be used to calibrate a HEC-RAS model of the creek and will be integrated with the current GIS database available for the watershed.

Although, HEC RAS is a powerful tool for analyzing river systems, it is not capable of predicting sediment movement. HEC 6 v. 4.1, developed to model scour and deposition of sediments in river systems, will be used to this end in Little Leading Creek. A HEC 6 model will be calibrated using the data collected in the previous tasks, to better understand the primary factors that control sediment movement in Little Leading Creek and to predict future changes in the creek bed and banks due to current sedimentation trends and proposed restorations. Output from this model will in turn be used as input into the HEC RAS model, so that predicted changes in creek channel and bank elevation from the HEC 6 model can be used in the HEC RAS model to determine the impact on flooding events.

Task 5: Restoration Recommendations

Ultimately, this research will assess options for improving the macroinvertebrate and fish habitat in Little Leading Creek and reducing the frequency and severity of flooding.

First, a thorough analysis of all data available on Little Leading Creek and the baseline watersheds will be conducted including macroinvertebrate surveys, fish surveys, QHEI, water quality, sediment chemistry, and substrate quality. A multivariate correlation analysis will be performed to estimate the primary stream factors that affect fish habitat in Little Leading Creek. Restoration activities to improve fish habitat will target improving those factors most closely linked to habitat degradation.

A literature review will be performed and numerous vendors consulted to identify flooding mitigation and habitat restoration alternatives, evaluate the success of past operations, and identify novel approaches. If it is determined that significant sources of sand to the watershed exist, land-based activities to stabilize those sources will be investigated. Mitigating sediment sources will be a primary objective. In addition, in-stream activities will likely be necessary to remove or stabilize the excessive quantities of sand currently in the streambed. Fish habitat will likely not be restored until the streambed substrate is improved. A comprehensive list of options will be developed for this activity, including options such as natural stream design techniques, passive sediment extraction, dredging, current deflectors, bank stabilization, and substrate augmentation. Similarly, innovative and respected vendors will be contacted for alternatives, including companies such as Streamside Systems, LLC. (Findlay, Ohio), JFNew (Walkerton, Indiana), and Oxbow River and Stream Restoration, Inc. (Delaware, Ohio). Where appropriate, flooding mitigation and habitat restoration options will be assessed for its application to Little Leading Creek using the developed flow and sediment transport models.

A creek segment will be identified to test several low-cost in-stream restoration alternatives and invite vendors to demonstrate equipment or services. These preliminary tests will be short in duration (several months), but will identify the feasibility and potential of several options. Additional thorough testing of these restoration alternatives (beyond the scope of this project) may be necessary before full-scale implementation. Several ranked recommendations will be provided based on this initial assessment. It may be determined that different activities are optimal for flooding mitigation and habitat restoration

Deliverables

During the course of this investigation, progress reports will be provided to ODNR by the first week of each quarter. Project status will also be presented at six meetings scheduled over the course of the two-year project, after the completion of major tasks. At the end of the project, a final report will be prepared as well as a long-term monitoring plan that meets the goals of the LCIP.

Project Management

Two graduate students will be employed for the duration of the project. One student directed by Dr. Riefler will focus primarily on chemical and physical sediment characteristics, source identification, impact to fish habitat, and habitat restoration options. A second student directed by Dr. Chang will focus primarily on sediment accumulation and transport within Little Leading Creek, impacts on flooding, developing flow and transport models, and flood mitigation options. Dr. Stuart will oversee several technical aspects of the project, including sediment characterization, sediment transport assessment, habitat restoration, and flood mitigation and liaison with key personnel outside of the project. All personnel will work closely together, and most sampling events will require both graduate students regardless of whether the focus of the sampling event is flood mitigation or habitat restoration.

Budget

Per request, the budget has been divided between the two goals of flood mitigation and habitat restoration. Because the two goals are tightly linked, there is tremendous overlap in the effort required to address each goal, and consequently there are significant cost savings when carried out simultaneously. The costs described in the flood mitigation and habitat restoration budgets are based on the fact that the two goals will be investigated simultaneously. Costs would be higher to investigate flood mitigation or habitat restoration individually.

