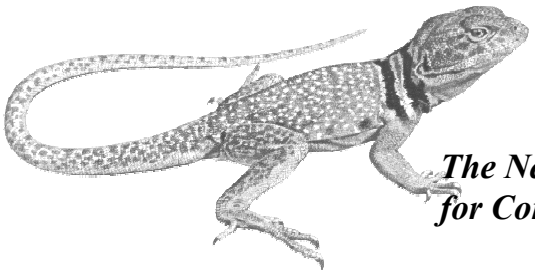

The Glade

The Newsletter of the Missouri Chapter of the Society for Conservation Biology

Volume 5, Number 2 **August 2002**

Contents

The Corner

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"Human activity is such a pervasive influence on the planet's ecological framework that it is no longer possible to separate people and nature." This statement came from a science section of the New York Times published in anticipation of the World Summit on Sustainable Development in Johannesburg.[1] Setting aside the question of whether it ever was possible to separate people and nature, the articles in this section provided an interesting big-picture view of global environmental trends and the factors driving the loss of biological diversity. I was struck again by how the people responsible for inflicting the most damage to the environment seem largely unconcerned about the consequences of a collapse of ecological systems for themselves and future generations. (The section provided, for example, a host of statistics on the disproportionate consumption and generation of waste by U.S. citizens relative to those of other countries.) Unfortunately, the words of conservation biologists will likely fall on deaf ears unless we find ways to insert measures of environmental quality, including the conservation of biological diversity, into our mainstream definition of quality of life.

The New York Times article went on to say that "global warming and species extinction are examples of potential catastrophes that are hiding in plain sight." As with most examples of environmental degradation, the loss of biological diversity is driven partly by a problem of scale. The erosion of biological diversity occurs incrementally, population by population, and is often driven by remote processes. Our ability to

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Fire Effects on the Genetic Diversity of Clonal Plant Species: A Hypothesis

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Fire is a natural component of many ecosystems throughout the world. It is an important factor in creating environmental heterogeneity as it changes the microclimate, nutrient availability, and water relations in the system (Christensen 1985). These changes appear to be important in maintaining community structure and function, and likely play a role in the evolution of plant form and life history characteristics (Vogel 1974, Abrams et al. 1986, Christensen 1985).

After years of fire suppression policy in the management of lands, we are now using fire as a management tool. Restoration and habitat management efforts seek to create and maintain ecological systems that are similar to, and act the same as reference systems (Jordan et al. 1987). The success of these conservation efforts are often assessed by comparing species presence or abundance as well as species diversity of the managed habitat to a reference system.

Prescribed fires may also be used to manage populations of rare plants (i.e., Bowles et al. 1990) as many plants indigenous to fire-prone ecosystems have adaptations that enable them to survive and regenerate after fires. The effects of fire on demography vary among species. Some species respond positively to fire with increases in such variables as vegetative growth, flowering and/or germination. Other species respond less favorably to fire and may show increased mortality.

Vegetative and sexual reproductive strategies are used by plant species to vegetate an area after fire. The combination of strategies used by the species to vegetate an area is likely to have a profound effect on the genetic diversity of the population. For example, if fire increases the number of sprouts and causes no change in seedling recruitment then the species will likely have no change in or lower genetic diversity within a population. On the other extreme, if the species does not increase the number of clonal sprouts but favors seedling recruitment, then the species will likely have greater genetic diversity within a population. Currently there is little or no data on the effect of fire intensity or frequency on the population genetic diversity of fire adapted species.

Information does indicate that as fire frequency increases resprouting becomes more favorable than germination as a mechanism for vegetating the open habitat (Bond and Midgley 2001). The ability to resprout quickly after a fire from fire-resistant structures, such as rhizomes, may give these species a head start on intra- and interspecific competitors.

Numerous studies are reporting that some clonal plant populations have high levels of genetic diversity within a population (i.e, Ellstrand and Roose 1987; Bayer 1990; Cheliak and Dancik 1982; Yeh et al. 1995; Alpert et al. 1993). Genetic diversity in clonal populations can be affected by both the extent and timing of sexual reproduction. Populations of many clonal species are founded from seeds, but show increasing vegetative reproduction over time (Eriksson 1993). Such populations can be genetically diverse by maintaining genetic diversity of the initial population through clonal growth of the founder population even in the absence of novel genotype recruitment (Yeh et al. 1995). Repeated seedling recruitment or somatic mutations could add genetic diversity.

