The Freshwater Mollusk Conservation Society (FMCS) is an organization devoted to the advocacy for, public education about, and conservation science of freshwater mollusks, North America's most imperiled fauna. Membership in the society is open to anyone interested in freshwater mollusks who supports the stated purposes of the Society:

- advocate conservation of freshwater molluscan resources,
- serve as a conduit for information about freshwater mollusks,
- promote science-based management of freshwater mollusks,
- promote and facilitate education and awareness about freshwater mollusks and their function in freshwater ecosystems,
- assist with the facilitation of the National Strategy for the Conservation of Native Freshwater Mussels (Journal of Shellfish Research, 1999, Volume 17, Number 5), and a similar strategy under development for freshwater gastropods.

4th Biennial Symposium

Freshwater Mollusk Conservation Society

May 15-18, 2005 • Radisson Riverfront Hotel • St. Paul, Minnesota, USA

Are Your Natives Restless?

Holistic Strategies for Conserving Freshwater Mollusks During Exotic Species Invasions

Meeting Program and Abstracts

Symposium Host Sponsors

Ecological Specialists, Inc.
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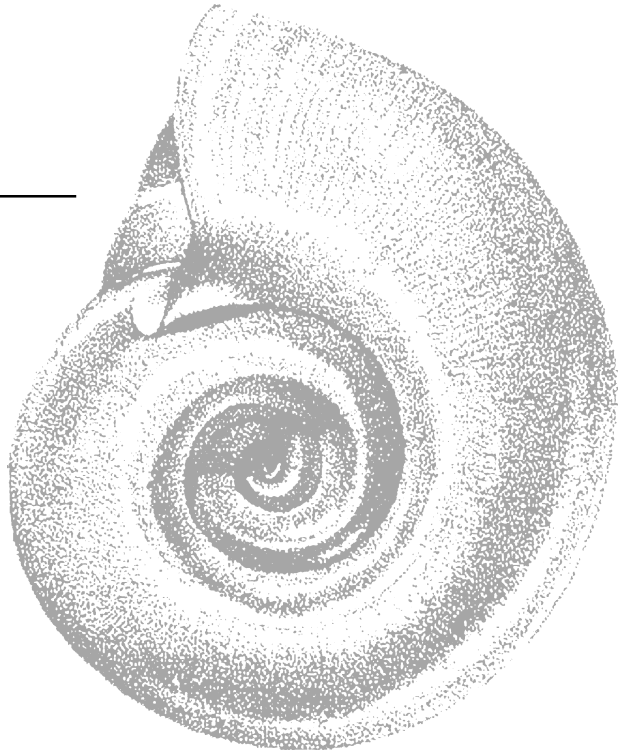
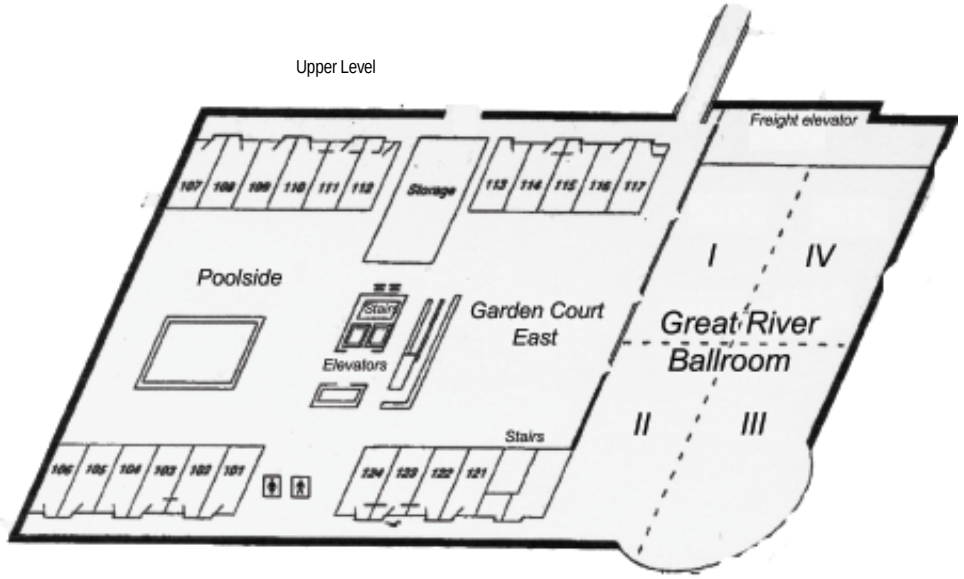
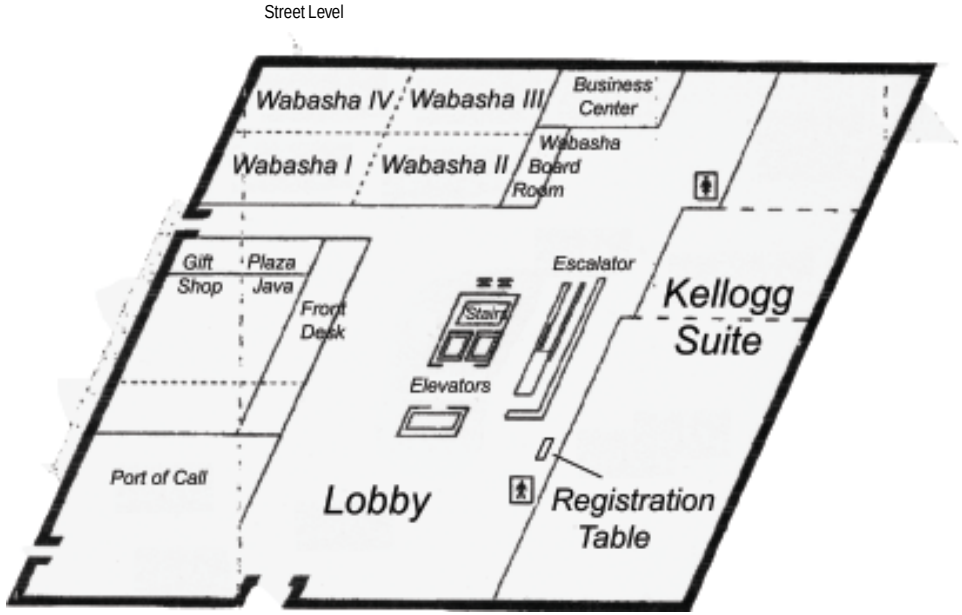


Layout of Hotel Meeting Rooms





Sunday, May 15, 2005

1:00 PM - 9:00 PM-Registration ..... Radisson Lobby

1:00 PM - 4:00 PM- Monday Platform Presenters to Turn in PowerPoint Files at Registration Table ..... Radisson Lobby

7:00 - 10:30 PM-Welcome Social at Science Museum of Minnesota (light refreshments provided)....Downtown St. Paul

7:00 PM - 10:00 PM-Speaker Ready Room Available .....

.....Wabasha Board Room

Contents

4th Biennial Symposium of the Freshwater Mollusk Conservation Society

MAY 15-18, 2005 • RADISSON RIVERFRONT HOTEL • ST. PAUL, MINNESOTA

"Are your Natives Restless?"

Monday, May 16, 2005

7:00 AM - 5:00 PM Registration ..... Radisson Lobby

7:00 PM - 4:00 PM Tuesday Platform Presenters to Turn in PowerPoint Files at Registration Table ..... Radisson Lobby

7:00 AM - 5:00 PM Speaker Ready Room Available ..... Wabasha Board Room

7:00 AM - 8:00 AM Morning Coffee and Light Refreshments. ..... Garden Court East

8:00 AM - Noon Welcome and Plenary Session.. ..... Great River Ballroom I, IV

9:45 AM - 10:15 AM Break ..... Garden Court East

Noon - 1:00 PM Box Lunch and Committee Meetings

Awards ..... Kellogg I

Environmental Quality & Affairs ..... Kellogg II

Gastropod Status & Distribution ..... Kellogg III

Guidelines & Techniques/Commercial ..... Wabasha I

Information Exchange ..... Wabasha II

Mussel Status & Distribution ..... Wabasha III & IV

Outreach ..... Wabasha III & IV

Propagation, Restoration & Introduction ..... Great River Ballroom I & IV

1:00 PM - 6:30 PM Poster Setup.Great River Ballroom II & III

1:00 PM Platform Session 1A: Mussel Conservation in the Upper Mississippi River System I ..... Kellogg Suite

Platform Session 1B: Evolution & Phylogenetics I ..... Great River Ballroom I, IV

2:40 PM Break ..... Garden Court East

3:20 PM Platform Session 2A: Mussel Conservation in the Upper Mississippi River System II ..... Kellogg Suite

Platform Session 2B: Contaminants and Water Quality ..... Great River Ballroom I, IV

5:00 PM - 7:00 PM FMCS Board Meeting ... Wabasha III & IV

7:00 PM - 10:00 PM Poster Session (Light Refreshments Provided) ..... Great River Ballroom II & Ill

7:00 PM - 10:00 PM Speaker Ready Room Available ..... Wabasha Board Room

Tuesday, May 17, 2005

7:00 AM - 8:00 AM- Morning Coffee and Light Refreshments. ..... Garden Court East

7:00 AM - **5:00 PM**-Speaker Ready Room Available ..... Wabasha Board Room

8:00 AM - Noon-Registration ..... Radisson Lobby

8:00 PM - 4:00 PM-Wednesday Platform Presenters to Turn in PowerPoint Files at Registration Table ..... Radisson Lobby

8:00 AM—Platform Session 3A: Life History & Ecology ..... Kellogg Suite

Platform Session 3B: Propagation & Reproduction I ..... Great River Ballroom I, IV

9:40 AM-Break ..... Garden Court East

10:00 AM-Platform Session 4A: Habitat & Conservation ..... Kellogg Suite

Platform Session 4B: Status & Distribution I ..... Great River Ballroom I, IV

11:40 AM - 1:00 PM-Lunch ..... On Your Own

1:00 PM—Platform Session 5A: Relocation Recovery ..... Kellogg Suite

Platform Session 5B: Evolution & Phylogenetics II ..... Great River Ballroom I, IV

2:40 PM-**Break**. ..... Garden Court East

3:20 PM-Platform Session 6A: Zebra Mussel & Unionid Interactions. ..... Kellogg Suite

Platform Session 6B: Pathogens & Exotic Species ..... Great River Ballroom I, IV

5:00 PM-Awards Committee Meeting ..... Wabasha III & IV

5:00 PM Poster Judge's Meeting ..... Wabasha III & IV

7:00 - Midnight-Dinner with Invited Speaker-**James Pritchard of Iowa State University**

FMCS Business Meeting

Awards Presentations

Auction/Raffle & Mixer-Bring Instruments for Jam Session ..... Great River Ballroom II, III

Wednesday, May 18, 2005

7:00 AM - 8:00 AM-Morning Coffee and Light Refreshments ..... Garden Court East

7:00 AM - Noon-Speaker Ready Room Available ..... Wabasha Board Room

8:00 AM-Platform Session 7A: Status & Distribution II ..... Kellogg Suite

Platform Session 7B: Status & Recovery ..... Great River Ballroom I, IV

9:40 AM Break. ..... Garden Court East

9:40 AM-Poster Take Down ..... Garden Court East

10:00 AM-Platform Session 8A: Status & Distribution III .... Kellogg Suite

Platform Session 8B: Propagation & Reproduction II ..... Great River Ballroom I, IV

11:40 AM - 1:00 PM-Lunch ..... On Your Own

1:00 PM-Depart for Tours/FieldTrips ..... Gather in Radisson Lobby near Registration Table

Monday, May 16, 2005
Wellcome and Plenary Session

8:00 AM - Noon
Moderator: Kevin Cummings, Illinois Natural History Survey • Location: Great River Ballroom I, IV

8:00-8:15 AM
Welcome and Introduction -
G. Thomas Watters, FMCS President, Ohio State University
Kurt I. Welke, Symposium Chair, WI Department of Natural Resources

8:15-9:00 AM
PE 1 ASIAN CARP IMPACTS—Jerry L. Rasmussen

9:00-9:45 AM
PE 2 "NOT SO GENTLY DOWN THE STREAM" – DYNAMICS OF ZEBRA MUSSEL POPULATIONS IN THE OHIO RIVER AND THEIR EFFECTS ON NATIVE MOLLUSKS—Patricia A. Morrison

9:45-10:15 AM Break

10:15-11:00 AM
PE 3 PREVENTING FUTURE INVASIONS: RISK ASSESSMENT FOR NON-INDIGENOUS FRESHWATER MOLLUSKS IN THE US—Reuben P. Keller

11:00-11:45 AM
PE 4 IS THERE LIFE AFTER ZEBRA MUSSELS?—Susan J. Nichols

11:45-Noon Questions & Discussion

Noon - 1:00 PM
Box Lunch and Committee Meetings
Awards
Environmental Quality & Affairs
Gastropod Status & Distribution
Guidelines & Techniques / Commercial
Information Exchange
Mussel Status & Distribution
Outreach
Propagation, Restoration & Introduction

About the Artists and Artwork Displayed Throughout the Program

Kerissa Nelson is a Senior at Grantsburg High School. Her past artwork has been featured in Argia, the newsletter or the Dragonfly Society of the Americas, and received commendation from the National Park Service. In 2004, her oil painting of a green-winged teal was the chosen as Wisconsin's 1st place entry in the in Ducks Unlimited Junior Duck Stamp Contest. Her enclosed drawing, entitled, "St. Croix River of Life" has been entered in the National Park Service's - River of Words contest, and is also being forwarded to the National Park Service at Harpers Ferry for considered in future publications. Her artwork will also be featured in the upcoming Wisconsin Environmental Education Science Curriculum - Freshwater Mussels: Endangered Species in Our Backyard.

Kristina Westberg is a Senior at Grantsburg High School. Her past artwork has been displayed at the St. Croix Research Rendezvous and at the Great Lakes Mollusk Watchers Conference. In addition to her artwork, she has been involved in original research of mussel communities on Wisconsin tributaries of the St. Croix and host suitability studies on Pistolgrip (Tritogonia verrucosa), Plain Pocketbook (Lampsilis cardium) and Fat Mucket (Lampsilis siliquoidea). Her enclosed picture, entitled "Sauger and Pistolgrip" was inspired by that work, and has been entered in the National Park Service's - River of Words contest.

The students are supervised by Mr. Matt Berg in the Department of Biology at Grantsburg High School in Grantsburg, Wisconsin.

Darter Host Fish —Kerissa Nelson

Monday, May 16, 2005
Platform Session

Session 1A, Mussel Conservation in the Upper Mississippi River System I
Moderator: Kurt I. Welke, Wisconsin Department of Natural Resources • Location: Kellogg Suite

1:00-1:20 PM
PL 1 **LONG-TERM TRENDS IN NATIVE MUSSELS ON THE UPPER MISSISSIPPI RIVERS**
Mark D. Farr

1:20-1:40 PM
PL 2 **LONG-TERM TRENDS IN NATIVE MUSSELS ON THE ST. CROIX AND WISCONSIN RIVERS**
David Heath

1:40-2:00 PM
PL 3 **STATUS OF ZEBRA MUSSEL POPULATIONS (*DREISSENA POLYMORPHA)* WITHIN THE UPPER MISSISSIPPI RIVER SYSTEM—**Elliott Stefanik

2:00-2:20 PM
PL 4 **NEW LIFE IN A DEAD ZONE - AN URBAN MISSISSIPPI'S REDEMPTION; OPPORTUNITIES FOR MUSSEL REINTRODUCTIONS—**Mike Davis

2:20-2:40 PM
PL 5 **CONSERVATION PLANNING FOR NATIVE MUSSELS OF THE UPPER MISSISSIPPI RIVER SYSTEM—**Gary Wege

2:40-3:20 PM **Break**

Session 1B, Evolution & Phylogenetics I
Moderator: David J. Berg, Miami University • Location: Great River Ballroom I, IV

1:00-1:20 PM
PL 6 **REGIONAL PATTERNS OF POPULATION GENETIC VARIATION IN FRESHWATER MUSSELS**
David J. Berg

1:20-1:40 PM
PL 7 **CONSERVATION GENETICS OF THE ENDANGERED NORTHERN RIFFLESHELL (*EPIOBLASMA TORULOSA RANGIANA*)—**David T. Zanatta*

1:40-2:00 PM
PL 8 **RANGE-WIDE TAXONOMIC ANALYSIS OF TWO RARE LAMPSILINE MUSSEL SPECIES RAISES QUESTIONS ABOUT HYBRIDIZATION AND CONGENERIC SPECIES BOUNDARIES—**Morgan W. Kelly*

2:00-2:20 PM
PL 9 **SYSTEMATICS AND MORPHOMETRICS OF *ELIMIA COMALENSIS* (CAENOGASTROPODA: PLEUROCERIDAE) FROM THE EDWARDS PLATEAU, TX—**David M. Hayes*

2:20-2:40 PM
PL 10 **AN INTRASPECIFIC PHYLOGEOGRAPHIC ANALYSIS OF THE RAINBOW MUSSEL, *VILLOSA IRIS* (BIVALVIA: UNIONIDAE)—**Kody F. Kuehnl*

2:40-3:20 PM—Break

Session 2A, Mussel Conservation in the Upper Mississippi River System II
Moderator: Kurt I. Welke, Wisconsin Department of Natural Resources • Location: Kellogg Suite

3:20-3:40 PM
PL 11 **CONTROLLED PROPAGATION AND CAGE CULTURE ACTIVITIES BY THE MUSSEL COORDINATION TEAM TO CONSERVE THE FEDERALLY ENDANGERED HIGGINS EYE PEARLYMUSSEL (*LAMPSILIS HIGGINSII*)—**Roger Gordon

3:40-4:00 PM
PL 12 **REINTRODUCTION ACTIVITIES OF THE UPPER MISSISSIPPI RIVER MUSSEL COORDINATION TEAM TO CONSERVE THE FEDERALLY ENDANGERED HIGGINS EYE PEARLYMUSSEL (*LAMPSILIS HIGGINSII*)—**Dan Kelner

4:00-4:20 PM
PL 13 **HOST FISH IDENTIFICATION AND EARLY LIFE THERMAL REQUISITES OF THE FEDERALLY ENDANGERED WINGED MAPLELEAF MUSSEL (*QUADRULA FRAGOSA*)—**Mark T. Steingraeber

4:20-4:40 PM
PL 14 **RECOVERY OF WINGED MAPLELEAF (*QUADRULA FRAGOSA*)- PLAN FOR EXPERIMENTAL CAGE CULTURE—**Susan (Rogers) Oetker

4:40-5:00 PM
PL 15 **PANEL DISCUSSION, QUESTIONS, AND INPUT FROM THE AUDIENCE—**Moderator and Presenters

Lession 2B, Contaminants & Water Quality
Moderator: Jerry L. Farris, Arkansas State University • Location: Great River Ballroom I, IV

3:20-3:40 PM
PL 16 **DEVELOPING STANDARDIZED GUIDANCE FOR CONDUCTING TOXICITY TESTS WITH THE EARLY-LIFE STAGES OF FRESHWATER MUSSELS—**Ning Wang

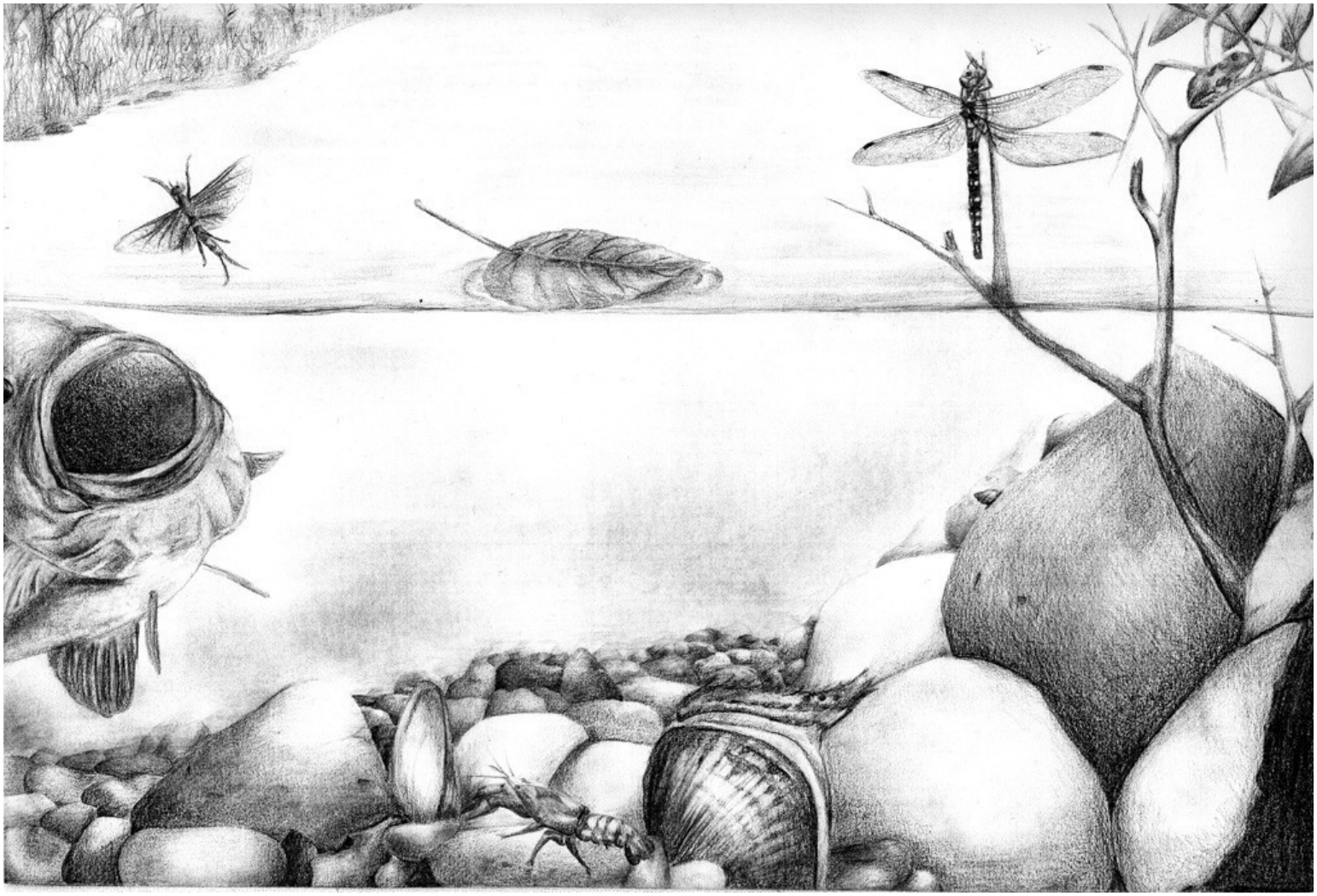
3:40-4:00 PM
PL 17 **ACUTE AND CHRONIC TOXICITY OF POLYCYCLIC AROMATIC HYDROCARBONS TO NATIVE FRESHWATER MUSSELS—**LeRoy F. Humphries*

4:00-4:20 PM
PL 18 **ASSESSING THE HAZARDS OF CURRENT USE PESTICIDES TO EARLY LIFE STAGES OF NATIVE FRESHWATER MUSSELS—**Robert Bringolf

4:20-4:40 PM
PL 19 **WHAT FACTORS IMPACT FRESHWATER MOLLUSCAN SURVIVAL IN THE CONASAUGA RIVER BASIN?—**Adam J. Sharpe*

4:40-5:00 PM
PL 20 **PRELIMINARY FINDINGS OF REPRODUCTIVE EFFECTS OF THE PHARMACEUTICAL FLUOXETINE ON A NATIVE FRESHWATER MUSSEL—**W. Gregory Cope

***Denotes Student Presentation**



St Croix - River of Life —Kerissa Nelson

Monday, May 16, 2005
Poster Session
7:00 PM - 10:00 PM
Moderator: Teresa Newton, U.S. Geological Survey
Location: Great River Ballroom II & III

PO 1 ACOUSTIC DETECTION OF UNIONID MUSSEL BEDS IN LARGE RIVERS
Steven J. Zigler

PO 2 USE OF PIT TAGS TO TRACK FRESHWATER MUSSELS IN MAINE
Jennifer E. Kurth*

PO 3 IN VIVO MAGNETIC RESONANCE IMAGING OF FRESHWATER MUSSELS
F. Michael Holliman

PO 4 SPECIFIC GRAVITY AND FRESHWATER MUSSELS
John J. Jenkinson

PO 5 POPULATION DYNAMICS, REPRODUCTIVE BEHAVIORS, AND HABITAT USE BY A THREATENED, ENDEMIC ARKANSAS MUSSEL, *LAMPSILIS POWELLII* (LEA, 1852)
Mary C. Scott*

PO 6 USE OF RELIC SHELLS TO DETERMINE TIME SINCE MORTALITY
Elizabeth A. Ashcraft*

PO 7 SIZE AND AGE DISTRIBUTIONS OF FRESHWATER MUSSELS CONSUMED BY MUSKRATS IN THE MISSISSIPPI RIVER NEAR FAIRPORT, IOWA
Tatsuaki Nakato

PO 8 TOXICITY OF SYNTHETIC MUSKS TO EARLY LIFE STAGES OF THE FRESHWATER MUSSEL, *LAMPSILIS CARDIUM*
Teresa J. Newton

PO 9 THE INFLUENCE OF DIET ON SURVIVAL OF *LAMPSILIS CARDIUM* JUVENILES IN LABORATORY EXPOSURES
Teresa J. Newton

PO 10 IMPROVED BEDLOAD COLLECTORS FOR SEDIMENT TMDL'S AND SIZE-SELECTIVE SEDIMENT REMOVAL
David A. Braatz

PO 11 OBSERVATIONS OF AMBLEMINE UNIONID MANTLE DISPLAYS AND GLOCHIDIA RELEASE
Bernard E. Sietman

PO 12 REPRODUCTIVE TIMING AND ISOLATION IN FRESHWATER MUSSEL SPECIES
Heather S. Galbraith*

PO 13 ENVIRONMENTAL FACTORS AFFECTING REPRODUCTIVE ACTIVITY OF FRESHWATER MUSSELS IN SHOAL CREEK, AL
Michael L. Buntin*

PO 14 PRACTICAL INVENTIONS AND INNOVATIONS IN MUSSEL PROPAGATION AND FIELD SAMPLING TECHNOLOGY IN VIRGINIA
Joe J. Ferraro

PO 15 WHAT'S HAPPENIN' AT WHITE SULPHUR SPRINGS NATIONAL FISH HATCHERY?
Catherine M. Gatenby

PO 16 IDENTIFICATION OF SUITABLE HOST FISHES FOR THE ROUND HICKORYNUT (*OBOVARIA SUBROTUNDA*) FROM KENTUCKY
Adam C. Shepard

PO 17 PERSISTENCE OF ACQUIRED RESISTANCE OF LARGEMOUTH BASS TO GLOCHIDIA OF A UNIONID MUSSEL
Benjamin J. Dodd*

PO 18 IDENTIFICATION OF FLOW REFUGES AND POTENTIAL COLONIZATION BY JUVENILE FRESHWATER MUSSELS IN LARGE RIVERS
Yenory Morales

PO 19 BIOLOGICAL FEATURES OF UNIONIDS MAY INFLUENCE THEIR DISTRIBUTION IN THE UPPER MISSISSIPPI RIVER
Michelle R. Bartsch

PO 20 NOT ALL THAT DAM(N) BAD: CHANGING PERSPECITIVES ON THE ROLE OF IMPOUNDMENTS IN FRESHWATER MOLLUSK CONSERVATION BIOLOGY
Michael M. Gangloff

PO 21 COMPARATIVE WATER RELATIONS IN THREE SYMPATRIC SLUGS: *DEROCERAS LAEVE, LEHMANNIA VALENTIANA*, AND *PHILOMYCUS CAROLINIANUS*
Jody M. Thompson*

PO 22 BY WATER THEY GO: AQUATIC SNAILS IN THE SYSTEM. ARE THEY NATIVE, EXOTIC, INVASIVE OR JUST GREAT BIO-INDICATORS?
Gina M. Malizio*

PO 23 INVADERS FROM THE SOUTH: APPLESNAIL (*POMACEA CANALICULATA*) ECOLOGY AND LIFE HISTORY
Rebecca K. Marfurt*

PO 24 ASSESSING THE SPREAD OF ZEBRA MUSSELS IN THE ST. CROIX RIVER USING DENSITY MEASUREMENTS AND NATIVE MUSSELS
Byron N. Karns

PO 25 OUR ST. CROIX RIVER: BATTLEGROUND FOR INVADING ZEBRA MUSSELS
Nicholas Rowse

PO 26 ASSOCIATIONS BETWEEN UNIONIDS AND *CORBICULA* AT SMALL SPATIAL SCALES
Caryn C. Vaughn

***Denotes Student Presentation**

PO 27 FURTHER RANGE EXPANSION OF THE INTRODUCED *CORBICULA FLUMINEA* (MÜLLER, 1774) IN CONNECTICUT
Jay R. Cordeiro

PO 28 INVASIVE AND ENDANGERED MOLLUSKS IN THE SNAKE RIVER, USA
David C. Richards

PO 29 LONG-TERM POPULATION DYNAMICS OF UNIONOID MUSSELS IN THE ST. CROIX RIVER, MINNESOTA AND WISCONSIN, USA
Dan J. Hornbach

PO 30 LONG TERM MONITORING OF THE MUSSEL COMMUNITY AND HABITAT IN THE KENTUCKY DAM TAILWATER IN ASSOCIATION WITH THE NAVIGATION LOCK ADDITION AT KENTUCKY LOCK AND DAM
Chad E. Lewis

PO 31 RECRUITMENT OF JUVENILE UNIONIDS (BIVALVIA: UNIONIDAE) IN NAVIGATION POOL 8 OF THE UPPER MISSISSIPPI RIVER
Jennifer S. Sauer

PO 32 A SURVEY OF FRESHWATER MUSSELS (UNIONIDAE) IN TWIN CREEK, SOUTHWEST OHIO
Kara L. Wendeln*

PO 33 DIVERSITY AND DISTRIBUTION OF FRESHWATER MUSSELS IN BAYOU BARTHOLOMEW, ARKANSAS
Jeff A. Brooks*

PO 34 UNIONID ASSESSMENT OF THE UPPER OHIO RIVER, DOWNSTREAM OF THE BELLEVILLE LOCK AND DAM
Cristi Milam

PO 35 PRELIMINARY RESULTS OF A MOLLUSK INVENTORY OF THE CAHABA RIVER BASIN, ALABAMA
Jeffrey D. Sides

PO 36 UPDATING KNOWLEDGE OF LAND SNAIL DISTRIBUTIONS IN PENNSYLVANIA
Timothy A. Pearce

PO 37 CONTRIBUTIONS TO THE FRESHWATER MUSSEL FAUNA OF GUINEA
Russell L. Minton

PO 38 GLOBAL DISTRIBUTION OF FRESHWATER MUSSEL DIVERSITY
Kevin S. Cummings

PO 39 DEVELOPMENT OF AN INITIAL CONSERVATION ASSESSMENT FOR NORTH AMERICAN FRESHWATER GASTROPODS
Paul D. Johnson

PO 40 THE ENIGMATIC *QUADRULA NOBILIS* (CONRAD 1854): WHAT IS IT?
Robert G. Howells

PO 41 WHO ARE YOUR NATIVES? BIOGEOGRAPHY AND CAUTIONS FROM "*PLEUROBEMA*" SPECIES IN THE MOBILE BASIN.
David C. Campbell

PO 42 CONSERVATION GENETICS OF THE ENDANGERED GENUS *ALASMIDONTA* (UNIONIDAE: ANODONTINAE) IN NORTH CAROLINA
Morgan E. Raley

PO 43 PHYLOGENETIC RELATIONSHIPS AMONG FRESHWATER MUSSEL SPECIES OF THE GENUS *EPIOBLASMA* (UNIONIDAE)
Jess W. Jones

PO 44 POPULATION GENETIC ANALYSIS OF THE ENDANGERED CUMBERLAND COMBSHELL *EPIOBLASMA BREVIDENS*: IMPLICATIONS FOR SPECIES RECOVERY
Nathan A. Johnson*

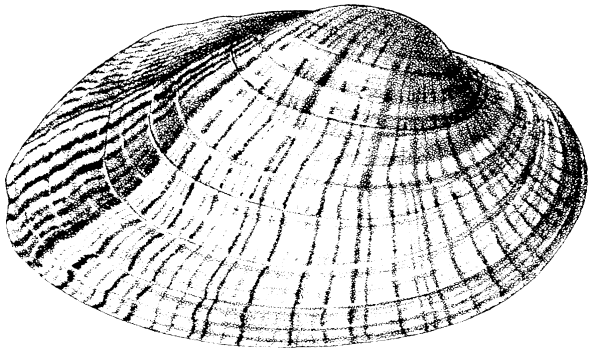
PO 45 POPULATION GENETICS OF *QUADRULA QUADRULA:* REGIONAL DIFFERENCES
Todd D. Levine*

