Farris
1999

Project Proposal: Propagating and reintroducing native unionid species into the recovering Strawberry River in northeastern Arkansas

I. Success of the goal to restore impacted mussel populations will be very difficult to evaluate because a potpourri of different methods, species, and sites are proposed.

II. A. The proposal does address a valid conservation need, although no review of the current status of mussels in the river is provided.

B. It can meet the objective but I question whether success or failure can truly be evaluated.

C. The proposed methodology includes lab produced juveniles from host fish, release of infested host fish, translocation of gravid adults, and in vitro-produced juvenile mussels. With this shotgun approach to augmentation of populations, how does the researcher propose to determine which method(s) are most successful. The management goal (augmentation) is good, but the science lacks rigor.

D. Releases of cultured juvenile mussels into the Clinch and Powell rivers, TN

E. The partners have been assembled to participate in actual recovery efforts of species.

F. The focus of the project should be the production and release of the 4 rare species first, followed by release of the other species, which are largely common in many parts of their respective ranges. Project success will not be the number of successfully transformed juveniles released into the river (as stated on p.5), but whether sufficient juveniles survive to augment natural reproduction by the various species.

III. The P.I. and his cooperators are qualified to conduct this project.

IV. A. The budget seems a little high for a 1 year effort, and the 1 year period infers that no follow-up will be mandated. The supplies category seems high for a 1year project.

B. No, because the focus is not on rare species.

V. A. If the P.I. was more rigorous in design and provided an evaluation of success, then the project would have broader management potential. As presently written, the project does not have broader management potential.

B. No, because no real evaluation of the various methods is to be conducted.

VI. My suggestion to the P.I. is that he focus on 1 or 2 methods of release and compare the success of each within a 3 year time frame. Unless the study is designed to demonstrate measurable results toward conservation of 1 or more species, the project lacks scientific merit. The project will produce warm and fuzzy feelings of good intentions, but no measure of success in recovery of the mussel fauna.

NFWF FAX Transmission

1120 Connecticut Ave; Suite 900
Washington, DC 20036

BBN

To: Richard Neves

VPI

Telephone number: 540-231-5927

Facsimile number: 540-231-7580

Pages 15, total.

From: Pamela K. McClelland

Bring Back the Natives Coordinator

Telephone number:202-857-0166 Facsimile number:202-857-0162

Electronic mail: mcclelland@nfwf.org

March 22, 1999

Dear Dick,

Would you be willing to help me out on a review of this project?

Please feel free to comment on as many aspects of the project as you want to. I am most interested in your opinion on the science and on the the usefulness of this project.

Also I would like to talk with you on raising the non federal match for your project. We received written approval on your project on Friday and have been able to raise another $15,000 non-federal funds from the Munson Foundation. We gather that the Nature Conservancy may be able to raise more funds. If this is possible I am willing to telephone them.....

I will try and reach you again tomorrow.

Many thanks,

Pam

National Fish and Wildlife Foundation Grant Application

Deadline: Close of Business

Incomplete applications will be returned to applicant

APPLICANT INFORMATION

Organization (to be named as Grantee): Arkansas State University Ecotoxicology Research Facility
Street: 2645 Caddo St
City, State, Zip: State University, AR 72467
Homepage: www.csm.astate.edu/~biology/env/toxfacil.html

Project Contacts: Jerry L. Farris, Cristin D. Milam

Project Officer: Jerry L. Farris, Ph.D.
Tele: (870) 972-2570
Fax: (870) 972-2577
E-mail: jfarris@navajo.astate.edu

Financial Officer: Arlene Smith
Tele: (870) 972-2400
Fax: (870) 972-3818
E-mail: asmith@omaho.astate.edu

Tax status: university status (i.e. non-profit, university, 501(c)(3)etc)
Tax ID#: 71-6000-556
Fiscal Year: 7 / 1 To 6 / 30

PROJECT INFORMATION

Project Name: Propagating and Reintroducing Native Unionid Species into the Recovering Strawberry River in northeastern Arkansas

Location(s) of Project:
City: Mammoth Spring
State: Arkansas
Country: USA
Congressional District: 1st District

Dates:
Project Start Date: 7-1-99
Project End Date: 7-30-00
Application Submission Date: 12-15-98

GRANT REQUEST

Use U.S. dollars (rounded to the nearest hundred) for all amount listed below:

NFWF Funds: $_____ (NFWF Federal Funds)
Challenge Funds: $_____ (Non-Federal Funds to be Raised by Applicant)
Total Grant Amount: $ 71,300 (NFWF Funds + Challenge Funds)

Sources of Challenge Funding:

Please list the names of organizations and the amounts they are donating to this project.