To effectively use fire as part of a plan to manage populations that reproduce primarily through vegetative reproduction, we must understand how fire affects seedling recruitment and demography of genets. We need to address such questions as: What factors increase seedling recruitment ? Are fire intensity or frequency important factors in seedling recruitment? What are the effects of fire intensity

and frequency on survival of genets (genetically unique individuals)? Are some genets more aggressive in regrowth than others? The answers to such questions are important in maintaining or increasing genetic diversity within the population. Ideally management plans should allow windows of opportunity for seedling recruitment without significant loss of genets or change in the size of genets. Comparison of the managed system to reference systems would ensure positive effects of fire on clonal plant population genetic diversity, both in terms of the number of genets and size of genets.

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"After the leaves have fallen, we return
To a plain sense of things. It is as if
We had come to an end of the imagination,
Inanimate in an inert savior."

--Wallace Stevens, The Plain Sense of Things

Meet Your New MOSCB Executive Board

The election of of the 2002-3003 Executive Board has now concluded. Since only one person volunteered to serve in each position, the casting of ballots was cancelled. The board members for the next year are:

President: Betsie Rothermel

Betsie Rothermel is a Ph.D. candidate at the University of Missouri-Columbia. She is investigating how habitat fragmentation and landscape composition influence the dispersal success of juvenile salamanders and toads in forest and agricultural lands in mid-Missouri. Previously, Betsie worked in the conservation field in Georgia for five years. While in Georgia, she held positions with the Georgia Wildlife Federation, The Nature Conservancy of Georgia, and Georgia State Parks. She also studied Allegheny woodrats, a threatened species in Pennsylvania, while at Penn State University (M.S., 1994). Before pursuing graduate studies, she worked for an environmental consulting firm in Maryland that specialized in ecological monitoring of aquatic ecosystems.

Past President: Kim McCue

Kim McCue is currently a Conservation Biologist for the Missouri Botanical Garden, a position she took in 1997 after completing her Ph.D. at the University of Missouri-Columbia. Her graduate research focused on the population genetics of rare plants. Her current work, which is done in association with the Center for Plant Conservation, involves the conservation of rare plants native to the Midwest region. In addition to her interests in rare plant biology and conservation, Kim is active in conservation education for students and members of the general public.

Vice President: Stacy James

Stacy James is a Ph.D. candidate in the Division of Biological Sciences and Conservation Biology Program at the University of Missouri-Columbia. She is interested in the impacts of contaminants on amphibian populations and the role of contaminants in the global decline of amphibians. Her dissertation research is focusing on the effects of cadmium on larval and juvenile American toads. She also volunteers for the Show-Me Clean Streams program and Columbia's Community Storm Water Project.

Treasurer: Chrissy Howell

Chrissy Howell is a NSF Bioinformatics Post-Doctoral Fellow at the University of Missouri-Saint Louis and a research associate at Missouri Botanical Garden. She earned a Ph.D. at the University of Missouri, Columbia. Her research interests include spatial ecology, avian life history evolution, and conservation applications of GIS. Her current projects are aimed at modeling spatial distributions of rare South African plants, Atlantic Forests Brazilian birds, and centers of Ecuadorian biodiversity.

Secretary: Emily Coffey

Emily Coffey received a B.S. in Biology and Chemistry as well as a Certificate of Conservation from the University of Missouri-St. Louis. She previously was employed and now volunteers at the Shaw Nature Reserve in Gray Summit, MO as an Environmental Educator. She has also studied rare and endangered plants in the midwest.

Conservation Chair: Michelle Boone

Michelle Boone is a post-doc with the USGS Columbia Environmental Research Center studying the effects of contaminants and invasive species on native amphibian communities. She has served as editor of *The Glade* since 1999.