PO 46 GENETIC DIFFERENCES AMONG POPULATIONS OF THE FLUTED-SHELL MUSSEL (*LASMIGONA COSTATA*) FROM THE OHIO RIVER AND LAKE ERIE WATERSHEDS
Jessica L. Hoisington*

PO 47 MICROSATELLITE VARIATION IN POPULATIONS OF *LAMPSILIS CARDIUM* FROM THE UPPER MISSISSIPPI RIVER
Emy M. Monroe*

PO 48 MICROSATELLITE ASSESSMENT OF GENE FLOW IN *AMBLEMA PLICATA* IN THE OUACHITA HIGHLANDS OF SOUTHEASTERN OKLAHOMA
Kathleen L. Reagan*

PO 49 GENETIC IDENTIFICATION OF FISH HOSTS FOR THE YELLOW LAMPMUSSEL (*LAMPSILIS CARIOSA*) AND TIDEWATER MUCKET (*LEPTODEA OCHRACEA*) USING A MOLECULAR IDENTIFICATION KEY
Stephen Kneeland*



***Denotes Student Presentation**

Tuesday, May 17, 2005

Session 3A, Life History & Ecology
Moderator: Caryn C. Vaughn, Oklahoma Biological Survey • Location: Kellogg Suite

8:00-8:20 AM
PL 21 **A FIELD EXPERIMENT EXAMINING THE EFFECTS OF MUSSEL SPECIES COMPOSITION ON ECOSYSTEM PROCESSES IN STREAMS—**Caryn C. Vaughn

8:20-8:40 AM
PL 22 **PHYSIOLOGICAL ECOLOGY OF FRESHWATER MUSSEL COMMUNITIES: EFFECTS OF TEMPERATURE ON COMMUNITY STRUCTURE AND ECOLOGICAL SERVICES—**Daniel E. Spooner*

8:40-9:00 AM
PL 23 **MICROSATELLITE DNA MARKERS DETECT SIGNIFICANT POPULATION STRUCTURE OF *ALASMIDONTA HETERODON* WITHIN THE DELAWARE RIVER BASIN. —**Kristine M. Playfoot

9:00-9:20 AM
PL 24 **CONSERVATION OF THE SPECIAL CONCERN OUACHITA CREEKSHELL (*VILLOSA ARKANSASENSIS*) (LEA 1852): LIFE HISTORY, ECOLOGY, AND CONSERVATION IMPLICATIONS—**Sara E. Seagraves*

9:20-9:40 AM
PL 25 **OBSERVATIONS ON THE BEHAVIOR OF FRESHWATER MUSSELS (BIVALVIA:UNIONIDAE) FROM KENTUCKY—**Monte A. McGregor

9:40-10:00 AM **Break**

Session 3B, Propagation & Reproduction I
Moderator: Chris Barnhart, Southwest Missouri State University • Location: Great River Ballroom I, IV

8:00-8:20 AM
PL 26 **HOST INFECTION STRATEGY OF THE SNUFFBOX MUSSEL, *EPIOBLASMA TRIQUETRA*—**Chris Barnhart

8:20-8:40 AM
PL 27 **THE EFFECTS OF GLOCHIDIOSIS ON FISH RESPIRATION—**Brianna E. Kaiser*

8:40-9:00 AM
PL 28 **CROSS-RESISTANCE OF LARGEMOUTH BASS TO UNIONID MUSSELS—**Benjamin J. Dodd*

9:00-9:20 AM
PL 29 **HOST FISH IDENTIFICATION TRIALS FOR FOUR SPECIES OF FRESHWATER MUSSELS IN THE SUBFAMILY ANODONTINAE—**Rachel A. Mair*

9:20-9:40 AM
PL 30 **STUDY OF THE CAPTIVE SURVIVAL RATE AND FEASIBILITY OF PEARL PRODUCTION BY THE PINK HEELSPLITTER (*POTAMILUS ALATUS*)—**Dan Hua*

9:40-10:00 AM **Break**

Session 4A, Habitat & Conservation
Moderator: Heidi L. Dunn, Ecological Specialists, Inc. • Location: Kellogg Suite

10:00-10:20 AM
PL 31 **USE OF MESOHABITAT AND MICROHABITAT PATCHES BY FRESHWATER MUSSELS IN THE CLINCH RIVER, VIRGINIA AND TENNESSEE—**Brett J. K. Ostby*

10:20-10:40 AM
PL 32 **COWS, CONDOS AND CORNFIELDS: CAN CANADA'S ENDANGERED MUSSELS COPE?** Todd J. Morris

10:40-11:00 AM
PL 33 **SIZE MATTERS: NORTH AMERICAN FRESHWATER MUSSEL EXTIRPATIONS REFLECT LANDSCAPE SCALE ALTERATION OF RIVERINE HYDROGEOMORPHOLOGY—**Michael M. Gangloff

11:00-11:20 AM
PL 34 **A REACH SCALE COMPARISON OF FLUVIAL GEOMORPHOLOGICAL CONDITIONS OF FRESHWATER MUSSEL BEDS: DIFFERENCES BETWEEN THE HAVES AND HAVE NOTS** Andrew J. Peck*

11:20-11:40 AM
PL 35 **AN ANALYSIS OF RATES OF SEDIMENTATION LOADING AT SELECTED STATIONS IN THE BEAR CREEK SYSTEM, ALABAMA AND MISSISSIPPI, 2004—**Stuart W. McGregor

11:40 AM - 1:00 PM-Lunch On Your Own

Session 4B, Status & Distribution I
Moderator: Rita Villella, U.S. Geological Survey • Location: Great River Ballroom I, IV

10:00-10:20 AM
PL 36 **FISH MEDIATED MOVEMENT OF UNIONIDS: NEUTRAL MODEL OF FISH COMMUNITIES IN THE UPPER MISSISSIPPI RIVER—**Daelyn Woolnough*

10:20-10:40 AM
PL 37 **PREDICTING THE SPATIAL DISTRIBUTION OF MUSSELS BASED ON FISH ZOOGEOGRAPHY IN WISCONSIN—**David Heath

10:40-11:00 AM
PL 38 **USE OF HYDRAULIC VARIABLES TO PREDICT THE ABUNDANCE OF UNIONIDS IN TWO REACHES OF THE UPPER MISSISSIPPI RIVER—**Jeffrey Steuer

11:00-11:20 AM
PL 39 **THE USE OF AN ACOUSTIC DOPPLER CURRENT PROFILER SYSTEM IN AQUIRING COMPLEX HYDRAULIC VARIABLES FOR THE PREDICTION OF FRESHWATER MUSSEL DISTRIBUTION IN A LARGE RIVER—**Pascal Irmscher*

11:20-11:40 AM
PL 40 **DETERMINING STATUS AND TRENDS OF THE NEW RIVER MUSSEL COMMUNITY, NEW RIVER GORGE NATIONAL RIVER, WV—**Brian Richards*

11:40 AM - 1:00 PM-Lunch On Your Own

***Denotes Student Presentation**

Session 5A, Relocation & Recovery
Moderator: Marian E. Havlik, Malacological Consultants • Location: Kellogg Suite

1:00-1:20 PM
PL 41 **EVALUATION OF FRESHWATER MUSSELS (MOLLUSCA: UNIONOIDEA) FITNESS PRE- AND POST- RELOCATION EFFORTS—**Heidi E. McIntyre*

1:20-1:40 PM
PL 42 **RELOCATION OF MUSSELS FROM THE MUSKINGUM RIVER NEAR DRESDEN, OH—**Thomas G. Jones

1:40-2:00 PM
PL 43 **2003 AND 2004 FOLLOW-UPS ON A 2002 UNIONID TRANSLOCATION FROM MISSISSIPPI RIVER MILE 818.9, COTTAGE GROVE, MN—**Marian E. Havlik

2:00-2:20 PM
PL 44 **FRESHWATER MUSSEL RESTORATION GUIDELINES IN VIRGINIA: THE WHY, WHAT, AND RESULTING MYTHS AND REALITY—**Brian T. Watson

2:20-2:40 PM
PL 45 **OPPORTUNITY FOR RECOVERY OF MUSSELS IN COPPER CREEK, RUSSELL AND SCOTT COUNTIES, VIRGINIA: IN SEARCH OF A REFUGIUM—**Shane D. Hanlon

2:40-3:20 PM **Break**

Session 5B, Evolution & Phylogenetics II
Moderator: Bonnie S. Bowen, Iowa State University • Location: Great River Ballroom I, IV

1:00-1:20 PM
PL 46 **CONSERVATION GENETICS OF ENDANGERED *LAMPSILIS HIGGINSII*: MITOCHONDRIAL AND MICROSATELLITE DNA ANALYSIS AID THE RECOVERY AND PROPAGATION PLANS—**Bonnie S. Bowen

1:20-1:40 PM
PL 47 **IDENTIFYING NEW POPULATIONS OF THE ENDANGERED WINGED MAPLELEAF *QUADRULA FRAGOSA* USING MOLECULES AND MORPHOLOGY—**Jeanne M. Serb

1:40-2:00 PM
PL 48 **PHYLOGENETIC RELATIONSHIPS AMONG MEMBERS OF THE TRIBE PLEUROBEMINI: PRELIMINARY RESULTS—**Cheryl L. Morrison

2:00-2:20 PM
PL 49 **ISOLATION, CHARACTERIZATION, AND CROSS-SPECIES AMPLIFICATION OF NOVEL MICROSATELLITE DNA MARKERS FOR THE ENDANGERED CLUBSHELL (*PLEUROBEMA CLAVA*)—**Tim L. King

2:20-2:40 PM
PL 50 **CONCHOLOGICAL AND GENETIC VARIATION IN THE KIDNEYSHELL, *PTYCHOBRANCHUS FASCIOLARIS* (RAFINESQUE, 1820)—**Kevin J. Roe

2:40-3:20 PM **Break**

Session 6A, Zebra Mussel & Unionid Interactions
Moderator: Janice L. Metcalfe-Smith, National Water Research Institute, Ontario, Canada • Location: Kellogg Suite

3:20-3:40 PM
PL 51 **CHARACTERISTICS OF A NATURAL REFUGE FOR UNIONIDS IN THE DELTA AREA OF LAKE ST. CLAIR—**Janice L. Metcalfe-Smith

3:40-4:00 PM
PL 52 **GLYCOGEN AND FATTY ACIDS AS BIOMARKERS FOR IMPACTS OF ZEBRA MUSSELS ON UNIONIDS IN THE DELTA AREA OF LAKE ST. CLAIR—**Daryl J. McGoldrick

4:00-4:20 PM
PL 53 **KENTUCKY DAM TAILWATER, TENNESSEE RIVER, AS A MUSSEL REFUGE FROM INVADING ZEBRA MUSSELS—**James B. Sickel

4:20-4:40 PM
PL 54 **NUMERICAL SIMULATION OF COMPETITION FOR FOOD RESOURCES BETWEEN UNIONIDS AND ZEBRA MUSSELS—**Yenory Morales

4:40-5:00 PM
PL 55 **THE EFFECTS OF PREDATION AND SEDIMENT DEPTH ON DREISSENIDS AND UNIONIDS IN A GREAT LAKE COASTAL WETLAND—**Richard W. Bowers

Session 6B, Pathogens & Exotic Species
Moderator: William F. Henley, Virginia Tech University • Location: Great River Ballroom I, IV

3:20-3:40 PM
PL 56 **SAFETY OF FISH THERAPEUTANTS TO MUSSEL GLOCHIDIA ATTACHED TO FISH GILLS** —Tony R. Brady

3:40-4:00 PM
PL 57 **TREMATODE INFESTATIONS IN FRESHWATER MUSSELS OF THE UPPER NORTH FORK HOLSTON RIVER—**William F. Henley

4:00-4:20 PM
PL 58 **STUDIES ON THE BACTERIAL FLORA OF MUSSELS: NORMAL FLORA FROM MUSSELS OF THE CLINCH AND HOLSTON RIVERS, VA AND DEPURATION OF THE FISH PATHOGEN *AEROMONAS SALMONICIDA*—**Clifford E. Starliper

4:20-4:40 PM
PL 59 **HELMINTH PARASITES OF FRESHWATER MUSSELS FROM MANITOBA, NORTH DAKOTA AND SASKATCHEWAN—**Joe Carney

4:40-5:00 PM
PL 60 **IMPACT OF EXOTIC SPECIES ON TEXAS FRESHWATER MOLLUSKS—**Robert G. Howells

Invited Dinner Speaker • Location: Great River Ballroom II, III
7:30-8:00 PM
DS 1 **NATURE AND THE ARTIFICIAL: A HISTORICAL VIEW OF MUSSEL PROPAGATION ON THE MISSISSIPPI RIVER—**James Pritchard

Wednesday, May 18, 2005

Session 7A, Status & Distribution II
Moderator: Gregory F. Zimmerman, EnviroScience, Inc. • Location: Kellogg Suite

8:00-8:20 AM
PL 61 **PROTOCOLS FOR SAMPLING FRESHWATER MUSSELS IN WADABLE STREAMS—**Randal R. Piette

8:20-8:40 AM
PL 62 **EXPANSIVE VS. CONCENTRATED QUANTITATIVE SAMPLING: SOME SPATIAL OBSERVATIONS FROM AN INTENSIVE MONITORING STUDY OF UNIONID COMMUNITIES IN INDIANA—**Gregory F. Zimmerman

8:40-9:00 AM
PL 63 **FACTORS INFLUENCING STATUS OF *VENUSTACONCHA ELLIPSIFORMIS* (BIVALVIA: UNIONIDAE) IN MINNESOTA—**Daniel C. Allen

9:00-9:20 AM
PL 64 **CLASSIFICATION OF PENNSYLVANIA'S RIVERINE MUSSEL COMMUNITIES—**Betsy Nightingale

9:20-9:40 AM
PL 65 **DEVELOPMENT OF A FRESHWATER MUSSEL DATABASE—**Keith R. LeClaire

9:40-10:00 AM **Break**

Session 7B, Status & Recovery
Moderator: Glenn Miller, U.S. Fish and Wildlife Service • Location: Great River Ballroom I, IV

8:00-8:20 AM
PL 66 **CONVERGENCE AND THE UNIONIFORMES—**Arthur E. Bogan

8:20-8:40 AM
PL 67 **THE MIGHTY HOLSTON: A DECIMATED FAUNA REINVIGORATED?—**Stephen J. Fraley

8:40-9:00 AM
PL 68 **PROGRESS IN FRESHWATER MUSSEL CULTIVATION AND RECOVERY AT VIRGINIA'S AQUATIC WILDLIFE CONSERVATION CENTER—**Michael J. Pinder

9:00-9:20 AM
PL 69 **FRESHWATER MOLLUSK PROPAGATION AND RECOVERY PROGRAMS OF THE TENNESSEE AQUARIUM RESEARCH INSTITUTE, AN UPDATE—**Sabrina F. Novak

9:20-9:40 AM
PL 70 **AN OVERVIEW OF THE COLUMBUS ZOO AND AQUARIUM FRESHWATER MUSSEL PROPAGATION AND RESEARCH FACILITY—**G. Thomas Watters

9:40-10:00 AM **Break**

Session 8A, Status & Distribution III
Moderator: Tim Savidge, The Catena Group, Inc. • Location: Kellogg Suite

10:00-10:20 AM
PL 71 **PRELIMINARY FINDINGS OF A COMPREHENSIVE QUALITATIVE SURVEY OF UNIONID MUSSELS IN THE LOWER PEE-DEE RIVER BASIN, SOUTH CAROLINA—**Tom Dickinson

10:20-10:40 AM
PL 72 **HISTORICAL AND CURRENT EXAMINATION OF FRESHWATER MUSSELS OF THE DUCK RIVER BASIN TENNESSEE—**Stephen A. Ahlstedt

10:40-11:00 AM
PL 73 **SURVEY FOR THE THREATENED PURPLE BANKCLIMBER (*ELLIPTOIDEUS SLOATIANUS*) IN THE MIDDLE REACH OF THE FLINT RIVER, GEORGIA—**Mary T. McCann

11:00-11:20 AM
PL 74 **THE FRESHWATER GASTROPODS OF IOWA (1821-1998): SPECIES COMPOSITION, GEOGRAPHIC DISTRIBUTIONS, AND CONSERVATION CONCERNS—**Timothy W. Stewart

11:20-11:40 AM
PL 75 **PRELIMINARY ANALYSIS OF THE STATUS OF AQUATIC SNAILS IN WEST VIRGINIA —**Ralph W. Taylor

11:40 AM - 1:00 PM-Lunch On Your Own–1:00 PM Depart for Tours/Field Trips

Session 8B, Propagation & Reproduction II
Moderator: G. Thomas Watters, Ohio State University • Location: Great River Ballroom I, IV

10:00-10:20 AM
PL 76 **IMMUNE RESPONSE OF LARGEMOUTH BASS TO THE FATMUCKET OVER REPETITIVE INFESTATIONS AND OVERWINTERING—**G. Thomas Watters

10:20-10:40 AM
PL 77 **AN EVALUATION OF ADULT FRESHWATER MUSSELS HELD IN CAPTIVITY AT THE WHITE SULPHUR SPRINGS NATIONAL FISH HATCHERY—**Julie L. Devers

10:40-11:00 AM
PL 78 **THE EFFECT OF POSITION IN STACKED TRAYS ON CULTURED FRESHWATER MUSSELS IN AVIGLIANA LAKES (N-W ITALY)—**Elsa Panini

11:00-11:20 AM
PL 79 **UTILITY OF GENETIC MARKERS AS AN AID TO PROPAGATION OF IMPERILED FRESHWATER MUSSELS—**Eric M. Hallerman

11:20-11:40 AM
PL 80 **A MOLECULAR PHYLOGENETIC REASSESSMENT OF THE FRESHWATER SNAILS OF THE GENUS *PLEUROCERA* (GASTROPODA: PLEUROCERIDAE) OF THE MOBILE RIVER BASIN** —Jeffrey D. Sides

11:40 AM - 1:00 PM-Lunch On Your Own—1:00 PM Depart for Tours/Field Trips

Plenary Abstracts

Monday, May 16, 2005

PE 1 ASIAN CARP IMPACTS.

Jerry L. Rasmussen, MICRA, P.O. Box 774, Bettendorf, IA 52722

The invasion and spread of Asian carp (bighead and silver) into many mainstream rivers and tributaries of the Mississippi River Basin has occurred at an alarming magnitude and rate. The biological impacts of these large (100+ lb.), prolific invaders on native fish species and their habitats has not been well documented scientifically, but observation and experience with the common and grass carp invasions raises significant concerns for the long term. More than 100 years after the introduction of the European or common carp, this species remains the number one most troublesome fish species to fish and wildlife managers in the Basin. The bighead and silver carp have quickly achieved second and third place on this most troublesome list, while a more recent invader, the black carp, has quickly become the fourth most troublesome fish in the Basin. The black carp was introduced to control snails in fish culture ponds, and has recently found its way into the wild where biologists are gravely concerned for the welfare of the Basin's endangered snail and mussel species that could fall victim to black carp predation. This paper explores the biological, physical, economic, social, and emotional impacts of the Asian carp invasions on fish and aquatic organisms, fishing, recreation, and fish and wildlife management in the United States.

PE 2 "NOT SO GENTLY DOWN THE STREAM" - DYNAMICS OF ZEBRA MUSSEL POPULATIONS IN THE OHIO RIVER AND THEIR EFFECTS ON NATIVE MOLLUSKS.

Patricia A. Morrison, U. S. Fish and Wildlife Service, Ohio River Islands National Wildlife Refuge, P. O. Box 1811, Parkersburg, WV, 26102-1811.

Zebra mussels first entered the lower Ohio River in 1991. Unlike the Mississippi River which has an upstream source of zebra mussel veligers, the invasion into the Ohio River progressed from downstream to upstream reaches. By the mid-1990's, adult zebra mussels were found all the way up to Pittsburgh, PA. By the late-1990's, native mussels and snails were seriously impacted. Field measurements of live density, biomass, % live, and juvenile recruitment declined as much as 90% at selected sites over a five year period. The results of zebra mussel and native mussel monitoring at ten sites in the Ohio River will be discussed along with implications for native mussel conservation over the long term. Factors such as locations of zebra mussel adult meta-populations, timing and frequency of spawning, local habitat conditions, and river velocities on an annual and seasonal basis all interact to determine the year to year recruitment and survival of zebra mussels at any given point in the Ohio River. Understanding these interactions also gives us an opportunity to develop possible control strategies.

PE 3 PREVENTING FUTURE INVASIONS: RISK ASSESSMENT FOR NON-INDIGENOUS FRESHWATER MOLLUSKS IN THE US.

Reuben P. Keller, John M. Drake1, David M. Lodge. Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556. 1Current address: National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, CA 93101.

Freshwater mollusk invasions have caused enormous ecological and economic damage in the Great Lakes, and more generally across the US. These impacts include, but are not limited to, drastic declines in native mollusk taxa in some areas and high costs of cleaning fouled industrial equipment. Despite this, only a small proportion of introduced mollusks have negative impacts, with most species having no measured effect. Because invasive aquatic species are generally impossible to eradicate and are expensive to control, the most efficient way to reduce their impacts is to prevent the initial introduction. Ideally, all future mollusk introductions would be prevented to minimize further impacts, but current technology and reliance on international trade makes this unrealistic. Hence, it is imperative to predict which mollusks are most likely to cause impacts and concentrate resources on keeping those species out. To this end, we used logistic regression to analyze natural history data for species already introduced to the Great Lakes and found that just one parameter, female annual fecundity, is adequate to discriminate between species that have caused measured impacts (n=5) and those that have been apparently benign (n=13). Expanding this analysis to all introduced freshwater mollusks in the US (n=8 with impacts, n=19 benign), we found that

fecundity was again a good predictor of impact. We have used this model to predict the impact of some mollusks not yet in the US. Implementation of this model would enhance the ability of the US to prevent unwanted introductions, and thus to prevent large economic and ecological impacts.

PE 4 IS THERE LIFE AFTER ZEBRA MUSSELS?

Susan J. Nichols, U. S. Geological Survey, Great Lakes Science Center, 1451 Green Rd., Ann Arbor, MI 48105

Abstract not available at time of printing.

Platform Abstracts

PLATFORM SESSION 1A

Mussel Conservation in the Upper Mississippi River System I

PL 1 LONG-TERM TRENDS IN NATIVE MUSSELS ON THE UPPER MISSISSIPPI RIVERS.

Andrew C. Miller, Barry S. Payne, and Mark D. Farr. U.S. Army Engineer Research and Development Center, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

Since the early 1980s we have used divers equipped with surface supplied air and communication equipment to collect freshwater bivalves using qualitative and quantitative methods at historically prominent mussel beds in the upper Mississippi River (UMR). Typically up to 60 total substratum 1/4 m2 samples as well as 60 or more minutes of search-by-feel samples were taken at replicated sites and subsites. The majority of the work was conducted in Pools 10, 12, 14, 17, and 24 although studies were conducted in other pools The quantitative samples provided an estimate of population demography and density unbiased by size, and the qualitative samples gave an indication of richness and the abundance of rare species. Our data set spans a time of extreme interest by resource agencies over the effects of commercial navigation traffic (1980s), an apparent abrupt and widespread mortality (the mussel die-off of the mid 1980s), and introduction and spread of zebra mussels (Dreissena polymorpha) beginning in the early 1990s. When studies were initiated 15 to 20 years ago, we typically found a species rich (up to 30) and dense (typically 50 to 100 individuals/m2) mussel assemblage at moderately depositional shoals located outside the navigation channel. Commercial vessel passage caused only temporary and minor physical impacts; usually water velocity increased by less than 1 m/sec for less than 60 seconds. At none of five study sites did we record significant impacts to mussel density, species richness, or recruitment. We have never observed a widespread, unexplained mussel mortality that affected all species and size ranges; it is likely that die-offs reported by others were either site-specific from an unknown cause, or natural mortality of older individuals. The introduction and spread of zebra mussels caused extensive mortality at the historically prominent mussel beds, such as at River Mile 635 in the east channel near Prairie du Chien, WI. Although mean unionid densities sometimes declined to less than 1 individua/m2 at this and similar locations, we usually found adult and sub adult unionids, including the endangered Lampsilis higginsii when physical conditions were appropriate. It is likely these beds will survive, although it could take many tens of years before conditions are similar to those prior to zebra mussel introduction. Unionid assemblages in slightly erosional sandy shoals with sandy substratum supported lower density D. polymorpha populations and occasionally did not experience widespread mortality. Although Milner and Pine loved this work when it began, they now look forward to new challenges.

PL 2 LONG-TERM TRENDS IN NATIVE

MUSSELS ON THE ST. CROIX AND WISCONSIN RIVERS.

David Heath1 and the Mussel Coordination Team2. 1Wisconsin Department of Natural Resources, 3550 Mormon Coulee Rd, La Crosse, WI 54601; 2U.S. Army Corps of Engineers - Rock Island District; 2U.S.Fish and Wildlife Service; 2U.S. Geological Service; 2National Park Service; 2U.S. Coast Guard, and 2Departments of Natural Resources for Minnesota, Wisconsin, Iowa, Illinois.

Since 1988, we have periodically monitored freshwater mussel populations at five sites on the St. Croix River and two sites on the lower Wisconsin River. Some of these sites contain the federally endangered Lampsilis higginsii and Quadrula fragosa along with numerous state listed taxa. Using a random sampling scheme, a number of metrics were collected including population density, total mussel density, size distributions, species richness, living/dead and sex ratios. At one site on the St. Croix R. where Q. fragosa survives, total mussel population densities have remained stable until sometime between 2000 and 2004. During 1988, 1996 and 2000 mean total mussel population densities were 16.6, 16.1 and 19.7/m². In 2004 there were 9.5/m² which was significantly different from all previous years. Population densities of the most environmentally sensitive taxa have declined since 1996 while they have remained stable for the remaining taxa. The reasons for these declines are unknown, but hypothetically may be from a major flood during 2001. At another St. Croix R. monitoring site where L. higginsii occurs, population densities have remained stable from 1988 - 2004. This location may have been less prone to the negative effects of the 2001 flood. At the Orion site of the Wisconsin River where L. higginsii occurs, population densities have gradually declined since 1988. Total mussel densities were 6.05, 2.52 and 1.34/m² in 1988, 1995 and 2002 respectively. The immediate reason for these population declines appear to be due to a reduction in recent recruitment. At another site on the Wisconsin River, where L. higginsii occurs, total mussel population densities have declined as well. Total mussel densities were 2.44, 1.42 and 0.69/m² in 1988, 1997 and 2004 respectively. I will discuss possible reasons for these declines as well as the various metrics used to assess these populations.

PL 3 STATUS OF ZEBRA MUSSEL POPULATIONS (*DREISSENA POLYMORPHA*) WITHIN THE UPPER MISSISSIPPI RIVER SYSTEM.

Elliott Stefanik1, Jim Stoeckel2, John Sullivan3, Mark Farr4. 1U.S. Army Corps of Engineers, 190 5th Street East, Saint Paul, MN, 55101; 2Miami University, Pearson Hall Room 212, Oxford, Ohio 45056; 3Wisconsin Department of Natural Resources, 3550 Mormon Coulee Road, LaCrosse, WI, 54601; 4U.S. Army Corps of Engineers, 3909 Halls Ferry Road, Vicksburg, MS, 39180.

Upper Mississippi River System (UMRS) native mussel resources are adversely affected by the exotic zebra mussel (Dreissena polymorpha). Since its discovery in the Illinois and Upper Mississippi rivers in the early 1990s, zebra mussels have spread throughout the upper river, as well as into select connected tributaries and even disconnected aquatic habitats. Within the UMR, adult zebra mussels are sparsely populated at and above Pool 3, more heavily populated from Pool 4 through about Pool 14, with decreasing abundance further downstream. Similarly, zebra mussel veliger concentrations have consistently been highest from Pool 4 downstream, with relatively low concentrations from Pool 3 and above. In some instances zebra mussel populations were observed to peak in 2001 with a decline through 2003, although this trend is not evident in all samples or locations. Field studies and modeling suggest that Lake Pepin (Pool 4) plays a major role in maintaining UMR zebra mussel populations. Long residence times in Lake Pepin likely allows for self-recruitment and downstream dispersal of larval life-stages. Any attempt to successfully manage zebra mussel populations on the UMR, or other river systems, must consider the role of lentic habitats in maintaining downstream zebra mussel populations.

PL 4 NEW LIFE IN A DEAD ZONE - AN URBAN MISSISSIPPI'S REDEMPTION; OPPORTUNITIES FOR MUSSEL REINTRODUCTIONS.

Mike Davis1, Dan Kelner2. 1 Minnesota Department of Natural Resources, 1801 South Oak St. Lake City, MN 55041; 2 U. S. Army Corps of Engineers, 190 5th Street East, Saint Paul, MN, 55101

During 2000-2001, we sampled 138 sites along the Mississippi National River and Recreation Area Corridor from 20 miles north of the Twin Cities, to just downstream of Hastings, MN. Surveyed reaches include; Coon Rapids Pool, St. Anthony Falls Pool, and Pools 1, 2, and 3. Sample methods consisted of timed, hand collection of mussels while wading, snorkeling, and SCUBA diving. Quadrat samples were collected at five sites. Over 12,000 live mussels representing 28 species were collected. Mussels in Pools 1-3 are recovering from pollution present during most of the 1900s. We documented recent, ongoing mussel recruitment; most individuals were less than 10 years old. Several state listed species were collected including two listed as endangered in Minnesota, rock pocketbook (Arcidens confragosus) and wartyback (Quadrula nodulata). Zebra mussels were absent above Lock and Dam 1 and very scarce from Pools 2 and 3. Downstream of Pool 3 zebra mussels are extremely abundant and have decimated many native mussel communities. Improved water quality and low zebra mussel numbers present a rare

opportunity to reintroduce native species eliminated from this river reach by severe pollution, and now threatened in downstream pools by the persistence of zebra mussels. Recently, a Federally Endangered mussel species, Lampsilis higginsii, has been reintroduced to pools 2 and 3 along with several state listed species. More species reintroductions are planned. Ironically, this former dead-zone of the Mississippi may become a big river mussel refuge.

PL 5 CONSERVATION PLANNING FOR NATIVE MUSSELS OF THE UPPER MISSISSIPPI RIVER SYSTEM.

Gary Wege1, David Heath2, Pam Thiel3, Roger Gordon4, Tony Brady4, Dan Kelner5, and Mike Davis6. 1U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, MN, 55425-1665; 2Wisconsin Department of Natural Resources, 3550 Mormon Coulee Road, 108 State Office Building, LaCrosse, WI, 54601; 3U.S. Fish and Wildlife Service, 555 Lester Avenue, Onalaska, WI, 54650; 4U.S. Fish and Wildlife Service, S5689 State Road 35, Genoa, WI, 54632-8836; 5U.S. Army Corps of Engineers, St. Paul District, 190 Fifth Street East, St. Paul, MN, 55101-1638; 6Minnesota Department of Natural Resources, 1801 South Oak Street, Lake City, MN, 55041.

The Upper Mississippi River System (UMRS) includes the Mississippi River from the mouth of the Ohio River upstream to the Twin Cities in Minnesota. Historically 51 species of freshwater mussels lived in the UMRS; today, 44 species have been found in the past 35 years. In 1988, the Upper Mississippi River Conservation Committee (UMRCC) produced A Strategic Plan for the Management of the Freshwater Mussel Resource of the Upper Mississippi River in response to a large die-off of native mussels and the increased harvest for cultured pearls. With the arrival of exotic zebra mussels (Driessena polymorpha) in the Great Lakes and Upper Mississippi River, the concern for mussel conservation became national in scope. In 1997, the National Native Mussel Conservation Committee was formed and a national strategy was developed. In stepping the national strategy down, the goal of the 2004 UMRCC Conservation Plan for Freshwater Mussels of the UMRS is to restore a healthy, self-sustaining native freshwater mussel fauna. Objectives of the plan are to (1) identify the research, management, and conservation actions necessary to maintain and recover the mussel fauna; (2) increase government and public awareness of the plight of these animals and their essential ecosystems and garner support, including adequate funding, for species and habitat protection programs; (3) foster creative partnerships (working and funding) among federal, state, tribal, and local governments and the private sector to restore the mussel fauna and environmental quality to our rivers; (4) document the many problems which are barriers to effective mussel resource management efforts; and (5) prescribe a strategic plan of action, which if implemented, will restore the valuable freshwater mussel resources of the UMRS. Conservation activities of the interagency Mussel Coordination Team for the federally endangered Higgins eye pearlymussel (Lampsilis higginsii) and winged mapleleaf (Quadrula fragosa) are presented as examples of implementing the plan.

PLATFORM SESSION 1B

Evolution & Phylogenetics I

PL 6 REGIONAL PATTERNS OF POPULATION GENETIC VARIATION IN FRESHWATER MUSSELS.

