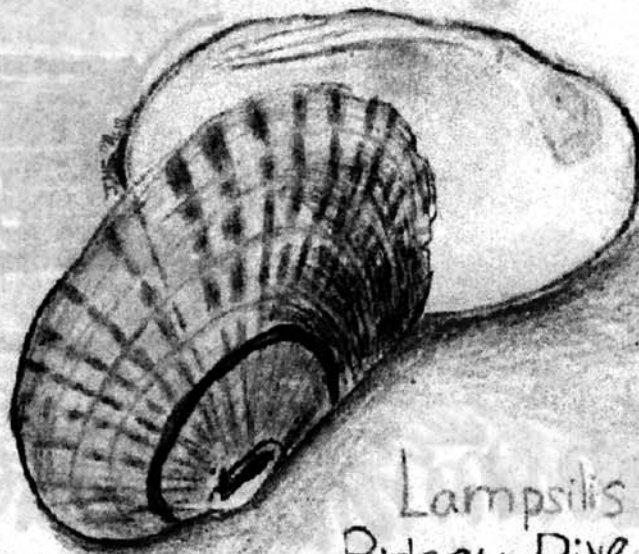


TRIENNIAL UNIONID REPORT

Report No. 16

November 1998

A forum for the informal exchange of information on the status of
North American unionid research, management, and conservation



Lampsilis radiata
Rideau River, below
Kilmarnock

Compiled by
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NOTE: The intent of this report is to expedite the exchange of information in an informal format. Report submissions were solicited from individuals and agencies involved in unionid conservation, copied as received, and assembled into this report. The submissions were **not** edited and were **not** peer reviewed.

FRONT COVER MUSSEL ART: THANKS TO JENNY SCHUELER, OXFORD,
STATION ONTARIO, CANADA.

INSIDE COVER MUSSEL ART: THANKS TO AMANDAN, ST. PAUL,
MINNESOTA, USA.



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NOVEMBER 1998

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Musseling in on

Hosted by:

1



Southeast Aquatic
Research Institute



**Tennessee
Aquarium**

The First Symposium of the Freshwater Mollusk Conservation Society

March 17 - 19, 1999 ♦ Clarion Hotel ♦ Chattanooga, Tennessee

The Southeast Aquatic Research Institute and The Tennessee Aquarium are pleased to host the first symposium of the newly formed Freshwater Mollusk Conservation Society. This meeting will be similar to the 1992 and 1995 "Conservation and Management of Freshwater Mussels" meeting held in St. Louis, and will interest biologists concerned with the status, distribution, regulation, management, and biology of unionid mussels - North America's most imperiled fauna. In addition to the mussel presentations, there will be a special session focusing on the biology and conservation of freshwater gastropods. The symposium committee is extending this first call for paper and poster presentation abstracts. As with the St. Louis meetings, the paper presentations will form a published proceedings.

PAPER PRESENTATIONS - Paper presentations are sought that discuss: status surveys, life history information, habitat requirements/utilization, relocation and quarantine procedures, artificial propagation, toxicity, genetics, outreach activities, physiology, mussel-fish associations, conservation and sampling strategies, and basic biology. In particular we are interested in a broad spectrum of presentations dealing with the biology and management of unionids. Additionally, there will be a contributed session for freshwater gastropod papers.

POSTER PRESENTATIONS - Presentations that address any of the topics listed above will also be welcomed as posters. Additionally, studies targeting the effects of zebra mussels and other aquatic nuisance species affecting native mussels are welcomed. The poster session, with authors present, will occur in the late afternoon on Thursday, March 18th.

WORKSHOPS - We are planning at least 2 different workshops during the symposium, and all conference attendees are welcome to participate at no additional charge. The first workshop will cover mussel and snail identifications

and will occur Wednesday evening, March 17th. The second workshop, organized by Heidi Dunn (Ecological Specialists, Inc., 114 Algana Ct., St. Peters, MO 63376), will discuss special guidelines, sampling protocols, state restrictions, and various techniques for mussel sampling. This workshop will be held on Thursday afternoon, March 18th, as part of the symposium's formal proceedings.

EVENING ACTIVITIES - There will be a "get acquainted" mixer on Tuesday evening, March 16th at the Tennessee Aquarium. On Wednesday, the evening activity will be the Informal mussel and snail identification workshop. On Thursday evening, there will be an auction with food and drinks. On Friday evening March 19th there will be an optional dinner cruise on the Chattanooga Southern Belle, which tours the Tennessee River Gorge. We are also planning Saturday activities, for those wishing to reduce airfare costs with a Saturday stay.

REGISTRATION INFORMATION

Please register early. The registration fee is \$125.00 before December 15th 1998, and \$150.00 thereafter. Student registration fees are \$75.00 before December 15th 1998, and \$100.00 thereafter. All students must provide a valid student ID at the registration desk and include a photocopy with their mail-in registration. The registration price includes 3 continental breakfasts at the Clarion Hotel, 3 buffet lunches at the Clarion Hotel, free drink tickets to mixers, a symposium registration packet, and a copy of the conference proceedings.

You may call the Southeast Aquatic Research Institute for more information (423) 267-4061, or access the institutes web site at (<http://www.sari.org>) and look under the current activities link. The web site contains more symposium information will support on-line registration.



**Freshwater Mollusk Conservation Society
First Annual Symposium
"Musseling in on Biodiversity"
March 17-19, 1999
General Registration Form**

You may also register on-line, after October 1, 1998, by accessing the Southeast Aquatic Research Institute's web site at www.sari.org (look under the "Current Activities" link), or mail the completed form and payment to: Dr. Paul D. Johnson, Southeast Aquatic Research Institute, 817-B North Market Street, Chattanooga, TN 37405, or fax this form with the credit card information to (423) 266-5124.

(Please Print)

Name: _____ Affiliation: _____

Address: _____

City: _____ Zip Code: _____

Daytime phone: _____ Fax: _____ e-mail: _____

ITEM	COST	TOTAL
Symposium participant - early registration (Due December 15, 1998)	\$125.00	_____
Symposium participant - late registration (After December 15, 1998)	\$150.00	_____
Symposium student - early registration (Due December 15, 1998)	\$75.00	_____
Symposium student - late registration (After December 15, 1998)	\$100.00	_____
Dinner and Tennessee River Gorge tour aboard the Southern Belle, Friday evening, March 19, 1999.	\$35.00	_____
Nickajack Mussel Midden Trip, on Saturday March 20, 1999. Trip leader Dr. Paul Parmalee, Professor Emeritus University of Tennessee, McClung Museum Price includes transportation and a boxed lunch.	\$40.00	_____
Trip to Lonnie Garner's shell operation, Saturday March 20, 1999. Trip leader Steve Ahlstedt of the USGS. Price includes transportation, and a boxed lunch. (In the event of inclement weather, field trip monies will be refunded)	\$40.00	_____

Total enclosed = _____

Symposium registration fees must accompany this form. Please be sure to make a check or money order payable to: 1999 Freshwater Mussel Symposium

☐ Check ☐ Money Order

or ☐ MasterCard ☐ Visa ☐ American Express ☐ Discover

Card Number: _____ Card Holder: _____

Expiration Date: _____ Signature: _____



Freshwater Mollusk Conservation Society Symposium March 17 - 19, 1999, Chattanooga, Tennessee

INSTRUCTIONS FOR AUTHORS

All abstracts must be received by December 31, 1998. Contributors will be notified by January 15, 1999 if their presentations have been accepted. Authors should request which format they prefer (oral or poster) when they submit their abstracts. However, due to space and time constraints final approval and scheduling will be determined by the conference organizers. The planning committee reserves the right to suggest a paper not assigned to an oral session be presented as poster.

Please submit 4 hard copies of your original abstract along with a 3½" diskette copy in Word 97, WordPerfect 7 (or earlier versions), or ASCII format by December 31, 1998. The diskette copy will help us construct the meeting bulletin, and insure a quality guide for all meeting participants. Please be sure to place your full name and indicate the software and version on the diskette label. Mail the presentation materials to Paul Johnson, at the Southeast Aquatic Research Institute (address below).

ALL contributed papers and posters must conform to the following format requirements:

- ◆ Abstracts not to exceed 250 words (Arial - 12 pt font, please).
- ◆ Abstract to include: brief title and author(s) name in bold- face type. The author's address(es), phone numbers, e-mail addresses, and the text of the abstract to appear as normal text.
- ◆ Clearly state study objectives, brief methodology, general results, and brief conclusion.
- ◆ Indicate at the bottom of the abstract the type of presentation (oral or poster), and the name of the contact person, if different from the author. Be sure to note if you will require a VCR or computer projector for your presentation. For poster presentations, please indicate if you will require a table and/or electrical outlet.
- ◆ Oral presentations will have a 12-minute time limit, followed by a 3-minute question and answer period. Limiting the format of oral presentations to 2" x 2" slides is strongly recommended. However, overheads and computer projectors will be available. Videotape will also be allowed, on VCR format. Video playback equipment will be provided for oral presentations only.
- ◆ Posters must fit in a 3' x 6' area and be held in place with either double-sided adhesive tape or velcro (no push pins please). Poster text should be readable from 4 feet away, titles from 8 feet. Please be well organized and focus only on the main points of the study. Approximately 50% of the poster area should be used for graphs, tables, and illustrations. Finally, poster presenters must be available to attend their posters on Thursday, March 17th from 4:30 - 6:30 p.m.
- ◆ Those oral presenters who wish to publish their results in the symposium proceedings must submit their manuscript (3 hard copies and diskette) by March 19, 1999. No exceptions or extensions will be allowed. All submitted manuscripts should conform to the Journal of the North American Benthological Society format, which is printed in the first issue of each volume, or can be obtained from the NABS website at www.benthos.org (instructions for authors). As with the abstracts, all manuscripts must be saved in WordPerfect or Word format, and the author's names, software type and version must appear on the diskette label. Failure to submit your manuscript by March 19th, in the proper format, will result in the publication of the abstract only in the conference proceedings. Only the abstracts of posters will appear in the symposium proceedings.

The symposium committee strongly recommends that oral presenter's not devote presentation time to general information about mussels (i.e., number of species, conservation status, fish-host requirement). It is the committee's opinion that this widely known information wastes valuable meeting time that should be reserved for the presentation of original data. General information will be covered by the Plenary Session speakers.

Direct all abstracts and questions to: Dr. Paul Johnson, Southeast Aquatic Research Institute, 817-B North Market Street, Chattanooga, TN 37405, Phone (423) 785-4074, Fax (423) 266-5124, e-mail: pdj@tennis.org

**Minutes of Executive Committee Meeting
Freshwater Mollusk Conservation Society
(Formerly the National Native Mussel Conservation Committee)**

November 9-10 1998

Chattanooga, TN

The minutes have been abstracted to save space for the Triannual Unionid Report. The lengthy discussion concerning the Freshwater Mollusk Conservation Society's constitution and bylaws and a detailed discussion of the items to be included in the Society's application form have been deleted. A draft copy of the constitution and bylaws is included in the Triannual Unionid Report for your comments.

Subcommittee Reports

1. Commercial

Not much is going on currently. Most exporters are intermittently shipping shells and should get a good return. TN Shell, which was 80% of the market, was focus of a Federal investigation and case has been settled. Paid largest restitution of a wildlife case, \$1,000,000. Believe shell companies have decided to shut down for a time to let things cool down. Biological problem with oysters in Japan, but world wide demand for pearl still there. Revenue from license and excise tax is way down.

Steve is liaison between commercial committee and shell industry. Suggest inviting Bob Leisure and Lonnie Garner to the executive committee meetings. Setting dollar value for mussels brought up at ORVE mollusk subgroup meeting. There are values set for fish, need similar situation for mussels for restitution. Need to come up with fair market value considering difference in value of shell among different states and regions. Natural Resource damage assessment - contaminants people set these values so would be good group to talk to.

The commercial committee will explore dollar value of mussels for restitution costs. The executive committee will bring this up at the March meeting to get volunteers to assist. Currently those that will work on this: Steve Ahlstedt, Don Hubbs, and Al Buchanan (assist)

Distribution/Status

No money to fund the atlas project. Next step to get seed money (mussel mitigation trust) or write an NSF grant to get support. Tom Muir is exploring other funding avenues. Estimate cost will be around \$250,000. Need people to do species accounts. People were identified in different states that are working on major surveys. Database probably be filemaker pro, which is MAC and PC based and is compatible with Excel. Every dot on map is to be backed up with a reference. Trying to make it all specimen based if possible. Need money to distribute to people to start compiling the information. Feel about \$30,000 seed money will get it off the ground. Funded TN book with reverted section 6 money. ORVE can send letter of support. Contact states that have georeferenced distribution data, such as VT, NH, ME, TN, VA, NC, SC, GA the. By March business meeting Kevin will talk with Tom and update progress and needs.

Distribution/Status of Gastropods

Just getting started to re-monograph freshwater snails of N. America. Snail information is way behind freshwater mussels. Met with AMU with people interested in monographing freshwater snails. Has names of 50 people to help work on this project. No format yet or set plan on approach. Rob Dillon will invite specific number of snail people to the March meeting to get the project started. Suggested this group adapt the format of the mussel atlas which was adapted from the fish atlas. This way people will know these volumes were put together by the same outfit.