Flooding Mitigation Budget

Categorized expenditures are provided in the attached budget table. Personnel consist primarily of one graduate student and one undergraduate student for the calendar years of 2005 and 2006. Graduate student cost is based on a Research Assistant (RA) contract of $3,700 per quarter in 2005 and $3,848 per quarter in 2006. The undergraduate student is paid $10 per hour for 10 hours per week in fall, winter, and spring quarters for 2004 and 2005. Travel is paid at the rate of $0.36/mile. Round trip distance from Ohio University to the site is approximately 60 miles and from Ohio University to the ODNR Columbus office is approximately 150 miles. Supplies are estimated and include the cost of producing two posters for conference presentations. Indirect costs are charged at the State of Ohio rate of 25% of all direct costs, not including equipment. Ohio University will provide the use of personal computers, analysis/modeling/GIS software, and stream monitoring equipment purchased previously for other ODNR projects.

PERSONNEL:		
1 Graduate Student (2 years)		$ 30,192
1 Undergraduate Student (2 years)		$ 13,000
Benefits		$ 378
	sub-total	$ 43,192
SUPPLIES:		
Task 1		$ 200
Task 2		$ 750
Task 3		$ 3,200
Task 4		$ 400
Task 5		$ 0
posters		$ 60
	sub-total	$ 4,610
TRAVEL:		
Task 1		$ 43
Task 2		$ 173
Task 3		$ 324
Task 4		$ 508
Task 5		$ 0
project meetings		$ 189
	sub-total	$ 1,237

TOTALS

Direct costs	$ 49,417
Indirect costs	$ 12,354
Project total	$ 61,771

Habitat Restoration Budget

Categorized expenditures are provided in the attached budget table. Personnel consist primarily of one graduate student for the calendar years of 2005 and 2006. Graduate student cost is based on a Research Assistant (RA) contract of $3,700 per quarter in 2005 and $3,848 per quarter in 2006. One month summer salary is requested for Dr. Riefler in 2005. Travel is paid at the rate of $0.36/mile. Round trip distance from Ohio University to the site is approximately 60 miles and from Ohio University to the ODNR Columbus office is approximately 150 miles. Supplies are estimated and include the cost of producing two posters for conference presentations. Indirect costs are charged at the State of Ohio rate of 25% of all direct costs, not including equipment. Ohio University will provide the use of personal computers, analysis/modeling/GIS software, and stream monitoring equipment purchased previously for other ODNR projects.

PERSONNEL:		
1 Graduate Student (2 years)		$ 30,192
Faculty (1 summer month for Riefler)		$ 6,895
Benefits		$ 1,314
	sub-total	$ 38,401
SUPPLIES:		
Task 1		$ 0
Task 2		$ 1,300
Task 3		$ 1,430
Task 4		$ 0
Task 5		$ 1,000
posters		$ 60
	sub-total	$ 3,790
TRAVEL:		
Task 1		$ 108
Task 2		$ 108
Task 3		$ 324
Task 4		$ 400
Task 5		$ 173
project meetings		$ 189
	sub-total	$ 1,302
TOTALS		
	Direct costs	$ 43,493
	Indirect costs	$ 10,873
	Project total	$ 54,367

GANTT CHART

MILESTONE	Win 2005	Spr 2005	Sum 2005	Fall 2005	Win 2005	Spr 2006	Sum 2006	Fall 2006
T1: Review historical data		■	■					
T1: Survey baseline watersheds	■							
T1: Conduct interviews			■					
T2: Collect sediment cores			■	■	■	■		
T2: Sample potential sediment sources and baseline watersheds			■	■	■	■		
T2: Collect soil borings in floodplain			■					
T2: Test several sand analysis techniques	■	■	■	■	■	■		
T3: Testing of sediment traps	■	■						
T3: Bedload sediment collection	■	■	■	■	■	■	■	■
T3: Suspended sediment collection	■	■	■	■	■	■	■	■
T3: Storm sediment collection	■		■		■		■	
T3: Develop sediment depth test	■	■						
T3: Survey sediment depth	■	■	■	■	■	■	■	■
T4: Survey cross-sections and profiles	■		■		■		■	
T4: Develop HEC RAS model					■	■	■	■
T4: Develop HEC 6 model					■	■	■	■
T5: Assess restoration options							■	■
T5: Test selected restoration actions							■	■

Exhibit B

Mussel Resurvey and Reintroductions to Leading Creek

Proposal to SOCCO

Proposed by:

G. Thomas Watters, PhD
Museum of Biological Diversity
Ohio State University
1315 Kinnear Road
Columbus, OH 43212
614-292-6170
Watters.1@osu.edu