David J. Berg1 and Curt L. Elderkin2. 1Department of Zoology, Miami University, Hamilton, OH 45011; 2Department of Zoology, Miami University, Oxford, OH 45056

Effective conservation of biodiversity requires an understanding of the geographic distribution of genetic variation within species. In aquatic organisms, this variation is distributed in a hierarchical fashion within populations, among populations within rivers, among rivers within drainages, and among drainages. We compared this variation in three species of freshwater mussels, all of which are widely distributed in the Mississippi River basin, by sequencing the mitochondrial COI gene. Within-population variation accounted for 94% of the total genetic variation of Cumberlandia monodonta, with the remaining 6% consisting of variation among three widely scattered populations. For Amblema plicata, 89% of total variation occurred within rivers, 8.5% occurred among rivers within drainages, and 2.5% occurred among drainages. However, these values were 38%, 30%, and 32% respectively for E. dilatata. For each species, a maximum of 13 base pairs differed between individuals out of > 630 base pairs sequenced. Mismatch distributions showed that all populations of C. monodonta consisted of the same two distinct lineages. Haplotype networks show very little geographic structuring of A. plicata populations, while E. dilatata populations are highly differentiated between regions.

Overall, C. monodonta and A. plicata showed little geographic variation, while E. dilatata was highly structured. These results are consistent with earlier allozyme studies that found greater geographic structure in a number of small stream species including E. dilatata, than in species that inhabit larger streams and rivers such as C. monodonta and A. plicata. The consistency of these patterns implies that some mussel species such as E. dilatata may be more insular and therefore, population genetic variation exists at much smaller spatial scales in these species.

PL 7 CONSERVATION GENETICS OF THE ENDANGERED NORTHERN RIFFLESHELL (*EPIOBLASMA TORULOSA RANGIANA*).

David T. Zanatta1, Robert W. Murphy1 and Bonnie S. Bowen2, 1Department of Zoology, University of Toronto, c/o Department of Natural History, Royal Ontario Museum, 100 Queen's Park, Toronto, ON Canada M5S2C6, 2Department of Ecology, Evolution & Organismal Biology, 353 Bessey Hall, Iowa State University, Ames, IA USA 50011-1020.

The Northern Riffleshell (Epioblasma torulosa rangiana) is an imperiled stream-dwelling freshwater mussel from the family Unionidae. Remaining populations of this mussel are small, fragmented and geographically isolated from one another. The Northern Riffleshell has become extremely rare and has declined or disappeared from much of its historical range. In planning for the recovery of endangered freshwater mussels, their ecology, captive care and propagation have been greatly emphasized. However, information on the genetic characteristics of populations of mussels are needed to make scientifically sound decisions regarding the numbers, localities, and logistical concerns of potential relocations or population augmentation through artificial propagation. This study investigated the genetic structure of the Northern Riffleshell in the Allegheny River, Pennsylvania and the Sydenham River, Ontario Canada to determine amount of gene flow between populations, genetic variability within and among populations, and potential sources for breeding stock. We used two separate, but complementary, genetic approaches: first, specific microsatellite DNA-based markers were developed from a microsatellite library created for the Northern Riffleshell; these markers in addition to microsatellite markers available in the literature, were used to determine fine-scale population structure, estimate gene flow among populations, and determine genetic diversity and effective population sizes. In the second approach, two mitochondrial DNA regions (Cyt b and ND1) were sequenced for use in a phylogenetic analysis to determine the history of maternal lineages within and among populations of the Northern Riffleshell.

PL 8 RANGE-WIDE TAXONOMIC ANALYSIS OF TWO RARE LAMPSILINE MUSSEL SPECIES RAISES QUESTIONS ABOUT HYBRIDIZATION AND CONGENERIC SPECIES BOUNDARIES.

Morgan W. Kelly and Judith M. Rhymer, Department of Wildlife Ecology, University of Maine, Orono, ME, 04469

The tidewater mucket, Leptodea ochracea, (Say 1817) and yellow lampmussel, Lampsilis cariosa, (Say 1817) are two freshwater mussel species in need of conservation, as they are declining throughout most of their Atlantic slope ranges. Basic taxonomic information, although critical to the development of conservation plans, has thus far been lacking for both species, as morphological characters have proved unreliable in diagnosing monophyletic clades for freshwater mussels. We evaluated range-wide taxonomy for specimens collected throughout the ranges of both species using DNA sequences of the mitochondrial (mtDNA) ND1 gene. L. ochracea and L. cariosa each form well-supported monophyletic lineages. However, individuals from the Potomac River drainage identified as L. cariosa on the basis of morphology had the mtDNA of L. cardium or L. ovata, while individuals identified as L. ovata from the St. Lawrence river drainage had the mtDNA of L. cariosa. The discrepancy between morphology and DNA sequence data is evidence for hybridization of L. cariosa with L. cardium and/or L. ovata in the Potomac River drainage, and possibly in the St. Lawrence River drainage. In addition, L. ovata and L. cardium specimens formed three lineages, two of which were well-supported. However, none of these lineages corresponded to currently-recognized morphological species designations, or to geographic location, calling into question the current taxonomy of these species. Further work is needed to understand the nature and extent of potential hybrid zones among L. cariosa, L. ovata, and L. cardium, and also to understand the taxonomy of L. cardium and L. ovata. This information will have important implications for the Federal and state-level status of all species involved.

PL 9 SYSTEMATICS AND MORPHOMETRICS OF *ELIMIA COMALENSIS* (CAENOGASTROPODA: PLEUROCERIDAE) FROM THE EDWARDS PLATEAU, TX.

David M. Hayes1, Kathryn E. Perez2, Russell L. Minton3 1Department of Biology, University of Louisiana at Monroe, Monroe, LA 71209, 2Department of Biological Sciences, University of Alabama, Tuscaloosa, AL 35487, 3Museum of Natural History, University of Louisiana at Monroe, Monroe, LA 71209

Elimia comalensis (Pilsbry, 1890) represents the southwestern-most distribution of the genus, and is geographically disjunct from the nearest species by hundreds of miles. Pilsbry and Ferris (1906) gave the distribution of the species as the system of short rivers comprising the Guadalupe and San Antonio Rivers and their tributaries along the edge of the Edwards Plateau. Museum collections expand the range to include springs in the San Saba and Frio basins and large spring populations in Del Rio at the southwestern corner of the plateau. The populations in Del Rio occur outside the Balcones physiographic province, an area having unique faunas. Therefore, E. comalensis in the Balcones may represent a different species than those occurring outside of it. Del Rio is also in a separate river basin (Rio Grande) than the Balcones populations, and pleurocerids show high amounts of endemism by river drainage. Putative E. comalensis from the Rio Grande drainage are known only from recent and museum collections, are not mentioned in modern literature, and may represent an introduced species to the Rio Grande. We will present data on morphological variation as well as molecular investigations into the evolutionary history of putative E.comalensis.

PL 10 AN INTRASPECIFIC PHYLOGEOGRAPHIC ANALYSIS OF THE RAINBOW MUSSEL, *VILLOSA IRIS* (BIVALVIA: UNIONIDAE).

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Intraspecific phylogeographic analyses have been used extensively to help guide conservation efforts and resolve morphology-based taxonomic problems associated with many species, including unionids. The majority of these studies have typically dealt with listed species. While these studies do little to help us understand the large-scale phylogeographic patterns that may arise by addressing widely distributed and more common species. This study used the common and widespread Villosa iris. Three conchologically separable populations of Villosa iris may be differentiated. Villosa iris iris (Lea, 1829) occurs in the upper Ohio River system in Kentucky, Ohio, West Virginia, and in the Cumberland and upper Tennessee River systems. Villosa iris novieboracii (Lea, 1838) is associated with the lower Great Lakes drainages to southern Indiana. A third population, unnamed, occurs in southern Missouri and northern Arkansas; it is separated from other iris populations by several hundred miles. Its distribution relative to other iris populations is reminiscent of similar taxon pairs in Cyprogenia, Ptychobranchus, and others. The degree of genetic variation between these populations of Villosa iris was determined using the cytochrome c oxidase subunit 1 gene of the mitochondrial DNA. Preliminary sequence analyses performed on a relatively small number of individuals from each population have revealed variation between these populations of V. iris. Further sequencing to evaluate the patterns of molecular divergence and genetic diversity of the species is ongoing.

PLATFORM SESSION 2A

Mussel Conservation in the Upper Mississippi River System II

PL 11 CONTROLLED PROPAGATION AND CAGE CULTURE ACTIVITIES BY THE MUSSEL COORDINATION TEAM TO CONSERVE THE FEDERALLY ENDANGERED HIGGINS EYE PEARLYMUSSEL (*LAMPSILIS HIGGINSII*).

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Drastic reductions in critical populations of the federally endangered Higgins' eye pearlymussel (Lampsilis higginsii) within the Upper Mississippi River (UMR) has prompted a consortium of federal and state resource agencies to begin active recovery efforts for the species. A major component of the recovery plan involves the reintroduction and recovery of L. higginsii populations through the use of artificial

propagation techniques. The use of a combination of strategies, which have included the free release of glochidia bearing fish and modified cage culture, has led to the estimated release of over 1.8 million juvenile L. higginsii into identified recovery sites in the UMR watershed. Efforts to produce sub-adult L. higginsii via cage culture have also yielded over 10,000 mussels for use on the main stem of the Mississippi River.

PL 12 REINTRODUCTION ACTIVITIES OF THE UPPER MISSISSIPPI RIVER MUSSEL COORDINATION TEAM TO CONSERVE THE FEDERALLY ENDANGERED HIGGINS EYE PEARLYMUSSEL (*LAMPSILIS HIGGINSII*).

Dan Kelner1 and the Mussel Coordination Team2. 1U.S. Army Corps of Engineers - St. Paul District, 190 5th Street East, St. Paul, MN 55101; 2U.S. Army Corps of Engineers - Rock Island District; 2U.S.Fish and Wildlife Service; 2U.S. Geological Service; 2National Park Service; 2U.S. Coast Guard, 2Departments of Natural Resources for Minnesota, Wisconsin, Iowa, Illinois; and 2Science Museum of Minnesota.

Since 2000, a variety of conservation measures have been used by the U.S. Army Corps of Engineers in collaboration with the Upper Mississippi River Mussel Coordination Team to conserve the federally endangered Higgins' eye pearlymussel (Lampsilis higginsii). One goal is the establishment, through reintroduction, of new and viable populations within its historic range in areas with few or no zebra mussels (Dreissena polymorpha). Reintroduction activities include; 1) development of relocation site criteria and population size and demography requirements, 2) evaluation of alternative relocation methods, 3) genetics studies, 4) controlled propagation via glochidia-inoculated fish released into the wild or used for cage culture in the wild, 5) relocating naturally propagated adults and artificially propagated juveniles, and 6) monitoring success. To date over 10,000 juvenile Higgins' eye have been artificially propagated and reared in cages with over 2,800 reintroduced to sites in Mississippi River pools 2, 3, and 4. Stocking efforts will continue at these sites and are planned for the Rock River (Illinois), Mississippi River pool 17, and a site to be determined. Nearly 500 adult Higgins' eye have been relocated from heavily infested zebra mussel waters to Mississippi River pools 2 and 3. Since 2000, over 20,0000 inoculated fish averaging approximately 300 glochidia each, have been placed in open bottom cages in the Wisconsin River and released into four tributary rivers in Wisconsin (Wisconsin River) and Iowa (Iowa, Cedar, and Wapsipinicon rivers). Reintroduction efforts will continue through at least 2008 followed by monitoring and augmentation of the populations as needed.

PL 13 HOST FISH IDENTIFICATION AND EARLY LIFE THERMAL REQUISITES OF THE FEDERALLY ENDANGERED WINGED MAPLELEAF MUSSEL (*QUADRULA FRAGOSA*).

Mark T. Steingraeber1, Mark C. Hove2, Michelle R. Bartsch3, John A. Kalas1, and Teresa J. Newton3. 1U.S. Fish and Wildlife Service, 555 Lester Avenue, Onalaska, WI, 54650; 2University of Minnesota, 1980 Folwell Avenue, St. Paul, MN, 55108; 3U.S. Geological Survey, 2630 Fanta Reed Road, La Crosse, WI, 54602.

The winged mapleleaf mussel historically occupied a greater range than it does today and now has only one known reproducing population that is restricted to a 12-mile reach of the lower St. Croix River (Wisconsin and Minnesota). Federal, state, and university biologists are working cooperatively to learn more about the current range, life-history, and genetics of this federally endangered species to initiate controlled propagation programs that will aid its recovery. Successful propagation depends on identifying suitable host fish for transformation of glochidia into juveniles. We initiated a series of host fish tests at three different temperature regimes on 3 October 2003 that later identified blue catfish (Ictalurus furcatus) and channel catfish (Ictalurus punctatus) as suitable hosts for this mussel. During the first test, groups of glochidia-infested fish were held at a near constant and unseasonably warm water temperature (~19.6°C) to accelerate the rate at which transformation might occur. Meanwhile, additional channel catfish used in the two remaining tests were infested with the same stock of glochidia but kept at colder temperatures (~12.6°C) for the next 47 days. Fish used in the second test were then supplied with water at a temperature (~19.5°C) similar to that of the first test. Peak juvenile recovery occurred about 6 weeks after the start of the first test

and 10 weeks after the start of the second. About 11,000 live juveniles were recovered from 20 blue catfish and about 10,000 juveniles were recovered from 25 channel catfish used in these tests. Comparisons of the time and cumulative water temperature units required to recover juveniles from channel catfish reared under these thermal regimes allowed us to empirically estimate: the minimum daily mean water temperature (9.25?C) required for winged mapleleaf glochidia to grow and transform into juveniles; and the cumulative water temperature units of net daily growth (~395?C?d) needed to initiate peak excystment and recovery of winged mapleleaf juveniles. Remaining fish used in the third test were subsequently maintained in a thermal regime that closely followed St. Croix River water temperatures from mid-November 2003 through June 2004. Peak recovery of juveniles in this test began 21 June 2004, 261 days after infestation (453?C?d of growth) and just 7 days later than we predicted. Our test results also suggest that minimum daily mean water temperatures of 17 to 20?C are likewise needed to trigger peak excystment of winged mapleleaf juveniles from the gills of their host fish. These early life-history findings will soon be applied in propagation programs to help recover winged mapleleaf populations within this species' historic range.

PL 14 RECOVERY OF WINGED MAPLELEAF (*QUADRULA FRAGOSA*)-PLAN FOR EXPERIMENTAL CAGE CULTURE.

Susan (Rogers) Oetker1 and the Winged Mapleleaf Site Plan Implementation Team2. 1U.S. Fish and Wildlife Service, Twin Cities Field Office, 4101 E. 80th Street, Bloomington, MN 55425; 2U.S. Army Corps of Engineers; U.S. Geological Survey; Minnesota Department of Natural Resources; National Park Service; Wisconsin Department of Natural Resources; Macalester College.

Following the determination of host fish for the winged mapleleaf (Quadrula fragosa) in 2003, a propagation and augmentation plan was developed by a team of biologists working on this rare species. In the fall of 2004, two gravid females were collected from the St. Croix River and used to infest 100 channel catfish, which are being held at Genoa National Fish Hatchery at St. Croix River temperatures. Because research indicates winged mapleleaf glochidia overwinter on host fish and drop off in the spring, infested fish must be held at winter river temperatures so that resulting juveniles are collected when river temperatures are warm enough for the juveniles to survive and grow. To determine if fish may be held in the river over the winter until juvenile transformation, 100 uninfested catfish were placed in cages in successful cage sites in the St. Croix and Mississippi Rivers. In the spring prior to the expected dropoff period, the infested catfish will be placed in cages similar to those used for Higgins eye (Lampsilis higginsii) propagation. Should cage transformation and rearing be successful for this species, the resulting juveniles will become part of a long term propagation and reintroduction effort in the Upper Mississippi River basin as well as throughout the former range of the species, including Arkansas, Tennessee, and Missouri.

PL 15 PANEL DISCUSSION, QUESTIONS, AND INPUT FROM THE AUDIENCE.

Moderator and Presenters.

PLATFORM SESSION 2B

Contaminants & Water Quality

PL 16 DEVELOPING STANDARDIZED GUIDANCE FOR CONDUCTING TOXICITY TESTS WITH THE EARLY-LIFE STAGES OF FRESHWATER MUSSELS.

Ning Wang1, Tom Augspurger2, Chris Barnhart3, Joe Bidwell4, Gregory Cope5, Jim Dwyer6, Steve Geis7, Eugene Greer1, Chris Ingersoll1, Cindy Kane8, Dick Neves9, Teresa Newton10, Andy Roberts6, Cindy Tibbott11, and David Whites1. 1U.S. Geological Survey, Columbia, MO 65201; 2U.S. Fish and Wildlife Service, Raleigh, NC 27636; 3Southwest Missouri State University, Springfield, MO 65804; 4Oklahoma State University, Stillwater, OK 74078; 5North Carolina State University, Raleigh, NC 27606; 6U.S. Fish and Wildlife Service, Columbia, MO 65201; 7Wisconsin State Laboratory of Hygiene, Madison, WI 53718; 8U.S. Fish and Wildlife Service, Gloucester, VA 23061; 9U.S. Geological Survey, Blacksburg, VA 24061; 10U.S. Geological Survey, La Crosse, WI 54603;

11U.S. Fish and Wildlife Service, State College, PA 16801.

A joint research project is ongoing to develop standardized guidance for conducting toxicity tests with the early life stages of freshwater mussels. Multiple tests were conducted to assess the survival time of glochidia of 15 mussel species. Toxicity tests were repeatedly conducted to examine the influences of exposure time, test chambers, and age of test organisms. Over 90% survival of glochidia was observed for = 2 d with 67% of the species tested and for = 1 d with 80% of the species tested. Similar EC50s were observed when using 2- or 24-h-old glochidia. EC50s of copper, ammonia, and chlorine decreased over 6- to 48-h exposure period for glochidia tests and over 48 to 96 h for juvenile tests. The intralaboratory variability of EC50s for all three toxicants, expressed as the coefficient of variation (CV), ranged from 13 to 36% for glochidia of two species. The interlaboratory CVs of EC50s for glochidia and juvenile of one species ranged from 13 to 42%. EC50s for 48-h glochidia tests are similar to EC50s for 96-h juvenile tests. These results indicate that (1) 48 h is a reasonable duration for toxicity tests with glochidia, although shorter exposures may be needed based on the life history and survival time of glochidia; (2) glochidia and juvenile tests can be reproduced within and between laboratories; and (3) a 48-h glochidia test may be useful as a surrogate measure for responses observed in 96-h juvenile tests.

PL 17 ACUTE AND CHRONIC TOXICITY OF POLYCYCLIC AROMATIC HYDROCARBONS TO NATIVE FRESHWATER MUSSELS.

LeRoy F. Humphries 1,2, W. Gregory Cope2, Jay F. Levine1, Robert B. Bringolf2, Peter R. Lazaro2, Chris Eads1, Damian Shea2, and Arthur E. Bogan3 1Population Health and Pathobiology Department, North Carolina State University College of Veterinary Medicine, Raleigh, NC 27606; 2Department of Environmental and Molecular Toxicology, North Carolina State University, Raleigh, NC 27695; 3North Carolina State Museum of Natural Sciences, Raleigh, NC 27606.

Exposure to aquatic contaminants is listed among the potential factors contributing to the global decline of native freshwater mussels. Compounds like polycyclic aromatic hydrocarbons (PAHs), a ubiquitous group of contaminants released largely as a byproduct of the incomplete combustion of fossil fuels, enter waterways via terrestrial runoff and atmospheric deposition. Many components of this suite of compounds are known or suspected genotoxic or carcinogenic agents. Freshwater mussels, due to their sessile and filter feeding lifestyles, may be at particular risk for damage due to exposure to PAHs. The objectives of this study were to assess the acute and chronic effects of PAH exposure on three lifestages (glochidia, juvenile, and adult) of freshwater mussels. Acute (48 h) toxicity tests were conducted with glochidia and juveniles of Lampsilis fasciola and L. siliquoidea. Results indicate that PAHs were not acutely toxic (LC50 >200 µg/L) to the glochidia and juveniles of the species tested. Adult Elliptio complanata were exposed to a range of concentrations (0-200 µg/L) of total PAHs in a 28-d laboratory test to assess the effects of chronic exposure. Hemolymph was sampled at 7-d intervals to obtain hemocytes for determination of genotoxicity based on single-strand DNA breaks with the comet assay. A concentration-response curve was generated with the comet assay data obtained from the laboratory study. Additionally, hemolymph samples were collected and analyzed for genotoxicty from adult E. complanata obtained from six stream sites in North Carolina with average daily traffic counts ranging from <1,000 to >100,000 for comparative field-based PAH exposure.

PL 18 ASSESSING THE HAZARDS OF CURRENT USE PESTICIDES TO EARLY LIFE STAGES OF NATIVE FRESHWATER MUSSELS.

Robert B. Bringolf1, LeRoy F. Humphries2, Peter R. Lazaro1, Chris Eads2, Chris Barnhart3, Damian Shea1, Jay F. Levine2, and W. Gregory Cope1. 1Department of Environmental and Molecular Toxicology, North Carolina State University, Raleigh, NC 27695; 2College of Veterinary Medicine, North Carolina State University, Raleigh, NC 27606; 3Department of Biology, Southwest Missouri State University, Springfield, MO 65804.

Native freshwater mussels (family Unionidae) are among the most imperiled faunal groups in North America. Approximately 67% of the nearly 300 freshwater mussel species are considered vulnerable to extinction or already extinct. North Carolina has historically supported 56 species of mussels; however, 82% of those species are currently listed as endangered, threatened, or of special concern by the U.S. Fish and Wildlife Service and the State of North Carolina. Although numerous stressors have been implicated in the decline of freshwater mussels, the effects of pesticides on native mussels is largely unknown. Timing of pesticide application combined

with the unique life history and reproductive strategy of mussels makes them susceptible to pesticide exposure. The objective of this study was to determine the hazards of pesticides to early life stages of freshwater mussels. We performed acute toxicity tests with glochidia (7 species) and juveniles (6 species) exposed to a suite of current use pesticides (atrazine, fipronil, pendimethalin, and permethrin) and a reference toxicant (NaCl). Our results indicate that these pesticides, at concentrations approaching water solubility, were not acutely toxic to the species of glochidia and juveniles tested. However, in a 21-d chronic toxicity test performed with 4-month old juvenile Lampsilis siliquoidea exposed to atrazine, the 14-d atrazine LC50 was 15.8 mg/L (95% confidence interval 12.0 - 19.5) and the 21-d atrazine LC50 was 4.3 mg/L (95% confidence interval 2.8 - 5.8). Effects on growth and genotoxicity (single-strand DNA breaks) were also determined in the chronic test. Our results indicate that the relative risk associated with acute exposure of early life stages of mussels to the current use pesticides tested singly is likely low; however, survival and genotoxicity results indicate that chronic exposure of juvenile mussels to atrazine may be impacting mussel populations and warrants further investigation, as does the assessment of pesticide mixtures.

PL 19 WHAT FACTORS IMPACT FRESHWATER MOLLUSCAN SURVIVAL IN THE CONASAUGA RIVER BASIN?

Adam J. Sharpe1, Chris S. Hofelt1, James D. Gregory1, Paul D. Johnson2, Elizabeth G. Nichols1. 1North Carolina State University, Raleigh, NC 27695, 2Tennessee Aquarium Research Institute, Cohutta, GA 30710

Recent biological inventory data shows a consistent decline in molluscan abundance and biodiversity in the Conasauga River Basin in Northwest GA. Preliminary toxicity screening using juvenile Utterbackia imbecillis and anandVibrio fischeri indicated chronic and acute toxicity of river sediments. For this study a more thorough watershed assessment was initiated to monitor sediment and water quality by stable nitrogen isotope ratio analyses (IRMS) of snails and sediments, permeable membrane devices (PMD), polar organic chemical integrative samplers (POCISTM), and conventional water quality analyses on a seasonal basis and over select 24-hour periods. Data suggests that a shift to livestock and row crop land-use results in greater water nutrient levels and increased d15N signatures for aquatic snails and sediments. Mean d15N values for snails collected at national forest sites are significantly different from d15N in snails collected in agricultural areas of the Conasauga river basin (student t-test, $p<0.05$). d15N signatures of cow manure (6.71‰ wet, 8.40‰ dry) and poultry manure treated soil (9.47‰) were similar to those of the snails collected in the agricultural areas of the Conasauga. Dissolved nitrate had an elevated signature that reflected the upper range of signatures for the aquatic snails. Elevated nitrogen isotope signatures indicate the high likelihood that nitrogenous compounds entering the water are being assimilated by snails. Atrazine, prometon, and simazine were the most frequently detected herbicides throughout the basin. Most of the ambient concentrations of detected organic contaminants are at or near the method detection limit and all are well below any aquatic life criteria. Recent evaluation of water quality criteria for ammonia and nitrate suggest that these criteria levels are not protective for mussels. Continued evaluation of water quality criteria levels are needed to determine if aquatic habitats are viable for mussel reproduction, growth, and survival.

PL 20 PRELIMINARY FINDINGS OF REPRODUCTIVE EFFECTS OF THE PHARMACEUTICAL FLUOXETINE ON A NATIVE FRESHWATER MUSSEL

W. Gregory Cope1, Robert B. Bringolf1, Rebecca M. Heltsley2, and Damian Shea1. 1Department of Environmental and Molecular Toxicology, North Carolina State University, Raleigh, NC 27695; 2Hollings Marine Laboratory, National Institute of Standards and Technology, Charleston, SC 29412.

Recently, widespread occurrence of fluoxetine and other pharmaceuticals and personal care products (PPCPs) has been reported in surface waters of the United States and elsewhere; however, impacts of PPCPs on aquatic organisms are largely unknown. Fluoxetine is the active ingredient in the prescription anti-depressant drug ProzacTM, which acts as a selective serotonin reuptake inhibitor (SSRI) to increase serotonin levels at nerve synapses. In preliminary efforts to determine the potential of fluoxetine to disrupt native freshwater mussel reproduction, we exposed gravid adult female eastern elliptio (Elliptio complanata) mussels to fluoxetine at target concentrations of 0, 0.3, 3.0, 30, 300, and 3000 ?g/L for 96 h in static-renewal tests. We used serotonin (400 mg/L) as a positive control and methiothepin, an inhibitor of serotonin pathways, as a confirmatory agent of pathway effects. Time to glochidial release, glochidial maturity

and viability, and the number of glochidia released (fecundity) were the endpoints measured. Fluoxetine exposure concentrations were analyzed by liquid chromatography/mass spectroscopy (LC-MS) to confirm exposure concentrations. Time to glochidial release was variable among the fluoxetine treatment groups, but was generally inversely related to exposure concentration. No glochidia were released by mussels in the control group in < 72 h; however, some mussels in each fluoxetine treatment, including low, environmentally relevant concentrations, released glochidia in < 24 hours. The average number of glochidia released was variable, but was generally positively correlated with fluoxetine exposure concentration. Additional studies of the endocrine and reproductive effects of fluoxetine on ripe adult male eastern elliptio are needed, as well as definitive studies with gravid adult females.

Poster Abstracts

POSTER SESSION

Monday, May 16, 7:00 PM- 10:00 PM

Radisson Riverfront Hotel
Great River Ballroom II, III

PO 1 ACOUSTIC DETECTION OF UNIONID MUSSEL BEDS IN LARGE RIVERS.

Steven J. Zigler, Robert J. Kennedy, and Teresa J. Newton. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI 54603.

Recent technological advances in methods to process acoustic signals may provide a novel method for rapid, spatially-explicit identification of unionid mussel beds and other significant features in large rivers. We evaluated the capability of an acoustic system to detect artificial mussel beds in shallow areas common to rivers. Experiments were conducted at two sites with sand and silt substrates in a reach of upper Mississippi River during August 2002. Multivariate analyses indicated significant differences in acoustic signatures among mussel densities in sand and silt. Significant models included metrics derived from indices of substrate roughness and hardness. Differences in acoustic signatures between substrate types were larger than differences among mussel densities. Consequently, river reaches with homogeneous substrates will facilitate acoustic detection of mussel beds, but detection in reaches with diverse and complex patterns of substrates will be more challenging. Future studies should seek to combine experimental data with careful groundtruthing of natural mussel beds to estimate the minimum number of acoustic data points needed for accurate classification of mussel densities, and elucidate interactions with depth and substrate type.

PO 2 USE OF PIT TAGS TO TRACK FRESHWATER MUSSELS IN MAINE.

Jennifer E. Kurth1, Cynthia S. Loftin, Joseph D. Zydlewski, and Judith M. Rhymer. Department of Wildlife Ecology, University of Maine, 5755 Nutting, Orono, ME 04469.

Translocation of freshwater mussels in response to habitat alteration is increasingly used to conserve populations of rare species. We designed a translocation experiment to assess the use of PIT tags, previously not used in freshwater mussel research, as a means of obtaining accurate survival estimates of resident and translocated mussels where a dam removal is pending. We chose a relatively common species (Lampsilis radiata radiata) for initial experiments. Mussels in the source population and at two translocation sites were tagged externally with 23mm PIT tags attached to the posterior end of the right valve using dental cement. Three treatments were established at each translocation site: resident mussels left in place, resident mussels moved within site, and mussels translocated from the source population. In the source population, there were also three groups: tagged mussels left in place, mussels moved within site, and mussels moved into within-site enclosures. Mussel locations were recorded using GPS, and mussels were relocated using the GPS coordinates and a backpack PIT tag reader and antenna. To study internal PIT tag retention in the laboratory, we inserted PIT tags between the shell and mantle flap of 120 L. r. radiata (59-102mm in length); 40 received 23mm PIT tags, 40 received 12mm tags, 40 received 12mm tags with anti-migration caps, and 40 were untagged controls. Mussels in each group were randomly divided among three tanks with flow-through recirculating systems and were monitored for tag retention and mortality. Preliminary results

indicate tag retention rates are 75-98%. Retained tags are coated with a thin layer of nacre by five months post-insertion, suggesting long-term retention is likely.

PO 3 IN VIVO MAGNETIC RESONANCE IMAGING OF FRESHWATER MUSSELS.

F. Michael Holliman1, Denise Davis2, Thomas J. Kwak1, W. Gregory Cope3, Jay F. Levine4 1USGS, North Carolina Cooperative Fish and Wildlife Research Unit, North Carolina State University, Department of Zoology, Box 7617, Raleigh, NC 27695-7617. 2 Magnetic Resonance Research Center, University of Pittsburgh Medical Center, Pittsburgh, PA 15213. 3Department of Environmental and Molecular Toxicology, North Carolina State University, Raleigh, NC 27695-7633. 4Department of Population Health and Pathobiology, College of Veterinary Medicine, North Carolina State University, Raleigh, NC 27695-8401.

The precarious state of unionids and the need to enhance our understanding of their basic life-history and physiology in support of conservation efforts, povide impetus for developing non-lethal methods for studying their biology. We evaluated the feasibility of non-invasive, in vivo magnetic resonance imaging (MRI) for quantitative analyses of freshwater mussel soft tissues. We used the eastern ellipto Elliptio complanata as a representative test model. The anterior and posterior adductor muscles, visceral mass, heart, pericardial cavity, stomach, intestine, rectum, inner and outer demibranchs, dorsal passages, mantle, and gills, were identified in the analyses. Median estimated volumes for the visceral mass, posterior adductor, anterior adductor, intestine, and foot were 400, 178, 119, 56, and 325 mm3, respectively. Body condition indices (BCI = weight/length; weight, 40-65 g; length, 64-77 mm) ranged between 0.39 and 0.65. We demonstrated strong, positive correlations between BCI and structure volume ($r > 0.9$); the intestine was an exception ($r = 0.6$). This relation shows promise for application as an organ somatic index of mussel health. Magnetic resonance imaging has become routine procedure for studying the health and biology of vertebrates. This study constitutes an important first step in developing MRI for testing scientific hypotheses related to freshwater mussel biology, and its utility as a non-lethal means of assessing their physiological response to environmental contaminants.

PO 4 SPECIFIC GRAVITY AND FRESHWATER MUSSELS.

John J. Jenkinson, 305 Revere Avenue, Clinton, TN 37716

Specific gravity can be defined as the relationship between the mass of an object and the mass of an equal volume of water. With regard to aquatic animals and their habitats, specific gravity is a quantitative way to compare the tendency of a body to float higher or lower in the water - and the substrate - than the objects around it. I have used very simple procedures to calculate specific gravity values for several species of native mussels, Corbicula, and some typical substrate components. So far, the results indicate that live mussels exhibit a range of specific gravity values that remain fairly consistent within a given population (and species?). The results also suggest that specific gravity could help explain the loss of some mussel species when changes occur in their habitat. Specific gravity could turn out to be an important but, so far, unexplored physical characteristic of native mussel species. If so, this characteristic may help explain the occurrence of mussel communities or species in various types of habitats; point out unexpected variations in mussel behavior; and, maybe, help us understand the basic principles controlling the range and convergences in mussel shell shapes and ornamentation.