Outreach

Native Mussel Speakers Bureau: People listed all volunteered. Draft will be updated and Susi will try to distribute through state outreach folks, like project wild, etc.. Also will be put on the Unio Listserver, and possibly the first newsletter of Society. Need to stress to conservation groups that they will have to incur costs associated with having speakers, such as travel expenses. Will be easiest for speakers to make presentations within the state. River Crossings newsletter is another outlet. Broaden it to include gastropods. Will be renamed Native Mollusk Speakers Bureau. Any additional people to add contact Susi. Delay distribution of speakers bureau until after the March meeting to give opportunity to request more volunteers.

Development of logo and slogan. Slogan for March meeting and Society is "Musseling in on biodiversity". Logo completed for the Society. Outreach committee requested outreach be listed as a special session for the March symposium. Committee members will assist with this session.

Mussel beanie baby letter has been drafted. There is concern on how the money will be distributed from the TN Shell settlement. The ORVE mollusk subgroup requested the Society have input on how the money is used. \$250,000 has been deposited with Fish and Wildlife Foundation. ORVE is sending a letter suggesting how funds should be administered and distributed to fund proposals. Suggested the Mussel Mitigation Trust model be used for selection criteria and review process. A broad based group should set the criteria.

Slides will be put on computer and be available to speakers on the speakers bureau. Suggested someone take responsibility to organize slides and make them available. There are slides available through NABS. Suggest slide library be developed for the Society for speakers to use. Recommendation will be made to the outreach committee at their next meeting to develop slide library.

The strategy is at the editor for the National Shellfish Association. Cost will be about \$1.00 a copy with cover art but no internal art. A cover letter will be drafted and sent to the executive committee for review and the letter will be sent with the strategy. We will ask FWS Fisheries in Washington to mail the strategy out to Federal, State and Congressional addresses. Rita will contact Susan Mangin about this and if they would draft a transmittal letter to accompany the package. Susan will also be asked if FWS will fund an extra 2000 reprints, distribute more than 1 reprint to states, etc. Susi will find out for the northeast (VA on up) how many reprints are needed for each state. People need to contact and help Madeleine to update the mailing list and to come up with the appropriate state contact to assure that the strategy is distributed to the right people in each state.

Mailing of Strategy: Paid by BRD/FWS fisheries hopefully and mailed by FWS: 1) Congressional, 2) Federal agencies, 3) State agencies - at March meeting request number of reprints needed for each state

Other mailings: paid for by?

Mailing labels will continue to be reviewed by Madeleine Lyttle.

Al will draft a letter to MICRA to state representatives to request how many copies needed.

Propagation/Restoration

Bob is moving forward with genetics issues and relocations. Latest draft sent in the Triannual Unionid Report and received no comments. Like to get an article in Fisheries to provide guidelines for relocations. Need buy in from states and genetics folks. Some comments received at the Columbus meeting. Bob will move forward to get this formalized and get it published. Dick Neves is moving towards getting a group together to discuss this issue and review the guidelines and from that get an article put together. Dick has

sent a letter to 5 geneticists. This article would then be sent out for review. Draft aquatic mollusk translocation database sheet available for comments. This way we will know what has and is going on. North Carolina is working on a draft white paper that will set policy for relocations. Jim Williams will maintain this database. Suggest the Society contact FWS offices and suggest this form be sent out with permits for translocations and be required to be filled out and sent to Jim Williams. Make it clear this form is an attempt to make a national database on translocation data. Bob Butler and Dick Biggins will have a draft form available at the March meeting and request that comments be received within 3 months of the meeting.

Guidelines/Techniques

Met in March and decided on 7 subcategories with a leader for each. Contaminants/stress assessment, Jerry Farris; Captivity/propagation, Catherine Gatenby; Relocation/reintroduction, Heidi Dunn; Field sampling, Heidi Dunn; Life History/Community Ecology, Jim Layzer and Diane Waller; Processing, Rita Villella; Protection/Management/Mitigation, Deb Mignogno. Leaders looking for authors for individual papers. Guidelines were developed for paper format. Need help on life history - will contact Mark Hove, Tom Watters, Chris Barnhardt, Barry Wicklow, and others. Annotated bibliography will accompany each topic and list of contacts. Working on a special session for the March meeting. Each group leader will present overview of their topics, as to what we have received input on, what guidelines are needed, what is known and what research is needed and provide time to interact with meeting participants to get volunteers to provide input and be authors. Also will have a poster presentation. Titles for individual talks are to be sent to Paul. Each presenter will have an abstract in the proceedings. For the proceedings have one paper presenting the overview and major points of the topics.

Water Quality, Habitat, Zebra Mussels

Some of the papers have been through peer review and gone to NABS. Has not been published yet. The working document was put together and is available from Jerry Diamond.

Information Exchange

Mailing labels have been printed.

Regional Update

N. Carolina working with FWS and Champion International and other groups to conserve lands along the Tar River and other streams in the drainage. Champion working with other timber companies to get 200 foot buffers around streams. Starting on a web atlas with historical and current maps using hydrologic units as the base maps. May ask other bordering states to buy into the project. Assistance from FWS and COE to initiate the project. Basins proposed as critical habitats are having conservation plans developed in coordination with FWS, state agencies and other conservation groups. Ultimately use funds from clean water management trust fund (state funds) to purchase land and easements in these basins. New project to relocate common species first back into these basins.

Northeast - Lake Champlain working on quarantine facility with little funds and seeing significant declines in natives. High mortality rate also in the quarantine facility. Zebras were found in the Housatonic drainage which has several state listed species. Will have a northeast mussel meeting after the March meeting. State of Maine almost done with their atlas, New Hampshire almost complete. Connecticut and Massachusetts still working on theirs.

Symposium

Logo finalized. Hotel arrangements made but contract not signed yet.

Theme is musseling in on biodiversity. Plenary session will be held jointly with World Wildlife Fund (SE

rivers project will be announced as biodiversity initiative in the southeast.) Keynote speaker either will be Sec. Babbitt or Jamie Clark. Expect up to 600 people at this session. This is our opening session and their closing session. Burch will give status paper on gastropods, and J. Williams status of N. American mussels, Tom Watters will present mussel-fish interactions. Status papers will include global status.

Other papers are limited to 15 minutes including questions, no concurrent sessions. Program will be out by mid-January. Another mass mailing will be sent when program is set.

Symposium planning: Flier announcement was placed in Columbus packet.--Over 500 copies of announcement mailed.--Placed in NABS and will be in AFS and AZA Communique.--Additional flier will be mailed to update potential attendee's on the program specifics.--Symposium announcement, registration form and first call for papers went out just before Labor day.--Deadline for registration and submission of abstracts Dec. 15.--Registration is mail in and online.--Clarion Hotel reservations will be mail-in and online.--Early registration will receive a confirmation notice.--Walkup registration will be possible the first 2 days of the conference.--Registration is \$125.00 for early and \$75 for early student.--Buys 3 breakfasts and 3 lunch, mixer drink tickets and copy of proceedings.

Space: Front room can accommodate 600 and will be used for the plenary session. Will then be reset with tables and chairs for 300 for the conference. Back area will have posters. Two rooms will be set up as hospitality rooms.

Evening sessions: Tuesday night is mixer at the aquarium and shared with world wildlife fund. From 7-10. Wednesday night is informal mussel and snail identification workshop. People can bring in problem shells and have people help them out. Thursday night is general business meeting of FMCS and the auction. Deb will facilitate the business meeting. Kurt Welke putting together the auction, Steve and Dick Neves helping. Send material for auction to Paul. More time needed for the business meeting so will try to move it on the agenda. Proceeds from auction hopefully will go to the Society and not towards meeting expenses. Friday evening is the dinner cruise. Lot of interest in boat tour. Working on mussel midden trip for Saturday and having Saturday activities for those attendees that stay. Try to have TNC speaker for Friday morning session to give closing address. Try to get president of TNC or Larry Master.

Gastropod session - invited speakers will highlight various problems with the literature, what we know and don't know, conservation status, molecular systematics, ecology of N. American freshwater gastropods, physiological ecology of N. American gastropods, conservation and recovery strategies for N. American freshwater gastropods. Hope to publish separate from proceedings. Hope to have a contributed session for papers on gastropods.

Budget: Based on 300 attendees. Total cost projected to be \$36,540. Handout provided with cost breakdown. Hope to generate \$49,000. Have \$2000 from TWRA, and \$3000 from Forest Service, \$2000 from TVA, and UMRCC \$2000. Those that have committed include FWS hatcheries \$2000 and endangered species \$2000, N. Carolina State museum \$1000, Mussel Mitigation Trust \$1000, VA Department Fish and Game \$1000, NPS \$1000.

Suggest moving the executive committee meeting to Tuesday morning at 8 am till 3 pm at the Imax theater. One room available for committee meetings and for speakers to prepare talks. Try to arrange a time on the first day.

AFS 2000

An estimate of 150 people attending turned into AFS. AI will check on logistics between now and the March meeting. Has 4-5 volunteers to help work on this meeting. Held in St. Louis. Don't have an alternate plan if we decide not to go with the AFS meeting. Registration fee would go to AFS so no revenue to the Society. Need to make decision within the next 6 months. Put on agenda for March meeting to start deciding on 2001 meeting, place and time. Symposium committee will start working on this and present ideas at the March meeting.

Ohio River Mollusk Subgroup

Group chose their focus areas which will be sent to the Ohio River Valley Ecosystem Team.

They would like this group to address criteria for people applying to work on endangered mussels. Feel this should be addressed on a national level. There currently is no criteria to evaluate these applications. Status/distribution committee should work on this issue. Put this on agenda for the March meeting as well as how to make it easier to collect dead shell material. Need to look at collector's needs and needs of the regulatory agency.

TN Endangered Mollusk Committee

Will meet Dec 2-3 at Norris, TN. Open to anyone. Jeff Garner and Don formally doing endangered mussel survey and providing animals for propagation. Funded by FWS through Dick Biggins. Also identifying habitat to reintroduce juveniles. Subgroup formed to prioritize streams in the Tennessee valley to augment mussel populations. For example, lower French Broad River, the habitat is improved and fish and snails are returning. Will look at experimental populations.

Other Reports:

Inventory of the Conasauga River for mollusks and the product, a field guide for mollusks in the basin, will be on a web page. Shell material will go to NC State Museum. Tissue from gastropods and mussels to Chuck Lydeard for genetics. Will expand to upper Coosa tributaries later on. Trying to propagate gastropods in captivity. Have fish distribution data on Conasauga.

Bob Butler working on recovery plans for species in the Appalachian basin.

Membership Form

Example of ASB form handed out. Make comments on the form and mail to Steve or email comments by 12/31/98. He will make changes and send a draft to Susi and Kurt Welke for their comments and a final form will be developed. The outreach committee will work on how to handle postage, printing membership forms, return envelopes, and mailing.

Applications sent to the treasurer and the treasurer will send applications to the secretary to be compiled into a database. Renewal forms sent out by treasurer.

Award Criteria

Type of award: Lifetime achievement - Criteria is significant lifetime contribution to the conservation and science of freshwater mollusks

Award: 1) Plaque with logo, 2) Framed photograph (11 x 14) with small plaque, or 3) Both
AI will set up an ad hoc committee to design the award, award categories and criteria, nominations and text for this first round, nominating process for future awards, and text for presenters of awards. Ad hoc committee will consist of Paul Johnson, Steve Ahlstedt, John Jenkinson. This round will be 4 awards, then one per year.

The following Draft Constitution and Bylaws of the Freshwater Mollusk Conservation Society (FMCS) was developed by the Executive Committee (soon to be the Board of Directors) of the FMCS. As you can see, some of the legal language remains to be filled in, and Tom Muir and others are working on that aspect. Please forward any comments you may have to Alan Buchannan, 1110 S. College Avenue, Columbia, MO 65201 (buchaa@mail.conservation.state.mo.us) by January 15, 1999. Keep in mind, this is a working document. Like any fledging organization, we expect that as the FMCS gets its feet on the ground and membership grows there may be a need to change the constitution and bylaws. Thanks in advance for any comments you may provide.

Al Buchannan

FRESHWATER MOLLUSK CONSERVATION SOCIETY

DRAFT CONSTITUTION

Article I: Name

The name of this organization shall be the Freshwater Mollusk Conservation Society. This Society shall be an independent non-profit scientific and professional organization.

Article II: Purpose

This corporation is organized and may be operated for any and all lawful purposes authorized by **Legal Stuff Inserted Here**. However, said purposes shall be limited to the purposes of a business league within the meaning of Section 501(c)(6) of the Internal Revenue Code of 1986, as amended (or the corresponding provisions of any future United States Internal Revenue law). **Need legal stuff here checked also.** Said purposes shall include, but shall not be limited to, activities in accord with the following general objectives:

1. Advocate freshwater mollusk conservation.
2. Serve as a source and conduit of information on freshwater mollusks.
3. Promote science-based management of freshwater mollusks.
4. Promote and facilitate education about and awareness of freshwater mollusks and their importance to freshwater ecosystems.
5. Facilitate implementation of the *National Strategy for the Conservation of Native Freshwater Mussels*, and any similar strategy developed for the conservation of freshwater gastropods.

No part of the net earnings of the corporation shall inure to the benefit of, or be distributable to, its members, officers, directors, or other private persons, except that the corporation shall be authorized and empowered to pay reasonable compensation for services rendered and to make payments and distributions in furtherance of the purposes set forth above. **No substantial part of the activities of the corporation shall be carrying on of propaganda, or otherwise attempting to influence legislation, [does this preclude the Society from lobbying for changes which will benefit mollusks?] and the corporation shall not participate in, or intervene in (including the publishing or distribution of statements) any political campaign on behalf of any candidate for public office.**

Notwithstanding any other provision of this Constitution or the By-Laws, the corporation shall not

substantially carry on any other activities not permitted to be carried on by a corporation exempt from federal income tax under Section 501(c)(6) of the Internal Revenue Code of 1986, as amended (or the corresponding provision of any future United States Internal Revenue law). [again, this legal stuff needs to be worked out].