Web Master: Neal Sullivan

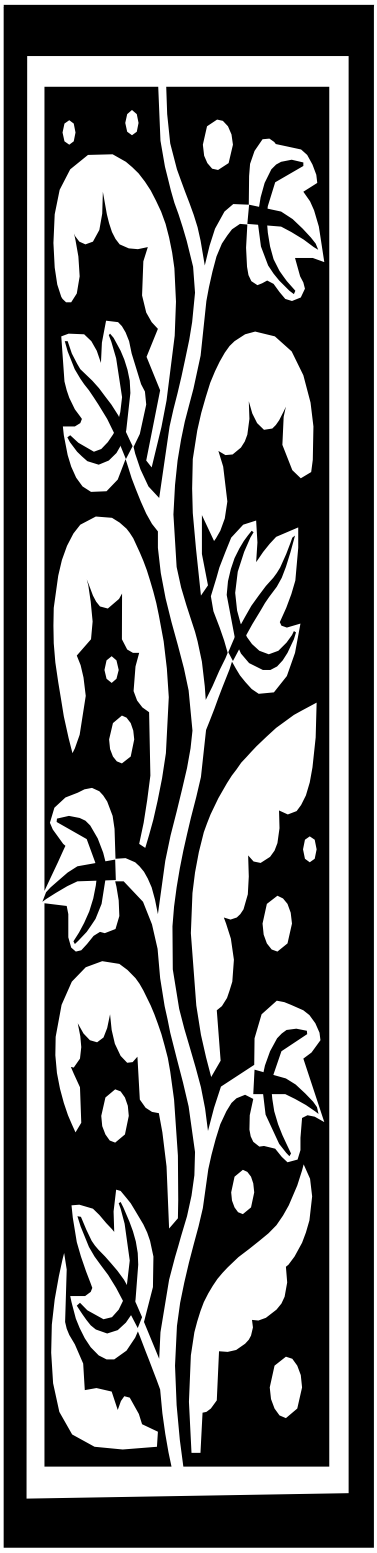
Neal Sullivan is a post-doctoral research fellow working for the Forest Service in Columbia. He studies tree ecophysiology as well as regional patterns of forest production. In general, his research is aimed at developing indices of ecological processes suitable for modeling at a landscape scale, particularly those processes affected by a potentially changing climate. Further information about him can be found at http://snr.missouri.edu/~sullivan/index.html.

The Corner (Continued from page 1)

perceive environmental change and the consequences of our actions is hampered by a mismatch between the scale of our own existence and the spatial and temporal scales at which those changes take place. Likewise, steps taken now to mitigate habitat loss or pollution may not pay off until well into the future, making it hard to convince present generations to act. In addition, a basic understanding of ecological interactions is required to comprehend potential cause-and-effect pathways. With such an understanding comes a painful awareness of the implications of various activities, but how many people possess that understanding? I imagine each of us, at one point or another, wonders whether our work can possibly have any impact. This brings me to the point of this publication and the very existence of a local chapter of the Society for Conservation Biology. By connecting people working on complex issues, we may be able to translate individual efforts into initiatives that scale more appropriately to the issues at hand. When this occurs, the development of knowledge and solutions, while still incremental, can proceed at an accelerated pace. Toward that end, I would like to find ways to leverage university resources to facilitate greater interaction between university researchers and those in agencies and organizations developing policy and implementing conservation programs throughout the state. We will, of course, continue publishing *The Glade* and we welcome contributions of information and notices of opportunities that would be of interest to our members. Please let us know if you have ideas for activities or services our organization could offer that would further our common goals.

[1] Revkin, Andrew. August 20, 2002. Forget Nature. Even Eden Is Engineered. Science Times, New York Times.

Announcements



• We are presently reviewing articles for *The Glade*'s April 2003 issue. If you are conducting research in the field of conservation biology and are willing to submit an article for consideration, please contact Michelle Boone at michelle_boone@usgs.gov. Articles may pertain to any topic related to conservation biology, and may include a discussion of your research, philosophical considerations, or local efforts to promote conservation through education in schools or through public outreach.