May 2004

Introduction and Justification

Following the dewatering of the Meigs 31 Mine into Leading and Raccoon Creeks, all freshwater mussels were killed. Watters had surveyed both creeks in 1987: six sites in Leading Creek, 26 in Raccoon Creek. At that time mussels were common in Leading Creek, comprising ten species, none of which were listed by ODW or USFWS. Raccoon Creek was heavily impacted by acid mine runoff and mussels were only found in the extreme headwaters in several impoundments. As part of mitigation methods to return mussels to Leading Creek, adult mussels were transplanted from neighboring systems into several sites in Leading Creek and monitored for reproduction. Many of these mussels persisted until as late as 2001, and evidence was found of one transplanted species having reproduced. In 2001 the original six survey sites in Leading Creek were resurveyed. No evidence of any of the transplanted mussels was found and we suspect they had been removed by vandals.

Based upon the very limited amount of mussel recruitment seen in Leading Creek, we believe that stream conditions have recovered to the point where mussels may be successfully reintroduced. Contrary to earlier opinions, the mussel fauna of Leading Creek will require decades to recovery if left to its own devices. We suggest the introduction of propagated mussels into the creek to significantly accelerate the recovery process.

Because the original survey of Leading Creek was only a small part of a large survey effort across southern Ohio, only six sites were originally sampled. At that time there was no way of predicting the future importance of that small survey. We suggest a more comprehensive survey of the system as an additional part of this mitigation in order to establish a better baseline for future changes in the mussel fauna.

Methods

Survey work will be conducted during low water in summer or early fall. At least 20 sites will be surveyed and all sites will be recorded by GPS position. Dead specimens will be vouchered at the Ohio State University Museum of Biological Diversity. Live specimens may be taken for propagation work.

Propagation will be conducted at the Columbus Zoo & Aquarium Freshwater Mussel Research and Conservation Facility in Shawnee Hills. That facility may be viewed at:

http://www.biosci.ohio-state.edu/~molluscs/OSUM2/columbus_zoo.htm

Of the original ten mussel species we will attempt to propagate a minimum of five species. The choice of the species will be determined by the availability of gravid female mussels. Because we do not anticipate finding sufficient numbers of mussels in Leading Creek for propagation work, gravid females will be taken from neighboring streams. Preserving the genetic integrity of the original Leading Creek mussel populations is not an issue here – all original populations were destroyed. We anticipate using mussels from adjacent Pine, Symmes, Scioto Brush, and Salt Creeks. These populations probably are the most closely related to the original Leading Creek fauna.

Mussels are propagated by infesting suitable host fish with the parasitic larvae of the mussels. Once the larvae transform and leave the fish, the juveniles may be either immediately released into the creek or reared in captivity until a larger size is reached before release. It is believed that the larger the individual mussel is allowed to grow, the better chance it has for survival once released. However, procedural problems with raising mussels in captivity warrant a mixed released program. We suggest releasing half of the propagated mussels as newly transformed juveniles and placing half in holding. Reintroduction sites will be chosen based on faunal presence from pre-impact surveys, as well as potential new sites based on the new survey work. We anticipate that upwards of 500 individuals of each species will be propagated.

These reintroduction sites would be monitored annually for five years. The cost of the monitoring is included in the budget of this proposal. The presence of juveniles, all of the same age at a relocation site, will be taken as evidence that they are propagated survivors rather than naturally occurring mussels.

Timeline

We are requesting funding for one year. Survey work would commence in the summer or early fall. Most of the mussel species in Leading Creek were of the type that are gravid in the fall. Juveniles would be propagated in the fall and half of the juveniles released. The remaining half would be held in captivity until the following spring and then released. An additional round of propagation could be conducted the following spring and summer. Ideally the funding would commence in September.

Deliverables

The results of the survey would be in a GIS format (ArcView, etc.) with database and commentary. Data on the relocation sites, numbers and species propagated, and monitoring efforts will be supplied as they become available.

Budget

We are requesting support for one year for a technician to conduct the survey and propagate the mussels, plus additional funds for travel. The technician would be housed at the Columbus Zoo Mussel Facility. The funds will be administered through either the Ohio Department of Natural Resources Division of Wildlife or the Columbus Zoo and Aquarium. The final version of this proposal will be sent to that agency.

	rate	# units	totals
salary	$11.00	2080 hrs	$22,880.00
benefits	30.20%		$6,909.76
mileage	$0.36	1000 miles	$360.00
miscellaneous			$1,000.00
			$31,149.76
overhead	5.80%		$1,806.69
TOTAL			$32,956.45