Article III: Membership

The membership of the Society shall consist of: Active, Emeritus, Student, and Sustaining members.

1. Active Members are qualified professionals and amateurs involved in freshwater mollusk conservation who share the stated purpose of the Society.
2. Emeritus Members are those qualified Active Members selected and honored in recognition of their contribution to freshwater molluscan conservation and to the Society.
3. Student Members are persons who share the stated purpose of the Society and are students showing promise of becoming qualified for Active Member status at a later date.
4. Sustaining Members are organizations or persons who share the stated purpose of the Society and wish to further the activities of the Society. Sustaining members provide financial support as defined by the Society.
5. Membership to all of the above membership classes, except Emeritus, requires the payment of dues or support as determined by the Society. Active Members and Emeritus Members constitute the voting membership of the Society and may hold office.

Article IV: Management and Elections

1. The affairs of the Society shall be managed by the membership through the **Board of Directors** in accordance to the Constitution and By-Laws.
2. The officers shall be four (4): President, President-Elect, Secretary, and Treasurer.
3. The President shall serve a one-year term in this office; however this term will be preceded by a one-year term as President-Elect, and followed by a one-year term as Past President to assist with Society functions as needed. An Active Member shall be elected to this sequence of offices at the beginning of the President-Elect year, and, automatically, advance to President and Past President without the necessity of a vote at either change of office.
4. The Secretary and Treasurer shall be elected for two (2) year terms (except for the first year of the Society's establishment, when the treasurer will serve for 3 years). The Secretary shall be elected in odd years and the Treasurer elected in even years. There is no limit to the number of consecutive terms the Secretary or Treasurer may hold.
5. If a vacancy, except that of President, occurs between terms, the **Board of Directors** shall appoint a successor to serve the remainder of the term. Should the post of President become vacant for any reason the President-Elect shall assume the post of President and serve the remainder of the term as acting President and shall succeed to the Presidency. In addition, a special election will be held to elect

a new President-Elect.

- 6 The President shall serve as Chair of the Board of Directors.
- 7 The **Board of Directors** shall have voting members consisting of the President as the presiding officer, the President-Elect, Secretary, Treasurer, and the chairs of the standing committees as defined in the Bylaws. Chairs of each Standing Committee are to be selected by members of that committee annually. A person may be chair of only one standing committee at any given time.
- 8 The **Board of Directors** shall determine the number, times and places of full Society meetings.
- 9 The first slate of officers, with the exception of the President-Elect, will be selected by the **Board of Directors**.

Article V: Duties

1. The duties of the President, President-Elect, Secretary, and Treasurer are those customarily performed by such officers, unless otherwise directed by the **Board of Directors**.
2. The duties of the **Board of Directors** shall be:
 - a. To manage the business, functions, programs, and activities of the Society.
 - b. To establish dues and support levels for Active Members, Student Members, and Sustaining Members.
 - c. To establish policy and promote the objectives of the Society.

Article VI: Quorum

More than fifty (50) percent of the voting members of the **Board of Directors**, including at least two officers, shall constitute a quorum. Ten (10) percent of the voting membership of the Society shall constitute a quorum of members.

Article VII: Amendments

An amendment to the Constitution may be proposed in writing to the **Board of Directors** at least three (3) months prior to a scheduled Society business meeting. If the proposed Amendment is supported by at least one voting member of the **Board of Directors**, the proposed amendment is distributed to all members prior to the next full business meeting. It is opened for discussion at that meeting. The amendment will be voted on by mail during the next officer elections. The amendment is consummated and ratified when approved by at least two thirds of the majority of respondents, provided the number of respondents constitutes a quorum.

An amendment to the By-Laws may be proposed in writing to the **Board of Directors** at least three (3) months prior to a scheduled Society business meeting. If the proposed Amendment is supported by at least one voting member of the **Board of Directors**, the proposed amendment is distributed to all members prior to the next full membership business meeting. The amendment is consummated and ratified at the next business meeting when approved by at least two thirds of the majority of members present, provided the number of members present constitutes a quorum.

Article IX: Procedures

Procedures and other items not specified in this Constitution or in the By-Laws or by action of the **Board of Directors** shall be in accordance with Robert's Rules of Order Revised.

Article X: Dissolution

Upon the dissolution of this corporation, and after paying or making provision for payment of all the liabilities of this corporation, assets shall be distributed for one or more exempt purposes within the meaning of Section 501(c)(3) of the Internal Revenue Code of 1986, as amended (or the corresponding provision of any future United States Internal Revenue law) or shall be distributed to a state or local government for a public purpose. Any such assets not so disposed of shall be disposed of by the Circuit Court of the county in which the principal office of the corporation is then located, exclusively for such purposes or to such organization or organizations as said Court shall determine, which are organized and operated exclusively for such purposes. [Legal stuff needs to be worked out]

FRESHWATER MOLLUSK CONSERVATION SOCIETY

DRAFT BYLAWS

Bylaw I: Membership

- I. Application for Active Member, Student Member, or Sustaining Member shall be made on an application authorized by the **Board of Directors** of the Society. An Emeritus Member is selected and so honored by the **Board of Directors** of the Society in recognition of contribution to the field and to the Society.

Qualifications and benefits are as follows:

A. Active Member

1) Qualifications

Must:

- a) share the stated purpose of the Society
- b) pay member dues

2) Benefits

May:

- a) vote in Society affairs
- b) hold office and/or serve on the **Board of Directors**
- c) participate in Society functions, programs and activities

B. Emeritus Member

1) Qualifications

Must:

- a) share the stated purpose of the Society
- b) be an member for 3 years [effective after 12/31/01].
- c) be elected by the **Board of Directors** of the Society after being nominated by an Active Member
- d) be recognized for service to the Society and

2) Benefits

May:

- a) vote in Society affairs and hold office
- b) participate in Society functions programs, and activities
- c) hold office and/or serve on the **Board of Directors**

freshwater malacology

C. Student Member

1) Qualifications

Must:

- a) share the stated purpose of the Society
- b) be a student
- c) pay Student Member dues

2) Benefits

May:

- a) apply for Active Member status when qualified
- b) participate in Society functions, programs and activities

E. Sustaining Member

1) Qualifications

Must:

- a) share the stated purpose of the Society
- b) provide support to the Society

2) Benefits

May:

- a) be acknowledged for Society support in newsletters, annual programs and activities
- b) participate in Society functions, programs, and activities

Bylaw II: Dues and Finances

1. All dues and support levels shall be established by the **Board of Directors**.
2. The fiscal year of the Society shall correspond to the calendar year. A member who joins the Society prior to October of any year shall be assessed dues for that calendar year. A member who joins after October 1 of any year shall be exempt from dues for that calendar year.
3. The **Board of Directors** may authorize any Officer to enter into any contract or to execute and deliver any instrument in the name or behalf of the Society and such authority may be general or confined to specific instances.
4. All checks, drafts or other orders for the payment of money in the name of the Society shall be signed by the Treasurer or President.
5. All funds of the Society, not otherwise employed, shall be deposited from time to time to the credit of the Society in such banks or other depositories as the **Board of Directors** may select.
6. The annual budget shall be prepared by the Treasurer, and approved or revised in sequence by both the **Board of Directors** and the membership

Bylaw III: Committee(s)

1. The **Board of Directors** shall consist of the President, President-Elect, Secretary, Treasurer, and the chairs of the standing committees.
2. The terms of the Officers and Committee chairs shall be established according to the constitution.

3. The President will appoint a Nominating Committee of not less than two (2) members, neither of whom are members of the **Board of Directors**. Nominations for the offices will be made by the Nominating Committee or by petition of at least three Society members. The list of nominees prepared by the Nominating Committee will be submitted to the **Board of Directors** for validation. The Secretary shall submit all valid the nominees to the membership for election.
4. The Standing Committees shall be: Symposium, Status/Distribution of Mussels, Status/Distribution of Gastropods, Outreach, Information Exchange, Water Quality/Habitat/Zebra Mussel, Propagation/Restoration, Guidelines/Techniques, and Commercial.
5. The President may form a Nominating Ad Hoc Committee and other ad hoc committees which shall serve at his/her discretion during the term of office.
6. The President may appoint an Executive Assistant as necessary.

Bylaw IV: Meetings

1. The **Board of Directors** shall determine the number, times and places of the regular meeting of the Society.
2. At least four (4) weeks before a regular meeting, the Secretary shall send to each member a notice of the time and place of each meeting.
3. One meeting each year shall be designated the Annual Meeting. At this meeting, there shall be an executive session open to all members for reports of officers, for a report on the election of officers, reports of the standing committee and other items of business.
4. There shall be at least one (1) meeting of the **Board of Directors** in each year.
5. The President shall convene the **Board of Directors** at a special meeting whenever the affairs of the Society require it.
6. A request to the President, made in writing, signed and approved by more than one half of the members of the **Board of Directors** shall render an **Board of Directors** meeting obligatory.

Bylaw V: Amendments

Amendments to the Constitution and Bylaws shall be conducted according to the Constitution.

Upstream and western range limits for pistolgrip *Tritogonia verrucosa* in Texas

Robert G. Howells

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Although pistolgrip *Tritogonia verrucosa* was recognized from eastern and central Texas (Strecker 1931), field-survey efforts by Texas Parks and Wildlife Department (TPWD) have found it to range further west and upstream in a number of river systems than previously thought.

In the Red River, pistolgrip has been found as far west as Lake Texoma (White and White 1977). Within the Trinity River drainage, Strecker (1931) reported it as far upriver as Dallas and Denton counties in the Dallas area. More-recently, Neck (1990) found it in Lewisville Reservoir, Denton County, and H.D. Murray collected it in Eagle Mountain Reservoir, northwestern Tarrant County (Trinity University collection, San Antonio; Howells et al. 1996).

In the Brazos River system, Strecker (1931) listed pistolgrip upstream to the Bosque and North Bosque rivers, McClennan County, as well as the Leon River, Gatesville, Coryell County. TPWD collected only long-dead and subfossil shells in Coryell County (Howells 1995, 1997), but found it alive downstream in Bell County (Howells 1996, 1997). However, Sue Martin and Chris Ireson (San Angelo, Texas) brought living specimens to TPWD from a population in Fort Phantom Hills Reservoir, Jones County, collected in August 1998 (over 250 km further upstream than previously known).

Strecker (1931) listed collections from the Colorado River at Austin, Travis County, and from the Llano River, Mason County, and South Concho River, Tom Green County. TPWD found recently dead specimens in the Colorado River in San Saba County (Howells 1997) and C. Lintz (TRC Mariah, Austin, Texas; pers. com.) collected the species alive in 1991 in the Colorado River upstream of Pecan Bayou, San Saba County, and in what is now O.H. Ivie Reservoir, Runnels County. Only subfossil material has been found in recent years in the Llano River (Howells 1994) and subfossil specimens were found in Sterling County about midway between Sterling and Water Valley on the North Concho River (Howells 1995). Additionally, a living population was documented in 1997 just downstream of Fort McKavett, Mason County, in the San Saba River (Howells 1998).

Within the Guadalupe River, Strecker (1931) reported the species from Comal and Kendall counties. TPWD found subfossil shells 2.4 km below Canyon Reservoir, Comal County (Howells 1995) with no trace of specimens further upstream. In the San Antonio River, Strecker (1931) listed pistolgrip from Bexar County and H.D. Murray (Trinity University collection; Howells et al. 1996) took it in Cibola Creek on the east side of the same county. TPWD surveys failed to confirm its presence at either location.

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Xanthid crabs in inland waters of Texas: a threat to unionids?

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Three specimens of a small xanthid crab (Family Xanthidae) were recently obtained from Possum Kingdom Reservoir on the upper Brazos River Drainage of westcentral Texas and presented to the Texas Parks and Wildlife Department's (TPWD) Inland Fisheries Management staff in Wichita Falls, Texas. One of these specimens was subsequently passed to Heart of the Hills Research Station and its identity was confirmed by Harriet Carter, Gulf Coast Research Lab, Ocean Springs, Mississippi, as white-fingered mud crab *Rithropanopeus harrisi*.

This species has previously been reported from fresh water, but such occurrences were believed to represent invasions by adults after transformation from early life stages in saline waters (Williams 1984). Collections in Possum Kingdom Reservoir have been reported throughout the impoundment, but not in the Brazos River up- or downstream. Egg-carrying females and small juveniles have been reported in the reservoir as well, suggesting an apparently-established freshwater population. It seems probable these crabs were introduced relatively recently (fishery management sampling over the past 50 years and a fish hatchery at the reservoir should have noted this species had it been present earlier).

Excess aquifer pumping and modification of terrestrial environments locally have reduced spring flows resulting in increasing salinity in the upper Brazos River and elsewhere in Texas. Brine waters generated by oil and gas drilling operations also appear to have contributed to increased salinity. Factors such as these are probably associated with "freshwater" red tides caused by *Primnesium parvum*, a coastal dinoflagellate, which has invaded central and western Texas where it has been responsible for fish and mussel kills (J. Ralph, TPWD Spills and Kills Team, Austin). The increased salinities supporting this destructive dinoflagellate may benefit these crabs as well.