• To subscribe to our list-serv for discussion of conservation biology issues and ideas for the development of the MOSCB, send an e-mail to listproc@lists.missouri.edu with the message: subscribe "MO_SCB-L YourFirstName YourLastName" (where you substitute your own first name for "YourFirstName" and your own last name for "YourLastName"). To sign off from the list, send an e-mail to the same address with the message: "Unsubscribe MO_SCB-L YourFirstName YourLastName."

• The University of Missouri-Columbia Conservation Biology Seminar Series will post upcoming speakers on its web site at http://www.conserv.missouri.edu/calendar.html. Upcoming speakers include:

• 19 September, Steve Farber, University of Pittsburgh, "Economics for Valuing Natures Services"

• 15 October, Martin Thoms, University of Canberra, Australia, TBA

• 18 October, Michael Kaspari, Univeristy of Oklahoma, "Towards Understanding Patterns of Diversity and Abundance: Studies of Litter Communities"

Voluntary Contributions

Voluntary contributions to support publication of *The Glade* and future activities can be sent to:

Chrissy Howell, MOSCB Treasurer
Department of Biology
223 Research Building
8001 Natural Bridge Road
University of Missouri-St. Louis
St. Louis, MO 63121-4499

Suggested donations are $5 for students and $15 for other members. Please make checks payable to MOSCB. Organizations interested in sponsoring an issue of *The Glade* can contact Chrissy Howell at the above address or chowell@jinx.umsl.edu. Thank you for your support!

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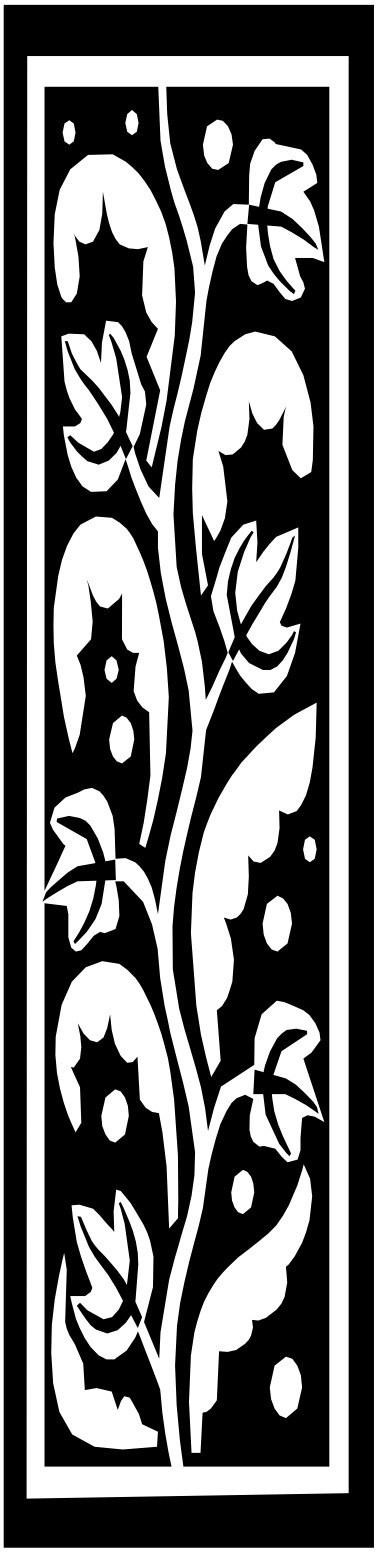


Photoenhanced Toxicity of Contaminants to Aquatic Organisms

Robin D. Calfee and Edward E. Little, U.S. Geological Survey, Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65201; email: robin_calfee@usgs.gov & edward_little@usgs.gov