PO 5 POPULATION DYNAMICS, REPRODUCTIVE BEHAVIORS, AND HABITAT USE BY A THREATENED, ENDEMIC ARKANSAS MUSSEL, *LAMPSILIS POWELLII* (LEA, 1852).

Mary C. Scott1, Jerry L. Farris1, John L Harris1, and Alan D. Christian1. 1Department of Biological Sciences, Arkansas State University. State University, AR, 72467.

Twenty-two species of Arkansas' 75 native mussels are listed as endangered, threatened, or of special concern. Factors contributing to declines include habitat alteration, water quality degradation, and commercial harvest. The US Fish and Wildlife Service listed Lampsilis powellii as threatened in 1990 and in 1992 developed a species recovery plan. Objectives of this study included 1) determination of L. powellii relative abundance and population demographics; 2) examination of reproductive biology including period of gravidity and glochidia release; 3) identification of suitable fish hosts; and 4) characterization and assessment of habitat use by L. powellii. Surveys were conducted at 34 sites on the Saline, Ouachita, and Caddo rivers in Arkansas. Collected L. powellii were measured, sexed, and inspected for gravidity. Host suitability trials were conducted with gravid females and potential fish hosts collected during spring of 2003 and 2004. Study sites were characterized using Basin Area Stream Surveys and assessed using US EPA Rapid Bioassessment Protocol for wadeable streams and water quality analyses. Twenty-eight species of mussels were identified including 137 L. powellii. Females were observed gravid from March - October 2003 and in April 2004. During these trials, suitable fish hosts were exclusively from the family Centrarchidae, with the most successful hosts being Micropterus punctulatus and M. salmoides. A total of 337 and 329 juveniles were reared during 2003 and

2004, respectively. L. powellii were collected from mid channel pool, glide, and run habitat types with gravel substrate. Measured water chemistry variables during this study suggest that additional monitoring is warranted to ensure adequate ranges in support of aquatic life. This study elaborates upon information necessary for the successful conservation and management of a threatened species.

PO 6 USE OF RELIC SHELLS TO DETERMINE TIME SINCE MORTALITY.

Elizabeth A. Ashcraft1, Jerry L. Farris1,2, and Robyn Hannigan2. 1Department of Biological Sciences, 2Environmental Sciences Program; Arkansas State University, P.O. Box 847, State University, AR 72467

Relic freshwater mussel valves composed of calcium carbonate persist in aquatic systems long after mussel mortality and may contain valuable information pertaining to mussel life history, mortality, and taphonomy. Because impacts to mussel communities may be indicative of ecosystem impairment and/or degradation, the ability to identify time passed since mortality may provide evidence in determinations of causality, responsibility, and reciprocity. Using freshwater mussels within the family Unionidae and freshwater bivalve surrogates (i.e. Corbicula fluminea), measurement of factors influencing decomposition rate for the visceral mass, periostracum, nacre, hinge and overall valve condition have been made through both laboratory and field experimentations. Analysis of trends in fluctuating dominant microbial communities associated with decomposing visceral mass may serve as markers to indicate short-term decomposition status. Use of X-Ray diffraction of internal shell structure (nacre) indicates calcium carbonate form variations within and among shells of different age and species. Digital microscopy imaging with polarized light and geographic information system (GIS) mapping of shell thin-sections allow analysis of shell cross sections through comparisons of percentages of aragonite, calcite, and other calcium carbonate polymorphs. Analysis with polarized light may indicate any mineral replacements within the shell structure as well. Validation of these methods through field deployments is currently underway. Through the selection of factors that influence decomposition and decomposition rate, measurable changes in shell integrity may be determined for the amount of time since mortality for a specific shell. Consideration for decomposition rates incorporate both site and species-specific factors that are being developed and tested on relic shells whose time since mortality can be validated.

PO 7 SIZE AND AGE DISTRIBUTIONS OF FRESHWATER MUSSELS CONSUMED BY MUSKRATS IN THE MISSISSIPPI RIVER NEAR FAIRPORT, IOWA.

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While investigating the diversity in mussel species and searching for Higginsi mussel shells around a small deltaic island formed at a small creek outlet along the right bank of the Mississippi River (MR) near IA DNR Fairport Fish Hatchery, we discovered abundant empty freshwater mussel shells on top of a large drift log wedged into the river bed approximately 250 ft from the bank on 17 November 2004. We cleared out all the shells on the drift log on 17 November 2004, and went back to the site the next day to find a considerable number of freshwater mussel shells on top of the log that were emptied by muskrats overnight. Since 18 November 2004 we have collected seven 1-day harvest data, four 2-days harvest, one 3-days harvest, and three 4-days harvest until the river froze on 18 December 2004. We found nine freshwater mussel species, including butterfly, threehorn wartyback, hickorynut, monkeyface, mapleleaf, Wabash pigtoe, wartyback, pimple back, and black sandshell. Among those harvested by muskrats from the river bed there was a high percentage of rocks that were similar in shape and size. It was found that approximately 25% of their harvest was rocks. The length and the age of each mussel shell was documented. The length of the mussel varied from 30 mm to 80 mm, approximately, and the age varied from 4 years to 10 years. We also found that muskrats harvest Sago Pondweed from the river bed at the site and consume them on the log.

PO 8 TOXICITY OF SYNTHETIC MUSKS TO EARLY LIFE STAGES OF THE FRESHWATER MUSSEL, *LAMPSILIS CARDIUM.*

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Polycyclic musks are common additives to many consumer products. As a result of their widespread use and slow degradation rates, they are widely found in aquatic environments. We evaluated the toxicity of two polycyclic musks AHTN (Tonalide(r)) and HHCB (Galaxolide(r)) to glochidia and juvenile life stages of the freshwater mussel Lampsilis cardium. In glochidia, 24-h LC50 values in replicate tests were 454 and 500 µg AHTN/L and 1000 and 1871 µg HHCB/L. Results for 48-h tests were similar to the 24-h tests. In 96-h tests with juveniles, we did not observe a dose-

response relation between survival and either musk. However, growth was affected at concentrations as low as 108 µg AHTN/L and 153 µg HHCB/L. These data suggest that these synthetic musks were not acutely toxic to the early life stages of this species at concentrations that are substantially higher than environmental concentrations. However, effects on growth were observed, suggesting that development of other sublethal endpoints measured over longer durations may help understand the potential effects of polycyclic musks on this imperiled faunal group.

PO 9 THE INFLUENCE OF DIET ON SURVIVAL OF *LAMPSILIS CARDIUM* JUVENILES IN LABORATORY EXPOSURES.

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We evaluated the effects of diet and laboratory holding time on the survival of juvenile Lampsilis cardium mussels in a 7-week study. The diets included a water only exposure, river sediment, a commercial shellfish diet, and a combination of the commercial diet and river sediment. The experimental design consisted of 3 38-L flow-through aquaria per diet, each containing 8 suspended PVC chambers (5 cm tall x 2 cm OD with 153 µm mesh on bottom). Fifteen 3-day old juveniles (cultured in vivo) were added to each chamber on day 0. Chambers receiving sediment diets received (200 g of surficial sediment from an uncontaminated reach of the Upper Mississippi River at the start of the test and aquaria receiving the commercial diet received 250 µL three times per week. Temperature, dissolved oxygen, and flow rate were measured in each aquarium three times per week. One chamber from each aquarium was randomly removed weekly for 7 weeks to assess survival. Survival of juveniles varied significantly among diets and over time. Survival exceeded 80% in all diets through week 3, exceeded 60% in the sediment diets through week 5 and then declined to 0% in all diets by week 7. These data suggest that diets containing sediment enhanced survival of juveniles for a longer duration than non-sediment diets, but no diet maintained juveniles in a healthy condition for more than (4 weeks.

PO 10 IMPROVED BEDLOAD COLLECTORS FOR SEDIMENT TMDL'S AND SIZE-SELECTIVE SEDIMENT REMOVAL.

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Sediment is a major pollutant and impact to surface waters and aquatic habitats. Silts and fine sands cause the greatest negative biological and habitat impacts as bedload and substrate components. Fine sediments fill interstitial spaces; reduce subsurface pore space, flow, and DO; decimate hyporheic and benthic fauna; and reduce fish spawning success and native mussel survival. Traditional bedload net samplers use coarse meshes (=0.5mm) for hydraulic efficiency, and generally miss the bedload fines that are most responsible for habitat impacts. Alternatively, finer meshes (0.06 to 0.25mm) have poor hydraulic efficiency; variability from short samples, net clogging, and small "sampler width to stream width" ratios; and TSS bias (by sampling the lower water column where TSS is highest). Any sediment budgets or transport models that have been developed using data from such samplers, or "validated" by such data, will share their significant inaccuracy. Improved bedload collectors from Streamside Systems selectively capture targeted bedload sediments for developing watershed sediment budgets, localizing NPS sediment sources, developing bedload TMDL's, and noninvasively removing impacting fines to restore substrate quality. The Streamside collectors are scalable to any size stream, and minimize subsampling variability (re: space and time) by capturing total bedload for extended periods. Streamside collectors can provide continuous sediment/sample removal, while avoiding the drawbacks of pit samplers (re: limited capacity; removal of gravel and cobble habitat; and potential for resuspension or flushing loss). Streamside collectors avoid inclusion of nearly all leaf litter, invertebrates, fish eggs, and suspended sediment, and successfully target only the desired sizes of inorganic sediment moving as bedload, including even iron floc (Koski and Herricks 2004).

PO 11 OBSERVATIONS OF AMBLEMINE UNIONID MANTLE DISPLAYS AND GLOCHIDIA RELEASE.

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Freshwater mussels have evolved impressive strategies to promote the transfer of glochidia to their hosts. Among these, modification of the mantle as host attractor or lure is the most well known. Members in the subfamily Lampsilinae are the only group with published accounts describing such lures. We document for the first time mantle modifications in the subfamily Ambleminae presumably used to attract host fish. We observed mantle displays in five amblemine species; Cyclonaias tuberculata, Quadrula fragosa, Q. metanevra, Q. pustulosa, and Tritogonia verrucosa. Displaying individuals contained mature glochidia, which were occasionally released when the display was touched. Cyclonaias tuberculata and Q. pustulosa, had similar displays, while the displays of

other species were different in appearance. Displays were static, but appeared to be enlarged at night for T. verrucosa. These structures do not appear to mimic known aquatic animals, e.g. minnow, but might resemble a novel food item to entice a fish strike, or perhaps is associated with the release of a chemical attractant.

PO 12 REPRODUCTIVE TIMING AND ISOLATION IN FRESHWATER MUSSEL SPECIES.

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Understanding freshwater mussel reproduction is one of the key elements to conserving species diversity and properly managing freshwater systems. To date very little is known about reproductive isolation, or how sperm "finds" the egg of the correct species, in unionid mussels. We are interested in quantifying differences in reproductive timing and the associated hormonal changes in a suite of mussels as one possible mechanism for minimizing interspecific fertilization. In addition, we plan to examine the role of gamete incompatability and species-specific sperm chemotaxis in ensuring reproductive isolation. We predict that each of these mechanisms could be important in minimizing interspecific fertilization and could have important consequences for gene flow and speciation in freshwater mussels.

PO 13 ENVIRONMENTAL FACTORS AFFECTING REPRODUCTIVE ACTIVITY OF FRESHWATER MUSSELS IN SHOAL CREEK, AL.

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Though studies have shown that freshwater mussels respond to fish signals in a laboratory setting, these patterns have not been well demonstrated in the field. We quantified fish diversity and activity patterns, numbers and reproductive condition of mussels, and physical habitat variables. These were quantified repeatedly during varying times of day and night throughout the reproductive season. Fish activity and mussel abundance were quantified by snorkeling. Time of year and fish assemblage best predicted the total number of mussels observed. Mussel activity increased as the season progressed and fish diversity and centrarchid abundance increased as fish migrated upstream from a reservoir. Mussel activity and reproduction was higher on bright sunny days when compared with overcast days. Although potential host fish numbers increased as the season progressed, observed mantle flap displays decreased. This was likely due to increased encounters between fish and mussels. Although laboratory trials suggest that increased host fish abundance should increase the number of observed reproductive displays, our data suggest that increasing host fish abundance may result in lower numbers of observed displays.

PO 14 PRACTICAL INVENTIONS AND INNOVATIONS IN MUSSEL PROPAGATION AND FIELD SAMPLING TECHNOLOGY IN VIRGINIA.

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The necessity of increasing efficiency and productivity in freshwater mussel cultivation and surveying has resulted in the invention of new systems and devices. To quantitatively-sample subsurface mussels in rivers, we have designed a metal streambed sampler that is used along with nested sieves. These samplers are durable and are able to collect juvenile mussels greater than 6 mm in height. In holding adult mussels as a brood stock, we have added small mesh baskets to 3 ft diameter tanks that allow for the collection of released conglutanent packets and individual glochidia . AHAB(r) systems are becoming increasingly popular in holding infested host fish for juvenile production. To save time spent siphoning for juveniles, a modification to this system allows us to collect juvenile mussels with little effort. A flow-through rearing system was built to raise juvenile mussels that features small round tanks fed by filtered river water. The system allows for high growth while eliminating invertebrate predators and high sediment loads. For transporting juvenile mussels to release in the river, a 32-quart cooler was renovated with aeration and 100 µm nylon bags to carry mussels. Each of these systems and devices help to increase the efficiency and productivity that translates into a greater potential for recovery of freshwater mussels.

PO 15 WHAT'S HAPPENIN' AT WHITE SULPHUR SPRINGS NATIONAL FISH HATCHERY?

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The decline of our nations natural bio-filters - freshwater mussels - has led in part to the overall decline in aquatic ecosystem integrity and ecosystem function. IF we wish to restore and sustain healthy aquatic ecosystems, it is imperative that management steps be taken to mitigate the loss of this keystone fauna. Propagation and reintroduction of these important aquatic organisms will allow for the overall recovery of degraded aquatic ecosystems. Propagation technology is currently used as a conservation tool for restoring endangered species of mussels in parts of the midwest and southeastern United States. That technology is now available at White Sulphur Springs National Fish Hatchery (WSSNFH) and can be applied to the culture of common species of mussels, as well as propagation of endangered species of mussels for recovery purposes. A partnership between the Pennsylvania Department of Transportation, the State of Pennsylvania, the Fish and Wildlife Service, and the Environmental Protection Agency was formed to salvage, refuge, and relocate endangered and common freshwater mussels located in the vicinity of a bridge replacement project. Six hundred mussels were salvaged from the future bridge alignment area and are in residence at WSSNFH. Another 900 mussels were relocated to the Ohio River Islands National Wildlife Refuge. This project will be overlapped with another study of the effect of biomass on stream benthic ecosystem dynamics, as well as a study to look at remediation of streams in Pennsylvania formerly populated with freshwater mussels and subjected to acid mine drainage.

PO 16 IDENTIFICATION OF SUITABLE HOST FISHES FOR THE ROUND HICKORYNUT (*OBOVARIA SUBROTUNDA*) FROM KENTUCKY.

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The round hickorynut, Obovaria subrotunda, is a common species found throughout the Tennessee, Cumberland, and Ohio River systems, and in the Lake St. Clair and Lake Erie drainages in North America. However, it is critically imperiled throughout much of its northern range. Ortmann (1919) reported this species to be a long-term brooder with eggs present in September and glochidia in June, but a host has not been reported. We collected five males and one female from Buck Creek (Cumberland River) in south central Kentucky in the fall 2002. Individuals were returned to the Center for Mollusk Conservation, where they were held in semi-natural conditions in flow-through river tanks. In early winter, the female was examined and contained mature glochidia. Potential hosts were collected from several sites within the mussel's known range (primarily tributaries to the Cumberland and Kentucky Rivers), returned to the Center, acclimated to ambient room temperature, and held in Aquatic Habitats(r) tanks (1 to 9 L, depending on the size of the fish). We extracted larvae from the female and pipetted 15-200 larvae onto the gills of each fish (small fish received 15 glochidia). Infested fish were held in tanks at room temperature (23-24°C) and siphoned daily to check for metamorphosed juveniles or rejected glochidia. We tested 48 species, including 22 genera and 9 families (Percidae, Cyprinidae, Ictaluridae, Fundulidae, Catostomidae, Cottidae, Sciaenidae, Centrarchidae, and Atherinidae). Obovaria subrotunda had a high degree of host specificity (only 5 of 48 species were suitable). Hosts were all within the family Percidae (darters) and included the variegate darter, Etheostoma variatum, the frecklebelly darter, Percina stictogaster, the speckled darter, E. stigmaeum, the greenside darter, Etheostoma blennoides, and the emerald darter, Etheostoma baileyi. All five species were identified as good hosts, except for the greenside darter, which was considered marginal.

PO 17 PERSISTENCE OF ACQUIRED RESISTANCE OF LARGEMOUTH BASS TO GLOCHIDIA OF A UNIONID MUSSEL.

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Host fish acquire immunity to the parasitic larvae (glochidia) of freshwater mussels. We investigated the persistence of acquired immunity of largemouth bass (Micropterus salmoides) to glochidia of the broken rays mussel (Lampsilis reeveiana). Fish received 3 successive priming infections with glochidia to induce an immune response. Primed fish were challenged (re-infected) at 2, 6, or 11 months after priming. Transformation success was quantified as the percent of attached glochidia that transformed to the juvenile stage and were recovered alive. Transformation success on primed fish decreased from 68% to 28% over the course of the 3 priming infections. Transformation success on primed fish at 2, 6, and 11 months

(26%, 40%, and 68% respectively) after priming was significantly lower than on control fish (85%, 93%, and 92% respectively). Although a reduction in the magnitude of resistance was observed over time, our results indicate that partial acquired resistance can persist for nearly a year under laboratory conditions (~22(C). A second group of largemouth bass was used to determine whether serum antibody levels of primed fish correlated with transformation success. Fish received 3 priming infections, and blood was extracted at 0, 2, 6 and 11 months after priming. Immunoblotting was used to detect host serum antibodies to L. reeveiana glochidia proteins. Binding of antibodies from serum extracted immediately after priming was obvious, but diminished over time and was almost non-existent at 6 and 11 months after priming. Nonetheless, primed fish still showed significant resistance to glochidia at 6 and 11 months after priming. Rapid production of antibodies by memory B cells upon reinfection may be partially responsible for the persistence of acquired immunity in primed fish.

PO 18 IDENTIFICATION OF FLOW REFUGES AND POTENTIAL COLONIZATION BY JUVENILE FRESHWATER MUSSELS IN LARGE RIVERS.

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A numerical model for simulation of freshwater mussel dynamics was developed and applied to study the formation of mussel beds in a section of Pool 16 in the Upper Mississippi River. A combination of substrate and hydrodynamic variables was used to create a shear stress ratio (RSS) which proved to be an effective method for identification of flow refuges, which are suitable areas for mussel survival. Dispersal of post-parasitic mussels was simulated by a particle tracking mechanism that made it possible to estimate which suitable areas can be colonized by juveniles and have the potential to evolve into mussel beds. Our simulation results suggest that healthy and diverse mussel beds must fulfill two requirements: present suitable habitat for development of juveniles and persistence of adults and be connected to larval dispersal routes. The RSS was a powerful indicator of substrate stability and ultimately was used to determine where juveniles settled. The dimensionless RSS can be used across systems with varying flow regimes and may be used to evaluate management practices involving the effects of varying flow regimes on biota in large rivers.

PO 19 BIOLOGICAL FEATURES OF UNIONIDS MAY INFLUENCE THEIR DISTRIBUTION IN THE UPPER MISSISSIPPI RIVER.

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Attempts to predict the distribution of unionids from in situ habitat descriptors have been largely unsuccessful, but certain biological and calculated hydraulic variables have recently shown some predictive power. We used historic and recent unionid data and hydraulic conditions at 606 sites over a 38-km reach of the Upper Mississippi River to compare the distribution of unionids with different shell morphologies. We hypothesized that heavier, thick-shelled species and those with sculptured projections on their shells would be more effective at maintaining their position in the substrate and thus more likely to occur in areas with high velocity and shear stress, compared to thin- or smooth-shelled species. We used classification trees to model the presence and absence of thick- and thin-shelled, sculptured and non-sculptured species to determine which variables were most likely to predict their distribution. Candidate predictor variables included substrate, depth, and velocity and shear stress under low, moderate, and high discharges. Preliminary analyses indicate that both thick-shelled and sculptured species were most frequently found in areas of low to moderate shear stress under both low and high flow conditions. However, thick-shelled species were found in areas with a wider range of shear stress under high flow conditions compared to thin-shelled species. Overall, these data are consistent with the flow refuge concept in that unionids are more prevalent in areas with low to moderate hydraulic stresses regardless of shell morphology. Thus, future studies could benefit from incorporating hydraulic variables into predictive models.

PO 20 NOT ALL THAT DAM(N) BAD: CHANGING PERSPECITIVES ON THE ROLE OF IMPOUNDMENTS IN FRESHWATER MOLLUSK CONSERVATION BIOLOGY.

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Historically, biologists, resource managers, and nearly all conservation organizations have envisioned dams as detrimental to native biota. Many studies have demonstrated dramatic alterations of ecological processes and biotic assemblages associated with large

impoundments. Few studies have focused on how existing dams may contribute to the localized persistence of imperiled freshwater taxa. Recent surveys in the Duck, Cahaba, Coosa, and Tallapoosa drainages found that mussels were frequently abundant immediately below low-head dams. In the Duck and Cahaba rivers, mussel abundance adjacent to 4 of 5 mill dams was 2-10X greater and species richness was similar or greater than localities immediately up or downstream. These structures may be partially buffering fine sediments or toxins, but localized channel stability immediately below mill-dams is likely the dominant factor. Despite their sometimes positive influence on streambed stability and water quality, if left unmanaged mill dams can contribute to habitat degradation. When dams partially or totally collapse the debris can restrict the channel and exacerbate downstream scouring. Historical collections suggest that many reaches below breached dams that supported rich mussel assemblages, no longer do. Federal and state agencies need to be more concerned with the condition and future of low-head dams and recognize that these structures can have dramatic positive and negative localized impacts on imperiled aquatic fauna. Stabilization, restoration, or removal of low-head structures should be a priority of basin-scale mollusk conservation and recovery programs, on a case-by-case basis.

PO 21 COMPARATIVE WATER RELATIONS IN THREE SYMPATRIC SLUGS: *DEROCERAS LAEVE, LEHMANNIA VALENTIANA,* AND *PHILOMYCUS CAROLINIANUS.*

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We studied the water relations of the terrestrial slug species Deroceras laeve (Muller), Lehmannia valentiana (Ferussac), and Philomycus carolinianus (Bosc.) to provide a better understanding of microhabitat preferences and adaptability to different environments. D. laeve and P. carolinianus are native to North America, but D. laeve has shown worldwide invasibility and pest characteristics. L. valentiana is native to the Iberian Peninsula and has also shown worldwide invasibility and pest characteristics. Twenty slugs of each species were desiccated and weighed over a 24 hour period, after which we determined initial mass, percentage of total body water (%TBW), cuticular permeability (CP), water loss rates (WL), and hours to death (HR). P. carolinianus was the most desiccation tolerant having the greatest initial mass, lowest CP, lowest WL, and the most HR. L. valentiana was more desiccation tolerant than D. laeve having a lower WL and more HR. Although P. carolinianus showed a greater tolerance to desiccation conditions, it is found almost exclusively in relatively stable and undisturbed habitats. Additionally, L. valentiana, which is found almost exclusively in synanthropic habitats and D. laeve, which can be found in both disturbed and undisturbed habitats are significantly less tolerant of desiccation conditions. The data suggest that physical conditions are not the deciding factor in the habitat choices of these slugs. P. carolinianus has been observed although not documented to be dominantly mycophagous, while L. valentiana and D. laeve are generalist feeders. The feeding habits of each species provide support for their preference of habitat.

PO 22 BY WATER THEY GO: AQUATIC SNAILS IN THE SYSTEM. ARE THEY NATIVE, EXOTIC, INVASIVE OR JUST GREAT BIO-INDICATORS?

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The St. Croix National Scenic Riverway is a major tributary of the Upper Mississippi River. Freshwater mollusks are a keystone faunal group of freshwater systems and while the unionid mussels in the St. Croix and Namekagon Rivers have been relatively well studied, little detailed information is available for aquatic snail species. Therefore, discovering what snail species are present and where, whether the Riverway supports exotic/invasive species, and what impacts other invasive/native species will have on this faunal group is a critical set of questions needed to be answered. The poster will highlight early results from a survey of aquatic snails on the St. Croix and Namekagon during the 2004 field season. Location information will be detailed and methods explored. Emphasis will be placed on those species which are rare or invasive and what strategies might be best to conserve or eliminate species based on this determination. Also discussed will be tools that might be used to protect desired species from the onslaught of threats, particularly aquatic invasive species.

PO 23 INVADERS FROM THE SOUTH: APPLESNAIL (*POMACEA CANALICULATA*) ECOLOGY AND LIFE HISTORY.

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Exposure to multiple vectors increases the susceptibility of aquatic ecosystems to invasion. Transferred through the aquarium trade, channeled applesnails (Pomacea canaliculata) may negatively impact native ecosystems through their rapid reproduction and voracious appetite for aquatic plants. Current management efforts suffer from a lack of basic data regarding abiotic and biotic impacts on applesnails. To address this, we first tested how salinity affected snail mortality. Both adults and hatchlings tolerated salinity levels as high as 8 ppt. Higher levels quickly led to mortality. To examine salinity impacts on feeding, adult snails received lettuce and hatchlings fed on algae covering stone tiles. Adult feeding increased significantly at 8 ppt compared to 0 ppt ($p = 0.002$), while hatchling consumption did not vary ($p = 0.284$). To address biotic factors, we tested how applesnails responded behaviorally to predatory cues from fish, turtles, crayfish and adult applesnails. Our results indicated that fish and crayfish prompted similar predator-avoidance behaviors in hatchlings (p's < 0.05) and that hatchling response changed over time. Snails moved away from the bottom when these predators occurred. To examine the subsequent impact of predation, we allowed adult and juvenile redear sunfish (Lepomis microlophus) to prey on applesnails and native ramshorn snails. Consumption rates of juvenile fish did not vary (?2, $p > 0.05$), whereas adult snails consumed more applesnails ((?2, $p < 0.001$). Overall, our experiments indicated that applesnails tolerate abiotic stress and respond to likely predators. With high reproduction rates and varied ecological strategies, applesnails might be the next zebra mussel in terms of their economic and ecological impact. Research providing insight into their basic ecology can foster management efforts.

PO 24 ASSESSING THE SPREAD OF ZEBRA MUSSELS IN THE ST. CROIX RIVER USING DENSITY MEASUREMENTS AND NATIVE MUSSELS.

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The St. Croix National Scenic Riverway was the first wild and scenic river unit of the National Park System, in 1968. The Riverway is considered a nationally significant resource for its richness and abundance of freshwater mussels (~40 species, the greatest in the Upper Mississippi watershed) and is recognized for its outstanding recreational and biological assets. The diversity of unionids within the Riverway is well documented and many threats to that diversity have been identified. This faunal group will be severely impacted by a zebra mussel infestation and from other exotic invasions. To understand the invasion of zebra mussels into the St. Croix, measurements of density were taken within the known infestation zone (the last 21 miles of river). Sample locations were chosen based on native mussel bed survey work previously conducted by the second author. Six locations were identified from Stillwater, MN, to Prescott, WI, reflecting the range of habitats and hydrology found in the infestation zone. Thirty 1/8-meter quadrate samples were collected by divers at each of the locations. These samples were processed off river, frozen and examined under magnification. The poster will showcase the methods established to determine zebra mussel densities on the lower river, and present results of not only this invasive, but of Asian Clams and snails found during the sampling events. It will also highlight management decisions resulting from this information.

PO25 OUR ST. CROIX RIVER: BATTLEGROUND FOR INVADING ZEBRA MUSSELS.

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In 1992, zebra mussels (Dreissena polymorpha) were discovered in the Mississippi River through the Twin Cities, Minnesota. This led the National Park Service (NPS) and U.S. Fish and Wildlife Service (USFWS) to form an interagency task force to halt the spread of zebra mussels into the St. Croix and slow the spread of zebra mussels within the river. In 1993, a prevention plan was developed and implemented by the task force. Key elements of this plan included education and information, inspection and access management, monitoring, infestation control, and research. No reproducing population of zebra mussels had been detected in the St. Croix River for the next seven years. In 1995, zebra mussels were found attached to a small number of boats within the river and individual zebra mussels had been discovered scattered in small numbers on substrate along both sides of the lower 25 miles of river. A reproducing population of zebra mussels was discovered in the river during the summer of 2000. The source of this reproduction, while yet to be pinpointed, mussels is quite disturbing. The task force has made several recommendations for policy makers and agency managers. Management issues surrounding zebra mussels are complex and controver-

sial and future actions of river users are critical to the further spread of zebra mussels. The task force is now focused on multi-agency actions and will present zebra mussel monitoring field activities from 2001 through 2004.

PO 26 ASSOCIATIONS BETWEEN UNIONIDS AND *CORBICULA* AT SMALL SPATIAL SCALES.

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Studies examining the relationship between unionids and invasive Corbicula have produced contradictory results, with some studies finding negative associations and others finding no association between the two groups. These studies primarily have been conducted at the spatial scale of a mussel bed or larger. We examined the association between unionids and Corbicula at small spatial scales in eight rivers in the Ouachita Highlands, Oklahoma and Arkansas. Descriptions of these rivers along with unionid species lists are available at http://www.biosurvey.ou.edu/Biodiversity_Web_Site/main. We used a hierarchical sampling strategy of 300 patches (0.25 m2 quadrats) nested within 30 mussel beds. A suite of environmental parameters were measured in each quadrat prior to excavation. We found a significant, negative correlation between Corbicula and unionid densities across the 300 quadrats. This produced a triangular scatter pattern such that patches with low unionid density had a wide range of Corbicula densities, but patches with high unionid density never had high Corbicula densities. We found this same negative correlation and triangular scatter pattern for the relationship between Corbicula and overall unionid biomass, unionid species richness, and abundance of a keystone unionid species in these rivers, Actinonaias ligamentina. A multiple regression model found unionid biomass, substrate stability, and periphyton cover to be the most significant predictors of Corbicula density. A popular view is that unionids decline when Corbicula invade their habitat. Our data indicate an opposite scenario, ie. Corbicula may be unable to invade patches with high unionid biomass and species richness.

PO 27 FURTHER RANGE EXPANSION OF THE INTRODUCED *CORBICULA FLUMINEA* (MÜLLER, 1774) IN CONNECTICUT.

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The invasive Asiatic clam, Corbicula fluminea (Müller, 1774) (family Corbiculidae), is native to temperate and tropical southern Asia west to the far eastern Mediterranean, northern Africa, the southeast Asian islands, and eastern Australia. It was first reported in the United States in 1938 in the Columbia River in Pacific County, Washington. Since then it has been documented in nearly every U.S. state. The first documented occurrence in Connecticut was in the Connecticut Yankee nuclear power station in the lower Connecticut River in April 1990. This well-studied population has remained viable and expanded its range upriver at least 38 km despite extensive population die-offs during winter months. Populations survived well near the warm discharges of three electrical power plants on the Connecticut River, but survival around the Connecticut Yankee plant following its closure in 1996 suggests thermal discharges are not necessary for survival. Until now, the lower Connecticut River population was believed to be the only occurrence of C. fluminea in Connecticut. This study documents the occurrences in 15 other sites in the state including four of the seven major drainages in the state. Populations in the Housatonic, South Central Coast, and Thames River drainages, and elsewhere in the Connecticut River drainage appear to be surviving despite the absence of thermal refuge during winter. Further, it is speculated that since these populations are distributed randomly among different drainages, they represent distinct point source introductions, most likely through accidental or intentional human introduction. C. fluminea has been found in association with eight of the eleven extant species of freshwater mussels in Connecticut including federally endangered Alasmidonta heterodon, state threatened species Leptodea ochracea, and state special concern species Ligumia nasuta.

PO 28 INVASIVE AND ENDANGERED MOLLUSKS IN THE SNAKE RIVER, USA.

David C. Richards. EcoAnalysts Inc. Moscow, Idaho

I will present an overview of the status of the native threatened and endangered mollusks, including a possible new species of Taylorconcha, and the potential impacts of invasive mollusks in the Snake River, Idaho. Results will be presented from several years of research that colleagues and I have conducted on competition between natives and invasives and from recent surveys that we have conducted in Hells Canyon of the Snake River.

PO 29 LONG-TERM POPULATION DYNAMICS OF UNIONOID MUSSELS IN THE ST. CROIX RIVER, MINNESOTA AND WISCONSIN, USA.