Chinese mitten crabs *Eriocheir sinensis* (Grapsidae) have been introduced into U.S. waters and are known to be environmentally destructive, but direct interactions with unionids, if any, are largely unreported. However, other decapod crustaceans are known to prey upon bivalves. In the lower Nueces River, Texas, H.D. Murray observed large blue crabs *Callinectes sapidus* which had ventured into fresh waters in lower river reaches successfully killing Tampico pearlymussels *Cyrtomus tampicoensis* by chipping away at the shell margin until soft tissues were accessible (pers. comm.). Similar damage to depredated shells was observed by TPWD at upriver sites where large crayfishes may have been using the same technique. A number of coastal mud crabs (Xanthidae, *Panopeus* and other genera) are reported as major predators on young oysters and hard clams (Gosner 1979 and others).

Whether white-fingered mud crabs found in Possum Kingdom Reservoir ultimately have a negative impact upon local unionid populations remains to be determined. Interestingly, the only living specimens of the rare, endemic Texas fawnsfoot *Truncilla macrodonta* found in several decades were located in the Brazos River just downstream of Possum Kingdom Reservoir.

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Restoration of mollusk species within the territorial boundaries of Tennessee and Alabama

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Spiny riversnails (*Io fluvialis*) reintroduced into the Holston and French Broad rivers are surviving and dispersing. In August, 1998, an additional 500 specimens were moved from the Clinch into the Holston and 600 were moved into the French Broad with assistance from Tennessee Wildlife Resources Agency biologist Mark Fagg. The Holston River population was of concern since no specimens from the previous two years could be found. However, snails were found under excellent sampling conditions and appear to be doing well. Some have moved approximately 150 feet upstream and are probably moving out into the main current of the river. One small specimen 22.4 mm was found without a tag which may indicate reproduction. Only four specimens from the previous two reintroductions smaller than 22.4 mm were released into the Holston in 1996. Populations in the French Broad River continue to survive since we have found specimens from the previous two years. As in the Holston, snails are dispersing and becoming increasingly hard to find because of the abundance of aquatic vegetation. Snails have been observed grazing on top of the vegetation and are well hidden under it. Some specimens have been found dead with holes in the shell because of severe erosion and one specimen was found dead in a muskrat midden. This project is being funded by Richard Biggins, USFWS, and supported by the Tennessee Wildlife Resources Agency. Snails will continue to be monitored for adult survival and reproductive success.

Approximately 25,000 snails were released in August, 1998, into the Pigeon River at Tannery Island. Snails of four common species (genus *Leptoxis*, *Pleurocera*, *Elimia*) have been collected from the Nolichucky River the last two years where they are extremely abundant. Both the Nolichucky and Pigeon rivers are tributaries to the French Broad River. Specimens were scattered in a 25 x 100 foot swath adjacent to water willow on a rocky shoal. The large number snails may sound like a lot but it is an extremely low number considering snails no longer exist in the lower Pigeon River. The river has been polluted by paper plant effluent for almost 100 years. The Pigeon River is beginning to recover (greater diversity of fish and benthic macroinvertebrates) because of stricter EPA color and effluent standards. The project's main goal is to determine if recovery is conducive for the recolonization of snails. At present, snails from the previous two years are surviving. These populations will continue to be augmented and monitored for adult survival and reproductive success. The long-term goals of this project are to eventually reintroduce freshwater mussels back into the river. This project is being done in cooperation with regional biologist Mark Fagg of the Tennessee Wildlife Resources Agency.

The Tennessee Wildlife Resources Agency and Alabama Game and Fish Division entered into a cooperative agreement with the USFWS (Region 4, Asheville, NC, Field Office) to restore federally listed mollusk species into respective state waters. In July, 1998, the USGS entered into a cooperative agreement with the Tennessee Wildlife Resources Agency to provide assistance to researcher's involved with culturing and restoring federally listed species. Researcher's involved with restoration efforts are as follows:

Jeff Garner, Alabama Game and Fish Division

Don Hubbs, Tennessee Wildlife Resources Agency
 Dr. Paul Johnson, Southeast Aquatic Research Institute
 Dr. James Lazer (USGS-BRD), Tennessee Cooperative Fishery Unit
 Dr. Richard Neves (USGS-BRD), Virginia Cooperative Fishery Unit

To date, assistance has been provided on the location of T & E species for mussel life-history and propagation in the Conasauga (Dr. Paul Johnson), Clinch, and Powell rivers (Dr. Richard Neves), and Tennessee River (Dr. James Lazer). Shoals for future augmentation and experimental population designations are being looked at as possible translocation sites. Because of the improvements made by the Tennessee Valley Authority (increased oxygen and minimum flows) below tributary dams, Douglas Dam tailwater (French Broad River) has shown excellent potential for mollusk restoration. The reintroduction of the spiny riversnail and its survival has led to the reintroduction of five common mussel species by Dr. Lazer. Translocated specimens monitored by Dr. Lazer in August, show excellent adult survival.

At the request of the Tennessee Wildlife Resources Agency, a list was prepared on what mussel species occurred or should have occurred in the Ridge and Valley Province of the French Broad. Published mussel records were searched and Dr. Paul Parmalee provided archaeological evidence. Peggy Shute (TVA) collected mussel shells from an old shell pile on the French Broad. Those specimens were examined and identified with the assistance of Dr. Paul Parmalee. A list of streams and/or segments presently containing T & E species and streams that have the potential for recovery was compiled and provided by Charlie Saylor (TVA) and John Jenkinson (TVA). Mussel species occurrence (both recent and historic) are presently being documented for targeted streams.

The first symposium of the Freshwater Mollusk Conservation Society next March will have an auction to benefit the society. If you have items or can find items to donate, please bring them to the symposium. Items such as books, pictures (one of Kurt Welke would sell - I think!), camping and fishing equipment, lures, carvings, unusual stuff found on the river bottom. Just some ideas and no shells. We need some stuff!!!

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LENGTH/AGE/SEX OF FRESH-DEAD *LAMPSILIS HIGGINSI* (LEA 1857) FROM
MISSISSIPPI RIVER, PRAIRIE DU CHIEN, WISCONSIN, APRIL-NOV. 1987

In 1987 316 empty whole specimens, and 203 single valves of endangered *Lampsilis higginsii* were salvaged from the Mississippi River, Prairie du Chien, WI, during receding water levels. These shells were the largest number of this species ever collected from one area in one year; most are deposited at The Ohio State University Museum of Biological Diversity. There was an obvious, recent high mortality of young females. After cleaning and numbering, 137 fresh-dead (43%) whole specimens were processed for length, height, width, sex, nacre color, general condition, and comments. Measurements were done with a dial caliper. A few fresh-dead single valves were measured to increase the sample size for each age class per sex, for a base total of 145 specimens. Each specimen was aged three times. Many rest rings were represented by indistinct lines (usually slight shell indentations) particularly from 3-8 years. Distinct rest rings on the entire shell were the exception. Generally older specimens had more distinct rings, especially after 10 years of age. Data were also recorded from 8 living *L. higginsii* before they were numbered and returned to the river. Ages ranged from 2-21 years, with most between 4-13 years; only 3 were older than 17 years. Over 63% were females, 31.7% males, and 4.8% were juveniles under 4 years of age. The large number of young females suggested they are particularly vulnerable to fluctuating, or adverse, river conditions. Mean length range per age class was 16.3 mm for females and 20.2 mm for males. Increased growth rate in length for males began at 3-4 years. Preliminary analysis of length and age for all specimens yielded an R² of 0.66. Sorting data by sex, and including data on seven immature juveniles with each females and males grouped separately, increased the R² to 0.67 for females and 0.75 for males. Back-measuring was done on randomly selected specimens to bring the sample size to 10 for each age group (1-11 years) of both sexes. Length gave a higher R² than height. Final analyses on 137 females and 119 males increased the R² to 0.72 for females, and decreased the R² to 0.74 for males. The R² for all 256 data sets together was 0.70. My experience with over 3500 *L. higginsii* suggests this species has a life span of about 25 years in the Prairie du Chien area, but *L. higginsii* have been observed alive at over 30 years of age in the lower Rock River, Illinois. Little is known of the demography of living *L. higginsii* populations in the Prairie du Chien area. A similar analysis, using only living specimens, would likely yield quite different results since living and empty shells from the same area from 1972-1986 had reversed sex ratios. Due to continued low river levels, a large number of empty shells were also collected in 1988. Similar analyses could be done on these specimens, plus on 63 live *L. higginsii* measured in 1997 from 200 miles of the Mississippi River, from Ferryville, Wisconsin, to Moline, Illinois.

Vitelin-type proteins in Unionidae: a measure of endocrine disrupting effects *in situ*

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Since the 1880s, one third of the original unionid mussel species have disappeared from the Grand river in southern Ontario (Metcalfe-Smith *et al.* 1998). The watershed is heavily impacted with both urban and agricultural activities. One persistent cause of poor water quality is municipal effluents released from sewage treatment plants (STPs). Effluent samples have been shown to contain chemicals that include estrogens and xenoestrogens (EDCs) which disrupt the normal functioning of the endocrine system in fish. Some of the estrogenic compounds have also been observed to affect the growth, sexual development and reproduction in certain invertebrate groups. A common biomarker for determining exposure to these compounds is the measure of vitellogenin (Vg), the egg precursor protein, in fish. A method to detect Vg - proteins was adapted for use with a marine mussel (*Mya arenaria*) (Gagne and Blaise 1998). We proposed that it would be possible to detect Vg - proteins in unionids as well using this method.

Two species, *Lasmigona costata* and *Pyganodon grandis*, were collected at sites above and below possible sources of EDCs in the Grand River watershed during July - September 1998. Preliminary results suggest that, at the control site, Vg - protein levels increased at each successive sampling date. This effect correlates with the developing reproductive state in both species as the breeding season progressed. Below a source of sewage effluent we observed that Vg - protein levels in *L. costata* were significantly greater than in those found at the control site and in a second case the levels in mussels closest to the outfall were significantly greater than from those further downstream. Levels of Vg - proteins in *P. grandis* were not induced by exposure to effluent from a sewage lagoon or from exposure to non-point sources of agricultural runoff.

Examination of unionid biodiversity data collected from the Grand River indicates that there is an inverse relationship between decreasing diversity and abundance and induced Vg - protein levels in stretches of the river, especially below STPs. Below one plant there was a 4 km stretch of river where no mussels were found alive. It is tempting to try and make a connection between the presence of EDCs and poor reproduction of mussels in the Grand River but it is complicated by the presence of other water quality problems, destruction of habitat and possibly loss of fish hosts. However, if the more tolerant species are indicating a sensitivity to the presence of EDCs it would be interesting to measure the same response in mussels which are considered threatened.

In conclusion, we feel that the Vg - protein assay could provide a practical method for determining exposure to EDCs in freshwater mussels once some of the confounding issues are resolved. Future plans for this research include validation of estrogen - Vg induction through laboratory exposures and caging experiments below point sources of EDCs.

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Potential hosts for *Lampsilis reeviana brevicula*, *Obliquaria reflexa*

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Species (n) = # fish infected	Parasitic Duration (days)	#Glochidia Attached	#Juveniles Recovered
<i>Lampsilis reeviana brevicula</i> (Strawberry River, AR)			
Goldfish (1)	14	2	0
Common shiner (4)	21	6	0
Spotfin shiner (4)	21	12	0
Sand shiner (4)	31	16	8
Rosyface shiner (4)	14	15	0
White sucker (1)	24	82	6
Bluntnose minnow (4)	28	49	8
Northern hogsucker (1)	26	7	0
Siamese fighting fish (1)	26	33	5
Lavender gourami (1)	26	57	24
Longear sunfish (1)	17	5	0
Bluegill (1)	26	125	7
Pumpkinseed (1)	31	382	337
Rock bass (1)	31	368	199
White crappie (1)	28	123	11
Largemouth bass (1)	31	501	288
Greenside darter (1)	12	24	0
Banded darter (2)	21	74	7
Fantail darter (2)	0	0	0
Logperch (1)	31	113	55
<i>Obliquaria reflexa</i> (Muskingum River, OH)			
Mottled sculpin (1)	14	64	0
White sucker (1)	21	1284	0
Bluntnose minnow (4)	11	7	0
Sand shiner (4)	19	68	0
Common shiner (4)	19	21	1
Whitetail shiner (4)	19	71	0
Spotfin shiner (4)	0	0	0
Fallfish (1)	21	542	0
Longnose dace (2)	17	129	3
Rosyface minnow (2)	19	307	0
Silverjaw minnow (4)	17	26	2
Stoneroller (4)	20	5	0

Obliquaria reflexa (cont.)

Largemouth bass (1)	21	667	0
White crappie (1)	21	1065	0
Bluegill (1)	14	87	0
Longear sunfish (1)	14	318	0
Variegate darter (1)	19	41	0
Banded darter (4)	21	117	0
Logperch (1)	14	6	0

Non-parasitic life cycle in the Green Floater, *Lasmigona subviridis* (Conrad, 1835)

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The uncommon Green Floater was found to have transformed juveniles within the marsupia of females from two widely-separated populations. On March 29, 1998, one of us (MB) found juveniles in 17 of 24 individuals collected in Little River, a tributary of the Neuse River in North Carolina. Adults discharged all juveniles held in marsupia within one week of collection. On April 26, 1998, one of us (TW) found this species in Sideling Hill Creek, a tributary of the Susquehanna River in Pennsylvania. Only one gravid female was found, but it contained transformed juveniles as well. This female released juveniles for over a month after capture. No non-metamorphosed glochidia were found in either population. The juveniles from both sites are very active. SEM photographs show that the juveniles had deposited a small amount of new shell material before release.