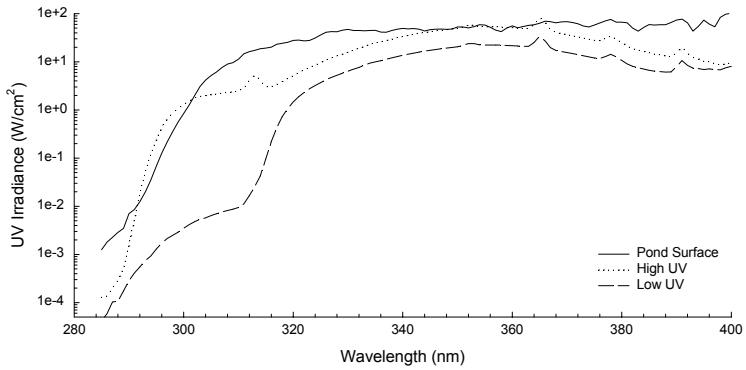
Contaminants have always been a concern environmentally, especially in aquatic ecosystems. There have been numerous studies examining the effects of various pesticides, herbicides, metals, and petroleum hydrocarbons on aquatic organisms. Only recently has ultraviolet radiation been recognized as a hazard to aquatic organisms that can cause severe damage and death to many aquatic organisms that receive high doses in their environment alone and in combination with certain contaminants.

So, what happens when a contaminant is exposed to ultraviolet radiation? The ultraviolet (UV) portion of sunlight (290-400 nm) can compound other stressors such as a contaminant through additive or synergistic interactions. UV radiation can also interact directly with certain contaminants by altering the chemical structure thereby increasing toxicity, a process known as photoactivation. Another mechanism known as photosensitization takes place when an organism bioaccumulates the contaminant and upon UV exposure is subjected to increased toxicity within the body. These two mechanisms are both examples of photoenhanced toxicity.

At the USGS Columbia Environmental Research Center (Columbia, MO), one of our main research programs is to study the interactive effects of UV radiation and contaminants on aquatic vertebrate and invertebrate organisms. Contaminants that are potentially photoenhanced by UV are not well known, but include certain pesticides and polyaromatic hydrocarbons.

We have examined the effects of several contaminants individually and in combination with UV radiation on various species of invertebrates, fish, and amphibians. The contaminants of concern were a common pesticide (carbaryl), a distilled petroleum product and several fire-fighting chemicals. Most experiments were conducted using a "solar simulator" which provided ultraviolet radiation as well as visible light using a combination of UVB, UVA, halogen, and fluorescent bulbs. Some experiments were also conducted outside using natural sunlight. UV dose was controlled through the use of various filtering plastics and confirmed with spectroradiometric measurements.

UV measurements were made in several habitats to assess the amount of radiation an organism may potentially receive. Once we determined how much UV radiation was present, we used those values to simulate the same dose in the laboratory. We wanted to use environmentally relevant doses in order to interpret our results seen in controlled laboratory experiments. Figure 1 depicts how comparable our high and low UV intensity was to an outside dose at the surface of a pond.



Carbaryl/UV Exposures: The highest concentration (15 mg/L) of the insecticide carbaryl was toxic to gray treefrog (*Hyla versicolor*) tadpoles after 48 hours of exposure, killing all individuals. However, when UV radiation was introduced, all concentrations were toxic with the lowest dose being 3.8 mg/L which is comparable to what you may actually find in the environment. Carbaryl appeared to be photoactivated because when it was irradiated with UV 10 hours prior to the exposure, toxicity significantly increased than with non-irradiated carbaryl solutions.

Petroleum/UV Exposures: A variety of estuarine species were used to conduct these experiments. The mysid shrimp (*Mysidopsis bahia*) and cladoceran (*Ceriodaphnia dubia*) were selected as representative invertebrates, and the Atlantic silverside (*Menidia beryllina*) and southern leopard frog (*Rana sphenocephala*) were selected as representative vertebrates. Both invertebrates and the Atlantic silverside were very sensitive to UV radiation alone, so their UV dose had to be lowered so as not to kill them off. In order to expose the organisms to the oil, a water accommodated fraction (WAF) needed to be formulated and this was done by adding the oil with well water and mixing the solution for 18 hours then pouring off the supernatant. Organisms were exposed to five dilutions of the WAF in conjuction with UV radiation. All WAF concentrations were significantly more toxic in the presence of UV radiation since mortality was induced progressively sooner with increasing WAF concentration. The WAF appeared to be a photosensitizing compound with *Menidia* that had been previously exposed to the WAF alone suffering greater mortality when exposed to UV radiation, indicating the accumulated body burden led to toxicity.