Received	*Amount*	*Application Submitted*	*Amount*
	$		$
	$		$
	$		$
	$	*Intend to Apply*	*Amount*
	$		$
	$		$
	$		$
	$		

Challenge funds raised by the grantee must be sent directly to NFWF from the donor. Donations must be received in the same fiscal year as the grant award. NFWF will not accept challenge funds from the grantee. If this is not possible, contact a NFWF representative.

PROJECT BUDGET

A) Budget Guidelines

The proposed budget must be in compliance with OMB circulars. Budget categories must be line items that specifically describe project costs, not program items or acronyms. For example, program categories such as "Education", "restoration", or "workshops" are not acceptable because they are too vague and do not indicate what is being paid for. These categories must be broken down into specific line items such as "Salaries", "Supplies" or "Equipment". The following are examples of line items:

Line Item	Additional Information the Applicant Must Provide
Salaries	Research Associate position 75% annual salary; Graduate Stipend for a 9-month appointment 100% salary; Project Coordinator for a 1-month summer salary
Travel	Weekly and monthly travel from ASU to the hatchery, as well, to several sites within the Strawberry River watershed.
Equipment	Equipment associated with field identification will include 2 dissecting scopes and light sources
Supplies	Supplies associated with *in vitro* propagation include antibiotics, antimycotics, serum replacements, culture dishes, amino acids, and glassware. *In vivo* supplies would include coolers, dissecting kits, seining equipment, pipettes, and buckets.
Contractual Services	Diving services associated with mussel collections
Printing/Promotion	na
Contributed Goods/Services	*Use of Mammoth Springs National Fish Hatchery, its vehicles, boats, shocking equipment, holding house, and lodging amount to approximately $ 42,000 in contributed goods to support this project. Contributed salaries for project personnel from Arkansas State University, Arkansas Dept. of Transportation and the Arkansas Game and Fish Commission amount to approximately $ 59,750 in contributed services to support this project. Contributed goods from Arkansas State University to support *in vitro* laboratory transformations amount to approximately $ 29,000.

Overhead/Indirect Costs

NFWF Federal Funds CANNOT be used for overhead or indirect costs of any kind. Challenge funds may be used for overhead costs specifically related to the project if justification is provided as to how the amount was determined. No funds may be used for general administrative overhead.

B) Budget Form

Use U. S. dollars (rounded to the nearest hundred) for all amounts listed below.
NOTE: List only financial line items under the column "Budget Category . Contributed Services should be included under Challenge Funds.

Budget Category	Expense per Category	Challenge Funds	NFWF Funds
Salaries			$ 38,430
Travel			$ 10,400
Equipment			$ 3,200
Supplies			$ 11,070
Contractual Services			$ 8,200
Printing/Promotion			
Contributed Goods/Services	$ 130,750 including use of federal facilities $ 88,750 not including federal facilities		
Totals			**$71,300**

If this space is not adequate, please use the same format on a separate sheet of paper.

*If the overall budget for this project exceeds the total NFWF grant amount (including both Challenge and NFWF Funds), please attach a copy of the overall project budget.

AGENCY/PEER REVIEWERS

The purpose of the agency and peer review is to provide NFWF with a critical review of pending projects reflecting a range of disciplines, expertise, and view points. Peer reviewers should not be affiliated with the applicant's organization (e.g. Board of Directors) or stand to directly benefit from the proposed project. All proposals submitted to NFWF are subject to review by a local congressional delegation.