This represents the first recent report of a non-parasitic life cycle in a North American unionid. Earlier reports of *Strophitus undulatus* (Say, 1817) and *Utterbackia imbecillis* (Say, 1829) transforming without a host have never been substantiated; indeed, *U. imbecillis* has more potential hosts identified than any other unionid. Outside of North America, several South American mycetopodids and a Lake Tanganyikan unionid have been shown to bypass the parasitic stage.

We thank John Alderman, Judy Johnson (NC Wildlife Resource Commission) and Tom Proch (PA Dept. Environmental Protection) for help with this discovery.

**Release of metamorphosed juveniles by the
green floater, *Lasmigona subviridis***

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Two years of laboratory-based reproductive and behavioral studies of the green floater *Lasmigona subviridis* have now been completed. Mussels were collected December 1996 through May 1998 from Pine Creek, Tioga County, Pennsylvania (tributary of the Susquehanna River) and held in 160 l glass aquariums with white sand/gravel substrate. Tanks received approximately 1 l/min flow-through well water and were lit with overhead fluorescent lights. Temperature and photoperiod were adjusted throughout the year to match Pine Creek conditions. A current was maintained in each tank using a long rectangular airstone at one end. Mussels were fed twice daily with a mixture of cultured microalgae, pond detritus, and commercial algal products.

In 1997, several mussels released what appeared to be transformed juveniles between June 6-12 at 16.8-18.3°C. Expulsion was observed in one individual as a 3-step process: 1) with both apertures open, small numbers of individuals began spilling from the exhale aperture; 2) exhale aperture closed tightly, the mussel inhaled deeply sucking up most of the spilled juveniles; 3) inhale aperture shut, juveniles were expelled 20-30 cm into the water column from the exhale aperture. Release continued in short bursts at 4-5 min intervals for 2 hours. The apparent juveniles were spherical, measuring approximately 400 μ m in diameter, were toothed, and had a fully developed and active pedal foot. Photographs revealed that the juveniles remained closed during the expulsion process. Juveniles consumed algae and remained active for several weeks, often climbing solid structures found in the culture environment.

In 1998, release of juveniles again occurred between June 2-9 at 16.1-16.5°C. Material was released as small clumps, containing a single live transformed juvenile within 10-20 smaller particles that were believed to be either unfertilized eggs or underdeveloped glochidia. The particles had a darkened triangular appearance and were held together by sticky, translucent strands. DNA analysis of the juveniles confirmed their identity as *Lasmigona subviridis*. On June 15, a dead or dying adult was found that contained live, active, transformed juveniles in her marsupia.

To this date, no unmetamorphosed glochidia have been observed released from any adult, although this event could easily have been missed if occurring in mid-winter. Studies are continuing on the transformation process within the marsupia, identification of expelled materials, and ecology and culture of juveniles.

MEASURING THE DEGREE OF VARIATION IN THE WISCONSIN WATERWAYS MOLLUSK Anodonta grandis

Abstract of Poster

Wisconsin Academy of Sciences, Arts & Letters Annual Conference May 2, 1998

Joan Jass and Jeanette Glenn, Invertebrate Zoology Section
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Variation in the ubiquitous and abundant freshwater bivalve Anodonta grandis (giant floater) was studied using Milwaukee Public Museum specimens collected during a 1973 to 1977 statewide survey of Wisconsin rivers for unionid mollusks by collector H. Mathiak. For this study of intraspecific variation, data on six shell traits were gathered for each specimen: 1) beak sculpturing, 2) length overall, 3) height, 4) width, 5) anterior-to-beak length of the right valve, and 6) darkness of the periostracum. Variables 2-5 represent morphometric traits, while 1 and 6 represent continuous, nonnumeric traits which were assigned to numeric classes for analysis purposes. The resulting data were subsequently pooled into three Wisconsin regional groupings representing sites from the northeast, the southwest, and an intermediate tension zone. Comparison of the three groups revealed statistically significant differences and indicated a high degree of intraspecific variation. Northern region shells had a beak sculpture less consistently double-looped, widths, heights, lengths and anterior-to-beak measurements that were smaller, and a darker color than those in the southern group.

Setback Hinders Endangered Mussel Recovery

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Efforts to recover endangered freshwater mussels suffered a tragic setback on August 27, 1998, when a tanker truck wreck spilled about 1,250 gallons of Octocure 554, a rubber accelerant, into the Clinch River at Cedar Bluff, Virginia. The spill resulted in the largest "take" of endangered species since passage of the Endangered Species Act in 1973. The Clinch River ran a snowy white color, the water filtration plant at Richlands, Virginia was shut down, and most aquatic organisms over at least a 6.6 mile stream reach were killed. Aquatic fauna killed included fish, aquatic insect larvae, snails, crayfish, turtles, and mussels. The Virginia Department of Environmental Quality reported a kill of approximately 3000-4000 fish. The spill devastated snail and mussel populations. Freshwater mussels from 17 species been killed by the spill. Biologists at the U.S. Fish and Wildlife Service's Southwestern Virginia Field Office have collected the remains of 242 endangered mussels killed by the spill--including the tan riffleshell, purple bean, and rough rabbitsfoot-- and approximately 6000 non-listed mussels. The Service and others working to protect and restore aquatic fauna of the upper Tennessee River basin fear the total number of individuals of listed and non-listed species killed is likely much higher. A storm event could resuspend particles that may have settled or precipitated out in pools, potentially resulting in further die-offs of mussels and other aquatic fauna further downstream.

The Service, The Nature Conservancy, and others recognize the Clinch River as one of the most ecologically significant freshwater river systems in North America. Take of endangered tan riffleshells resulting from the spill represents a significant loss from the world's only known reproducing population of this species. Service biologists are working desperately to save remnants of this population that extend a short distance upstream into a tributary of the Clinch River. Efforts to protect the remaining "seed source" of tan riffleshell and recover the species include artificial propagation, augmentation of existing populations, and establishment of non-essential experimental populations in Tennessee's Hiwassee River. The Service also hopes to garner support in the State of Virginia to establish non-essential experimental populations there as well.

New Unionid Records for Coastal Matagorda County, Texas

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Ecological Specialists, Inc. surveyed for unionids in a small unnamed tributary of the Colorado River, Matagorda County, Texas on 7 April 1998. Specimens were subsequently sent to Texas Parks and Wildlife Department's Heart of the Hills Research Station for examination. Six unionid species and the Asian clam were collected in 8 hours of sampling; however, only one unionid was alive when taken (Table 1). Substrate in the tributary was primarily sand, silt, and soft mud. The stream channel and riparian vegetation were heavily disturbed from trampling by grazing cattle. All of the species are common and relatively widespread in Texas, and each represents a new record for Matagorda County (Howells et al., 1996).

Table 1. Bivalves collected in a tributary of the Colorado River, Matagorda County, Texas.

Common Name	Species	No. live
Tampico pearlymussel	<i>Cyrtonaias tampicoensis</i>	WD
Fragile papershell	<i>Leptodea fragilis</i>	WD
Yellow sandshell	<i>Lampsilis teres</i>	WD
Bleufer	<i>Potamilus purpuratus</i>	WD
Giant floater	<i>Pyganodon grandis</i>	WD
Texas liliput	<i>Toxolasma texasensis</i>	1
Asian clam	<i>Corbicula fluminea</i>	WD

WD = Weathered dead

Literature Cited:

Howells, R. G., R.W. Neck, and H. D. Murray. 1996. Freshwater Mussels of Texas. Texas Parks and Wildlife Press, Austin. 218 pp.

Unio Gallery Website

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Conservation of endangered species requires public interest and support. Unfortunately, unionids lack the stage presence of eagles, wolves, or even little blue butterflies, and the uninitiated public may wonder why we are all so excited about a bunch of living rocks. Public interest can be enhanced by focus on the unionid life cycle. The interaction of mussels with fish is especially compelling, and adds color and intrigue to the story. Pictures of these phenomena are a great way to convince others that mussels are worth their attention.

The Unio Gallery is an Internet site presenting photographs of unionids and their life history stages. The purpose of the site is to give conservation professionals, educators, and other interested parties access to pictures for illustrating presentations. The images are JPEG files. They can be viewed on the Internet, but they can also be downloaded individually and entered into PowerPoint or other presentation software. They can then be used for electronic presentations, which are becoming increasingly popular, or they can be printed as 2x2 photographic slides and used with a traditional slide projector.

The Unio Gallery currently contains 61 images, mostly photographs that illustrate strategies for infecting fish hosts. Each page (group of 6-12 images) illustrates the adaptations of a particular species or genus. Each image is captioned with a brief explanation. I anticipate adding more pictures soon and I hope to add pages that illustrate other aspects of unionid biology, as well as reproduction.

If you would like to share your own photographs in this format, please contact me. I can scan your slides, or, if you scan your own, you can E-mail the JPEG files to me. Your name and copyright can be added to the pictures if you wish. Visit the Unio Gallery at the following URL: "<http://www.smsu.edu/mcb095f/gallery>".

Unionid	Species	Life Stage
Asian clam	<i>Corbicula fluminea</i>	WD
Texas liggett	<i>Liggettia liggettii</i>	I
Giant water bug	<i>Belostomatidae</i>	WD
Golden shiner	<i>Notropis aureolus</i>	WD
Striped bass	<i>Morone saxatilis</i>	WD
White perch	<i>Morone americana</i>	WD
Yellow perch	<i>Perca flavescens</i>	WD
Rock bass	<i>Ambloplites rupestris</i>	WD
Blackchin shiner	<i>Notropis heterodon</i>	WD
White sucker	<i>Catostomus commersoni</i>	WD
Striped bass	<i>Morone saxatilis</i>	WD
Golden shiner	<i>Notropis aureolus</i>	WD
White perch	<i>Morone americana</i>	WD
Yellow perch	<i>Perca flavescens</i>	WD
Rock bass	<i>Ambloplites rupestris</i>	WD
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White sucker	<i>Catostomus commersoni</i>	WD

WD = Weibull dead

Howell, R. G., R. W. Mack, and H. D. Murray. 1996. Freshwater Mussels of Texas. Texas Parks and Wildlife Press, Austin. 218 pp.

Release of Endangered Freshwater Mussels in 1998

Authors: Jess W. Jones and Richard J. Neves, VA Cooperative Fish and Wildlife Research Unit, Dept. of Fisheries and Wildlife Sciences, VA Tech, Blacksburg, VA 24061-0321, 540-231-5927

Research Sponsors: Tennessee Wildlife Resources Agency, U.S. Fish and Wildlife Service, U.S. Geological Survey, and Virginia Department of Game and Inland Fisheries **Cooperating Agencies:** Tennessee Valley Authority, U.S. Army Corps of Engineers, U.S. Forest Service

Project Description: The Tennessee Wildlife Resources Agency has committed funds to a 5 year project to produce, culture, and release juvenile mussels of numerous endangered species into rivers of eastern Tennessee. The goal of this project is to augment natural reproduction in current populations and to release juvenile mussels into historic habitat to expand the range of existing populations. Our initial focus for the first 2 years will be the Clinch and Powell rivers, where sufficient suitable habitat exists to augment and re-establish the populations of rare mussels. The selection of species and release sites was determined by a joint meeting of mussel biologists representing the various funding and cooperating agencies. This is the first project of its kind in the United States, to implement recovery plans for each of these species using captive propagation.

Methods: Procedures for infestation of host fish were those of Zale and Neves (1982). Juvenile mussels were placed on a sand substrate, held in artificial streams, and fed cultured algae until a desired size was achieved. Most juvenile mussels were 1 month old when released into the wild, although ages ranged from 1 to 22 weeks.

Results: In 1998, a total of over 35,000 endangered juvenile mussels of 6 species were released primarily into the Clinch River at 3 sites. Similar releases will occur annually for the next 4 years, and an evaluation of the success of the releases will be initiated in the year 2000. The following table is a summary of our juvenile production results:

Mussel Species	Number of Juveniles Released	Release Site
fanshell <i>Cyprogenia stegaria</i>	397	Clinch River at Horton Ford
	203	Clinch River at Wallens Bend
Cumberland combshell <i>Epioblasma brevidens</i>	7,286	Clinch River at Horton Ford
	20	Clinch River at Wallens Bend
oyster mussel <i>Epioblasma capsaeformis</i>	12,767	Clinch River at Horton Ford
	4,757	Clinch River at Wallens Bend
	7,973	Clinch River at Kyles Ford
	1,706	Powell River at Bales Ford
snuffbox <i>Epioblasma triquetra</i>	229	Clinch River at Horton Ford
birdwing pearlymussel <i>Lemiox rimosus</i>	44	Clinch River at Wallens Bend
cracking pearlymussel <i>Hemistena lata</i>	5	Clinch River at Sneedsville
Total for 1998	35,387	

Literature Cited: Zale, A. V. and R.J., Neves. 1982. Fish hosts of four species of lampisiline mussels (Mollusca: Unionidae) in Big Moccasin Creek. Canadian Journal of Zoology 60: 2535-2542.

Update of various ongoing mollusk projects at the Southeast Aquatic Research Institute. Please direct any questions to Paul Johnson, 817-B North Market Street, Chattanooga TN 37405, Phone (423) 785-4074, pdj@tennis.org, <http://www.sari.org/>.