Fire Retardant Chemicals/UV Exposures: The interactive effects of UV radiation and fire retardant chemicals were evaluated by exposing juvenile rainbow trout (*Onchorhyncus mykiss*) and southern leopard frog (*R. sphenocephala*) tadpoles to six fire retardant formulations with and without sodium ferrocyanide (YPS) and to YPS alone under three simulated UV light treatments. The chemical concentrations tested represented a range of concentrations that may result following field application. The underwater UV intensities approximated 2 to 10% of surface irradiance measured in various aquatic habitats, and were within tolerance limits for the species tested. Mortality of rainbow trout and southern leopard frog tadpoles exposed to Fire-Trol® GTS-R, Fire-Trol® 300-F, Fire-Trol® LCA-R, and Fire-Trol® LCA-F was significantly increased in the presence of UV radiation when YPS was present in the formulation. Limited tests indicate that the endangered boreal toad and southern leopard frog were similar in their sensitivity to these chemicals. Photoenhancement of fire retardant chemicals can occur in a range of habitats and may be of concern even when optical clarity is low.

In summary, solar UV radiation at environmentally relevant doses can potentially be harmful to aquatic organisms, both due to the radiation stress alone and in combination with certain photoenhanced contaminants. Since less than 1% of surface irradiance photoenhanced the toxicity of these particular chemicals, numerous aquatic habitats may be affected, including surface waters that are eutrophic, turbid, or contain limited amounts of UV-mitigating humic acids.

Results of these studies will help us to identify compounds that are toxicologically photoenhanced. The data will be used to determine the threshold sensitivities of aquatic organisms for such compounds in their habitats using survival, mortality, behavioral modification, and biochemical measures as indicators of stress.

Autumn is a second spring when every leaf is a flower.
--Albert Camus

Ecological and Conservation-Related Research at Missouri Valley College

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Small liberal arts college and ecological research are not two terms you often see together. With a few exceptions, small baccalaureate colleges tend to focus on teaching with little to no emphasis on research. Having said this, I do not intend to imply that research is never done at small teaching colleges. The purpose of this article is to expose the readers of *The Glade* to the ecological and conservation-related research currently being conducted at Missouri Valley College (MVC), a small (1400 students) liberal arts college located in Marshall, MO.

Since arriving at MVC in the fall of 1998, I have encouraged (okay, maybe coerced is a better word) students to conduct research during their junior and senior years (at the present time independent research is not required for graduation). Past students who have been actively involved in ecological research at MVC include Caleb Hickman, who recently finished his master's degree at Southwest Missouri State University under the direction of Alicia Mathis. I currently have two students involved in independent research projects, Waylon Hiler and Teffany Sample. Waylon is involved in a turtle population study and herpetofaunal survey of the recently designated Oumessourit Natural Area at Van Meter State Park (VMSP) and Teffany is working on the breeding ecology of a population of small-mouthed salamanders (*Ambystoma texanum*) on the MVC campus in Marshall.

The research at VMSP (approximately 15 miles north of Marshall) began in the spring of 2000 when the late Wes Johnson, park superintendent, approached me about conducting a survey of the marsh pondsnail (*Lymnea* [*Stagnicola*] *elodes*). Wes was worried that his current management activities (primarily water level fluctuations and controlled burns) of a 186-acre marsh might be harming the snails, which are known to live in only three Missouri sites; however, they are common in the northern states and Canada. I agreed to do it, but was not highly interested in snails. As a herpetologist, I immediately saw other potential projects that could be done involving vertebrates, specifically reptiles and amphibians. I asked Caleb Hickman, then a student at MVC, to conduct a general survey of the park's herpetofauna. From his preliminary work grew the current study that Waylon Hiler, a senior biology major, is conducting. In addition to documenting herpetofaunal diversity, Waylon is marking turtles as part of a population study in this marsh ecosystem.

The marsh (officially known as the Oumessourit Natural Area) at VMSP is ecologically "special" for several reasons. First, whereas the marsh had been partially drained, it has never been plowed. Second, it is the largest state-owned Missouri River floodplain marsh. Third, in addition to the marsh pondsnail mentioned above, the marsh contains approximately 115 species of plants including several rare or uncommon species (e.g., tufted loosestrife and yellow water crowfoot) and is bordered by two fens. Therefore, the Van Meter marsh is truly a unique habitat in the state.