The applicant must submit the proposal for review to one reviewer from each of the following categories:

A. Federal (USFS, BLM, etc.) or State wildlife or land management agency in your area;
B. Conservation/Environmental organization;
C. Academic institution;
D. Resource industry or corporation (e.g. timber, mining, and grazing interest); and
E. U. S. Fish and Wildlife Service (if the wildlife refuge is NOT submitting the application).

The applicant must ensure that these reviewers (minimum of 5) submit their comments directly to NFWF no later than the application due date (i.e. March 3, 1998). NFWF reserves the right to require the applicant to send this proposal to additional reviewers selected by NFWF. All reviews submitted to NFWF are kept confidential.

You must send copies of your application directly to the reviewers listed below with copies of the NFWF Reviewer Guidelines (attached).

A) Name: Roger Schulz Title: Area Manager – AR Ozark Region
Organization: U.S. Fish & Wildlife Service Phone/Fax: 404-679-4157 / 404-479-4141
Address: 1875 Century Blvd. Atlanta, GA 30345

B) Name: Brian Wagner Title: Biologist
Organization: Arkansas Game & Fish Commission Phone/Fax: 501-847-3611 / 501-676-2734
Address: 23 Joe Hogan Lane Lonoke, AR 72086

C) Name: Nancy DeLamar Title: State Director
Organization: The Nature Conservancy Phone/Fax: 501-663-6699 / 501-663-8332
Address: 601 North University Little Rock, AR 72205

D) Name: W. Gregory Cope, Ph.D. Title: Associate Professor, Environmental Toxicology
Organization: North Carolina State University Phone/Fax: 919-515-2274 / 919-515-7169
Address: Box 7633 Raleigh, NC 27695-7633

E) Name: John Van Hassel Title: Environmental Biologist
Organization: American Electric Power Service Corporation Phone/Fax: 614-223-1249 / 614-223-1252
Address: 1 Riverside Plaza Columbus, OH 43216-6631

SIGNATURE OF APPLICANT *(an original signature page must be received with this application)*

I certify that the above information is true and accurate.

1. Jerry L. Farris
Name of Executive Director or Project Officer

2. 
Signature

3. 12-12-98
Date

PROPOSAL NARRATIVE

SUBMIT SIX (6) COPIES BY MAIL OF THIS APPLICATION AND NARRATIVE IN THE FOLLOWING FORMAT:

I. Two-sentence Project Summary

II. Project Abstract - (one page maximum) to include:
- A. Project Description
- B. Why NFWF should fund your project;
- C. Partner Justification (strengths of your organization and other collaborating organizations);
- D. Final Product(s).

III. Proposal
- A. Project Need-describe the conservation need(s) the project will address;
- B. Objectives - list the project's specific objectives;
- C. Methodology – describe the project's methodology and timetable for implementation;
- D. Research/Management Implications - describe anticipated project results/outcome;
- E. Evaluation – describe the strategy for monitoring and evaluating program results, including how success will be defined and measured.
- F. Overall context – if this proposal is part of a larger program, please describe the larger Program and how this component is integrated.
- G. Dissemination – describe how the results of the project will be communicated to appropriate Audiences.

NOTE: *To make photocopying easier, please do not staple or bind proposals.*

National Fish and Wildlife Foundation

REVIEWER GUIDELINES

ALL REVIEWS SUBMITTED TO NFWF WILL BE KEPT CONFIDENTIAL

Please return your comments on your organization's letterhead to at the address below.

Project Name: Propagating and Reintroducing Native Unionid Species into the Recovering Strawberry River in northeastern Arkansas

Reviewer's Name: _____

Institutional Affiliation: Arkansas State University

I. SUMMARIZE in one sentence your position regarding the proposal.

II. EVALUATE the benefits of the proposed project to the *conservation* and *management* of fish, wildlife, and plant resources.
- A. Does the proposal address a real conservation or management need?
- B. Can the project accomplish the stated objective?
- C. Do you believe that the project's goal can be achieved under the proposed methodology?
- D. Are you aware of other projects, currently underway or proposed, which address this need?
- E. How will this project facilitate cooperation between federal, state, and private organizations?
- F. What is the weakest part of this proposal?