Survey of mollusks in the upper-Conasauga River system inventory project

Paul Johnson along with Ryan Evans and several other research interns have recently completed the summer component of a survey of the upper Conasauga River system for mussels and snails. Additional experience was lent to the task when Steve Ahlstedt (USGS), Leigh Ann McDougal (USFS), and Bob Bulter (USFWS) participated in some of the field operations. This work is being supported by a contract from the U.S. Geological Survey's Species At Risk program. The overall goal of the project is to produce a database of both historical and contemporary distribution records for mollusks within the Conasauga River and its tributaries above the Georgia Highway 76 crossing just east of Dalton, Georgia. Survey results will be the basis of Mr. Evan's Master's research.

To date approximately 80% of the survey area has been examined. Historically the Conasauga River contained one of the densest and most diverse mussel faunas of any small river system in the world. However, although at least 40 species of freshwater mussels occurred in the watershed, Johnson's survey has only located 25 species. Furthermore, the apparent decline in the numbers of individual mussels is just as alarming. Historically, some shoals in the Conasauga were reported to have mussel densities in excess of 50 mussels per square meter. This summer, the survey crew was only able to locate about 400 live mussels in the entire region they examined. Without recovery efforts many of the remaining mussel species within the Conasauga River system will almost certainly disappear.

The Conasauga mollusk survey is a critical component of the mussel propagation program underway at SARI because it is providing data that can help to identify where mussels might be successfully reintroduced. The survey work also allows founder stock to be located that can be used in SARI's propagation efforts. Results from the survey are being shared with other groups concerned with the health of the Conasauga, such as The Nature Conservancy, the Conasauga River Alliance, the U.S. Forest Service, U.S. Fish and Wildlife Service, and the USGS.

Construction phase of mussel and snail propagation projects completed

The construction phases of SARI's mussel and snail propagation projects are virtually complete. Propagation and holding facilities have been constructed at both the Cohutta Fisheries Science Center, in Cohutta, Georgia and at the Tennessee Aquarium. Partially funded by a contract with the Jackson Office of the U.S. Fish and Wildlife Service, the snail propagation and rearing facilities consist of two raceways and one additional standing tank. The mussel propagation facilities were partially funded by a contract with the Asheville Office of the U.S. Fish and Wildlife Service, and because the mussel propagation work is relatively more elaborate these facilities are more extensive. This project when operation will focus on artificial propagation/restoration efforts with the upper Coosa River fauna. Angela Collier, an Environmental Science graduate student at UTC, and Paul Johnson designed and constructed much of the propagation facilities, with additional help and advice coming from the Aquarium's Maintenance and Husbandry departments. The mussel propagation work is expected to be the focus of Collier's Master's thesis research.

SARI to Co-Host First Symposium of the Freshwater Mollusk Conservation Society, March 17-19, 1999

Plans are underway for SARI and the Tennessee Aquarium to co-host the first symposium of the Freshwater Mollusk Conservation Society in Chattanooga, March 17-19, 1999. The symposium, *Musseling in on Biodiversity*, will interest biologists concerned with the status, distribution, regulation, management, and biology of unionid mussels – North America's most imperiled fauna. The symposium is expected to attract 250-300 attendees. In addition to the information exchange regarding freshwater mussels, a special session is planned that will focus on the biology and conservation of freshwater gastropods.

A local organizing committee consisting of Drs. Paul Johnson and George Benz (both SARI), Dr. John Jenkinson (TVA), and Steve Ahlstedt (USGS) has recently released a first call for papers. For more information about the meeting, please see the attached information and registration sheets in this issue of the Triannual Report.

Effects of temperature and chronic hypoxia on survivorship of the zebra mussel (*Dreissena polymorpha*) and Asian clam (*Corbicula fluminea*)

29

Can. J. Fish. Aquat. Sci. 55: 1564-1572 (1998)

Paul D. Johnson and Robert F. McMahon

Abstract: We examined the effects of four levels of chronic hypoxic stress at three temperatures on the survivorship of *Dreissena polymorpha* and *Corbicula fluminea* to assess the efficacy of O₂ deprivation as a macrofouling control treatment and examine if critical hypoxia limits support reported distribution patterns. At 25°C, the hypoxia tolerance was examined at Po₂ = 7.9, 11.9, 15.9, 23.8, and 31.8 Torr (1 Torr = 133.322 Pa) or 5, 7.5, 10, 15, and 20% of full air O₂ saturation (Po₂ = 159 Torr). At 15°C, the hypoxia tolerance to 7.9, 11.9, and 15.9 Torr was tested and at 7.9 Torr for 5°C treatments. For both species, Po₂ and temperature influenced survivorship dramatically with increasing survivorship at higher Po₂ and decreasing temperatures. At 25°C, *C. fluminea* experienced mortality at 7.9, 11.9, and 15.9 Torr, with LT₅₀ values of 144, 216, and 216 h, respectively, versus 288, 384, and 480 h for the 15°C exposures. *Dreissena polymorpha* treatments had LT₅₀ values of 120, 216, and 216 h at 25°C for the 7.9-, 11.9-, and 15.9-Torr treatments versus 26% mortality after 600 h and 28% mortality after 720 h at 15°C. The 7.9-Torr treatments at 5°C had LT₅₀ values of 480 h for *C. fluminea* and 1056 h for *D. polymorpha*. This study showed that both species displayed broad seasonal variation in hypoxia tolerance and that hypoxia limits may be used to assess infestation risk.

Intraspecific life history variation in the threatened Louisiana pearlshell mussel, *Margaritifera hembeli*

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Freshwater Biology (1998) 40, 317-330

SUMMARY

1. *Margaritifera hembeli* is a threatened mussel limited to twenty-two headwater streams in the Red River drainage in central Louisiana, USA. This study evaluated intraspecific variation in density, growth, size and age structure and shell morphology among several isolated populations. This study also identified the host fish and considered the role that host fish distribution played in determining mussel recruitment.
2. Mussels were aggregated in beds and average densities differed among streams. However, maximum mussel densities in beds were similar in all streams; the observed maxima were among the largest for monospecific mussel beds in North America, often exceeding 300 individuals m⁻².
3. The maximum size reached by individuals differed among streams, but all size distributions were skewed towards larger individuals. A repeated measures analysis of tagged mussels in four populations, over a 2-year period, indicated 2-fold differences in growth rates among streams, and significant variation among years. Growth rates were not affected by local population density. Maximum ages reached, determined indirectly by comparing growth rates, varied from 45 to 75 years. A canonical discriminant analysis also revealed significant differences in shell morphology across populations.
4. Half of the populations showed evidence of recent recruitment, and these sites had fish assemblages dominated by the host fish *Noturus phaeus* (Taylor). Host fish abundance appeared more important than adult mussel density in explaining recruitment patterns.
5. Considerable intraspecific life history variation suggests that management strategies for this species should be stream-specific, with emphasis on ensuring long-term habitat stability.

Decline and Extirpation of Freshwater Mussels in Little Black River, Missouri: There's Still Hope

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Qualitative timed-searches using snorkeling and waterscoping techniques were conducted in March and August, 1997 in the upper Little Black River, Ripley County, Missouri for the federally endangered Curtis pearlymussel, *Epioblasma florentina curtisi* (Utterback 1915). Nineteen freshwater mussel species were recorded from the survey reach in 27 person-hours of search time. In September, 1998, quantitative surveys ($n=130$, $.25\text{m}^2$ quadrats) were conducted to compare with three previous quantitative surveys conducted at the same sites between 1980-1992. No Curtis pearlymussels were found during the study. Its absence in repeated surveys, and continued decline in species richness, abundance, recruitment, and excessive shell erosion in other associated naiad species during the past two decades indicate that the Curtis pearlymussel no longer exists in the upper Little Black River, Missouri. Problems identified in Little Black River, Missouri include chronic, elevated levels of fecal coliform bacteria in drinking water and excessive silt in the river bed. Potential sources of observed problems include inadequate treatment of human sewage, excessive nutrients from high densities of cattle and other domestic livestock, and poor land-use practices in this mostly-forested upper section of the watershed. Recent upgrades to the water treatment facility in the town of Grandin in the headwaters of the stream should correct some historical problems. Besides water quality problems, however, physical habitat in upper Little Black River is relatively stable compared to other Ozark streams in Missouri. Restoration will be difficult, but possible with a coordinated interagency, interdisciplinary, and public effort within the watershed. A population of the Curtis pearlymussel may still exist in Arkansas, which is a potential source of specimens for artificial propagation and the last hope for preserving this federally endangered species. Regardless of the outcome of the Curtis pearlymussel, the upper Little Black River still contains a relatively unique and diverse aquatic fauna worth saving. Recovery seems possible if actions are taken immediately to further identify and arrest problems in the watershed.

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The mussel shell harvest has been nearly non-existent since July, with none of the major companies openly purchasing shells. Commercial shell industry contacts speculate that next year will be as bad or worse for them as 1998. But as the industry is experiencing hard times, the resource is certainly benefitting from the decreased harvest activity.

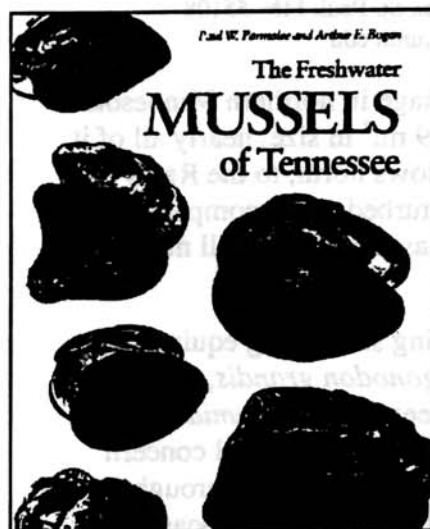
Lack of commercial harvest activity has allowed TWRA mussel personnel to concentrate on survey work on the upper Kentucky Reservoir mussel beds. A new section 6 project has provided funding to locate habitat of endangered mussels, collect adults for propagation by Dr. James Layzer at Tenn. Tech. Co-op Fish Research Unit, and establish sites for population augmentation. Several endangered mussel species have been brought into the propagation program including: *Lampsilis abrupta*, *Plethobasus cooperianus*, *Pleurobema plenum*, & *Cyprogenia stegaria*. This reach of the Tennessee River below Pickwick Dam has areas of prime mussel habitat that have populations of common species at densities exceeding 100 mussels per square meter and evidence of recent recruitment of almost all species encountered.

TWRA will again be attempting to revise its commercial mussel regulations this winter. The Wildlife Resources Commission has shown increased interest in the commercial aspect of Tennessee's mussel program since the Federal investigation of the shell industry and its illegal harvest activities made headlines this past summer. TWRA is currently evaluating existing regulations in light of information gained through the investigation. We hope to develop a program which benefits the legal harvester and gives more control over the resource to the TWRA.

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The species accounts comprise 128 members of Family Unionidae—from pigtoes and pocketbooks to lilliputs and spikes—plus four additional species. The authors cover classification and synonymy, range and distribution, life history and ecology, and survival status. Particular attention is paid to shell description and structure to assist the reader in identification. Each species account includes a distribution map and color photos of two specimens.

The Freshwater Mussels of Tennessee is a major reference that encompasses historical and modern mussel collections and draws on conservation studies that span two centuries. It will stand as an authoritative guide to understanding Tennessee mollusks and as a benchmark in the study of these species worldwide.

The Authors: Paul W. Parmalee is professor emeritus of zooarchaeology and director emeritus of the McClung Museum at the University of Tennessee, Knoxville.

Arthur E. Bogan is curator of aquatic invertebrates at the North Carolina State Museum of Natural Sciences, Raleigh.

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Special concern mussels found in northern Minnesota watershed

Mark Hove, Jodi Gustafson, Jennifer Sieracki, Jennifer Kurth, Parnell Mahoney, Melissa Tenpas & Susan Weller

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Very little survey work has been conducted in the Lake of the Woods drainage in northern Minnesota (Graf 1997). The Little Fork River, a subdrainage in the watershed, is 1,849 mi² in size, nearly all of it flowing through the bed of Glacial Lake Agassiz. The Little Fork River, flows north, to the Rainy River; Minnesota's border with Canada. This watershed is relatively undisturbed when compared with the rest of the state. Pine and aspen forests cover much of the land in the basin, with a small number of ranches (Waters 1977).

Twenty-five sites within the Little Fork River watershed were surveyed using snorkeling equipment and SCUBA. *Lampsilis siliquioidea* was observed at nearly every site. *Pyganodon grandis*, *Anodontoidea ferussacianus*, and *Lampsilis cardium* were observed at thirteen sites. *Ligumia recta*, a special concern species in Minnesota, were found at nearly half the sites. The other special concern species encountered, *Lasmigona compressa*, was observed at five sites distributed widely throughout the basin. *Lasmigona complanata* and *Strophitus undulatus* were collected at six and two locations respectively. Live mussel densities ranged between 0.4-7 mussels/m² in the Little Fork River (Figure 1).