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The diverse mussel community in the St. Croix River is a nationally recognized resource. We quantitatively assessed mussel communities and habitat from 1991-

2004 at 9 locations. Eight locations were sampled a minimum of 3 times during this period, with one site sampled for the first time in 2004. Thirty-five species of mussels were collected in quantitative samples, although the river contains >40 species of unionoids including two federally endangered species. Mussel density varied from 2.5 to 38.4 mussels/m2, depending on year and location. Large mussel density (> 30 mm shell length) declined over the period at most sites, with an average decline of 28.1%. The decline in density was not statistically significant due to the large within-site variability. Likewise there was a decline in small mussel density (<30 mm shell length), averaging 54.5%. These declines were statistically significant, especially at sites located downstream of a hydroelectric dam on the river. Shell-length frequency diagrams suggest there has been little recruitment or there is low juvenile survival among many dominant species at many sites. At some sites there has been an increase in fine sediments, although this is variable among sites. The site with the greatest decline in small mussel density has had the largest increase in fine sediments and is located just downstream of the hydroelectric dam. This site holds the largest known population of the endangered winged mapleleaf (Quadrula fragosa) and one of the few populations of endangered Higgins eye (Lampsilis higginsii) not threatened by the invasive zebra mussel, Dreissena polymorpha. The causes for the overall decline in the health of the mussel communities are unknown but could include an increased human population in the watershed, the invasion of zebra mussels in lower reaches of the river, and increased recreational use of the river.

PO 30 LONG TERM MONITORING OF THE MUSSEL COMMUNITY AND HABITAT IN THE KENTUCKY DAM TAILWATER IN ASSOCIATION WITH THE NAVIGATION LOCK ADDITION AT KENTUCKY LOCK AND DAM.

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In conjunction with the U.S.A.C.E.'s construction of a new navigation lock at Kentucky Dam in Livingston County, Kentucky, Tennessee River Mile 22.4, a mussel monitoring program was initiated in 2003. The purpose was to establish a baseline data set so that changes in the mussel community downstream from the dam could be monitored during construction and later operation of the new lock. Mussels were collected from four sites, including two "experimental sites" close to the dam and two "control sites" several miles downstream. Within each site, eighty 0.25 m2 quadrats were sampled by excavation and screening. A total of 4,496 mussels in 28 species were identified, measured, recorded, and returned to the sample locations. A baseline of habitat conditions was documented using survey quality hydrographic equipment and sediment analysis. Six substrate samples were collected to a depth of 15 cm within each of the four sites and analyzed for grain size and organic content. The combination of the baseline mussel and habitat data will be used for future comparisons to document positive or negative changes in the mussel community and habitat conditions. This project provides a unique opportunity to examine mussel community structure in a large river environment.

PO 31 RECRUITMENT OF JUVENILE UNIONIDS (BIVALVIA: UNIONIDAE) IN NAVIGATION POOL 8 OF THE UPPER MISSISSIPPI RIVER.

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We quantitatively sampled six unionid beds in Navigation Pool 8 of the Upper Mississippi River to assess the level of recent recruitment. Beds were chosen based on historic density, species richness, anecdotal observations of juveniles, and geospatial location within the Pool. At each site, we obtained 30 to 35, 0.25-m2 quads and excavated sediments down to ~10 cm. We obtained 1,291 live unionids and 52% of these were considered juveniles (age 5 or younger, based on external annuli). Of the 26 species encountered alive, 22 (85%) were represented by juveniles, including the federally endangered Higgins' Eye, Lampsilis higginsii. Total density ranged from 8 to 49 mussels/m2 and juvenile densities ranged from 3 to 26 mussels/m2, with greatest densities in large side channels. These data suggest that there has been substantial recent recruitment to at least some beds in Pool 8 of the Upper Mississippi River.

PO 32 A SURVEY OF FRESHWATER MUSSELS (UNIONIDAE) IN TWIN CREEK, SOUTHWEST OHIO.

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Twin Creek, located in southwest Ohio, is considered to be an exceptional warm water habitat with the second highest fish diversity in Ohio. The purposes of this study are to characterize the mussel fauna of Twin Creek and determine major patterns of distribution of mussel species with regard to the environment. We hypothesize that mussel species diversity will be high and regionally important. We also predict that mussel distribution will be positively correlated with high quality environmental conditions. To document mussel fauna 36 sites were analyzed across 47 miles and 4 counties. Unionids presence was determined with visual, timed (2hr), random searches, with effort concentrated in the best apparent mussel habitat. Shells of dead mussels were collected for identification, and site characteristics were recorded. Water quality measurements were taken at 15 of the 36 sites at high and low flow rates. Fifteen species were recorded, 14 from the subfamilies Anodontinae and Lampsilinae, and 9 live species were documented at 17 of the 36 sites. Two large sections, one above Germantown Metropark and one below, did not contain live mussels. Further studies need to be completed to determine the cause for the lack of mussels in these areas. Although 1995 data report healthy host fish populations, the subfamily Ambleminae is almost completely missing from the area. Initial water quality measurements do not contain significant correlations with mussel parameters except those that indicate change from head waters to mouth. These results document both presence of a mussel fauna and its precariousness.

PO 33 DIVERSITY AND DISTRIBUTION OF FRESHWATER MUSSELS IN BAYOU BARTHOLOMEW, ARKANSAS.

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Bayou Bartholomew, originating in Loess hills west of Pine Bluff, Arkansas, runs 284 miles south before emptying into the Ouachita River in Morehouse Parish, Louisiana. Currently, it is the only major river of the alluvial plain in southeastern Arkansas and northeastern Louisiana that has not been channelized. Bayou Bartholomew contains both regionally common species as well as those with more restricted or localized ranges. More importantly, it harbors relatively undisturbed habitats that may serve as both a source of species for other streams in the region and may provide important refugia for species sensitive to environmental changes. Previous surveys have indicated that Bayou Bartholomew harbors one of the most diverse freshwater mussel faunas in Louisiana, with 40 known native species. Eight species in Louisiana, including one federally endangered species, are primarily limited to this river. Less is known about mussel distributions in the Arkansas portion. We sampled 50 sites in the Arkansas portion of Bayou Bartholomew and its major tributaries during the period of June through October, 2004. We collected 35 species of freshwater mussel, along with Corbicula fluminea and fingernail clams. A discussion of the diversity in Bayou Bartholomew and comparisons to the Louisiana portion of the river are presented.

PO 34 UNIONID ASSESSMENT OF THE UPPER OHIO RIVER, DOWNSTREAM OF THE BELLEVILLE LOCK AND DAM.

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The reported existence of Lampsilis abrupta and Cyprogenia stegaria below the Belleville, WV lock and dam in the early 1990s prompted the investigation and monitoring of freshwater unionids in the Belleville project area. The purposes of this mussel survey were to meet the specific conditions outlined in the Federal Energy Regulatory Commission license, including, (1) monitoring the density of most abundant species (Amblema plicata, Obliquaria reflexa, Potamilus alatus, and Truncilla truncata), (2) monitoring recruitment and growth of collected species, and (3) measuring zebra mussel densities. Results of these data indicate that the following conditions are occurring: density and abundance of selected adult species may be in decline, and juvenile (<5 years) recruitment of several species (A. plicata, Leptodea fragilis, Ligumia recta, O. reflexa, P. alatus, Quadrula metanevra, and Q. pustulosa) and the presence of

gravid females indicate that conditions may be suitable for reproductive activities. Abundance of several species (P. sintoxia, Elliptio crassidens, Lampsilis siliquoidea) was reported for 2004 that had not been reported in previous (2002) assessments. Age determinations indicate that the average age of these communities is generally increasing throughout both stations. Zebra mussel densities in the vicinity have increased in the past two years and show that they may be impacting native unionid survival. If the existing juvenile cohort of zebra mussels survives to adulthood, there may be a more dramatic decline in unionid survival downstream of the lock and dam.

PO 35 PRELIMINARY RESULTS OF A MOLLUSK INVENTORY OF THE CAHABA RIVER BASIN, ALABAMA.

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During late summer of 2004, a two-year inventory of the mollusks of the Cahaba River in Alabama was initiated. To date, 37 sites have been inventoried, most in the mainstem Cahaba. The sites ranged from lower Oakmulgee Creek to the Cahaba River headwaters in St. Clair County. Each site was sampled primarily by snorkeling, but visual wading searches were also employed for locating shell material of additional species. Gastropods were identified according to current taxonomy, recorded, and voucher samples of non-listed species were preserved in 95% ethanol. Unionid mussels were identified, shell length was measured using vernier calipers, and they were returned live to the point of collection. In order to follow trends in mollusk species diversity, we also developed a database of historical museum records. Over 1,500 individual records have been collected from four different museums. Sampling results at 37 sites found 23+ species of gastropods and 28 species of mussels. Live specimens were sampled of the six federally listed species: *Leptoxis ampla*, *Lepyrium showalteri*, *Lioplax cyclostomaformis*, *Lampsilis altilis*, *Pleurobema perovatum*, and *Ptychobranchus greenii*. All listed species, with the exception of *P. perovatum*, were found in a 39-mile reach of the 191-mile long Cahaba, between Centreville and Helena, Alabama. *Pleurobema perovatum* was found at a single location in lower Oakmulgee Creek. *Lepyrium showalteri* had the next smallest range of approximately 3.5 river miles. The range and occurrence of several mollusk species has been greatly reduced or eliminated from the Cahaba River basin since the early 20th century.

PO 36 UPDATING KNOWLEDGE OF LAND SNAIL DISTRIBUTIONS IN PENNSYLVANIA.

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In order to protect rare species, we need to know what is rare and where they live. While Pennsylvania has more than 100 land snail species, our knowledge of their distribution is so poor that we cannot determine conservation needs reliably. Existing distribution maps from 1985 show 34 of the 67 counties (50%) with fewer than 15 species, while six well-surveyed counties reporting 35 or more species are near Pittsburgh and Philadelphia, which are historical centers of land snail research. Recent field and museum work reveals new distribution records indicating gaps in our knowledge. As examples, our recent work documents the minute snail Carychium nannodes Clapp, 1905 in Pennsylvania (Greene Co.) for the first time. The minute land snail Punctum minutissimum (I. Lea, 1841) was reported from a single county in western Pennsylvania (Beaver Co.) in the 1985 distribution maps but our research over the last three years has documented it in 18 of the 31 western Pennsylvania counties. We are filling knowledge gaps about distributions and habitat associations of land snails by two methods. First, we are compiling information from existing museum collections that hold important unpublished information on Pennsylvania land snails. Second, fieldwork is intensively inventorying land snails in limestone communities in poorly sampled areas of western Pennsylvania, and documenting habitat associations. Limestone has diverse snail faunas, so sampling limestone areas should quickly assess presence of common species, and should reveal uncommon species as well. Updated distribution maps of Pennsylvania land snails with documented habitat associations will provide necessary information to biologists and land managers for protecting snails, for using snails as indicator taxa, and for identifying biodiversity hot spots that warrant long-term protection.

PO 37 CONTRIBUTIONS TO THE FRESHWATER MUSSEL FAUNA OF GUINEA.

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Like many freshwater faunas, the distribution and diversity of unionoid bivalves in Guinea are poorly understood and have been incompletely treated. Only three publications have addressed freshwater mussels in Guinea: Haas (1969); Mandhal-Barth (1988); and Daget (1998). These three authors list between eight and seventeen species occurring in the country based on literature and assumptions regarding fauna in Mali, Niger and Senegal. As part of a CEPF-funded survey of the Guinean ichthyofauna in 2002 and 2003, six species of unionoid were collected from the Parc National du Haut Niger, five with preserved voucher

material: Aspatharia chaiziana, A. tristis, Chambardia wissmanni, Coelatura decampsiana, Etheria elliptica, and Mutela dubia. Vouchered taxa are illustrated along with a discussion of the current taxonomic status of Guinean unionoids and proposed future research in the Niger River drainage.

PO 38 GLOBAL DISTRIBUTION OF FRESHWATER MUSSEL DIVERSITY.

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Freshwater mussels (= pearly mussels or naiades) of the bivalves order Unionoida have a worldwide distribution, presently occurring on all non-glaciated continents. Estimates of global freshwater mussel species diversity have, in the Modern Era, ranged from less than 850 to more than 1200. Our census, to-date, suggests that the actual number is closer around 900 extant (or recently extinct) species, many with multiple recognized subspecies. Nearly 5000 species-group taxa have been described for the Recent Unionoida, and we have been working in collaboration since 2002 to vet the available taxonomic data and refine our estimate of the global freshwater diversity. While the order Unionoida is worldwide in distribution, the numerous individual species are not. On a global scale, most freshwater mussel species are restricted to relatively few adjacent drainage basins, and almost none have ranges across continental boundaries. Nor are freshwater mussel species randomly distributed. Certain regions are apparent 'hot spots' of freshwater mussel diversity, most notably the southeastern United States and Southeast Asia. To illustrate the global distribution of freshwater mussel species, we have surveyed the literature and museum collections to determine individual species ranges. These are depicted on a color-coded map of the world showing the number of species present in each country. This map is available on the MUSSEL Project Web Site (http://clade.acnatsci.org/mussel/).

PO 39 DEVELOPMENT OF AN INITIAL CONSERVATION ASSESMENT FOR NORTH AMERICAN FRESHWATER GASTROPODS.

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In 1993 the American Fisheries Society (AFS) published a general conservation assessment of freshwater mussels of North America authored by J.D. Williams et al. This mussel assessment was followed by similar assessment for crayfishes (Taylor et al. 1996) and southeastern fishes (Warren et al. 2000). The AFS has granted permission to begin a conservation assessment for North American freshwater gastropods and an initial committee has been formed. The final evaluation will be based on our current understanding of freshwater gastropod taxonomy. Breaking with earlier assessments, we seek to replace categorical rankings (i.e. Endangered, Threatened, Species of Concern...), with more definitive global conservation rankings (G rank), that are actively monitored by NatureServe, state Natural Heritage Programs, and UNITAS. A draft evaluation focusing on 655 species in all 50 states and 11 Canadian Provinces was completed in early 2004. This initial assessment determined 60 species of freshwater snails are likely extinct, and at least 310 additional species rank as G1 or G2. With another 75 species listed as G3, fully 70% of currently valid taxa are extinct, endangered, threatened, or of special concern (GX, G1, G2, or G3). This is the highest imperilment rate for any major taxa group in North America, including mussels. The initial draft checklist will be presented and comments from symposium participants solicited.

PO 40 THE ENIGMATIC *QUADRULA NOBILIS* (CONRAD 1854): WHAT IS IT?

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The mapleleaf, Quadrula nobilis, was first described by T.A. Conrad in 1854. Although Conrad correctly described and illustrated a number of morphological traits unique to this mussel, it was quickly synonymized with "common" mapleleaf Quadrula quadrula (Rafinesque 1820). When Texas Parks and Wildlife Department began survey work in Texas waters, "nobilis" types taken in field surveys were also considered to be Q. quadrula until typical Q. quadrula from several other states and Q. apiculata were compared electrophoretically to "nobilis" forms from Texas and Mississippi. Unexpectedly, "nobilis" was clearly distinct. Several years later, DNA analysis performed at University of Alabama also found Q. nobilis to be distinguishable from Q. quadrula. Additionally, a large adult Q. nobilis from the Neches River, Texas, was described as Tritogonia verrucosa var. obesa by Simpson (1900). Despite Conrad's original description that addressed this larger form, the Simpson description remained and served to add to the confusion around Q. nobilis. Another mapleleaf description, Unio asper Lea (1831), also confounded

recognition of Q. nobilis. A present, it appears the Q. nobilis is indeed taxonomically distinct from Q. quadrula and Q. apiculata, but the status the "asper (aspera)" types and several morphological deviations from the basic "nobilis" form remain unclear. Classic examples of Q. nobilis are quadrate when young specimens with two rows of horizontal, shelf-like pustules, but shells become more rectangular with age and size and begin to resemble male Q. [T.] verrucosa. None become as large or heavily-shelled as Q. quadrula.

PO 41 WHO ARE YOUR NATIVES? BIOGEOGRAPHY AND CAUTIONS FROM "*PLEUROBEMA*" SPECIES IN THE MOBILE BASIN.

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Protection of the native fauna from invasive species and other threats requires knowing what the native fauna is. Analysis of DNA sequences of "Pleurobema" species from the Mobile basin revealed that two Coosa endemics, Pleurobema hanleyianum and "Pleurobema" stabile, have been incorrectly synonymized with or misidentified as Pleurobema perovatum, a Tombigbee and Alabama River species, and P. rubellum, a Black Warrior endemic. Also, all of these except P. perovatum have been reported as extinct. Recognition of the tenuous continued existence of these species and their endemicity to specific river basins within the Mobile system emphasizes the need to conserve and restore habitat in each drainage. Focusing on a few relatively undisturbed river systems could fail to preserve these local endemics. In addition, "P." stabile is probably not congeneric with Pleurobema.

PO 42 CONSERVATION GENETICS OF THE ENDANGERED GENUS *ALASMIDONTA* (UNIONIDAE: ANODONTINAE) IN NORTH CAROLINA.

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The freshwater bivalve genus Alasmidonta Say (1818) contains six species from North Carolina: A. heterodon, A. robusta, A. varicosa, A. raveneliana, A. viridis and A. undulata. Clarke (1981) described A. robusta as presumed extinct and conceded that its distinctness from A. varicosa was problematic. Williams et al. (1993) listed A. robusta as extinct, A. heterodon and A. raveneliana as endangered, A. varicosa as threatened, and A. viridis and A. undulata as special concern. A. varicosa and A. viridis are considered state endangered while A. undulata is listed as state threatened in North Carolina. Although most species in Alasmidonta are imperiled, relatively little information is available on the phylogenetic relationships or the genetic variability of these species. Correct relative relationships and genetic characterization are critical for preserving ecological and evolutionary integrity of the genus. To characterize the species, we are analyzing the nucleotide sequences of the internal transcribed spacer region (ITS1) and the first subunit of the mitochondrial NADH dehydrogenase (ND1) and cytochrome oxidase one (COI) genes. This presentation focuses on the results of studies designed to: 1) develop a molecular phylogeny for the bivalve genus Alasmidonta and determine its position within the Anodontinae; 2) characterize the Carolina Elktoe (A. robusta) and the Brook Floater (A. varicosa); 3) characterize the Triangle Floater (A. undulata) and the Southern Elktoe (A. triangulata); and 4) determine the phylogenetic position of the Applachian Elktoe (A. raveneliana).

PO 43 PHYLOGENETIC RELATIONSHIPS AMONG FRESHWATER MUSSEL SPECIES OF THE GENUS *EPIOBLASMA* (UNIONIDAE).

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Species belonging to the genus Epioblasma represent one of the most endangered groups of freshwater mussels (family Unionidae) in the world; 10 of the recognized 17 species already are extinct. Therefore, inferring phylogenetic relationships among the recognized species using modern systematic methods is inherently difficult, being confounded by a lack of data from extinct taxa. A genetic study of extant populations of E. brevidens, E. capsaeformis, E. florentina walkeri, E. obliquata, E. penita, E. torulosa rangiana, and E. triquetra was conducted to infer phylogenetic relationships among remaining taxa. Traditional taxonomy divides species of the genus into 5 subgenera: Epioblasma, Pilea, Plagiola, Torulosa, and Truncillopsis. However, we present data from DNA sequences and morphology to suggest that only 2 natural groups exist of Epioblasma species. Phylogenetic analyses of data from mitochondrial (1378 bp of

16S, cytochrome-b, ND1) and nuclear (515 bp of ITS-1) DNA sequences, and from mantle-lure displays indicated that the "riffleshells" (e.g., E. capsaeformis, E. florentina walkeri, and E. torulosa rangiana) formed one group, while the "combshells" (e.g. E. brevidens E. obliquata, E. penita, and E. triquetra) formed the second group. Based on extensive molecular and morphological data, we propose a new classification of subgenera for extant species in the genus.

PO 44 POPULATION GENETIC ANALYSIS OF THE ENDANGERED CUMBERLAND COMBSHELL *EPIOBLASMA BREVIDENS*: IMPLICATIONS FOR SPECIES RECOVERY.

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A genetic characterization of two populations of the federally endangered Cumberland combshell Epioblasma brevidens was conducted in order to provide guidance for recovery planning. Twenty individuals were sampled from populations in the Clinch and Big South Fork Cumberland (BSF) rivers, TN. We sequenced a total of 1284 base-pairs of mtDNA (ND-1 and Cytochrome-b) and amplified 10 polymorphic DNA microsatellite loci. Analysis of molecular variance (AMOVA) for mtDNA indicated significant genetic differentiation between the two populations ($p < 0.05$), with a majority of the variation residing between populations (69.27%), and less variation (30.73%) within populations. Only a single mtDNA haplotype was observed among individuals sampled from the BSF population, suggestive of a population bottleneck. Phylogenetic analysis of mtDNA sequences and population genetic analysis of DNA microsatellites indicated that both populations were genetically distinct. Established molecular genetic criteria suggest that the investigated populations of E. brevidens in the Clinch and BSF rivers minimally qualify as separate management units. We suggest that no interbasin transfer of individuals occur between the Cumberland and Tennessee river systems.

PO 45 POPULATION GENETICS OF *QUADRULA QUADRULA*: REGIONAL DIFFERENCES.

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The population genetic structure of freshwater mussels is essential to conservation and may provide key insights to understanding host-parasite relationships and historical dispersal of freshwater species. The population genetics of freshwater mussels reflect their dispersal abilities and limitations in the ability of glochidia to utilize host fishes for dispersal. We present preliminary results on the population genetic structure of Quadrula quadrula, using ten allozyme loci and a 550 base pair sequence from the mitochondrial COI gene. Analysis of the allozyme data yielded average Modified Rogers Genetic Distances between sites in the Mississippi River drainage of 0.098, between Ohio River sites of 0.081, and between Lake Erie drainages of 0.315. The average number of alleles per locus increased with more southerly sites, the highest was found in the Tensas River (2.6), intermediate values occurred at three sites on the Ohio River (1.8), and the lowest was found in the Lake Erie drainage (1.3). Mean FST was calculated for the entire Mississippi (0.035) and Lake Erie (0.290) drainages. An AMOVA conducted on the mtDNA data sequences revealed that 45% of the genetic variation could be attributed to between population variation. Northern populations were dominated by a single haplotype found in both Manitoba and Ontario, while southern populations in the Mississippi River drainage frequently had multiple haplotypes with shifts in frequency along a north-south gradient. These results demonstrate substantial regional variation across molecular markers, which may be shaped by factors such as glacial history and host interactions.

PO 46 GENETIC DIFFERENCES AMONG POPULATIONS OF THE FLUTED-SHELL MUSSEL (*LASMIGONA COSTATA*) FROM THE OHIO RIVER AND LAKE ERIE WATERSHEDS.

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Sciences, Arkansas State University, State University AR, 4Department of Zoology, Miami University, Hamilton OH.

A hierarchical approach was used to examine the genetic structure of Lasmigona costata by 1) sequencing the mitochondrial cytochrome oxidase subunit I (COI) gene and 2) analyzing variation at 12 allozyme loci. We measured genetic variation within populations, among populations within rivers, among rivers within watersheds, and among watersheds from Lake Erie (Grand, Sandusky and Sydenham rivers) and the Ohio River (Licking, Stillwater, and Walhonding rivers). One hundred and eighty two individuals were used in the mtDNA analysis and 422 were sampled for allozymes. Mitochondrial DNA analysis revealed 25 haplotypes. Allozymes showed 7 of the 12 loci sampled were polymorphic for one or more populations. We observed significant mtDNA structure at all levels of the hierarchy, with the largest variation among watersheds (63%) and little or no variation among populations. Phylogenetic analysis indicated a monophyletic clade within each watershed. Similarly, allozymes revealed distinct populations between Lake Erie and Ohio River watersheds. These results are consistent with earlier allozyme studies of mussels that revealed significant genetic variation among drainage basins. A positive correlation was observed between genetic and geographic distance using a historical connection through the Wabash River, implying that historical factors along with isolation-by-distance are likely causes of differentiation. Basin-by-basin geographic variation must be considered when developing conservation strategies for these organisms.

PO 47 MICROSATELLITE VARIATION IN POPULATIONS OF *LAMPSILIS CARDIUM* FROM THE UPPER MISSISSIPPI RIVER.

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Conservation of imperiled unionids requires maintaining genetic diversity. Microsatellite markers were used to evaluate genetic variation of Lampsilis cardium from 10 beds in 5 navigation pools of the Upper Mississippi River (UMR) and one bed from the Boone River, IA. Objectives of this study were to screen primers developed for congeneric species to see if they would amplify microsatellites in L. cardium and, to evaluate genetic population structure within beds, among beds in pools, among pools in the UMR, and between rivers. Total DNA was isolated from mantle tissue and microsatellites were amplified by PCR. Amplified fragments were resolved by gel capillary analysis on an automated genetic analyzer. Currently, 8 of 10 primers screened have amplified microsatellites in L. cardium, 7 were polymorphic. Three loci have been further evaluated in a survey of 61 individuals (4-10 mussels per bed). These loci contained 37, 31, and 14 alleles. Observed heterozygosities for the three loci ranged from 0 to 0.80, 0 to 0.89, and 0 to 0.75 within a single bed, and averaged 0.78 ± 0.16 (SD), 0.69 ± 0.23, and 0.37 ± 0.23 for the 11 beds measured to date. Mean number of alleles per bed was 20 ± 8, mean number of alleles per pool was 36 ± 7, and there were 15 alleles found in the Boone River population. These preliminary results suggest that alleles from all three loci seem to be fairly evenly distributed among beds and among pools, revealing no strong population structure along this stretch of the UMR, nor between rivers.

PO 48 MICROSATELLITE ASSESSMENT OF GENE FLOW IN *AMBLEMA PLICATA* IN THE OUACHITA HIGHLANDS OF SOUTHEASTERN OKLAHOMA.

Kathleen L. Reagan and Caryn C. Vaughn. Oklahoma Biological Survey and Department of Zoology, University of Oklahoma, Norman, OK 73019.

Appreciation of genetic diversity in unionids is essential to their preservation. Understanding how habitat perturbations affect this genetic diversity will provide information for better management of their natural habitats. The use of microsatellites enables the assessment of relatedness in naturally occurring populations. We examined relatedness within a common mussel species, Amblema plicata from rivers in the Ouachita Highlands of southeastern Oklahoma that are fragmented to varying degress. We sampled A. plicata tissue from ten sites each in the Little, Glover and MT. Fork Rivers. Two of these rivers have had impoundments in place for ~34-35 years. At each site, mussels were sampled from 15, randomly placed, 0.25m2 quadrates. Tissue samples consisting of 20-40 µg of mantle tissue were clipped from each mussel and a minimum of 30 samples were taken from each site. A subsample of mussel individuals was taken from each site for shell thin-sectioning to determine age. Microsatellite markers will be used to examine the genetic diversity of A. plicata and to determine if the impoundments are impacting gene flow.

PO 49 GENETIC IDENTIFICATION OF FISH HOSTS FOR THE YELLOW LAMPMUSSEL *(LAMPSILIS CARIOSA)* AND TIDEWATER MUCKET *(LEPTODEA OCHRACEA)* USING A MOLECULAR IDENTIFICATION KEY.

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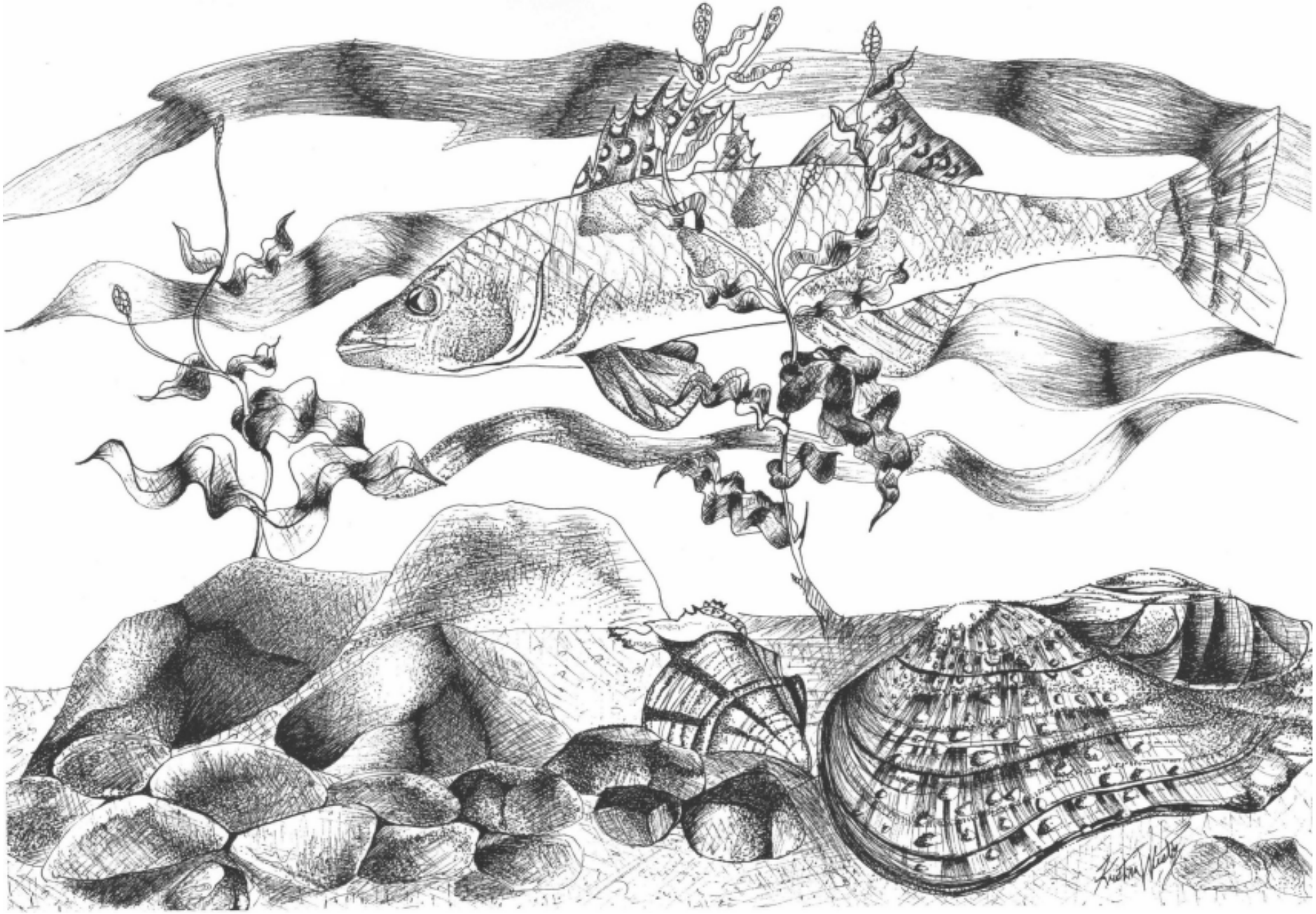
The yellow lampmussel (Lampsilis cariosa) and tidewater mucket (Leptodea ochracea) are listed as threatened in Maine, where their distribution is restricted to the Penobscot, St. George, and Kennebec River drainages. Probable host fish for the yellow lampmussel are white perch (Morone americana) and yellow perch (Perca flavescens), and for the tidewater mucket, white perch. However, these species are based on lab trials and have not been confirmed as hosts in natural conditions. The objective of this study is to determine if they act as host fish in natural conditions and also to assess additional species as possible hosts by sampling naturally parasitized fish in the wild. Identification of glochidia will be done using a molecular key based on restriction fragment length polymorphism (RFLP) patterns of the mitochondrial ND1 gene. The DNA key was developed by sampling all ten species of freshwater mussels found to occur in Maine throughout the Penobscot, St. George, and Kennebec River drainages and was tested on known species for accuracy. During the pilot season, fish with attached glochidia were sampled at several locations in each river drainage where tidewater muckets and yellow lampmussels occur. In addition, GIS analysis was used to compare the distributions of yellow lampmussels and tidewater muckets to those of various fish species in the state, to predict likely host species in the wild. Information gathered from the pilot field study, together with the GIS analysis, will be used to target specific fish species as possible hosts for the yellow lampmussel and tidewater mucket.



Sauger and Pistolgrip —Kristina Westberg

PLATFORM SESSION 3A

Life History & Ecology

PL 21 A FIELD EXPERIMENT EXAMINING THE EFFECTS OF MUSSEL SPECIES COMPOSITION ON ECOSYSTEM PROCESSES IN STREAMS.

Caryn C. Vaughn, Daniel E. Spooner and Heather S. Galbraith. Oklahoma Biological Survey and Department of Zoology, University of Oklahoma, Norman OK 73019.

We performed two, 6-week (summer & fall 2003) field enclosure experiments in the Kiamichi River, Oklahoma, examining functional redundancy among riverine mussel species and effects of mussel species composition on ecosystem processes. The 13 treatments (each replicated 5 times) were monocultures of 4 species, six 2-species combinations, a 4-species and an 8-species combination, and a no mussel control. Mussels were placed in homogenized river sediment in partially-buried 0.25 m2 mesh enclosures at densities of 24/m2. Response variables included periphyton and invertebrate abundance and composition on mussel shells and in surrounding sediment, chlorophyll accumulation on nutrient-releasing substrates, and changes in biomass and tissue glycogen content of individual mussels. While some samples are still being processed, results to date demonstrate strong effects of a potentially keystone species, Actinonaias ligamentina, but only weak diversity effects. In summer, A. ligamentina significantly increased the amount of periphyton growing on the sediment and A. ligamentina density was correlated with biomass changes in other mussel species. These patterns were not observed in the fall when water temperatures were lower and average discharge higher. Our results indicate that some mussel species are performing differently in streams and are thus not redundant. However, performance and potential redundancy are context-dependent and vary seasonally.