III. ORGANIZATIONAL QUALIFICATIONS: Please assess the ability of the principal investigator and/or sponsoring organization to conduct the proposed work.
- A. Are you aware of any conservation-related litigation in which this organization is currently a party?

IV. BUDGET:
- A. Is the proposed budget reasonable?
- B. Are you aware of other sources of funding, public or private available for this project?

V. APPLICATIONS:
- A. Evaluate the broader applied management potential of the proposed work.
- B. Will this project assist in your agency's or organization's fish, wildlife, and plant activities?

VI. ADDITIONAL (Optional): Technical and other comments/suggestions to be provided by NFWF directly to the applicant.

National Fish and Wildlife Foundation/1120 Connecticut Avenue, N.W./Suite 900/Washington, D. C./20036
Phone 202/857-0166 Fax 202/857-0162 Email projects@nfwf.org

National Fish and Wildlife Foundation
Full-Proposal

I. **Project Summary:** Current efforts to initiate the recovery and enhancement of the Strawberry River in Northern Arkansas offers the opportunity to utilize developed culturing techniques to restore impacted mussel populations. Improved water quality and basin management changes assures support for reintroduced juveniles and gravid adult unionids, as well as introduction of glochidia-infected host fish.

II. **Project Abstract:**

Conservation initiatives for the Strawberry River Watershed are underway in the eastern Ozarks in northeast Arkansas. The Strawberry has been identified by the NRCS as the fourth highest priority for watershed restoration in the state and by the Nature Conservancy as a critical watershed for conservation of the nation's freshwater biological diversity. This diversity is reflected in the 100 fish and 30 mussel species reported for the river, 16 of which are globally imperiled. Of those reported mussel species, four are rare yet having viable populations in a river that is hydrologically intact with no major dams or diversions present in the watershed. Six common species have been successfully propagated using host fish and are available for reintroduction efforts in habitat that has been previously altered by bad land use practices.

Techniques for successfully culturing unionid species in laboratory and hatchery facilities have been utilized for the past three years at Arkansas State University and Mammoth Spring National Fish Hatchery. Both *in vivo* and *in vitro* artificial culture techniques using host fish and tissue media were used to produce viable juveniles. Those efforts have resulted in transfer, maintenance and culture of fish and unionids for a recovering watershed in southeastern Ohio. The seasoned experience of University and hatchery workers will be valuable to implement techniques in an Arkansas watershed harboring species of more critical interest.

The project's goal is to not only produce viable juvenile mussels for reintroduction into specific segments of a recovering river, but to also increase government agency and public awareness of the plight of mussels and the benefits of maintaining the ecological integrity of aquatic ecosystems. The coalition that includes Arkansas State University, The Nature Conservancy, the U.S. Fish and Wildlife Service and the Arkansas Game and Fish Commission is well suited to engage local groups and landowners to establish a community-based conservation initiative. The coordination of this initiative is now well underway but does not have a specific component dedicated to the mussel restoration effort. All partners with the exception of the Nature Conservancy have been heavily involved with mussel restoration efforts in Arkansas and the strength of their involvement with strategies for the conservation of native freshwater mussels has been shown in work with mussel collection, transfer, and holding. The Mammoth Spring National Fish Hatchery has been used to provide refugia for mussels during the past two years and its personnel have an appreciation and expertise dedicated to such work. The partnerships formed with mussel conservation and an ongoing watershed restoration seems well suited for support from the National Fish and Wildlife Foundation.

III. Proposal

A. PROJECT NEED:

Freshwater mussels have comprised the largest group of threatened and endangered species for the last 10 years. As such, freshwater mussels should serve as suitable indicators of environmental change in streams and rivers and validate corrective actions on water quality, physical habitat degradation and exotic species expansion. Recent efforts to establish a national strategy for the conservation of native freshwater mussels have stressed the lack of understanding by the public about the plight and value of mussels. Many of the actions required to conserve molluscan diversity worldwide can be addressed by the work within the Strawberry watershed and include the establishment of self-sustaining populations in critical habitats and involving the public in such efforts to heighten awareness and concern for molluscan conservation programs. Mussel use of fish hosts and critical water quality factors related to basin management are tangible objects resulting from conservation measures. Quantifiable results can serve as a future feedback to stakeholder participants from the Strawberry River basin. There now exists a nascent interest in sustainability within the watershed but this has yet to fully materialize. An established interest in a biomonitor that requires long-term commitments can serve to activate community alliances to initiate their own conservation, prevention and recovery activities. The ability to establish not only reintroduced and relocated individuals but also fish with encysted glochidia, is the first step needed in a return to viable populations in the watershed.