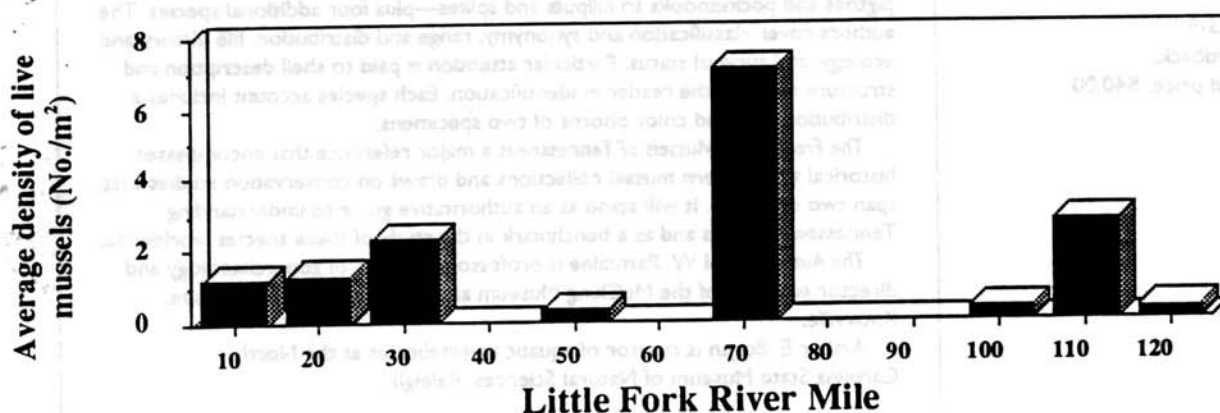


Figure 1. Live mussel densities in the Little Fork River, Minnesota.

Financial and logistic support for this survey was provided by: the Minnesota Legislature, ML 1997 Chapter 216, Section 15, Subdivision 15b as recommended by the Legislative Commission on Minnesota Resources from the Minnesota Environmental and Natural Resources Trust Fund, University of Minnesota's Undergraduate Research Opportunities Program, Science Centrum, the James Ford Bell Museum of Natural History, and Chantel Cook, Jeremy Cable, Nancy Berlin, and Brenda Stauffer of the National Forest Service.

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Quadrula fragosa exhibit unusual reproductive behaviors

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This fall brings to an end the second of a three-year study to describe aspects of the largely unknown life history of the federally endangered, winged mapleleaf (*Quadrula fragosa* (Conrad, 1835)). Although this species once ranged throughout the upper Mississippi River watershed, it is now thought to occur only in the St. Croix River, bordering Wisconsin and Minnesota, and possibly in the Ouachita River, Arkansas (Posey *et al.* 1996). The winged mapleleaf was listed as federally endangered in 1991.

The objectives of this study include: (1) description of the brooding period and reproductive behavior, (2) identification of conchological and molecular characters of glochidia, and (3) determination of suitable glochidial hosts.

We used SCUBA to sample nine species of amblesines biweekly from May to November 1997 and April through October 1998. During fall 1998, winged mapleleaf were sampled every week. Winged mapleleaf glochidia were collected in 1997 and 1998 for use in the 2nd and 3rd objectives.

Unlike most amblesines, which brood glochidia during spring and summer, winged mapleleaf brood glochidia during a relatively short period in September and October (Table 1). In 1997, only a single gravid individual was observed. Unfortunately this animal released immature glochidia that were unusable for host suitability trials. Nineteen gravid individuals were observed in 1998. Demibranchs of gravid winged mapleleaf were usually only slightly swollen making non-lethal gravidity determinations difficult. Consistent with other amblesines, all four demibranchs served as marsupia. Four gravid individuals brought into the laboratory released a few to several conglomerates. Conglomerates were released individually and in groups. They were roughly 5 mm wide by 10 mm long and were slightly negatively buoyant. Glochidia were densely packed throughout the length of the white, thin conglomerates that tapered at both ends.

Table 1. Observed amblesine brooding periods in the St. Croix River.

Species	'97 Brooding Period	'98 Brooding Period
<i>Amblesma plicata</i> (Say, 1817)	16 June - 16 July	8 June - 20 July
<i>Cyclonaias tuberculata</i> (Raf., 1820)	7 May - 29 July	28 April - 6 July
<i>Elliptio dilatata</i> (Raf., 1820)	20 May - 29 July	11 May - 11 July
<i>Fusconaia flava</i> (Raf., 1820)	3 June - 12 August	11 May - 3 August
<i>Pleurobema sintoxia</i> (Raf., 1820)	20 May - 29 July	11 May - 3 August
<i>Quadrula fragosa</i> (Conrad, 1835)	24 September	10 September - 8 October
<i>Quadrula metanevra</i> (Raf., 1820)	7 May - 29 July	28 April - 3 August
<i>Quadrula p. pustulosa</i> (Lea, 1831)	7 May - 16 July	28 April - 6 July
<i>Tritogonia verrucosa</i> (Raf., 1820)	7 May - 3 June	28 April - 8 June

A surprising behavior exhibited by brooding and some non-brooding individuals was the presence of a swollen excurrent siphon. The siphon protruded approximately 10 mm from the shell margin, had black-ridged crenulations overlaying the gray mantle. Similarly swollen siphons and mantles were observed on other brooding amblesines.

Glochidia from four of five females that released in the laboratory were mature and used in vertebrate host suitability trials. Seventy-five host suitability trials were conducted (53 species tested). Although no winged mapleleaf juveniles have been observed, glochidia grew while attached to yellow, black, and brown bullheads, and channel and flathead catfish. Some glochidia nearly doubled in size. Glochidia remain attached to flathead catfish. To date, we have not identified a definitive host.

We will continue this study in 1999 to better describe the environmental variables surrounding the winged mapleleaf brooding period, conduct additional host suitability tests, and attempt to collect fishes naturally infested with winged mapleleaf glochidia.

We thank Bill Smith, Matt Christianson, Helen Kitchel, Robert Hay, Jim Burnham and Colin Dovichin of the WI DNR; Mike Davis, Susan Miller, Bonita Eliason and Missy Wipf of the MN DNR; Rick Hart of North Dakota State University; Jerry Spetzman of the MN DoA; Byron Kams of the U.S. National Park Service, Jennifer Seiracki, Shawn Strong, Michelle Lebeau and Melissa Tenpas of U. of MN, and Nick Rowse and Chuck Kjos, USFWS; Glenn Miller of the Great Lake Indian Fish & Wildlife Commission; Keith Patrick of Northern Ecological Services (NSA); and R. Maercklein for assistance. Funding for this study was provided by the federal aid under Section 6 of the Endangered Species Act of 1973 with matching funds from the Wisconsin Department of Natural Resources, Minnesota Department of Natural Resources and Minnesota Environmental and Natural Resources Trust Fund.

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Hosts of salamander mussel (*Simpsonaias ambigua*) and snuffbox (*Epioblasma triquetra*) from the Meramec River system, Missouri.

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The salamander mussel is one of the most elusive and unusual unionids (Clarke 1985) and may be the only unionid that is an obligate parasite of an amphibian host. Howard (1915) collected naturally infected mudpuppies (*Necturus maculosus*) near Moline, Illinois on October 17. He maintained the hosts through the winter and observed excysted juveniles in late May of the following spring. Howard attributed the glochidia that he observed to *Simpsonaias* (formerly *Hemilastena*) *ambigua* by comparison with glochidia later collected from gravid female mussels. However, it appears that no experimental infections were ever carried out. In the present study, salamander mussels were collected in August 1997 in the Meramec River. These individuals were not gravid at the time of collection and therefore were caged on site over the winter. A single gravid female was recovered on April 9 and subsequently used for host tests.

The glochidia of *Simpsonaias* transformed on mudpuppies, but not on any of the 12 species of fish that were tested. Time from infection to excystment was 19-28 days (peak 23 days) at 20 °C. The percent transformation success on *Necturus* was rather low; 13% of initially attached glochidia survived and transformed. The glochidia used for host tests were removed manually from the marsupia by flushing with sterile water from a syringe. However, the mussel subsequently released glochidia in what appeared to be a normal fashion. No conglomerates were evident. The glochidia bore prominent larval threads and were carried away from the female on the excurrent water flow in strands of threads and mucus similar to those produced by *Utterbackia* and other anodontines.

Snuffbox mussels were collected from the Bourbeuse River (Meramec system) in the summer and caged over the winter as described above. A gravid female was recovered on April 9. Snuffbox glochidia transformed on three of the 23 host species tested. Transformation occurred on logperch (*Percina caprodes*), blackspotted topminnow (*Fundulus olivaceus*), and Ozark sculpin (*Cottus bairdii*). Transformation time on logperch was 21-27 days (peak 24 days) at 20 °C. Hosts of *E. triquetra* have been reported previously (Yeager and Saylor 1995, Hillegass and Hove 1997).

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Drum is host of the scaleshell, *Leptodea leptodon*.

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Scaleshell mussels were obtained from the Meramec River, Missouri in during surveys conducted by the Missouri Department of Conservation. Three females were gravid with early embryos on August 15, 1997. These individuals were caged on site over the winter, and recollected in April, at which time the glochidia were mature. Twenty-four fish and one amphibian species were tested as hosts by experimental infections, using fishes obtained primarily from Meramec tributaries. Transformation was observed only on drum (*Aplodinotus grunniens*), from which several thousand juveniles were recovered.

Transformation did not occur on the following species: common carp (*Cyprinus carpio*), striped shiner (*Notropis chrysocephalus*), central stoneroller (*Camptostoma anomalum*), bleeding shiner (*Notropis zonatus*), bluntnose minnow (*Pimephales notatus*), Ozark minnow (*Dioinda nubila*), spotfin shiner (*Notropis spilopterus*), northern hogsucker (*Hypentilium nigricans*), slender madtom (*Noturus exilis*), checkered madtom (*Noturus flavater*), blackspotted topminnow (*Fundulus olivaceus*), northern studfish (*Fundulus catenatus*), longear sunfish (*Lepomis megalotis*), bluegill sunfish (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), logperch (*Percina caprodes*), *Etheostoma blennioides* (greenside darter), rainbow darter (*Etheostoma caeruleum*), Missouri saddled darter (*Etheostoma euzonum*), walleye (*Stizostedion vitreum*), Ozark sculpin (*Cottus ozarkae*), and mudpuppy (*Necturus maculosus*).

A regionwide status assessment of scaleshell recently concluded that the species is in serious decline, and that recruitment is evident only in the Meramec basin (Szymanski 1998). This decline contrasts with the use of a widespread and relatively common host. Recent genetic studies link the genus *Leptodea* closely with *Potamilus* (Roe and Lydeard 1997). Other *Potamilus* and *Leptodea* species that have been investigated also utilize drum as host (e.g. Roe et al. 1997, Barnhart and Roberts 1997).

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1998 St. Croix River Research Rendezvous abstracts

The following abstracts were selected from presentations made at the 10th annual meeting of the St. Croix River Research Rendezvous. The meeting was held on October 20, 1998 at Marine on the St. Croix, and was sponsored by the Science Museum of Minnesota.

Mark Hove, Univ. of Minnesota, (612) 624-3019

EXAMINATION OF MUSSEL POPULATION AND COMMUNITY STABILITY AT INTERSTATE PARK, ST. CROIX RIVER.

Daniel J. Hornbach, Melissa Kemperman, Valerie Kurth, Alicia Andersen, Leda Cunningham, Faith Hareldson, Ben Miller, and Phoebe Vanselow
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There are 40 species of freshwater mussels in the St. Croix River. The Nature Conservancy states that the St. Croix Watershed is critical for the conservation of the North American mussel fauna. Little is known about the population and community dynamics of freshwater mussels in the St. Croix despite its importance.

The Interstate Park area of the St. Croix River contains an abundant and diverse mussel assemblage. Two federally endangered species of mussel (the Higgins' Eye mussel and the winged mapleleaf mussel) are found in this area. This area is subjected to daily variations in water level because of the Northern States Hydroelectric Dam located at Taylor's Falls/St. Croix Falls. There has been some controversy concerning the most appropriate water release regime for this facility which would protect and enhance mussel habitat. This study was designed to continue a long-term monitoring program that may shed some light on the mussel population and community dynamics at this location.

We have quantitatively sampled (at least 100 0.25-m² quadrats) this location in 1992, 1995 and again in 1998. After removing all of the substrate and mussels from the quadrats, we sieved the material to assess substrate size and to collect all mussels. We were able to collect mussels <10 mm using this procedure. We identified and measured the shell length of all mussels and then returned them to the river. At each quadrat we also measured water depth and velocity.

We found significant decreases in both average mussel density and average species richness over this 6 year period. We found that there appeared to be strong young age classes in 1992 and an absence of another large reproductive output during this period. The decrease in mussel density, thus may be due to higher juvenile mortality. It is unknown whether the presence/absence of strong recruitment peaks is a 'natural' event or a response to habitat alterations.

Funding provided by The National Park Service - St. Croix National Scenic Riverway.

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Hornbach, D.J., J.G. March, T. Deneka, N.H. Troelstrup and J.A. Perry. 1996. Factors influencing the distribution and abundance of the endangered winged mapleleaf mussel, *Quadrula fragosa* in the St. Croix River, Minnesota and Wisconsin. American Midland Naturalist 136: 278-286.

PHYSICAL MICROHABITAT LIMITATIONS OF JUVENILE MUSSELS

Melissa M. Kemperman and Daniel J. Hornbach
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Since stability of a viable, multi-cohort mussel population depends on localized juvenile recruitment, conservation efforts must ensure that juvenile microhabitat requirements are met. Prior research in the St. Croix River found juvenile mussels clumped in non-adult locales, suggesting preferential microhabitat use. Despite appropriate food sources and minimum competition and predation, juveniles will not persist locally if water currents dislodge them from their attachment site. This study explores the physical limitations to juvenile settlement and persistence in the Sunrise River, a tributary of the St. Croix River.