PL 22 PHYSIOLOGICAL ECOLOGY OF FRESHWATER MUSSEL COMMUNITIES: EFFECTS OF TEMPERATURE ON COMMUNITY STRUCTURE AND ECOLOGICAL SERVICES.

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Recent work suggests that freshwater mussel communities significantly influence stream ecosystem function through benthic-pelagic coupling of energy and nutrients. Mussel beds increase sediment organic matter and benthic algal production, facilitating the abundance and diversity of co-occurring benthic invertebrates. The magnitude of these effects, appear to be regulated by abiotic factors such as temperature and flow, which influence hydraulic residence time and biological rates of reaction. We are using an integrative approach to examine the role of temperature on measures of physiological condition (metabolic rate, glycogen concentration, RNA: DNA) and measures of ecosystem services (nutrient excretion, biodeposition and clearance rate). Eight different species of unionids were removed from a mussel bed in the Little River, OK and acclimated to four temperatures (5, 15, 25, and 35°C) for two weeks prior to the experiment. Measures of condition and ecosystem services were taken for all species at each temperature. Data collected to date suggest that there is significant variation in species-specific thermal performance. These performance curves influence resource acquisition, potentially shaping community structure (species dominance) and subsequent ecological function.

PL23 MICROSATELLITE DNA MARKERS DETECT SIGNIFICANT POPULATION STRUCTURE OF *ALASMIDONTA HETERODON* WITHIN THE DELAWARE RIVER BASIN.

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Species-specific microsatellite markers were developed for the dwarf wedgemussel *Alasmidonta heterodon* then used to survey 7-30 individuals (total N=90) at each of two tributary and three mainstem locations within the upper and middle Delaware River basin (PA, NY, NJ USA). Significant levels of genetic diversity were detected among these populations; alleles were observed across the 13 loci ranging from 4 to 26 alleles per locus. Estimates of individual pair-wise genetic distances indicated that levels of genetic diversity among loci were sufficient to produce unique multilocus genotypes for all animals surveyed. Ran-

domization tests showed that genotypes for all collections were consistent with Hardy-Weinberg expectations, and no significant linkage disequilibrium was observed between any loci. Pair-wise F_{ST} estimates were significant in all comparisons between the tributary populations; however, two comparisons within the mainstem collections were not significantly different. Maximum likelihood assignment tests revealed structuring of genotypic frequencies as individuals were correctly assigned to collection site 81% of the time and stream reach 94% of the time. These data suggest that fine scale management efforts may be appropriate for *Alasmidonta heterodon* populations within the upper and middle Delaware River basin.

PL 24 CONSERVATION OF THE SPECIAL CONCERN OUACHITA CREEKSHELL (*VILLOSA ARKANSASENSIS)* (LEA 1852): LIFE HISTORY, ECOLOGY, AND CONSERVATION IMPLICATIONS.

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The Ouachita Creekshell (Villosa arkansasensis) is an Arkansas State Species of Special Concern that is endemic to the Ouachita and Saline River drainages in Arkansas and Oklahoma. The objectives of this project are to investigate the life history and ecology of V. arkansasensis including determining suitable fish hosts and documenting migration habits of individuals. Nineteen known V. arkansasensis sites, based on a previous Lampsilis powellii status survey in 1988, were selected to resurvey for V. arkansasensis. Four of these sites, two sites from each drainage system (Ouachita and Saline), will be intensively studied for population demographics and migration behavior and also will be visited monthly physical and chemical water parameters and documenting reproductive status of female V. arkansasensis. Currently, habitat characterization and assessments for each of the 19 sites have been completed and temperature data loggers and grid systems at the 4 intensively sampled sites have been set in place to complete the population and vertical and horizontal migration studies. Gravid females in the Saline river drainage were collected in December 2004 and fish host suitability trials will begin in mid-winter at the Mammoth Springs National Fish Hatchery. By measuring the migration of each mussel, we expect to find a correlation between male and female migration patterns and time of reproduction. We further expect to document which species of fish are suitable host and determine if there are differences in host suitability between drainages. The results of this study will build our understanding of this organism's life history and ecology and help resource managers make decisions on watershed and host fish management.

PL 25 OBSERVATIONS ON THE BEHAVIOR OF FRESHWATER MUSSELS (BIVALVIA:UNIONIDAE) FROM KENTUCKY.

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The decline of freshwater mussel populations has led to recent advances in technology and proactive recovery of freshwater mussels. In 2002 the Kentucky Department of Fish and Wildlife's Wildlife Diversity Program developed the Center for Mollusk Conservation to aid in the recovery of rare and endangered mussels. As part of this continuing effort, we are currently holding 59 mussel species in semi-natural conditions in flow-through river tanks. Over the course of the last two years, we have observed several behavior types in captivity. The observations include many genera and subfamilies, primarily the Lampsilinae, Amblemidae, and Anodontinae. We have observed the use of worm-like lures by the endangered fanshell, Cyprogenia stegaria and the purple lilliput, Toxolasma lividus. A super conglutinate fish-type lure was observed with pheasant shell, Actinonaias pectorosa. The most common type of lure included the display of mantle flaps [yellow sandshell, Lampsilis teres, plain pocketbook, L. cardium, wavyrayed lampmussel, L. fasciola, and the Cumberland moccasinshell, Medionidus conradicus). Several species had conglutinate packets [round pigtoe, Pleurobema sintoxia, Ohio pigtoe, P. cordatum, Wabash pigtoe, Fusconaia flava, kidneyshell, Ptychobranchus fasciolaris and the fluted kidneyshell, P. subtentum]. Less common were nets (elktoe, Alasmidonta marginata), and tissue conglomerates (creeper, Strophitus undulatus, and the pistolgrip, Tritogonia verrucosa). Behavioral patterns were closely related to season and water temperature. Observations fit well to those described in the literature. Preliminary data suggests that conditions for survival and reproductive development are adequate in the semi-natural hatchery environment at the Center for Mollusk Conservation.

PLATFORM SESSION 3B

Propagation & Reproduction I

PL 26 HOST INFECTION STRATEGY OF THE SNUFFBOX MUSSEL, *EPIOBLASMA TRIQUETRA.*

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It has been suggested that mussels of the genus Epioblasma facilitate infection of host fish with glochidia by clamping shut on the host's head. We investigated this hypothesis in the snuffbox, Epioblasma triquetra. Gravid females assumed an erect station in the substrate, raising the posterior of the shell, while gaping to display a modified mantle margin that may act as a lure. Sharp denticles at the posterior margin of the female shell appear suited for grasping. We tested the responses of several females by lightly anaesthetizing darters and allowing snuffbox females to clasp them. Mussels immediately clamped shut on the fish, but were relatively unresponsive to plastic or wooden probes. Within 10-15 seconds after capture, the mantle expanded beyond the margin of the shell to form a seal around the fish's head at the point of insertion. The mussel then performed a series of rhythmic contractions, acting as a bellows to force water through the fish's mouth and out through the gills. Coincident with this pumping action, glochidia were released and entrained in the flow through the fish's gills. Interestingly, we found that darters of the genus Epioblasma were usually killed, apparently by the crushing force exerted by the mussel. However, logperch (Percina caprodes) of similar size repeatedly survived the encounters. The head of the logperch is relatively slender and solid, adaptations associated with its habit of using its snout to turn stones during foraging. This habit probably increases the chance of capture by female snuffbox, while the reinforced snout prevents crushing. Tests also confirmed previous reports that logperch is a suitable host for this species.

PL 27 THE EFFECTS OF GLOCHIDIOSIS ON FISH RESPIRATION.

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Little is known of the pathological effects of glochidia on their hosts (glochidiosis). Glochidia generally appear to be benign hitchhikers, although a few studies show that heavy infections can increase host mortality. Thus, the existence of an "evolutionary arms race" between mussels and their hosts is problematic. We investigated the effects of glochidia of Lampsilis reeveiana on respiration of largemouth bass. We predicted that glochidiosis would impair gas exchange, because the formation of glochidial cysts on the gills increases the diameter of the gill filaments and obliterates the lamellae in the affected area, increasing diffusion distance while reducing the surface area for gas exchange. Fingerling bass (~5 g) were infected with 0-1000 glochidia per fish. In normoxic water, resting ventilation rates were elevated in proportion to the number of attached glochidia and up to 2X controls. The rate of oxygen consumption (MO2) and tolerance for hypoxia (critical DO at which ventilation ceased) were tested in closed chambers. MO2 was not measurably affected, but critical DO was elevated up to 2X by glochidiosis. The largest effects occurred during the peak of juvenile drop-off. Thereafter effects decreased but were still significant 2.5 months after excystment. Microscopic examination at that time showed shortened or missing gill filaments and lamellae. The results indicate that glochidiosis can cause significant and persistent impairment of gill function. Hosts might also be exposed to increased predation if compensatory hyperventilation attracts the attention of predators. Selection pressure on fish to avoid glochidiosis presumably results in reciprocal selection on mussels to evolve ever more sophisticated lures.

PL 28 CROSS-RESISTANCE OF LARGEMOUTH BASS TO UNIONID MUSSELS.

Benjamin J. Dodd1, M. Christopher Barnhart1, Constance Rogers-Lowery2, Todd B. Fobian1, and Ronald V. Dimock, Jr2. 1Department of Biology, Southwest Missouri State University, Springfield, MO 65804; 2Department of Biology, Wake Forest University, Winston-Salem, NC 27109.

We tested whether host fish that acquired resistance to glochidia of one mussel species were cross-resistant to glochidia of other species. Largemouth bass (Micropterus salmoides) were primed with 4-5 successive infections of glochidia of Lampsilis reeveiana. The percentage of attached glochidia that survived and transformed to the juvenile stage (transformation success) was compared between primed fish and naïve controls. Transformation success of L. reeveiana, Lampsilis abrupta, Villosa iris, and Utterbackia imbecillis was significantly lower on primed fish (37.8%, 43.5%, 67.0%, and 13.2% respectively) than on control fish (89.0%, 89.7%, 90.0%, and 22.2% respectively). Immunoblotting was used to analyze the binding of serum antibodies from primed fish with glochidia proteins. Antibodies bound to glochidia proteins of similar molecular weight from L. reeveiana and L. abrupta. Bound proteins of V. iris differed in molecular weight from those of the Lampsilis species. There was no binding to specific glochidia proteins of U. imbecillis or Strophitus undulatus. Our results indicate that host acquired resistance can extend across mussel genera and subfamilies, and might involve both specific and nonspecific mechanisms. Understanding the specificity of acquired resistance of hosts to glochidia could

enhance understanding of the evolutionary and ecological relationships between mussels and their host fishes.

PL 29 HOST FISH IDENTIFICATION TRIALS FOR FOUR SPECIES OF FRESHWATER MUSSELS IN THE SUBFAMILY ANODONTINAE.

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Host fish identification trials were performed for four mussel species in the subfamily Anodontinae; elktoe, Alasmidonta marginata, Cumberland elktoe, Alasmidonta atropurpurea, Tennessee heelsplitter, Lasmigona holstonia, and fluted shell, Lasmigona costata. Twenty fish species in 7 fish families were tested as potential hosts for the elktoe mussel. Three fish species were verified as hosts, producing pedal-feeding juveniles; fantail darter, Etheostoma flabellare, blacknose dace, Rhinichthys atratulus, and mottled sculpin, Cottus bairdi, with the sculpin producing the most juveniles per fish. Seven fish species from 4 families were tested as hosts for the Cumberland elktoe. Four fish species produced pedal-feeding juveniles, with the banded sculpin, Cottus carolinae, and the northern hogsucker, Hypentelium nigricans, being the most suitable hosts in this experiment. Fourteen fish species of 6 families were tested in host trials for the Tennessee heelsplitter. Two fish species did not transform glochidia, the white shiner, Luxilus albeolus, and the northern hogsucker, Hypentelius nigricans. The most suitable host producing more juveniles per fish was the mottled sculpin, Cottus bairdi. The margined madtom, Noturus insignis, fantail darter, Etheostoma flabellare, and greenside darter, Etheostoma blennioides, are also adequate hosts for this mussel species. A total of 12 fish species of 6 families were tested as potential hosts for the fluted shell. Only three fish species were not identified as host fish for the fluted shell; crescent shiner, Luxilus cerasinus, whitetail shiner, Cyprinella galactura, and freshwater drum, Aplodinotus grunniens. The mottled sculpin, Cottus bairdi, fantail darter, Etheostoma flabellare, bluegill, Lepomis macrochirus, and rock bass, Ambloplites rupestris, produced the most juveniles per fish and are suitable hosts for the fluted shell.

PL 30 STUDY OF THE CAPTIVE SURVIVAL RATE AND FEASIBILITY OF PEARL PRODUCTION BY THE PINK HEELSPLITTER *(POTAMILUS ALATUS).*

Dan Hua and R. J. Neves, Virginia Cooperative Fish & Wildlife Research Unit, Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

The probability of natural pearl formation is very low, since approximately 1 in 10,000 mussels may produce a valuable pearl. The pink heelsplitter (Potamilus alatus), a common mussel species in the greater Mississippi River basin, produces a lustrous purple nacre in many populations. Because the species is relatively fast-growing and exhibits shell characteristics similar to pearl-producing species in China, a pilot project was initiated to determine whether this species could produce pearls in a captive environment. Three holding treatments were tested in two ponds; in substratum at 1 m depth, in substratum at 3 m depth, and suspended in nets. After one year in captivity in an aerated pond, mussels held in substratum at 1 m depth had significantly higher survival compare to those at 3 m depth ($p<0.05$). However, there was no significant difference between survival at 1 m and those in suspended nets. Three surgical operations for pearl formation were conducted in this research, including no nuclei implantation, nuclei implantation, and image implantation. Nuclei implantation was unsuccessfully implemented, since pink heelsplitter mantle tissues were too thin and weak to hold shell beads. Pearl formation was evaluated by sampling 2 pearls from each living mussel at monthly intervals. The first evidence of success was verified after 1 month, when seed pearls were produced, and inserted wax images were partially covered with nacre. Purple pearls have continued to grow larger, and image pearls are being formed with the purple lustrous surface with further time in culture.

PLATFORM SESSION 4A

Habitat & Conservation

PL 31 USE OF MESOHABITAT AND MICROHABITAT PATCHES BY FRESHWATER MUSSELS IN THE CLINCH RIVER, VIRGINIA AND TENNESSEE.

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Limited knowledge of the habitat use and requirements of freshwater mussels (families: Margaritiferidae and Unionidae) hinders effective management and restoration efforts. This study determined which flow and substrate parameters best described habitat use by mussel assemblages and species at two scales within similar reaches of the upper Clinch River, Virginia and Tennessee. Species richness and density was highest in riffle mesohabitats and lowest in pools, with run habitats intermediate to these. Flow characteristics varied significantly ($p > 0.05$) among mesohabitats, while differences in substrate characterization were less obvious. Comparison of logistic regression models by

Akaike's Information Criteria (AIC) demonstrated that Fleisswasserstammtisch (FST) hemispheres, embeddedness, and mean column velocity best described the probability of species occurrence in a microhabitat patch. Substrate characteristics were of secondary importance, although inclusion in models often improved model approximation. Subtle differentiation in habitat use among species was observed and statistically confirmed. Flow regime of the Clinch River, biological needs of mussel species, and fish host habitat use may explanation much of habitat use in this river.

PL 32 COWS, CONDOS AND CORNFIELDS: CAN CANADA'S ENDANGERED MUSSELS COPE?

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The recent general status assessment of Canadian fauna concluded that 65% of freshwater mussel species are in need of conservation making this group the most imperiled group in Canada. Eleven of the 55 species which occur in Canada have already been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being at risk (1 Extirpated, 8 Endangered, 1 Threatened, 1 Special Concern) with additional listings imminent. Southern Ontario is the hot spot of mussel diversity in Canada and home to 41 species including all 8 of the species listed as Endangered. The Thames, Grand and Sydenham rivers of the Lake Erie/Lake St. Clair drainage are the most diverse mussel rivers in Canada, however serious declines have been noted in all three rivers during the last two decades. Of the 34 species historically known from the Thames River, 8 species (including 3 federally Endangered species) no longer occur within the watershed. The distribution and population dynamics of mussel species at risk (SAR) within the Upper Thames watershed was examined in an effort to determine the extent of current distributions and the likelihood that these species will persist within the watershed. Although one SAR, Lampsilis fasciola, appears to be actively reproducing within the watershed, the recent establishment and spread of zebra mussels in the upper reaches may further complicate the survival of this and the other Endangered mussel species.

PL 33 SIZE MATTERS: NORTH AMERICAN FRESHWATER MUSSEL EXTIRPATIONS REFLECT LANDSCAPE SCALE ALTERATION OF RIVERINE HYDROGEOMORPHOLOGY.

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Freshwater mussel assemblages in many southeastern river drainages were historically populated by relatively small-shelled, endemic species. Our recent surveys in the Coosa and Tallapoosa drainage (Alabama) indicate that many assemblages now consist mostly of large-shelled species (e.g., Tritogonia verrucosa, Quadrula spp., Amblema elliottii, Pyganodon grandis) with nearly all small-shelled species being extirpated (e.g., Epioblasma spp., Medionidus spp., Pleurobema spp., Villosa spp.). We conducted a meta-analysis to investigate the importance of shell size and geographic range as predictors of imperilment (global heritage rank) of the southeastern mussel fauna. We found that both maximum shell size (as length) and relative range size (as number of drainages occupied) were positively related to global heritage rank. When we restricted our analysis to narrow-range endemics (i.e., taxa restricted to <3 drainages) shell size remained a strong predictor of imperilment while range size became less informative. However, shell length and range size were both strong predictors of global heritage rank for widespread taxa (i.e., mussels occurring in 4-15 drainages). Analyses of changes in mussel assemblages in each of 15 southeastern drainages indicated similar size-dependant shifts in mussel assemblages in virtually all (93%) focal drainages. We hypothesize that increased streambed destabilization and hydraulic sheer stress, and their attendant effects on more vulnerable young, or small-shelled mussels, are the principal mechanisms for these patterns. Hydro geomorphic modification of fluvial habitats is not restricted to the southeastern United States, so we predict that similar shifts in mussel assemblages have or will occur globally.

PL 34 A REACH SCALE COMPARISON OF FLUVIAL GEOMORPHOLOGICAL CONDITIONS OF FRESHWATER MUSSEL BEDS: DIFFERENCES BETWEEN THE HAVES AND HAVE NOTS.

Andrew J. Peck, John L. Harris, and Alan D. Christian. Department of Biological Sciences, Arkansas State University, Box 599, State University, Arkansas, 72467.

The White River basin of eastern Arkansas is a moderately sized, non-wadeable, sand-clay-gravel-bed river system. Through field surveys commencing in the mid-1990's through 2000, 110 historically commercially viable beds have been classified as currently substantial or historically substantial, based on mussel densities within the bed. Utilizing this information, the objective of this project is to assist in the definition of physical habitat ranges for freshwater mussels in the lower White River. We expect that reaches with current mussel beds will have lower bedload movement and more stable physical habitat conditions than historical mussel bed reaches. For this study, 12 sites were selected: six currently have high mussel densities

(>10 mussels per m2) and six currently have low mussel densities (0-10 mussels per m2). Analysis of the sediment and hydraulic regimes of the sites are being examined over multiple stage events and between two regions along the river continuum. Parameters being explored include velocity profiles, bedload transport, total suspended sediment (TSS), and discharge. Velocity profile information collected will assess hydraulic forces including Froude numbers and critical shear stress. We have collected data over a spring/summer moderate to high flow, late summer / early autumn low flow, and a late winter / early spring high flow. This information may prove useful to understanding physical factors that shape large river mussel habitat and to managers and engineers currently planning resource extraction activities within the basin and in other low-gradient systems in the southern U.S.

PL 35 AN ANALYSIS OF RATES OF SEDIMENTATION LOADING AT SELECTED STATIONS IN THE BEAR CREEK SYSTEM, ALABAMA AND MISSISSIPPI, 2004.

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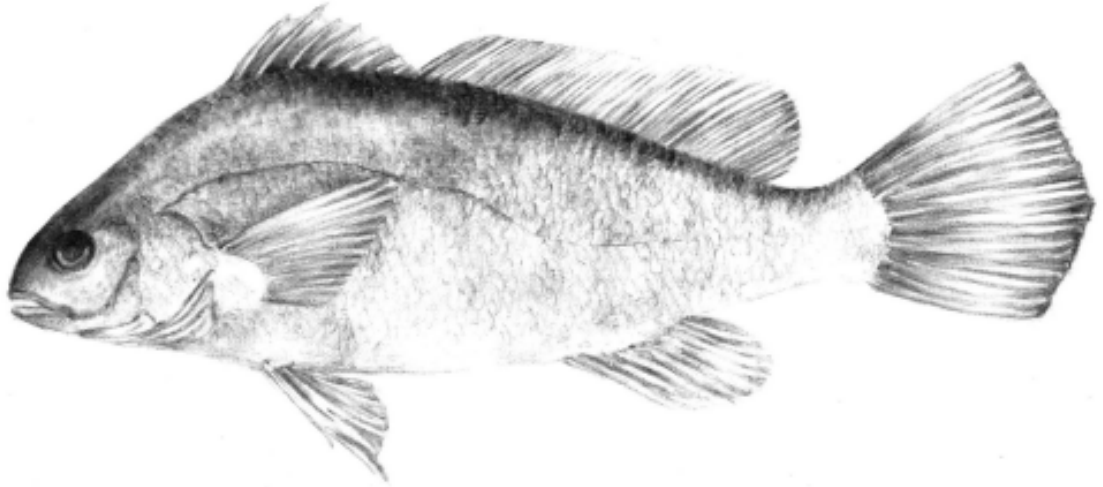
A short reach of Bear Creek harbors a diverse population of freshwater mussels, including 28 species in a short reach of the main channel downstream of the lowermost dam in the system. This total includes 14 previously unreported species, bringing the historic total to 40. The current fauna includes individuals of two species (Epioblasma brevidens and Lexingtonia dolabelloides) considered to be critical to survival of those species. Results of this study indicate that significant and, in some cases, excessive sedimentation is occurring in the Bear Creek system, primarily in the Bear Creek floodway, threatening the continued existence of mussel populations. All sites evaluated during this study showed some level of potential for continued habitat degradation due to sedimentation. However, the reach of Bear Creek from Red Bay, Alabama, to Tishomingo County Road 86 in Mississippi, including the floodway, consistently yielded values of most concern. Those values include (a) the largest volume of gravel bed material mobilized, (b) the highest mean streamflow velocity, (c) the largest suspended sediment load in total mass and in mass per unit area, and (d) the largest bedload in total mass and in mass per unit area. The gravel bed material moving through the floodway is composed of materials eroded from ridges in the mid and downstream reaches of the watershed (Tuscaloosa Group) and from the headwaters (Pottsville Formation). This suggests that disturbances of the land surface in those upland areas introduce large volumes of sediment into tributaries that transport it to Bear Creek and the floodway, which act as conduits for transport of sediment to the Tennessee River.



Drum Host Fish —Kerrisa Nelson

PLATFORM SESSION 4B

Status & Distribution I

PL 36 FISH MEDIATED MOVEMENT OF UNIONIDS: NEUTRAL MODEL OF FISH COMMUNITIES IN THE UPPER MISSISSIPPI RIVER.

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The distribution, abundance, and movement of host fish for unionids may contribute to the observed spatial patterns in unionid communities. Due to the spatial dependency of unionids on their host fish, movement of fish among mussel beds may create spatial patterns which cannot be explained by traditional models. Neutral models are used in place of null models and are valuable because they incorporate ecological processes. We hypothesized that unionid populations, driven by metapopulation dynamics, could be mediated by movement of host fishes. We developed a neutral model to represent the relation between fish-mediated connectivity and the success of mussel beds by chance alone. We first created a neutral model with the non-host fish community (57 species) and compared this to the known host fish community for 13 unionid species in the Upper Mississippi River (31 species). Next, we created surfaces with kriging of non-host fish (neutral) and host fish to compare differences in their spatial patterns. We found the fish host community has greater overall probability of providing connectivity among mussel beds than the non-host fish model. Also, comparisons with the neutral model show that in areas with mussel beds the non-host fish and host fish had similar overall connectivity, but different spatial patterns. Spatial patterns were analyzed with Ripley's K, which indicates clustering patterns of the non-fish host relative to the host fish model. This analysis suggests that the distribution and movement of fish hosts create spatial patterns that differ from those of non-fish hosts, underscoring the likelihood that the processes involved in fish movement influence dispersal among mussel beds.

PL 37 PREDICTING THE SPATIAL DISTRIBUTION OF MUSSEL BASED ON FISH ZOOGEOGRAPHY IN WISCONSIN.

David Heath. Wisconsin Department of Natural Resources, 3550 Mormon Coulee Rd, La Crosse, WI 54601.

Wisconsin is fortunate to have large electronic databases of fishes and mussels whose records date to 1820. I combined these databases with information on known unionid host fishes and attempted to correlate fish and mussel distributions. In all but a very small percentage of interrelationships, it was impossible to accurately predict a unionid's distribution in Wisconsin using its corresponding host(s). The few that were possible, are the few that are notorious examples. There may be several reasons for such weak predictive capability. 1) Not all host fishes are known. Only a small percentage of fishes have been adequately assessed for host suitability for any given mussel species. 2) Although host fishes may be present, some of the factors that comprise a mussels niche may be absent. Conditions may be suitable for the host but not for the mussel. 3) Mussels may not be using wild host fishes found suitable in laboratory assessments. 4) In some cases, mussels may never have had access to waterbodies while their suitable host fishes did. 5) Mussels may not have had recent access to recovered environments due to barriers while their suitable host fishes have.

PL 38 USE OF HYDRAULIC VARIABLES TO PREDICT THE ABUNDANCE OF UNIONIDS IN TWO REACHES OF THE UPPER MISSISSIPPI RIVER.

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The ability to predict the abiotic and biotic factors contributing to the abundance of unionids has been largely unsuccessful. Initial attempts were based on simple physical habitat descriptors (i.e., current velocity, substrate particle size, water depth) and were unable to predict abundance of unionids with much certainty. More recent efforts have focused on complex hydraulic variables such as shear velocity, bottom shear stress, and Reynolds number. We performed a retrospective analysis using unionid abundance, current velocity, and substrate particle size data from 1987-1988 in a 6-km reach of the Upper Mississippi River (UMR). We used classification and regression trees (CART) and the hydraulic and substrate variables to show that boundary Reynolds number and shear velocity were the best predictors of abundance. Further, this CART model was a substantial improvement over the previously published discriminate model-we improved the correct classification from 44 to 66%. In 2003, we built upon this approach in a separate 38-km reach of the UMR by using an acoustic Doppler profiler to more accurately measure shear velocity and bottom shear stress. Preliminary analyses in the first of six study areas indicate that bottom shear stress accounts for more than twice the variability in abundance than depth, current velocity, or substrate type. These data suggest that the highest unionid densities are typically found in areas with reduced bottom shear stress.

PL 39 THE USE OF AN ACOUSTIC DOPPLER CURRENT PROFILER SYSTEM IN AQUIRING COMPLEX HYDRAULIC VARIABLES FOR THE PREDICITON OF FRESHWATER MUSSEL DISTRIBUTION IN A LARGE RIVER.

Pascal Irmscher, University of Wisconsin at Madison, Department of Geography, 160 Science Hall, 550 North Park Street, Madison, WI 53706.

Native freshwater mussels are among the most endangered animals in North America. Many conservation attempts have failed because of the lack in knowledge about the animals and their habitat requirements. For example, the traditional approach to determine the abundance and spatial distribution of freshwater mussels using water depth, substrate composition, and simple hydraulic characteristics has often proven to be insufficient. A new approach considers the animals' location in areas that are protected from scouring, especially during high flow events. Complex hydraulic variables, for example bottom shear stress, reflect the hydraulic conditions that mussels are exposed to more precisely. Although this approach was tested successfully in smaller streams, the data collection of complex hydraulic variables in a large river is quite more challenging. A new attempt was to use an Acoustic Doppler Current Profiler system to measure water velocities along a grid over 6 mussel bed locations in the Upper Mississippi River Pool 8. The ADCP data was used to compute various complex hydraulic variables, which were then correlated with mussel density data obtained from scuba diving. Tree regression analysis showed the importance of individual complex hydraulic variables in determining freshwater mussel distribution. The results indicate that bottom shear stress accounts for more than twice the variability than characteristics used in the traditional approach. The results were visualized using GIS (ArcView) and Surfer software. They prove the significance of complex hydraulic variables as predictors for freshwater mussel abundance and distribution, and confirm the application of an ADCP as a useful tool in freshwater mussel conservation.

PL 40 DETERMINING STATUS AND TRENDS OF THE NEW RIVER MUSSEL COMMUNITY, NEW RIVER GORGE NATIONAL RIVER, WV.

Brian Richards, Joshua Westbrook, Thomas Jones, and Ralph Taylor. Marshall University, Dept. of Integrated Science and Technology, 1 John Marshall Drive, Huntington, WV 25755

With the given decline of freshwater mussel (Unionidae) populations across North America, a survey of the New River within the New River Gorge National River was conducted from July 2003 to September 2004 from Bluestone Dam (Hinton, WV) to the mouth of Coal Run (Cunard, WV). With listings of threatened, endangered, and species of special concern, mussels of the New River have not been surveyed since 1984-85. The objectives were conducted by a two-phase survey to determine distribution, mussel density, changes in mussel density since the last survey conducted, and to determine if any other invasive alien species (Zebra mussel) occurs within the river. The first phase is area extensive, resulting in mapped mussel beds using Geographic Information Systems (GIS). Sites were searched by SCUBA and snorkeling, counting mussels within approximate areas of 50 X 100 meters for 26 sites resulting in 25.95 man-hours searched and over 2,700 mussels counted. The second phase is intensive surveys of selected mussel habitats from the first phase to determine mussel community composition. Second phase sites are searched by SCUBA and snorkel on 100 meter transect lines or area time searches. All live mussels were collected for digital imaging and weight measurements and returned to the substrate. Dead shell was collected and measured to determine if there are correlations to size or age and the life span of collected species.

PLATFORM SESSION 5A

Relocation & Recovery

PL 41 EVALUATION OF FRESHWATER MUSSELS (MOLLUSCA: UNIONOIDEA) FITNESS PRE- AND POST- RELOCATION EFFORTS.

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Relocation of freshwater mussels has been used as a conservation tool when habitat disturbances from anthropogenic impacts are anticipated. Such disturbances include dredging, channelization, and bridge construction. However, little information is available assessing potential changes in fitness of Potamilus capax, the federal endangered fat pocketbook. The objective of this study is to determine if there are changes in fitness and survival in Potamilus capax due to relocation. We will mark individuals non-invasively by adhering PIT R tags to the shells prior to relocation for identification and re-capture. A number of individuals will be left at the collection site for re-evaluation. Small, non-lethal mantle snips (less than 2 grams) will be collected from both relocated and non-relocated mussels. We will then use three measures of physiological fitness/condition: glycogen, RNA/DNA ratios, and lipid content, each representing three differential time scales. Glycogen,

primary carbohydrate storage molecule, is a widely accepted indicator of hours to days fitness effects. RNA/DNA ratios represent a days to weeks indicator of fitness. Lipids, used as a long term fitness indicator, represent stored energy (similar to glycogen), which take longer to mobilize from tissues. We hypothesize that if an organism is subjected to stress, it should first use stored glycogen and cease growing until eventually experiencing a reduction of RNA in relation to the DNA present. Furthermore, if the stress continues, the animal will typically mobilize its fat stores and tissue lipid content will decrease. This study and its associated techniques have been developed to provide important information regarding the potential impacts from relocation efforts for Potamilus capax. This information will be of particular value when working towards the conservation of threatened and endangered species, and for determining equitable responsibility when significant impacts are detected.

PL 42 RELOCATION OF MUSSELS FROM THE MUSKINGUM RIVER NEAR DRESDEN, OH.

Thomas G. Jones, Ralph Taylor, James Spence, Brian Richards, and Katherine Channel. Marshall University, Dept. of Integrated Science and Technology, 1 John Marshall Drive, Huntington, WV 25755.