B. OBJECTIVES:

1) Apply proven juvenile mussel transformation techniques for indigenous species of the Strawberry River

2) Release basin specific genetic stock of juvenile mussels in suitable habitat and host fish carrying encysted mussels into the river

3) Initiate creative partnerships for mussel conservation activities among Federal, state, and local government agencies, universities and the private sector

C. METHODOLOGY: Mussel Propagation

Mussels for propagation will be collected from basin specific populations and managed as genetic units throughout reintroduction activities. All transformations will include *in vivo* and *in vitro* artificial culture techniques currently in use at the National Hatchery and at ASU. Standard Operating Procedures will be followed with regards to quarantine of individuals and management for control of nuisance organisms during hatchery handling. The facilities at the university and hatchery will be included as in recent development projects utilized in cooperative agreements and their Memorandum of Understanding. Scheduling timetables will be dictated by glochidia maturity for all species utilized in this project. Seasonal surveys coupled with published data will aid in more efficient glochidia collection and will commence within one year of the starting date.

in vivo Laboratory

Gravid mussels will be collected from locations throughout the Strawberry River basin and will include those unionids most commonly known to inhabit this system, as well as the addition of some of the rarer species that have also been identified in this river (Appendix 1). Individual species will be identified in the field and checked for gravidity, glochidial maturity and viability. Glochidia will be considered mature if valves were open and free of any embryonic case. A subsample of mature glochidia will be removed from the gills using an 18-gauge needle and will be checked for viability using a concentrated sodium chloride solution (NaCl). A drop of NaCl will be added to the mature glochidia and viability noted if glochidia responded with a snap-closure of the valves (Zale and Neves, 1982). Individual adult mussels that were identified as having mature, viable glochidia will be transferred to the Arkansas State University Ecotoxicology Research Facility and held in laboratory flow-through tanks receiving dechlorinated tap water and fed a tri-algal mix (*Ankistrodesmus*, *Chlorella* and *Selenastrum*) weekly. Glochidia from these adult mussels will be excised from gill pouches by removing the inflated gills and placing the pooled marsupia into a petri dish containing moderately hard synthetic water.

Prior to infection of fish with glochidia, potential fish hosts will be collected from the warm fork of the Spring River in Fulton County, AR and transferred to Mammoth Spring National Fish Hatchery for holding. Host fish will be held in concrete tanks on hatchery grounds one week prior to encystments. Fish will be removed from tanks, infected with glochidia , and placed into tanks for an excystment period of 2-4 weeks (Zale and Neves, 1982).

Fish with encysted glochidia will be isolated in flow-through monitoring tanks (190 L) and siphoned twice weekly during holding periods in order to determine success of *in vivo* laboratory techniques. Following a species-specific excystment period that should range from 10-18 days, a final siphon will used to collect juvenile mussels from the tank bottoms. Juveniles will be transferred to small holding chambers suspended in a flow-through trough receiving hatchery water. Cultures will be fed a tri-algal mix and yeast, cerophyl and trout chow (YCT) solution daily.

in vivo On Site

Gravid mussels collected in the basin will be used to infect host fish on site. Prior to infection of fish with glochidia, potential fish hosts will be collected from the Strawberry River in Lawrence and Sharp counties, Arkansas by either shocking or seining methods and held in temporary corals near the banks of the river. Fish will be checked for recovering conditions, infected with associated glochidia , and replaced into riverine corals to assure the glochidia are attached. Once checked for attachment, the fish will be released into the river.