We sampled fifteen sites along an area of high mussel density below Kost Dam, representing microhabitats of various flow, depth, and substrate type. A set of two settling samplers made of 11.4 cm diameter x 5.1 cm tall clear dishes was placed at each site during three time periods. Their contents were removed weekly to find newly-settled juveniles. Directly upstream and to the east and west sides of each set of settling samplers, Surber samplers were placed onto the substrate and the top portion of substrate loosened into the net to collect small juveniles. The rest of the sediment within a 0.09 m² quad was excavated to collect larger mussels and to assess sediment size. Sediment from settling and Surber samplers was preserved in alcohol and juveniles searched under polarized light.

Adult densities were high but varied (102 (61 mussels/m²). This can be explained partly by negative effects of bottom flow ($R^2 = 0.225$) and positive effects of depth ($R^2 = 0.198$) and mean phi ($R^2 = 0.29$). This indicates that adults are favored by sandier substrate and slower-flowing, deeper water. Surber and settling samplers are being processed to determine juvenile settlement rates and effects of sediment size distribution. Laboratory experimentation using a flume tank will investigate the effects of byssal thread strength, body shape and size, and substrate size on juveniles' resistance to shear stress.

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EFFECTS OF RELOCATION ON FRESHWATER MUSSELS

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Mussels are an important part of the St. Croix River system because they are biomonitors, indicators of habitat quality and stability, and because of the integral role they play in nutrient cycling. The St. Croix is home to 40 different species of freshwater mussels. Recent introduction of zebra mussels into the river and increasing construction of bridges and dams on the St. Croix make it necessary to study the effects of relocating mussels on the habitat into which they are moved and on the mussels themselves. This study explores these effects both qualitatively and quantitatively using two confined water sites on the St. Croix River. Beginning in July 1997, one 25m² grid was laid down at Wild River State Park and another just upstream of where the Sunrise River joins the St. Croix River. The grids were divided into five rows of five square meters (quadrats) and each quadrat was randomly assigned one of five different treatments. These were: Double Density, 78 mussels were added, QP, 10 *Quadrula pustulosa* were added, LC, 10 *Lampsilis cardium* were added, ED, 10 *Elliptio dilatata* were added, and Control, where no manipulation of these quadrats occurred. All of the mussels of the three introduced species were obtained from the Sunrise (reference) site and relocated to the Wild River site. Using SCUBA, all mussels in each quadrat, alive and

dead, were removed and brought onto the research vessel to be identified, weighed and measured for length. Mussels in all quadrats but the control were assigned a unique number that was etched into the mussel shell using a Dremel hand tool.

In August of 1998 the same procedure of mussel removal was followed as in 1997. Mussels found without a number were logged as "new", those numbers missing from the 1998 census were logged as "missing" and the rest were logged as "recovered", "control", or "dead" as applicable to their status. The data were analyzed using JMP. In the year-long study period, a total of 4531 mussels were catalogued, of which 40% were recovered, 32% were new, 12% were control (not given an identification number in 1997), 12% were missing, and 4% were dead. There were comparable numbers of New, Recovered, Control, and Missing mussels between the two sites. However, there were almost twice as many dead mussels found at the Sunrise site (0.05%) compared to the Wild River site (0.03%), though mortality was low at both sites. The large number of new and missing mussels indicates movement out of and into the grid, a topic that is currently being studied. It appears that introduction of mussels into an existing mussel habitat does not adversely affect either the original or the relocated mussel populations on a short-term basis. We will continue to follow this relocation to further examine the efficacy of this procedure for populations threatened either by zebra mussel infestations or human interference.

Funding provided by the Minnesota Legislative Commission on Minnesota Resources.

SUGGESTED READING:

Cope, W.G. and D.L. Waller. 1995. An evaluation of freshwater mussel relocation as a conservation and management strategy. *Regulated Rivers: Research and Management* 11: 147-155.

SCANNING ELECTRON MICROSCOPY OF FRESHWATER MUSSEL LARVAE.

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The conservation of mussels requires an understanding of their dispersal by fish hosts; thus, successful species identification during their larval state is crucial. Limited data exists for the determination of a species from its larvae, or glochidia. The confident identification of glochidia has many useful applications in bivalve research. While general identification of subclasses, such as Ambleminae, may be possible using standard light microscopy, determination of the species level is unreliable by these methods. Scanning electron microscopy (SEM) may offer a reliable means to identify glochidia to species. SEM allows observation both qualitative and small but quantifiable differences in mussel valve structures.

In this study we used SEM, to examine glochidia from *Quadrula metanevra*, *Q. pustulosa*, and the federally endangered, winged mapleleaf mussel, *Quadrula fragosa*. Preliminary analysis of hinge and valve dimensions suggests that an accurate differentiation between species can be made using statistical methods. In addition to this quantitative analysis, qualitative examinations (pictures from the SEM) yield even better results. Although positive field identification of glochidial species is not yet possible; the methods used in this study offer a reliable means for identification in laboratory.

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Waller, D.L., Holland Bartels, L.E., and Mitchell, L.G. 1988. Morphology of glochidia of *Lampsilis higginsii* (Bivalvia: Unionidae) compared with three related species. *American Malacological Bulletin*, Vol 6, p. 39-43.

Funding provided by the Wisconsin Department of Natural Resources.

SUBLETHAL EFFECTS OF EMERSION ON THREE SPECIES OF UNIONID MUSSELS

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²U.S. Geological Survey, Upper Mississippi Science Center, La Crosse, Wisconsin.

³Department of Toxicology, North Carolina State University, Raleigh, North Carolina.

Freshwater mussels are emersed (exposed to air) during conservation activities, such as status surveys, relocations and reintroductions. Success of these activities depends upon their ability to survive emersion and burrow into the substrate. Sublethal effects of emersion were determined by changes in energy reserves of mussels. Three species of unionid mussels (*L. cardium*, *Q. pustulosa* and *E. dilatata*) were acclimated in water at 25 °C and exposed to five aerial temperatures (15 to 45 °C) for 15, 30 or 60 min. After emersion, mussels were returned to water at 25 °C. Burrowing and survival were observed for 14 d; mussels were then sacrificed and mantle tissue was analyzed for total lipid, carbohydrate, and protein content. All species demonstrated significant treatment effects on lipid content due to aerial exposure temperatures. Carbohydrate and protein content were not as sensitive. Carbohydrate content within the mantle tissue of *Q. pustulosa* and *L. cardium* was significantly affected by aerial temperature. Protein content within the mantle of *Q. pustulosa* was affected by duration of exposure.

SUGGESTED READING:

Cope, W. Gregory, and Diane L. Waller. 1995. Evaluation of freshwater mussel relocation as a conservation and management strategy. *Regulated Rivers: Research and Management*. Vol. 11, pp. 147-155.

Waller, Diane L., Jeffrey J. Rach, W. Gregory Cope, and Glenn A. Miller. 1995. Effects of handling and aerial exposure on the survival of unionid mussels. *Journal of Freshwater Ecology*. Vol. 10(3), pp. 199-207.

WHERE HAS *QUADRULA NODULATA* BEEN HIDING: A UNIONID MUSSEL SURVEY, MISSISSIPPI RIVER MILE 820.0-821.6, LOWER GREY CLOUD ISLAND/MAIN CHANNEL, COTTAGE GROVE, MINNESOTA

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A unionid mussel (Mollusca: Bivalvia: *Unionidae*) survey was conducted September 1997 at the above site. During the first two random dives near Mississippi River Mile 820.0, each covering an area of about 3 X 15 m, yielded one Minnesota endangered *Quadrula nodulata* (Rafinesque 1820), wartyback, and one Minnesota threatened *Tritogonia verrucosa* (Rafinesque 1820), pistolgrip, among 130 living mussels (11 species). The latter specimen is probably the first living representative of *T. verrucosa* from the Minnesota portion of the Upper Mississippi River in many years. Other random samples yielded five more wartybacks scattered throughout the study area including two found downstream of Lower Grey Cloud Island. Quantitative samples using 0.25 or 1.0 m² quadrats (total 73.0 m²), yielded low densities (mean 1.41 mussels/m²), but included two additional wartybacks for a project total of 8. *Q. nodulata* each representing a different age class (3,4,6,7,8,9,10,13 years). The CPUE for random dives was 1.5/minute.

Early 1900s literature indicates the host may be the channel catfish, flathead catfish, bluegill, or smallmouth bass (Fuller 1977). The wartybacks were unexpected since this species was not found alive in 1996 among 6,000 mussels we handled at Winona, Minnesota, nor among 13,000 mussels we handled at La Crosse, Wisconsin, and is nearly unknown from the St. Croix River. The pistolgrip was 11 years of age. Studies for the pistolgrip host fish have been done recently. A total of 738 living mussels (14 species) were measured and aged. Live mussels were in excellent condition with almost no erosion of the umbo even at 10-20 years of age. An additional 11 species were represented by empty shells; four were fresh-dead; seven were sub-fossil special status species, mostly from the LDB main channel border islands. Only one living

Dreissena polymorpha (Pallas 1771), zebra mussel, was found attached to a *Quadrula quadrula* (Rafinesque 1820), mapleleaf. Improvements to sewage disposal plants in the Twin Cities area have apparently improved water quality to the extent that mussels have begun to re-populate the area around Lower Grey Cloud Island.

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HOSTS AND HOST ATTRACTING BEHAVIORS OF FIVE UPPER MISSISSIPPI RIVER MUSSELS

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Of 297 freshwater mussel species living in North America, 213 are either endangered, threatened, or of special concern. The identification of fish hosts is listed as an urgent research objective in the National Strategy for Freshwater Mussel Conservation. Suitable hosts were determined by artificially infesting various fishes and amphibians with glochidia from one of five mussel species. A fish was considered a suitable host when larval metamorphosis to the juvenile stage was observed. Observations of host attracting behavior were made in the laboratory and under natural conditions. *Cumberlandia monodonta* released branched, white conglutinates held together in a clear, gelatinous matrix. Hosts have not been identified. Brooding female *T. verrucosa* displayed a crenulate mantle, and release thin yellow conglutinates. Three-fold shell growth was observed on juveniles collected from yellow bullheads. *Cyclonaias tuberculata* displayed a slightly inflated mantle and released glochidia individually or together in a 1 x 3 cm conglutinate. Glochidial transformation was observed on four ictalurids. Brooding *V. ellipsiformis* displayed a small, light-sensitive, mantle flap with an eyespot. Glochidial transformation was observed in two cottids, four darters, and brook stickleback. *Ligumia recta* displayed a large, elaborate mantle and released 1 cm lanceolate, white conglutinates. Largemouth bass, bluegill, and walleye were suitable hosts for this species. Species-specific molecular markers are being developed for use in the identification of excysted juvenile mussels collected from naturally infested fish.

MUSSEL IDENTIFICATION WITH PCR TECHNOLOGY

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Freshwater mussels have an unusual life cycle that includes a period of parasitic encystment on fish hosts during their larval stage. Understanding these parasite-host interactions is integral to mussel conservation.

Mussels in their larval form, however, are difficult to distinguish from one another. Polymerase chain reaction (PCR) technologies may be one way to distinguish between these larval forms.

This project seeks to facilitate identification of larval mussels in the St. Croix by creating a key for the genetic fingerprints of the 40 mussel species found in the river. In this process, foot tissue from adult specimens or whole glochidia are minced and DNA is extracted from the tissue following a standard phenol-chloroform extraction procedure. The extracted DNA is precipitated in a solution of ethanol/ammonium acetate, dried, and resuspended in water.

The ITS-1 region of rDNA is then amplified via polymerase chain reaction. Gene products are "cut" by several restriction endonucleases in order to detect differences in the DNA sequence of the ITS-1 region. "Cut" and "uncut" DNA are applied to agarose gels and separated by size by passing an electric current through the gel (gel electrophoresis). Finally, gels are stained with ethidium bromide and DNA bands are visualized within the gels with UV light.

To date, DNA has been extracted from 20 of the St. Croix River mussel species including the federally endangered winged mapleleaf mussel, *Quadrula fragosa*. A promising number of inter-specific differences have been found. Preliminary data suggest that all 40 St. Croix River mussels can be distinguished with this method and that genetic fingerprinting through PCR may be a viable larval mussel identification tool in the near future.

Funding provided by the National Park Service, St. Croix National Scenic Riverway

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White, L. R., McPherson, B.A., and Jay R. Stauffer, Jr. 1996. Molecular Genetic Identification Tools for the Unionids of French Creek, Pennsylvania. *Malacologia*, 38(1-2): 181-202.

EFFECT OF CHLORPYRIFOS ON ACETYLCHOLINESTERASE ACTIVITIES OF THE UNIONID MUSSEL *AMBLEMA PLICATA PLICATA*.

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Populations of freshwater mussels in North America have declined greatly over the past 30 years. Studies have demonstrated that effects of pesticides on freshwater mussels may be significant, especially in highly agricultural areas. Depletion of mussel populations in the Upper Mississippi River (UMR), for example, may have been partly caused by extensive use of organophosphorus compounds (OPs), such as chlorpyrifos. However, relatively little is known on sublethal effects of chlorpyrifos to native unionid mussels in the UMR. *Ambelma plicata plicata* were exposed in duplicate to a control and five concentrations of chlorpyrifos in flow-through aquaria with sand substrate. After 12, 24, and 96 h of exposure, the anterior adductor muscles of four randomly chosen mussels from each exposure chamber were analyzed for acetylcholinesterase activity, a bioindicator of exposure to OPs. After 12h of exposure, six randomly chosen mussels were removed, marked, and transferred to a flow-through tank containing clean water and sand. After 7 and 21 d of exposure to clean water, the anterior adductor muscles of three organisms from each treatment were analyzed for acetylcholinesterase recovery.

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