Dresden Energy is building a gas-fired power plant near Dresden, Ohio. The plant will require up to eight million gallons per day for stream generation and cooling. A crescent-shaped intake structure will be built along the right descending bank of the Muskingum River. The dredged area will cover approximately 500 linear meters with the terminal ends extending slightly over a third of the stream width (~20m). The Muskingum River is known to have a rich mussel population. Preliminary mussel/habitat surveys confirmed dense (2.3 mussels/m2) mussel beds along the left descending bank with densities decreasing towards center channel then increasing towards the right descending bank (0.6 mussels/m2). In 2002, 2,328 mussels were relocated upstream. The following year 12% of the dredge area was resurveyed and an additional 195 mussels were moved upstream. Interpretation of survivorship was made more complex by a 60+ yr drought that occurred in 2002. Relocation was allowed to proceed during poor conditions, due to the acute stress displayed by resident mussels. Many mussels showed active migration with trails up to a meter long and several fresh dead mussels were found in the relocation area. Six of seventy relocation transects were sampled the following year. Sixty-nine marked specimens were located. Forty-two percent of the recaptures were Amblema plicata with only a single dead shell located. Fourteen of the 17 dead specimens were Quadrula quadrula. From this small sample, a 75% survivorship rate was calculated. Planted specimens gained a mean of 10.6 grams. Specimens placed on to the surface gained a mean of 6.1 grams. Planted verses placed specimens were recovered at similar rates. A second year of survivorship sampling has been completed and monitoring with continue for at least five more years.

PL 43 2003 AND 2004 FOLLOW-UPS ON A 2002 UNIONID TRANSLOCATION FROM MISSISSIPPI RIVER MILE 818.9, COTTAGE GROVE, MN.

Marian E. Havlik, Malacological Consultants, La Crosse, Wisconsin 54601-4969

In May 2003 and June 2004 we conducted follow-ups of a mussel translocation from Mississippi River Mile 818.9, downstream of St. Paul, Minnesota. The 52258 m2 area extended from the LDB to the Main Channel. The translocation area (wastewater pipe burial site) yielded 19,630 mussels, 23 live species, and density of 0.38/m2; 7.33% represented two Minnesota endangered and five threatened mussel species. In 2003, 515 of 609 unionids recovered (18 live + 5 sub-fossil species) were numbered or hash-marked. 98.3% of 232 Quadrula nodulata survived, 98.7% of 76 Arcidens confragosus survived; Tritogonia verrucosa, Obovaria olivaria, and Ligumia recta were each alive. Survival of numbered mussels was 98.36%; survival of all hash-marked and numbered mussels was 97.2%; 3% of numbered mussels showed little growth. In 2004, Quadrula nodulata (98.9% survival), and Arcidens confragosus (96.7% survival) represented 42.2% of 448 mussels recovered (15 live species). Of the numbered mussels, 33.3% were new to follow-up measuring and external aging. Overall survival of all hash-marked and numbered mussels was nearly 95%. Of the numbered mussels, 12.7% of mostly older mussels showed little or no growth. No numbered mussels ever moved into an upstream sandy area. The substratum was mostly mud, <1 meter deep. A total of 392 of 572 (68.5%) numbered mussels were recovered during two follow-ups. Similar percentages of age classes were recovered all 3 years. After two years, overall survival of all marked mussels was ~96%; nearly 98% of the numbered mussels survived. A few Dreissena were found in 2003, but none were found in 2004. Since several PVC pipes remained in the project area in 2004, construction impacts were unlikely beyond site.

PL 44 FRESHWATER MUSSEL RESTORATION GUIDELINES IN VIRGINIA: THE WHY, WHAT, AND RESULTING MYTHS AND REALITY.

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Over the past decade, freshwater mussel propagation has become a cornerstone in the effort to recover this declining fauna in the United States. Eight states are

currently involved with propagation efforts and several others are initiating efforts or exploring the possibility. While hundreds of thousands of propagated mussels have been released over the past few years, few policies exist to guide and oversee these activities within state or hydrological boundaries. As Virginia's natural resource agency, the Department of Game and Inland Fisheries developed freshwater mussel restoration guidelines for the upper Tennessee River Basin. The purpose of these guidelines is to outline what recovery efforts can be undertaken, where these activities can occur and with what species, and what is required of the facilities and persons conducting these activities. These guidelines were developed with the input and support of numerous state agencies and stakeholders in the upper Tennessee River Basin, allowing the release of threatened and endangered species to be a readily accepted practice, whereas it is often a major stumbling block. Additionally, these guidelines are currently being modified to apply to all of Virginia and specific species like the James spinymussel. Unfortunately, the implementation of these guidelines has been perceived as conservation limiting by some in the freshwater mussel community, and a number of misperceptions has arisen as a result. We believe that guidelines overseeing freshwater mussel restoration, particularly propagation and augmentation, are necessary to effectively guide and direct these efforts and to avoid political and social resistance.

PL 45 OPPORTUNITY FOR RECOVERY OF MUSSELS IN COPPER CREEK, RUSSELL AND SCOTT COUNTIES, VIRGINIA: IN SEARCH OF A REFUGIUM.

Shane D. Hanlon1, David Garst2, and Richard J. Neves2. 1U.S. Fish and Wildlife Service, Southwestern Virginia Field Office, 330 Cummings Street, Abingdon, VA 24210; 2Virginia Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, VA 24061-0321.

Previous surveys have shown a dramatic decline of the freshwater mussel fauna in Copper Creek, from a reported 19 species in 1980 to 11 species in 1998. In an effort to further assess this decline and the present status of extant species, we surveyed 43 sites within a 93-km reach of the creek in 2004. Using snorkeling and view bucket techniques, we documented 16 species from live specimens and 6 additional species from empty shell material. Of the 5 historic endangered species (Epioblasma capsaeformis, Fusconaia cor, Fusconaia cuneolus, Quadrula cylindrica strigillata, and Villosa perpurpurea) in 1980, four of these (F. cor, F. cuneolus, Q. c. strigillata, and V. perpurpurea) were found alive in 2004. The extremely low abundance of federally listed species in 2004 and the presence of relic shells of 3 additional species, not previously reported from the creek, support the conclusion that the mussel fauna has declined precipitously in the last 25 years. However, comparison of the 1998 and 2004 survey results suggest that some species in the creek may be in recovery. Given this, the goal to recover populations and establish a refugium for federally listed species through augmentation or reintroduction in Copper Creek is being pursued by natural resource agencies.

PLATFORM SESSION 5B

Evolution & Phylogenetics II

PL 46 CONSERVATION GENETICS OF ENDANGERED *LAMPSILIS HIGGINSII*: MITOCHONDRIAL AND MICROSATELLITE DNA ANALYSIS AID THE RECOVERY AND PROPAGATION PLANS.

Bonnie S. Bowen, Dept. Ecology, Evolution & Organismal Biology, Iowa State University, Ames, IA 50011-1020.

Lampsilis higginsii has been listed as a federally endangered mussel in the Upper Mississippi River basin since 1976. In April, 2000, the species was declared in jeopardy of extinction due to maintenance of the navigation channel in the Mississippi River. Zebra mussels (Dreissena polymorpha) currently threaten L. higginsii populations and the persistence of the species. A Relocation Action Plan has been developed that calls for relocation of individuals and propagation of juveniles. Since 1998, we have been conducting a genetic study to determine the amount of genetic diversity within and among populations of L. higginsii. We sampled 130 individuals from seven populations, with at least 20 samples from each of four populations, Hudson, Lansing, Cassville, and Cordova. Using segments from three mitochondrial DNA (mtDNA) genes, cytochrome-b, cytochrome oxidase I, and 16S rRNA, we recovered 24 unique haplotypes (1027 bp), which clustered into four clades and differed by 1-7% sequence divergence. There was little genetic differentiation among the populations, but a high level of genetic variation within the populations. Cytochrome b had the highest number of variable sites and the most haplotypes. Using the nuclear microsatellite

primers developed by Eackles and King for L. abrupta, we assessed nuclear genetic variation from three populations of L. higginsii, Hudson, Cassville, and Cordova. Based on 13-41 individuals from eight loci, we detected between six and 25 alleles per locus. This high level of genetic variation at nuclear loci is consistent with the mtDNA findings. Estimates are provided of the number of females that should be used in propagation and relocation efforts. A significant deficiency of heterozygotes at most microsatellite loci appears to be due to null alleles, which would limit the utility of these microsatellite primers for studies of paternity and maternity in L. higginsii.

PL 47 IDENTIFYING NEW POPULATIONS OF THE ENDANGERED WINGED MAPLELEAF *QUADRULA FRAGOSA* USING MOLECULES AND MORPHOLOGY.

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Members of the genus Quadrula are notorious for their conchological diversity and apparent phenotypic plasticity. For this reason, the taxonomy and validity of many Quadrula species have been controversial. One such species is the winged mapleleaf, Quadrula fragosa. This species historically occurred in the Mississippi, Tennessee, Ohio, and Cumberland river drainages, but has suffered severe population and range reductions. At the time that the species was federally listed as endangered, its range appeared to have been reduced to a stretch of the St. Croix River between northwestern Wisconsin and east-central Minnesota. Recently, morphologically similar specimens have been discovered at sites in Arkansas and Missouri. If these specimens are indeed Q. fragosa, those populations could have a significant impact in the development of conservation management plans for the species. We sought to improve our understanding of Q. fragosa as a genetic entity and to determine the affiliation of the northern and southern populations. We used DNA sequence of the mitochondrial ND1 gene to address three major questions: 1) Is Q. fragosa genetically distinct from other Quadrula species? 2) What is the phylogenetic placement of Q. fragosa in the genus? and 3) Do extant Q. fragosa populations exist outside of the St. Croix? Our results support the species status of Q. fragosa and place it in the quadrula species complex. Further, we conclude that at least two extant Q. fragosa populations exist outside of the St. Croix River.

PL 48 PHYLOGENETIC RELATIONSHIPS AMONG MEMBERS OF THE TRIBE PLEUROBEMINI: PRELIMINARY RESULTS.

Cheryl Morrison1, Jess Jones2, Mike Eackles1, Nathan Johnson3, and Tim King1. U.S.G.S.-Biological Resources Division, Leetown Science Center, Aquatic Ecology Branch, Kearneysville, West Virginia; 2U.S. Fish and Wildlife Service, Blacksburg, Virginia; 3Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Native freshwater mussels belonging to the superfamily Unionacea are arguably the most imperiled group of animals in North America (NA). However, knowledge of basic biology, ecology, and taxonomy of many of the nearly 300 species inhabiting NA is lacking, and severely limits the ability of conservationists to take action to protect this declining fauna. The distribution of many mussel species is small, restricted, and is generally related to limited dispersal capabilities of specific host fish species used for reproduction. Thus, populations become easily fragmented and susceptible to the activities of humans, such as habitat modification, pollution, over-harvesting, and invasive species introductions. Effective implementation of conservation and restoration plans requires clearly definable taxonomic units, yet some morphological characters can be misleading when used to identify species or evolutionary lineages in unionids. For example, species belonging to the tribe Pleurobemini exhibit considerable variation in shell morphology, which has lead to taxonomic confusion, and is unfortunate since many species are endangered. In this study, we examine relationships among over a dozen Pleurobema species inferred from mitochondrial (COI, ND1 and cytochrome b) and a nuclear (ITS) DNA sequences. Genetic analysis of several closely related species in the P. cordatum species complex, as well as other difficult to identify species, such as P. clava and P. oviforme, are discussed. Representatives of the genus Fusconaia and Elliptio (6 species each) are included. Our results suggest phylogeographic affinities between species groups inhabiting rivers in the Ohio, Tennessee, and Mobile river basins.

PL 49 ISOLATION, CHARACTERIZATION, AND CROSS-SPECIES AMPLIFICATION OF NOVEL MICROSATELLITE DNA MARKERS FOR THE ENDANGERED CLUBSHELL (*PLEUORBEMA CLAVA*).

Tim L. King, Michael S. Eackles, and Cheryl L. Morrison; USGS-BRD, Leetown Science Center, Aquatic Ecology Branch, 11649 Leetown Road, Kearneysville, WV 25430.

Correct delineation of the appropriate unit of manage-

ment is especially critical when the composition of a population is manipulated, whether by reintroduction from external stocks or by reestablishment of gene flow and migration patterns by the exchange of individuals from different populations. The intended use of cultured unionids as a conservation tool further underscores the need to recognize the genetic composition of natural and managed populations. To allow development of management strategies in Pleuorbema clava that increase the chances for long-term persistence throughout the Ohio River system, a thorough understanding of the level of gene exchange among populations is essential. Polymorphic genetic markers offer the only true measure of effective migration and recolonization rates (i.e., gene flow) among populations. We have developed over 30 polymorphic microsatellite DNA markers from four microsatellite-enriched libraries to delineate the genetic population structure among the few remaining P. clava populations. Significant levels of genetic diversity have been detected. Estimates of individual pair-wise genetic distances indicated that levels of diversity observed among loci were sufficient to produce unique multilocus genotypes (i.e., genetic distances > zero) for all animals surveyed. We believe this suite of markers, the first utilizing microsatellite DNA variation in a Pleurobema species, yielded sufficient genetic diversity to resolve patterns of effective migration among subpopulations even in cases of small effective population size. This information can be instrumental to restoration programs that attempt to allow recolonization among subpopulations. DNA from several Pleurobema species is currently being examined to determine the level of cross-species amplification within the genus. Preliminary results suggest that the availability of such a large suite of markers could reduce the amount of resources required in initiating new genetic studies assessing population structure, breeding structure, kinship, demographics, and possibly ecological interactions on the individual level in many species currently classified in the genus Pleurobema.

PL 50 CONCHOLOGICAL AND GENETIC VARIATION IN THE KIDNEYSHELL, *PTYCHOBRANCHUS FASCIOLARIS* (RAFINESQUE, 1820).

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Many species of unionid mussels are known to exhibit extreme amounts of conchological variation that is in part the basis for the many nominal species of unionids. One of the challenges facing both the novice and the experienced freshwater mussel biologist is discerning between variation that based on environment and is not heritable versus that which is heritable. Heritable variation is important in the practice of systematics in that it through such variation that species are identified. The kidneyshell, Ptychobranchus fasciolaris (Rafinesque, 1820) is a wide ranging freshwater mussel. It is found in tributaries of the Upper Mississippi and Ohio rivers and the Great Lakes drainages in the U.S. and Canada. Examination of a large number of museum specimens revealed a number of individuals that appeared referable to Unio camelus Lea, 1834. These specimens differ from "typical" P. fasciolaris in being somewhat more inflated, and having a shorter antero-posterior axis. In an attempt to assess the validity of U. camelus and differentiate it from P.fasciolaris I examined the degree of morphological variation with P. fasciolaris by measuring the length, height and degree of inflation of specimens from throughout the range of P. fasciolaris. The locality of specimens was plotted to examine the geographic distribution of putative U. camelus specimens and locality information was examined for evidence of an ecological component (headwater vs. mainstem) to the morphological variation. These morphological/geographical data were compared to a data set of mitochondrial DNA sequences from a larger study to determine if any correlation of genetic and geographic/morphological variation exists.

PLATFORM SESSION 6A

Zebra Mussel & Unionid Interactions

PL 51 CHARACTERISTICS OF A NATURAL REFUGE FOR UNIONIDS IN THE DELTA AREA OF LAKE ST. CLAIR.

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The introduction of the zebra mussel (Dreissena polymorpha) to the Great Lakes in the late 1980s caused catastrophic declines in unionids. There were fears that unionids would be extirpated from the system until researchers discovered several bays/marshes in Lake Erie where zebra mussel densities were low and unionids persisted. In 1999, a similar "refuge" was discovered in the delta area of Lake St. Clair where 23 of 32 historical species survived - including 6 species listed as endangered in one or more jurisdictions. We revisited the delta in 2003 to conduct extensive surveys for unionids and determine zebra mussel infestation rates and veliger densities. Infestation rates were low, averaging 15 zebra mussels/unionid. Unionid densities declined by 14% since 2001, but infestation rates also declined. Veliger densities were twice as high in offshore than nearshore waters, explaining why unionids continue to survive in the shallows long after they were lost from the open

lake. The predominant direction of water flow was to the south-east, preventing offshore waters laden with veligers from penetrating the shallows on a regular basis. Sites in Canadian waters of the Walpole Island First Nation supported more species (13 vs. 9 species) and 20% higher densities of unionids than sites in U.S. waters, most likely due to dramatic differences in land use. Management strategies are being developed to preserve this important remnant of the Great Lakes unionid fauna.

PL 52 GLYCOGEN AND FATTY ACIDS AS BIOMARKERS FOR IMPACTS OF ZEBRA MUSSELS ON UNIONIDS IN THE DELTA AREA OF LAKE ST. CLAIR.

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The delta area of Lake St. Clair still supports a large and relatively intact unionid community (23 of 32 historical species present) and may serve as a natural refuge from impacts of the zebra mussel. We conducted quantitative surveys for unionids at 18 sites throughout the delta in 2003. Richness varied among sites from 3-13 species; density ranged from 0.02-0.125/m2 and average zebra mussel infestation rate ranged from <1-36/unionid. Foot and mantle tissues were collected from Lampsilis cardium and/or L. siliquoidea from all 18 sites and analyzed for fatty acids and glycogen to determine if zebra mussels are affecting their health. Principal component analysis revealed that glycogen concentrations were positively correlated with unionid richness and density and negatively correlated with zebra mussel infestation rate. Lipid concentrations explained more variability in the data than glycogen but were not correlated with any of these variables and likely reflect differences in food sources among sites. Specimens from the two sites with the greatest richness and density of unionids and among the lowest rates of zebra mussel infestation also had the highest concentrations of glycogen in their tissues, suggesting that glycogen may be a sensitive indicator of zebra mussel impacts on unionids. We are currently investigating these sites, which are located in the waters of the Walpole Island First Nation, as potential managed refugia. Trial relocations of unionids from areas with high zebra mussel infestation rates into these refuge sites began in 2004.

PL 53 KENTUCKY DAM TAILWATER, TENNESSEE RIVER, AS A MUSSEL REFUGE FROM INVADING ZEBRA MUSSELS.

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For 10 years, a refuge area downstream from Kentucky Dam has been monitored. On 06/12/1993, a 1 x 15 m area was marked off with iron rebars driven into the sediment at the corners and nylon line tied tightly between the rebars on the 15 m sides parallel to the river current. Mussels were monitored within the area for several years: 1995, 1999, 2000, 2001, and 2002. On 9/15/2000 a Plethobasus cooperianus was discovered nearby and placed in the marked area after being measured and weighed. It was again recovered on 08/15/01 and 07/28/02 and weighed and measured. In 2003 an extensive monitoring survey in the vicinity examined 80 m2 by sediment excavation and screening at 320 random sites. Only 10 zebra mussels were found (density = 0.125/m2) while the mean unionid mussel density was 56.2/m2. At this density we do not believe the zebra mussels affect native mussels. Zebra mussels that are present most likely have fallen from barges and other river traffic from the Ohio River since all were adult mussels with no signs of juvenile recruitment. Since successful zebra mussel reproduction seems to require Ca++ ion concentrations above 20 mg/l and the Tennessee River averages 15-18 mg/l, it does not appear that zebra mussels can reproduce in the lower Tennessee River. Therefore, this area would be excellent to hold endangered species and to attempt to reestablish reproducing populations. Those that once occurred in this area have dwindled to such low densities that their continued survival is doubtful without some effort to replenish their numbers.

PL 54 NUMERICAL SIMULATION OF COMPETITION FOR FOOD RESOURCES BETWEEN UNIONIDS AND ZEBRA MUSSELS.

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A numerical model for simulation of freshwater mussel dynamics was developed and applied to assess the effect of food competition between unionids and zebra musssels in a section of Pool 16 in the Upper Mississippi River. Individual mussel growth was simulated with a bioenergetics model and the overall evolution of mussel populations was computed by adding up the

contributions from each individual. Inter-species competition was simulated by giving priority to zebra mussels over unionids for feeding. Grazing, reproduction and mortality rates for zebra mussels and the unionid Amblema plicata were estimated from the literature. Simulation results indicate that in competition with native mussels, zebra mussels up took most of the resources available, leaving just a small fraction of food for unionids. The invasion wave caused a sharp decline in the number and biomass of unionids. Estimated survival rates of unionids resemble empirically derived values reported for this species in Lake Pepin, Mississippi River. Simulated densities of zebra mussels coincided with reported values for Pool 16. After 45 years of simulation, some unionids survived under the new conditions. However, zebra mussels also influence unionids in ways other than food competition and these other effects may also contribute to the decline in native mussels.

PL 55 THE EFFECTS OF PREDATION AND SEDIMENT DEPTH ON DREISSENIDS AND UNIONIDS IN A GREAT LAKE COASTAL WETLAND.

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Abundant unionid populations have been found in some Great Lake coastal wetlands, but the reasons why they are not being killed by attachment of dreissenids are not well understood. We tested effects of predators and unionid burrowing on attachment by dreissenids in a Lake Erie coastal wetland. We used wire mesh exclosures with 2 mesh sizes and sampled dressenids after 15 months. Small mesh exclosures (1.3 X 1.3 cm) had higher numbers of dreissenids than large mesh exclosures (5 X 10 cm) or open controls. We also held live Leptodea fragilis, Quadrula quadrula and dead Pyganodon grandis shells in exclosures (2.5 X 2.5 cm mesh size) with either 5, 10, or 20 cm deep sediments for 2 months. There were fewer dreissenids on L. fragilis than P. grandis shells, but there was no difference between Q. quadrula than P. grandis shells. Numbers of dreissenids on unionids were higher inside than outside the exclosures, and numbers were higher in the 20 cm deep sediments than in the 5 cm deep sediments. We also counted dreissenids colonizing PVC plates in small-mesh exclosures (2.5 X 2.5 cm), large-mesh exclosures (5 X 10 cm), and small-mesh exclosures that had 40 X 40 cm openings to allow access by fish predators. Small mesh exclosures had the highest number of dreissenids on plates, and open exclosures had the fewest number of dreissenids on plates. Our data suggest that burrowing by unionids may be less important than feeding by fish in limiting the numbers of dreissenids on unionids in coastal wetlands.

PLATFORM SESSION 6B

PATHOGENS & EXOTIC SPECIES

PL 56 SAFETY OF FISH THERAPEUTANTS TO MUSSEL GLOCHIDIA ATTACHED TO FISH GILLS.

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Freshwater mussels have dramatically declined in the U. S. and numerous species are classified as threatened or endangered. The freshwater mussel's life cycle includes a larval or glochidia stage in which the glochidia attach to the gills or fins of a fish host for up to several months. Fisheries managers and scientists have developed propagation techniques to duplicate the natural glochidial infestation of fish. However, various fish diseases may threaten the survival of these fish and their glochidia. Chemical treatments may be required to control the causative fish pathogens. However, chemical treatment may be toxic to the glochidia or result in the premature detachment of the glochidia. We evaluated the safety of three common aquaculture therapeutants (formalin, Cutrine(r), and chloramine-t) to mussel glochidia during encystment on largemouth bass Micropterus salmoides by comparing the number of glochidia that transform into juvenile mussels in an untreated control group versus chemically treated test groups. Bass were infested with glochidia from the pocket book mussel Lampsilis cardium seven days before the first treatment. Aquaria were siphoned each weekday to determine the number of sloughed glochidia or transformed juveniles. The initial number of glochidia on fish was estimated to be the sum of the number of sloughed glochidia and juveniles in each aquarium. The mean percent of sloughed glochidia varied by less than 2 % between the untreated and treated test groups. In a mussel propagation program, therapeutic treatment of diseased fish with formalin, Cutrine(r), and chloramine-t at the treatment regimens we evaluated may be a viable option to enhance glochidia survival to the juvenile life stage.

PL 57 TREMATODE INFESTATIONS IN FRESHWATER MUSSELS OF THE UPPER NORTH FORK HOLSTON RIVER.

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To determine the possible association between incidence of trematode infestation and mussel mortality at selected river sites in the North Fork Holston River (NFHR), Virginia, specimens of slabside pearlymussels (Lexingtonia dolabelloides), Tennessee clubshells (Pleurobema oviforme), rainbow mussels (Villosa iris), and mountain creekshells (V. vanuxemensis) were collected from upper NFHR locations and histologically sectioned and examined. For comparison, trematode infestation rates were determined for specimens of paper pondshells (Utterbackia imbecillis), muckets (Actinonaias ligamentina), purple wartybacks (Cyclonaias tuberculata), and threeridges (Amblema plicata) collected from the Middle Fork Holston River (MFHR) and Clinch River (CR) Virginia, as well as from Halleyville City Lake, Alabama, and the New River (NR), West Virginia. Infestation rates in mussels at the NFHR sites ranged from 0% to 100%. Although no infestations were documented in mussels of the MFHR, those of the CR and NR showed rates between 3% and 55%. Predominately male mussels were infested, with rates as high as 85%. Based on initial DNA sequencing, cercaria were tentatively classified as an undescribed species of digenean trematode of the family Gorgoderidae. Metacercaria were observed in infested mussels, and cercaria exited mussels enveloped in previously undescribed cercarial pouches. The infestation data support the hypothesis that reported mussel die-offs in the upper NFHR in recent years may be associated with trematode infestations. Classification of this trematode to species, and further study of its life-cycle are ongoing

PL 58 STUDIES ON THE BACTERIAL FLORA OF MUSSELS: NORMAL FLORA FROM MUSSELS OF THE CLINCH AND HOLSTON RIVERS, VA AND DEPURATION OF THE FISH PATHOGEN *AEROMONAS SALMONICIDA*.

Clifford Starliper1, Richard Neves2, Patricia Barbash3, Patricia Morrison4, John Coll3, and Dean Rhine4. 1USGS National Fish Health Research Laboratory, Kearneysville, WV 25430; 2USGS Virginia Cooperative Fish and Wildlife Research Unit, Blacksburg, VA 24061; 3USFWS Lamar Fish Health Center, Lamar, PA 16848; 4USFWS Ohio River Islands National Wildlife Refuge, Parkersburg, WV 26102.

We report on two separate studies designed to further understand the nature of the bacterial flora of mussels. The objective with our ongoing effort on this research is to provide information to control pathogen and disease spread. Mussel dieoffs have been observed in the Holston and Clinch Rivers, perhaps with associated predisposing factors (e.g. gravidity, seasonality, host specificity) contributing to mortality; this scenario could indicate an etiological agent as a cause. Several mussel species were affected, with signs including weakened adductor muscles. In an effort to identify possible bacterial pathogens, the normal bacterial flora from healthy mussels from the aforementioned rivers was examined. Ideally, this will allow for comparisons with bacteria from diseased mussels. Fluids and soft tissues were assayed by inoculation onto bacteriological media and resulting bacteria were enumerated and characterized. Total bacterial counts generally ranged between 3×104 and 4×106 cfu/mL (gram) with motile Aeromonas spp., nonfermenting spp. and Enteric bacteria most frequently isolated. Ultimately, mussel pathogens may be screened for during health inspections and strategies to prevent their spread may be implemented. A model was employed to transmit Aeromonas salmonicida, a fish pathogen, to mussels and then determine the duration for animals to depurate it. Two mussel species, two temperatures and algae-fed vs. non-fed were evaluated. Results showed that a 30-day quarantine is sufficient to prevent the pathogens transmission to fish.

PL 59 HELMINTH PARASITES OF FRESHWATER MUSSELS FROM MANITOBA, NORTH DAKOTA AND SASKATCHEWAN.

Joe Carney. Dept. of Zoology, Brandon University, Brandon, Manitoba Canada R7A 6A9.

Freshwater mussels serve as host for a variety of metazoan parasites. This parasite fauna is reasonably well documented in mussels from the continental U.S.A., particularly from within the Mississippi-Ohio and Great Lakes drainages. There are no data concerning the parasites of mussels from systems north of these drainages. The objective of this study was to characterize the parasite fauna of freshwater mussels from the Lake Winnipeg drainage in Manitoba, North Dakota and Saskatchewan. A total of 1006 mussels representing 12 species was collected from 74 sites on 13 rivers that are part of the Lake Winnipeg drainage. Mussels were necropsied for parasites, aged, sexed and reproductive status determined. Five putative helminth parasite species were recovered. Adult Aspidogaster conchicola parasitized 5 mussel species and had the most restricted geographic distribution. Adult Cotylogaster occidentalis parasitized 9 mussels species and was widely distributed. Metacercariae, a larval stage in Digenean life cycles, parasitized 6 species with Lampsilis cardium and Lampsilis siliquoidea having the highest prevalence. Two types of sporocyst, another larval stage in Digenean life cycles, were recovered. The first type parasitized 3 species but was distributed throughout Manitoba, North Dakota and

Saskatchewan. The second type parasitized 5 species and was also widely distributed. This sporocyst appeared to be responsible for parasitic sterilization of infected hosts with Pygandon grandis being particularly affected. Parasites may play a role in regulating some mussel populations and can also provide insights into ecological interactions that otherwise may not be obvious.

PL 60 IMPACT OF EXOTIC SPECIES ON TEXAS FRESHWATER MOLLUSKS.

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Like several other southern states, Texas has been the dubious recipient of far too many exotic fishes and shellfishes, with over 100 introduced taxa documented in local waters. Direct confirmation of impacts on native mollusks is typically lacking. However, in some instances, circumstantial evidence of such impacts ranges from troubling to undeniable. Waterhyacinth Eichhornia crassipes, hydrilla Hydrilla verticillata, and several other exotic macrophytes form dense growths that result in habitats unacceptable to unionds and other native mollusks. Often reservoir managers negatively impact mollusks in their efforts to use winter drawdowns and cold-kills to control these plants. In some power-plant reservoirs, densities of the African cichlid, blue tilapia Oreochromis aureus, have exceeded 2,240 kg/hectare. Although these fish often eliminate most macrophytes, digging behaviors modify reservoir bottoms to resemble cratered moonscapes. In at least one Texas reservoir, unionids seem not to have had successful recruitment since high tilapia densities first occurred. The exotic snails Marisa cornuarietis, Melanoides tuberculatus, and Tarebia granifera likely compete with native gastropods, but baseline data needed to demonstrate impact is largely lacking. South American plecostomid catfishes are now impacting algae-feeding minnows in some Texas waters and are likely harming native gastropods as well. Asian clam Corbicula fluminea occurs virtually statewide and reaches densities in excess of 2,000/m2, but with little indication of direct impacts on native unionids. Increasing availability and improved transport of exotic species suggests the extent of this threat is likely to expand rather than diminish in the years ahead.

Dinner Speaker Abstract

DS 1 NATURE AND THE ARTIFICIAL: A HISTORICAL VIEW OF MUSSEL PROPAGATION ON THE MISSISSIPPI RIVER.

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From 1908 through the 1930s, the U.S. Bureau of Fisheries supported mussel propagation on the Mississippi River. In hopes of saving the shirt-button industry, a cooperative effort of industry, scientists, and government created a significant social investment, the Fairport Biological Laboratory at Muscatine, Iowa. Historical photos, reports, and letters, gathered from far-flung archives and libraries, reveal a narrative of scientists and fishery professionals over forty years facing a changing environment and a declining resource. Three phases of scientific effort proceeded from natural history traditions toward a technologically-oriented effort to mass produce mussels. Scientists including Robert Coker utilized increasingly artificial methods for propagation, while suspecting that nature held secrets that they could not replicate. Ultimately, human-induced changes in habitat seemed to carry more power than scientific cures. Despite lobbying efforts during the first third of the century, states were very reluctant to enact river protection. Indeed, the problem was much larger than technique alone could address. Today we might seek inspiration in the tenacity of Max Ellis, who never gave up his efforts to restore mussel populations through sophisticated techniques. Environmental legislation of the 1970s meant improved tools for conservation and new partnerships between science and natural resource professionals.

PLATFORM SESSION 7A
Status & Distribution II

PL 61 PROTOCOLS FOR SAMPLING FRESHWATER MUSSELS IN WADABLE STREAMS.

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The Wisconsin Department of Natural Resources is developing a set of standardized sampling protocols for sampling freshwater mussels in wadable streams. Quantitative and qualitative sampling techniques were developed and tested to find a balance between field effort and the collection of meaningful biological data. Sampling efforts were designed to answer three primary mussel survey objectives: first, are mussels present; second, which species are present; and third, population density, age structure, and habitat relations. Quantitative mussel sampling was conducted using a systematic random sampling design within defined grid

areas, with sampling effort increasing with stream size. Sampling areas were 2.5 x 2.5 m for streams less than seven meters wide and 5.0 x 5.0 m for streams greater than seven meters wide. Within each grid area, 0.25 m2 quadrats were used to sample 30% of the substrate. Quadrats were excavated to a depth of approximately 5 cm to detect small or buried mussels. Qualitative sampling consisted of timed searches using mask and snorkel gear. Quantitative sampling with quadrats produced a better overall picture of mussel communities, and provided density, abundance, age structure, and mussel habitat associations. Quantitative sampling was more effective at finding juvenile and cryptic colored species. Sampling time to search grid areas increased with the amount of rocky substrate, vegetation and mussel densities. Timed searches were more effective at finding rare low-density species, but were biased toward larger individuals and species. Search distances for timed searches were strongly influenced by turbidity, amount of vegetation and mussel density.