When possible, gravid mussels will be introduced into the Strawberry River from the White River Basin. These individuals will be tagged and monitored for survival and glochidia release throughout the year.

in vitro Laboratory

This method has been successfully used to artificially transform and grow juvenile freshwater mussels for use in propagation and as test organisms in acute toxicity tests (Isom and Hudson, 1982). The ability to produce large numbers of juvenile mussels of known age and maternal origin is one of the advantages of using this culturing technique. Two culture solutions, rabbit serum (RB) and rabbit-CPSR (KS), will be used as the media for all collected glochidia (Barfield et al., 1997, Milam et al., 1998). Viable glochidia will be collected from the marsupial pouch and glochidia rinsed and held in Unionid Ringers solution (a buffer solution consisting of 2.2 g $NaHCO_3$, 1.2 g CaCl, 1.0 g $MgCl \cdot 6H_2O$, 1.53 g NaCl, 0.099 g KCl / 1.09L of deionized water) until introduced onto media. Glochidia will be introduced onto inoculated petri dishes and placed into an incubator, where appropriate CO_2 (4.6 - 5.0%), pH (7.2 - 7.3), and temperature (24 □ 1°C) will be maintained. Cultures will be inspected daily for fungal and bacterial growth and treated using 0.075 ml of nyastatin and rifampin, respectively. Cultures that survive infection will be monitored for morphological changes associated with transformation. Depending on species, transformation should take place between 5 and 16 days post-media exposure as indicated by internal movements and organ development. Juveniles that transformed from this method will be transferred to a 250-ml beaker containing 150 ml Strawberry River water and fed daily 10 ml/L of YCT. After 24 hours, two grams riverine silt/L will be added to the holding chambers and renewed every other day thereafter. Once the juveniles have been transferred to the silt chambers, an additional food source of tri-algal solution (10 ml/L with algal cell concentrations equivalent to 3.2 x 10^7) will be given to each chamber. Juveniles will be checked for growth and survival immediately following excystment from fish or transformation in artificial media. Juvenile mussels will then be transferred to the Strawberry River and placed in sections of the river where mussel beds have been known to survive.

D. RESEARCH/MANAGEMENT IMPLICATIONS:

The anticipated results and outcome this project will provide for implementation of goals and strategies for mussel conservation include:

1) Identification of potential partners (landowners, agency personnel and conservation groups) to assist in the protection and recovery of key mussel habitats.
2) Identification of fish hosts and periods of spawning and gravidity for mussel species of interest.
3) Determination of species-specific physical and chemical habitat requirements for adults and juveniles.
4) Evaluation of best management practices and their impact on protection of mussel populations and their habitat.
5) Development of appropriate media and outreach for watershed audiences to strategically convey economic benefits of sustainability while maintaining the ecological integrity of aquatic ecosystems.
6) Implementation of glochidia transformation technology using artificial culture medium and host fish.

7) Implementation of mussel introductions using adult mussels and fish with encysted glochidia into optimum habitat within the Strawberry River watershed.

E. EVALUATION:

Monitoring adult freshwater unionids has been successfully attempted in many published projects. However, because of their complex life history, mussels are difficult to monitor within a short term due to their relatively slow growth rate. Measured success of these juvenile introductions is apparent upon release, while survival and growth evaluations could be seen as early as three years following release. This project will incorporate attempts to monitor the survival of released juveniles within the year by placing subsamples in situ immediately following transformation. Holding chambers will be anchored with reinforced rebar into the river bottom and will contain 105 µm mesh attached to each end, which allows water and selective particle exchange with the river's hydrologic processes.

Project success for the propagation of native unionids will be defined as the number of successfully transformed juveniles transferred to the Strawberry River (*in vivo* and *in vitro*), the number of glochidia-infested fish released during the year, and the number of gravid adults transferred from the White River basin. Integration of best management practices that protect declining populations, mussel habitats, and life history requirements will be used to evaluate the effectiveness of incorporating conservation efforts into the educational component of the watershed restoration plan.