PL 62 EXPANSIVE VS. CONCENTRATED QUANTITATIVE SAMPLING: SOME SPATIAL OBSERVATIONS FROM AN INTENSIVE MONITORING STUDY OF UNIONID COMMUNITIES IN INDIANA.

Zimmerman, G.F.1, C.S. Howard1, B. Fisher,2, and M. Ashton.1
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We monitored mussel beds at selected historical sites within the East Fork White (EFW, n=3), Tippecanoe (TIP, n=3), and Wabash (WAB, n=5) Rivers during 2003-2004 using a two-phased quantitative sampling method. During Phase I at each site, 20 regularly spaced, paired (side-by-side) quadrats (0.25m2 each) were excavated along each of 10 transects (=200 samples total). Transects extended bank-to-bank, and spacing was dependent on channel width (50 to 300m) and length of historical beds (0.5 to 1.5km long). Depth and substrate type were also recorded for each sample location. Mussel densities were mapped, and areas of highest mussel density or diversity were selected for Phase II (intensive) sampling. One hundred and twenty (120) quadrat samples were then collected within these areas along transects parallel to the channel. A total of 23, 35, and 27 species were found in the EFW, TIP, and WAB, respectively. In each case, 2-3 more species were collected in Phase I vs. Phase II sampling. Additionally, we detected the federally listed fanshell (Cyprogenia stegaria) in each river, as well as a previously undocumented reproducing population of the federal candidate rayed bean (Villosa fabalis). Our results indicate that large-scale quantitative methods can be comparable or more effective than sampling the "hot spots" of known beds and provide better spatial data in terms of site-specific unionid distribution.

PL 63 FACTORS INFLUENCING STATUS OF V*ENUSTACONCHA ELLIPSIFORMIS* (BIVALVIA: UNIONIDAE) IN MINNESOTA.

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The ellipse, Venustaconcha ellipsiformis (Bivalvia: Unionidae), was first recorded in Minnesota from the Straight River in 1987, but little was known about its distribution, status, or glochidia-host relationships. We surveyed over 1700 sites statewide, described mantle-flapping behavior, and identified suitable glochidia hosts from both laboratory and natural infestations. We found ellipse populations in five Mississippi River tributaries in southeast Minnesota: the Cannon, Cedar, Root, Upper Iowa, and Zumbro Rivers, though it was abundant only in select small to medium sized streams of the Cannon and Root River drainages. Brooding ellipse quickly flap a small mantle extension, often in response to passing shadows or jarring of the substrate, or their mantles may slowly undulate. The following fish species were identified as suitable hosts species for ellipse glochidia in the laboratory: brook sticklebacks (Culaea inconstans), logperch (Percina caprodes), mottled and slimy sculpins (Cottus bairdi and C. cognatus), and mud, rainbow, Iowa, fantail, Johnny, banded and blackside darters (Etheostoma asprigene, E. caeruleum, E. exile, E. flabbelare, E. nigrum, E. zonale, and P. maculata). Banded and rainbow darters from Deer Creek, and blackside and fantail darters from South Branch Middle Fork Zumbro River, were naturally infested with ellipse glochidia and facilitated their metamorphosis. The ellipse should remain classified as a "threatened" species in Minnesota due to its restricted range and localized abundance.

PL 64 CLASSIFICATION OF PENNSYLVANIA'S RIVERINE MUSSEL COMMUNITIES.

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Pennsylvania Natural Heritage Program biologists have recently completed a first draft of a statewide classification of riverine mollusk communities. The objective of this project was to identify riverine mussel communities and factors that may be influencing them. We believe this research can be used to drive more proactive efforts to highlight and protect entire mussel communities that may otherwise be overlooked in lieu of simply rare species. Mussel presence and abiotic data (adjacent land use, water chemistry, habitat quality and stream hydrology) for Pennsylvania streams were acquired through a number of sources. Cluster Analysis, Non-Metric Multidimensional Scaling, Indicator Species Analysis, Canonical Correspondence Analysis (CCA), and Classification and Regression Tree were used to classify communities of mussels, and examine relationships among community types and physical habitat characteristics. Results from eight large and distinct pilot watersheds indicate eight mussel community types. Four groups were specific to the Ohio River drainage, three specific to the Atlantic Drainage, and one (creeper community) had a small number of sites in both drainages. Generally, CCA did not show strong relationships between the occurrence of communities and physical habitat characteristics. However, some patterns were evident. The yellow lampmussel and creeper communities appeared to be weakly associated with increasing forest cover, and the Ohio lacustrine group showed a slight association with higher wetland coverage. There also appeared to be relationships between the occurrence of communities and water chemistry (alkalinity, dissolved oxygen, and pH), as well as stream characteristics (gradient and stream order). Here, the preliminary statewide classification results will be presented.

PL 65 DEVELOPMENT OF A FRESHWATER MUSSEL DATABASE.

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Long-term monitoring of Upper Mississippi River mussel populations is essential in evaluating environmental impacts and measuring success of re-introduction efforts of endangered species. The U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service collaborated on the development of a standardized database for storing mussel survey data. The key components of the database and its potential applications will be discussed. The adopted web-based approach offers several advantages over other standalone data management approaches. It provides increased data integrity, sophisticated relationships, database check in/out tools, and a simplified user interface. The standardized data structure will enhance data collaboration, reduce costs on customized query tools, streamline reporting functions, and facilitate system-wide project planning and resource modeling.

PLATFORM SESSION 7B

Status & Recovery

PL 66 CONVERGENCE AND THE UNIONIFORMES.

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A.J. Cain discussed the role of convergence of shell form in land snails. He cautioned about the under appreciated role of convergence. A.E. Ortmann, in discussing the definition of the subfamilies of Unionidae, noted that he was not using shell characters due to problems of convergence. B. Prashad more recently discussed the similarity of shell shapes from Southeast Asia and South America. G.T. Watters has provided information on the role of shell shape and sculpture and their role in providing stability in the aquatic environment. Shell shape, disc sculpture, hinge plate presence or absence, and relation to substrate are all features that have convergent elements between the six recognized unioniform families. Recent, preliminary phylogenies provide support for the recognition of convergence of the shell form and sculpture. Historically the freshwater mussel fauna of the Late Cretaceous of the Western Interior of North America is given as the ancestor for the great modern radiation of Unionidae in the southeastern United States. Similarity of shell shape and sculpture has been used to link the Cretaceous unioniform fauna of Africa with that of modern Asia, as well as linking fossils from the Cretaceous of Montana with the modern fauna of West Africa. More interesting, the Triassic species with radial umbo sculpture from Connecticut have been linked with those species with similar sculpture of the Late Cretaceous of the western United States as the precursors of the whole hyriid fauna of South America. We use the concept of convergence in the World's modern unioniform fauna to examine the fossil record of this group and question the interpretations of these faunas based on shell shape and sculpture similarities.

PL 67 THE MIGHTY HOLSTON: A DECIMATED FAUNA REINVIGORATED?

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The Holston River is a major tributary of upper Tennessee River that once supported one of the richest freshwater mussel faunas in the world (71 species). Seven major dams now impound or regulate most of the Holston system, including the entire length of the mainstem Holston River. The lower 52 miles of the Holston are unimpounded, but have suffered from a lack of minimium flows, low dissolved oxygen, cold hypolimnetic releases, and peaking hydropower regulation from Cherokee Dam (Tennessee Valley Authority). Surveys performed by TVA in 1981 found a sparse, relict fauna (13 species) in this reach 38 years after Cherokee Dam began operating. In the late 1980's and early 1990's, TVA began remediation of impacts from Cherokee Dam that improved dissolved oxygen levels and provided minimum flows. We surveyed portions of the lower Holston River in 2002 and found 18 unionid species represented by live specimens, including the federally endangered pink mucket, Lampsilis abrupta (Say, 1831) and the proposed federal candidate sheepnose, Plethobasus cyphyus (Rafinesque, 1820). Surprisingly, most individuals that were once eroded, senescent, living relicts showed evidence of recent shell growth. Thin sections of samples of these shells showed 12-21 growth arrests in the area of new growth. Evidence of gametogenesis and fertilization was found in some species. No juvenile mussels were found, but smaller, uneroded specimens (97-110mm) of three species were found. We review recent physical, fish, and macroinvertebrate data and discuss the potential for recovery of the mussel fauna in this reach of the Holston.

PL 68 PROGRESS IN FRESHWATER MUSSEL CULTIVATION AND RECOVERY AT VIRGINIA'S AQUATIC WILDLIFE CONSERVATION CENTER.

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The Virginia Department of Game and Inland Fisheries' Aquatic Wildlife Conservation Center was established in 1998 with the goal of recovering freshwater mussel populations in the Tennessee River drainage. Additional recent funding has allowed us to implement new operational designs and upgrades. Until last year, our operation used a 0.25 acre pond to increase water temperatures and algae production from our main water source, the South Fork Holston River. While this pond preformed adequately, we were able to acquire the use of a 5.0 acre pond that produced temperatures similar to those at good mussel sites on the Clinch River. The higher temperatures vastly improved juvenile mussel growth. The number of adult mussels species held at the facility has increased from 22 in 1998 to 35 today. The facility before 2004 used a series of raceways with one inlet, which had a limited ability to modify habitat conditions, prevent gamete exchange, and contain diseases. Presently, adult mussels are maintained in .93 m diameter round tanks (.60 m2) each with a separate water source. Using this system, we have held over 350 adults with 95% survival and produced viable glochidia from 11 species. We have also incorporated a flow-through propagation system. The system uses multiple filtration devices to sterilize and a heater to warm water during juvenile production. We will continue to improve our systems to meet Virginia's mussel restoration needs.

PL 69 FRESHWATER MOLLUSK PROPAGATION AND RECOVERY PROGRAMS OF THE TENNESSEE AQUARIUM RESEARCH INSTITUTE, AN UPDATE.

Paul D. Johnson1, Sabrina F. Novak1, Paul Hartfield 2 Jeffrey T. Garner3, Steven A. Ahlstedt1, and Jeffrey D. Sides1, 1Tennessee Aquarium Research Institute, 5385 Red Clay Road, Cohutta, GA 30710. 2USFWS, Jackson Field Office, 6578 Dogwood View Parkway, Jackson, MS 39213. 3Alabama Department of Conservation and Natural Resources, Freshwater Fisheries Division, 350 CR, Florence, AL 35633.

Freshwater mollusk recovery efforts of the Tennessee Aquarium Research Institute (TNARI) are primarily focused on species endemic to the Mobile River Basin. Planning efforts have targeted recovery programs for some 30 different species of snails and mussels across the basin. Since 2000, mussel recovery efforts have propagated and released over 80,000 mussels of 13 species, 6 listed as endangered or threatened by the U.S. Fish and Wildlife Service. Mussel releases have been completed in Tennessee, Georgia, and Alabama. The mussel program has also identified host fishes for numerous species of mussels including Pleurobema georgianum, Lampsilis virescens and Lasmigona sp. cf. holstonia. Artificial propagation methods for over 12 species freshwater gastropods (Pleuroceridae, Viviparidae, & Hydrobiidae) have also been developed. To date, TNARI gastropod restoration efforts have focused on Mobile River basin Leptoxis spp. with over 35,000 cultured snails of 2 federally listed species (L. foremani and L. plicata), released since 2003. Propagation techniques have also been developed for the federally endangered flat pebblesnail (Lyperium showalteri: Hydrobiidae) and the cylinder campeloma

(Campeloma regulare). In an additional gastropod restoration project, TNARI has also produced and released over 7,000 spiny riversnails (Io fluvialis) into the Tennessee River, as a model for large river restoration efforts. Development of mollusk culture techniques, and specific restoration policy and plans of Mobile River basin species will be discussed.

PL 70 AN OVERVIEW OF THE COLUMBUS ZOO AND AQUARIUM FRESHWATER MUSSEL PROPAGATION AND RESEARCH FACILTY.

G. Thomas Watters1, Doug Warmolts2, Mike Brittsan2, Trisha Menker1, Eric Norrocky2, and Kody Kuehnl3. 1Museum of Biological Diversity, 3Aquatic Ecology Lab, Department of Evolution, Ecology, and Organismal Biology, The Ohio State University, 1315 Kinnear Road, Columbus, OH 43212. 2Columbus Zoo and Aquarium, PO Box 400, Powell, OH 43065, USA.

In 2002 the Columbus Zoo and Aquarium began lease on a 32-acre riverfront property for the purpose of establishing a facility dedicated to research and eventual propagation of freshwater mussels. The goals are to create a facility that will meet four needs. 1) Establish brood stock. To date the facility has 1,000 individuals of 49 species. These individuals are maintained in a system that uses a combination of flow-through and recirculating river water. Newly introduced mussels are kept in a separate self-contained quarantine system before introduction to mussel holding tanks. 2) Conduct basic research on captive mussels, including host identification and phylogenetic analyses. Host identifications are conducted in four AHAB units - modular, temperature-controlled, self-contained aquaria systems using treated residential water. Test fish are quarantined and treated for disease, if necessary, before introduction to the AHABs. 3) Culture and propagation of newly transformed mussels for eventual introduction to the wild. Juveniles are maintained in AHAB tanks and daily cleaned and fed a combination of silt and cultured algae. 4) Offer temporary refugia to mussels removed from situations where there have been environmental disasters. Current upgrades include temperature controls for incoming river water, a supplemental algal dosing system for mussel tanks, and educational links to the Zoo.

PLATFORM SESSION 8A

Status & Distribution III

PL 71 PRELIMINARY FINDINGS OF A COMPREHENSIVE QUALITATIVE SURVEY OF UNIONID MUSSELS IN THE LOWER PEE-DEE RIVER BASIN, SOUTH CAROLINA.

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The Pee Dee River Basin is a major drainage of the Atlantic slope in the southeastern United States. The 10,755 sq mile drainage area incorporates portions of Virginia, North Carolina and South Carolina. 3,425 sq. miles occurs within the lower piedmont and coastal plain in the northeastern portion of South Carolina, making it the second-largest river basin in the state. With the exception of the main stem of the Pee Dee, the major tributaries to the lower basin are generally free-flowing with extensive forested buffers that are relatively free of urban development. Knowledge of the mussel fauna in the lower portion of the basin has been limited to scattered locales, largely in smaller tributaries, and shallow water habitats. Very little information existed for the deep water habitats throughout the basin. In an attempt to update and fill in major gaps in the knowledge of the mussel fauna in this basin The Catena Group in conjunction with Nature Conservancy and International Paper conducted a qualitative assessment of the Unionid fauna in the lower Pee Dee River and its major tributaries; The Black, Lynches, Pocotaligo, Little Pee Dee, and Waccamaw Rivers, in South Carolina. Surveys were conducted at 45 sites throughout the basin. All habitat types at each survey station were evaluated. SCUBA was used to sample the deepwater habitats. At least 19 species were located during surveys in the summer-fall 2004, and spring 2005. These surveys document extensions of the known ranges of Elliptio roanokensis, E. waccamawensis, Lampsilis cariosa, L. splendida, Leptodea ochracea, Ligumia nasuta, Strophitus undulatus, and Villosa vibex. Consistent habitat partitioning by species, as well as various forms within the Elliptio complanata complex was noted throughout the survey area.

PL 72 HISTORICAL AND CURRENT EXAMINATION OF FRESHWATER MUSSELS OF THE DUCK RIVER BASIN TENNESSEE.

Stephen A. Ahlstedt1, Jeffrey R. Powell2, Robert S. Butler3, Mark T. Fagg4, Don W. Hubbs5, Sabrina F. Novak6, Sally R. Palmer7, and Paul D. Johnson6 1 USGS, 1820 Midpark Drive, Knoxville, TN 37921, 2 USFWS, P.O. Drawer 1190, Daphne, AL 36526, 3 United States Fish and Wildlife Service, 160 Zillicoa Avenue, Street, Asheville, NC 28801, 4 TWRA, 3030 Wildlife Way, Morristown, TN 37814, 5

TWRA, Fisheries Management, P.O. 40747, Nashville, TN 37204, 6 TNARI, 5385 Red Clay Road, Cohutta, GA 30710, 7 TNC, Duck River Project, 106A Riverside Drive, Columbia, TN 38401.

The Duck River is a 442 km long system with a large reservoir, TVA's Normandy Dam, placed at river km 420 controlling some 95% of the rivers length. This inventory examined 112 sites throughout the basin. The Duck River historically contained 75 species and 53 remain extant, including 3 federally listed and 3 candidate species. Mussel abundance measured as CPUE or direct quadrat sampling indicates significant increases in 2002 from 1979 & 1988. Species richness tripled and abundance increased 11 fold at 17 sites examined in both in1988 and 2002. Species richness increased down-river, although the highest diversity sites were associated directly with mill dams. Mussel recovery is partially attributable to point source elimination, and land acquisition for the now defunct TVA, Columbia Dam Project. However, improvements in dissolved oxygen concentrations and flow release schedules from Normandy Dam initiated by TVA's - Reservoir Release Improvements (RRI) program in 1991 are likely the most critical development in mussel recovery. From 1991 - 2001 mean annual discharges improved 23 and 15% during critical spring and summer recruitment periods in comparison to discharge 10 years previous. Increased channel volume during critical recruitment periods improves conditions on channel margins where recruitment appears to be concentrated.

PL 73 SURVEY FOR THE THREATENED PURPLE BANKCLIMBER (*ELLIPTOIDEUS SLOATIANUS*) IN THE MIDDLE REACH OF THE FLINT RIVER, GEORGIA.

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A baseline mussel survey was conducted in the Flint River, between Lake Blackshear (Warwick Dam) and Lake Worth in support of the relicensing efforts for Warwick Dam. The federal and Georgia state-threatened mussel species, purple bankclimber (Elliptoideus sloatianus) was known to occur downstream of Lake Blackshear based on a limited survey conducted in the early 1990's but more recent and detailed information was needed. A qualitative mussel survey was conducted in September 2003 at five locations downstream of Warwick Dam. Surveys were conducted under conditions of low river flows and good water clarity. All available habitat types were searched at each location using SCUBA or snorkel until no new species were encountered. All mussels collected were identified, counted, and returned to the same habitat they were collected from. Listed species were measured for length (nearest mm). A total of 504 live mussels, consisting of at least nine species were collected. The purple bankclimber was the most abundant species and was collected at all sites except just below the dam. While the purple bankclimber (as well as all species combined) was collected from all habitat types, pools were the least productive and backwaters were the most productive. River substrate was wetted essentially from bank to bank under low flow conditions of 560 to 800 cfs. Mussel distribution appeared to be limited in high velocity areas. Recruitment of purple bankclimbers appears to be occurring at a low rate based on the few specimens collected that were less than 90 mm. Length frequency data also indicated a curious progressive downstream trend for smaller median and maximum length per site.

PL 74 THE FRESHWATER GASTROPODS OF IOWA (1821-1998): SPECIES COMPOSITION, GEOGRAPHIC DISTRIBUTIONS, AND CONSERVATION CONCERNS.

Timothy W. Stewart, Department of Natural Resource Ecology and Management, Iowa State University, Ames, Iowa 50011.

I used survey data from museums and peer-reviewed literature to summarize knowledge of the taxonomic composition and geographic distributions of freshwater gastropods in the state of Iowa, U.S.A. Excluding records likely based on erroneous reports, 49 freshwater gastropod taxa (i.e., 47 species and 2 genera with an unknown number of species) inhabited Iowa during all or part of the period when records were collected (1821-1998). Representative families include Valvatidae (4 species), Viviparidae (6 species), Hydrobiidae (6 species), Pomatiopsidae (2 species), Pleuroceridae (2 species), Lymnaeidae (10 species), Physidae (3 species), Planorbidae (11 species), and Ancylidae (5 species). Historically, Iowa's freshwater gastropod diversity compares favorably to states of similar geographic area. However, I found no recent Iowa records (within the last 50 years) for 18 species, and an additional 7 species appeared to be much less widespread at the end of the 20th century than formerly. Absence of modern records for some of these 25 taxa of conservation concern might result from taxonomic confusion and reduced attention directed toward snails in recent years. However, surveys of the Lake Okoboji region from 1915-1960 documented dramatic gastropod population declines and local extinctions following pollution events and habitat loss. Because similar environmental changes occurred throughout Iowa in the early and middle 20th century, freshwater gastropod diversity and abundance probably declined statewide during that

time. By comparing data summarized in this review with future field survey data, evidence of restricted or shrinking geographic ranges can be provided, and the true conservation status of Iowa gastropods will be determined. This information is of critical importance in establishing legal protection and recovery action plans for endangered species.

PL 75 PRELIMINARY ANALYSIS OF THE STATUS OF AQUATIC SNAILS IN WEST VIRGINIA.

Ralph W. Taylor. Department of Integrated Science and technology, Marshall University, 1 John Marshall Way, Huntington WV 25755

Little is known of the status of aquatic snails in West Virginia. There are good reasons for this as until recent years inaccessibility, as a result of our mountainous terrain, made studies of this nature difficult. Additionally there was no one in the area who was interested in studying snails. A few years back I began to look at this interesting group of animals and found that even basic information on distribution patterns of aquatic snails in West Virginia was almost totally lacking. The biggest surprise I found was the paucity of literature on snails inhabiting the upper Ohio River upstream of Cincinnati, OH. Along most of its northern boundary WV claims the Ohio River so I have included what I could find concerning upper Ohio River snails in my comments. Along with the Ohio, I have specimens from the Potomac, Guyandotte, Kanawha, Big Sandy, Elk, New and Bluestone rivers and their tributaries. Information for my presentation comes from the Marshall University Malacological Collections, and collected material from ORSANCO and the West Virginia Department of Environmental Protection. Several new state distributional records will be presented.

PLATFORM SESSION 8B

Propagation & Reproduction II

PL 76 IMMUNE RESPONSE OF LARGEMOUTH BASS TO THE FATMUCKET OVER REPETITIVE INFESTATIONS AND OVERWINTERING.

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Acquired immunity may develop in response to repetitive infestations under laboratory conditions. This study addressed three questions: do largemouth bass develop an acquired immunity to fatmucket glochidia; does host age play a part in the ability of the glochidium to successfully parasitize its host; and, is acquired immunity decreased or lost over winter. Largemouth bass were exposed every 39 days until acquired immunity was demonstrated. Both age-1 and 3 bass developed an immunity to glochidia after three to five repetitive infestations; age was not significant in acquiring immunity. Groups of over-wintered, non-wintered, and previously unexposed fish were then reinfested at 1 to 4 months post-immunity. Both over-wintered and non-wintered age-1 bass exhibited decreasing immunological memory with increasing winter duration. Over-wintered bass of both age classes lost immunity faster than non-wintered hosts. This study showed that largemouth bass could develop an acquired immunity after multiple infestations. This immunity could be decreased or lost during simulated over-wintering conditions faster than in non-wintered fish.

PL 77 AN EVALUATION OF ADULT FRESHWATER MUSSELS HELD IN CAPTIVITY AT THE WHITE SULPHUR SPRINGS NATIONAL FISH HATCHERY.

Julie L. Devers1, Richard J. Neves2. 1U.S. Fish and Wildlife Service, White Sulphur Springs National Fish Hatchery, 400 E. Main St., White Sulphur Springs, WV 24986; 2Virginia Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife Sciences, Virginia Tech University, Blacksburg, VA 24061.

In order to determine the feasibility of holding adult freshwater mussels in long-term captivity at the White Sulphur Springs National Fish Hatchery, White Sulphur Springs, WV, we relocated three mussel species in the summer of 2001 and 10 mussel species in the summer of 2002 to the hatchery. We evaluated survival, energy reserves, and gametogenesis of captive mussels in a recirculating pond system. Annual survival rates of 10 species were estimated for one year. Glycogen, protein, and lipid concentrations in mantle tissue of three captive species (Actinonaias ligamentina, Cyclonaias tuberculata, and Tritogonia verrucosa) were compared to those of wild mussels in the New River. Gametogenic activity and synchrony in A. ligamentina and C. tuberculata were compared between captive and wild mussels. The overall survival rate for 10 freshwater mussel species held in the raceway for one year was 77%. Villosa vanuxemensis had the highest survival rate (96%), and Lampsilis cardium had the lowest survival rate (31%). Although there were fluctuations in glycogen, protein, and lipid levels over 2 yr, there were no overall differences in energy substrates between captive and wild mussels at the end of the study and captivity did not appear to have a negative affect on gametogenesis. From these results, we conclude that captive holding conditions in the recirculating pond system at WSSNFH were adequate for long-term holding of a wide range of mussel taxa.

PL 78 THE EFFECT OF POSITION IN STACKED TRAYS ON CULTURED FRESHWATER MUSSELS IN AVIGLIANA LAKES (N-W ITALY).

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From May 2003 to September 2004, autochthonous adult freshwater bivalves, Anodonta anatina and Unio mancus (Unionidae), were reared in lake waters in the Natural Park of Avigliana Lakes (N-W Italy). An oyster culture technique, employing stacks of suspended trays was used. It is common knowledge that the success of rearing depends on environmental conditions and on the system of cultivation. Food supply and sedimentation on reared mussels of suspended particulates may affect survival rate in trays; in this study the effect of position of mussels in upper or lower trays was investigated. Rearing was aimed at bioremediation: A. anatina and U. mancus, which are not listed within threatened species, are two filter-feeders potentially suitable to reduce eutrophication in Avigliana lakes. Bivalves were cultured at two rearing densities (29 and 89 kg m-3) in metal cages of 0.6 m x 0.3 m x 0.7 m; each cage contained 4-5 rigid open-topped stacked plastic trays, with a size of mesh of 0.5 cm x 2 cm. Survival rates in trays were studied for 5 months, from May to September 2004, when bivalves seemed to be more sensitive to seasonal conditions, as suggested by preliminary studies. Statistical analysis were performed using one way ANOVA. Results showed that, for both the densities and the species, there were not significant differences in survival rate in trays in all the experimental cages. This suggests that a good exchange of water through the trays is ensured and that the culture method is suitable to maintain A. anatina and U. mancus in good conditions.

PL 79 UTILITY OF GENETIC MARKERS AS AN AID TO PROPAGATION OF IMPERILED FRESHWATER MUSSELS.

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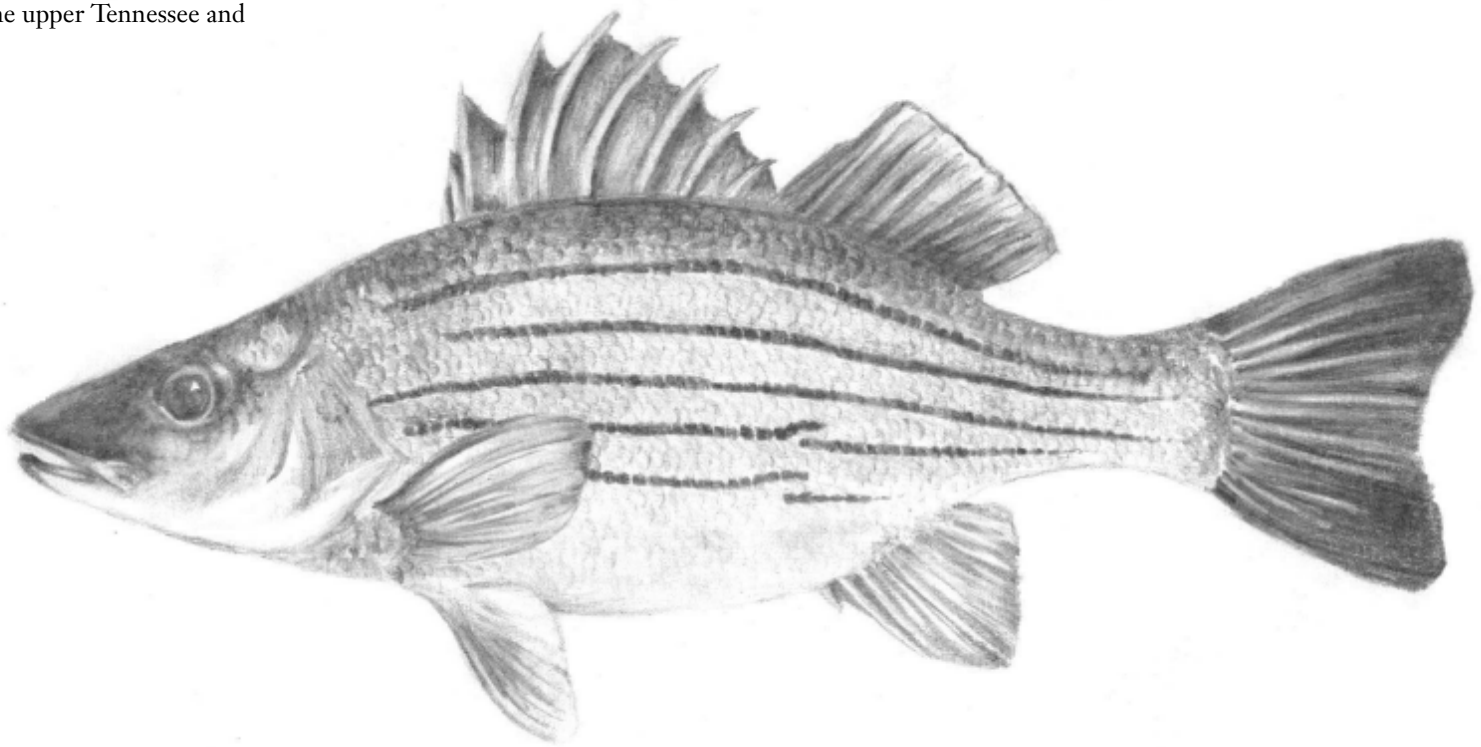
Captive propagation is a component of recovery plans for many imperiled freshwater mussels. We consider how screening of genetic markers can contribute to effective propagation and out-planting of imperiled mussels. Characterization of genetic variation among populations is central for identification of the unit subject to intervention; i.e., of species, subspecies, evolutionarily significant unit (ESU) or management unit (MU). Focus then turns to observing variation within the unit of interest. For setting propagation goals and collection of broodstock, genetic markers are useful for determining whether all broodstock candidates are of the species desired, how many spawners are needed, and whether the broodstock is representative of the wild stock; i.e., are all common life history morphs, nuclear alleles and mitochondrial haplotypes represented? When planning propagation, genetic markers are useful for assessing baseline diversity. Multi-locus genotypes can be used to observe percentage of shared alleles among individuals, in order to cross distinct individuals and avoid inbreeding and random genetic drift. After propagation, markers can be used to infer parentage, to determine how many spawners contributed to the new year-class. Knowing the sex ratio and family size for each spawner, managers can compare Ne. to the target for propagation; if smaller, the manager can equalize family size in the current year-class or add more spawners to the next propagation event. After stocking, incorporation of genetic screening into monitoring may help determine whether there was recruitment of out-planted juveniles.

PL 80 A MOLECULAR PHYLOGENETIC REASSESSMENT OF THE FRESHWATER SNAILS OF THE GENUS *PLEUROCERA* (GASTROPODA: PLEUROCERIDAE) OF THE MOBILE RIVER BASIN,.

Jeffrey D. Sides1 and Charles Lydeard2. 1Tennessee Aquarium Research Institute, 5385 Red Clay Road, Cohutta, GA 30710; 2University of Alabama, Department of Biological Sciences, Box 870345, Tuscaloosa, AL 35487.

In order to reassess the systematics of the five currently recognized species of the freshwater snail genus Pleurocera in the Mobile River basin, a molecular phylogenetic analysis was conducted using a portion of the cytochrome oxidase subunit I (COI) mitochondrial gene. The Mobile River basin Pleurocera were recovered as a non-monophyletic group. There is no evidence for a basin-wide Pleurocera 'vestita', as currently recognized. Instead, the species boundaries are correlated to the sub-basin(s) of the Mobile River basin where they are located. Pleurocera annulifera is comprised of the Pleurocera occurring in the Tombigbee and Black Warrior drainages. Pleurocera prasinata is contained within the Coosa and Alabama drainages. The Pleurocera of the Cahaba River drainage will be recognized as Pleurocera univittata following the synonymy of P. vestita with P. annulifera. Pleurocera univittata resembles Cahaba Pleurocera conchologically and has its type locality in the Cahaba River, but was formerly a synonym of P. prasinata. The status of P. showalteri remains uncertain given the inability to locate specimens resembling the historical description. The COI

phylogeny recovers P. foremani outside of the Mobile River basin Pleurocera clade, grouped with Elimia bullula, a sympatric species in Yellowleaf Creek in the Coosa River drainage. Based on the molecular data, P. foremani should be recognized as Elimia foremani. The phylogenetic examination of Mobile River basin Pleurocera and Pleurocera from adjacent drainages has revealed support for some controversial hypotheses concerning drainage evolution in the southeastern U.S., including the existence of the ancient Appalachian River connecting the upper Tennessee and Coosa Rivers.



White Bass Host Fish —Kerissa Nelson

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ACKNOWLEDGEMENTS

We would like to take this opportunity to acknowledge the contributions of the Symposium Committee, particularly the efforts of the following individuals:

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Kurt Welke

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Susan Oetker
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