OVERALL CONTEXT:

The mussel conservation and restoration effort will be an important component of a community-based conservation initiative in the Strawberry River watershed. That project's goal is to engage the local communities, including ranchers, businesses, schools, civic groups, landowners, and agencies of municipal, county, and state governments to form a framework for sustainable development in the watershed while conserving the river's rich ecological resources. Baseline biological, physicochemical, hydrological, and sociological data will be used to develop and implement a community-guided process and strategy for maintaining the watershed integrity while recognizing the environmental economics of cattle ranching in the region. This model may then be transferred to similar watersheds in the Ozark region at a much lower cost and with an awareness of mussel conservation needs. The reintroduction of mussels to previously known suitable habitats supported by improved water quality (as affected by reduced siltation and improved bank stabilization) will be integrated into the validation of support for biological communities in the watershed restoration. As ranchers move away from decades-old, non-sustainable behavior that leads to polluted water and sick cattle, improved water quality parameters will be used with mussels as biomonitors to quantify improved stream conditions. Various federal conservation programs such as the Conservation Reserve Program and Environmental Incentives Program will play key roles to help educate cattle producers of resource options that can lead to healthier herds while downstream communities and ranches will benefit from cleaner water. Finally, cleaner waterways are expected to certainly enhance regional tourism potential, an important and growing sector of the

Arkansas and the United States economy. The education component for mussel conservation is integrated as part of the community involvement for the watershed restoration as well as the ongoing public education program presented daily at the Mammoth Spring National Fish Hatchery and through publication and presentations.

F. DISSEMINATION:

Publication and presentation of the project results will occur in several arenas. Locally, within the watershed, the community alliance members will assist in putting together public meetings at which project personnel and state officials will present educational videos and slide presentations highlighting mussel conservation efforts. Partnership development and involvement with local landowners will be featured in news-related articles, television features, and classes within the environmental sciences program at Arkansas State University. Results of transformation and relocation efforts will be featured in project reports, manuscripts and conference proceedings.

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Appendix 1. Native unionid species known to inhabit the Strawberry River Basin

Species	Common Name	Fish Hosts	Gravid
Actinonaias ligamentina	Mucket	Large/Smallmouth Bass Green Sunfish Bluegill White/Black Crappie Sauger Rockbass	July – June
Amblema plicata	Threeridge	Channel/Flathead Catfish Shortnose Gar Largemouth Bass Green Sunfish Bluegill White/Black Crappie Sauger Rockbass	June – Aug
*Cyprogenia aberti**	Western fanshell	Goldfish Log Perch Fantail Darter	Dec.
Elliptio dilatata	Spike	Gizzard Shad Flathead Catfish White/Black Crappie	May – Aug
*Epioblasma triquetra**	Snuffbox	Banded Sculpin Log Perch	May - Jul.
Fusconaia flava	Wabash pigtoe	Bluegill White/Black Crappie	May – Aug
Lasmigona costata	Fluted shell	Common Carp	Aug – May
Lasmigona complanata	White heelsplitter	Orange-spotted Sunfish Common Carp Largemouth Bass Green Sunfish White Crappie	Dec – Apr
*Leptodea leiodon**	Scale shell	unknown	unknown
Ligumia recta	Black sandshell	Black Bass Banded Killfish Largemouth Bass Bluegill Green Sunfish White Crappie Sauger	summer; Nov - Apr
Obliquaria reflexa	Three-horned Wartyback	unknown	May – Sept

Appendix 1, contd. Native unionid species known to inhabit the Strawberry River Basin

Species	Common Name	Fish Hosts	Gravid
Potamilus purpuratus	Bleufer	Freshwater Drum	long term
*Quadrula cylindrica**	Rabbits Foot	Bigeye Chub Whitetail Shiner Spotfin Shiner	June
Quadrula pustulosa	Pimpleback	Shovelnose Sturgeon Black Bullhead White Crappie Channel/Flathead Catfish	June – Aug
Quadrula metanevra	Monkeyface	Bluegill Green Sunfish White Crappie	May - July
Tritogonia verrucosa	Pistolgrip	unknown	Apr – Aug ?
Truncilla truncata	Deertoe	Freshwater Drum Sauger	long term

*Rare species known to inhabit the Strawberry River, AR.