As part of the Van Meter research project we have documented 37 of the possible 63 species of amphibians and reptiles in Saline County. We also added five new county records (*Heterodon platirhinos*, *Nerodia rhombifer*, *Regina grahamii*, *Scincella lateralis*, and *Storeria dekayi*), and marked 41 individual turtles belonging to three species (*Chelydra serpentina*, *Chrysemys picta*, and *Trachemys scripta*).

One of the most interesting events in the Van Meter study was when I captured a turtle that was previously marked, but not by anyone at MVC! I sent out a few emails, and discovered that an old friend of mine, Russ Bodie, had marked the female slider four years ago as part of his master's thesis at University of Missouri-Columbia. He marked this individual in Lake Teteseau, a small oxbow lake in Grand Pass Conservation Area approximately 1.38 km from where I recaptured it in VMSP

(obviously this turtle did not realize that two separate political entities govern these two areas). The two areas are relatively close (0.8 km) and connected by water via the Van Meter Ditch, a drainage ditch constructed by Mr. Abel Van Meter and other adjacent landowners in 1918. We have plans to continue marking turtles at Van Meter, but to also expand our study to include Lake Teteseau and thus to monitor turtle movement patterns between these two Missouri River floodplain wetlands.

I have also kept my eyes open for the possible presence of the eastern massasauga (*Sistrurus catenatus*) at VMSP. This small rattlesnake was sometimes called a "swamp rattler" by the old-timers and is currently classified as state endangered because only three populations are known to exist in Missouri. The floodplain marsh habitat is ideal for this species and the late Wes Johnson conveyed to me that there were reports of CCC workers killing small rattlesnakes when they built the picnic shelters at the park in the 1930's. Also, a pre-1960 museum specimen collected by Paul Anderson was collected near Miami, which is about 4.9 km from Van Meter and connected to the marsh by the Van Meter Ditch, which empties into the Missouri River at Miami. The nearest viable population of these small rattlesnakes exists at Swan Lake National Wildlife Refuge, which is about 33 km north of Van Meter. Finding a massasauga would be a significant event indeed!

Teffany Sample is also a senior Biology major at MVC and is working on small-mouthed salamanders, *Ambystoma texanum*. I was first made aware of the presence of small-mouthed salamanders on campus in the spring of 1999 when a student found a female crossing a sidewalk near the football field after heavy spring rains. Later it was discovered that this species of salamander was using an old farm pond behind the gym as a breeding site. I talked Teffany into setting up a drift fence (I helped her!) to capture and mark all salamanders coming into this small pond to breed and to document the total number of juveniles that exit the pond in the summer.

This project is important and interesting for multiple reasons. First, it offers my students and me an opportunity to conduct meaningful biological research right on campus. This is important because of the convenience, but also because we are not a research-oriented university and therefore do not have a research budget. Second, the topics of urban wildlife and the effects of urbanization on plants and animals are hot topics. We have a salamander that lives on campus and we assume in residential neighborhoods nearby, and breeds in the only water available, an old man-made farm pond within the Marshall city limits. In addition to this salamander, I know of five species of frogs and toads that breed in this pond and two others use it. Third, I am building a potentially long-term database on the breeding ecology of this species in an urban environment.

We have already observed drastic year-to-year variability in the reproductive success of this salamander. During the spring of 2001 the pond filled, the salamanders reproduced, and the first larvae were observed by March 27th. The pond held water until late July or early August and hundreds of larval salamanders were present. Because we did not have a drift fence, we do not know exactly how many juveniles emerged last year. This spring, the pond did not fill until May 5th, with 87 males and 51 females captured entering the pond to breed, and the pond dried by July 3, with only 6 metamorphs emerging and countless others dying in the drying pond. All individuals were marked, therefore we will know which salamanders return next spring, but with Teffany graduating in December, that will be another student's project. Finally, we also use this area as an outdoor classroom for various biology classes and as a source of living material for labs (e.g., my biology lab found a water bear or tardigrade among the usual cladocerans, copepods, and other invertebrates living in the waters of this ephemeral pond).

In summary, it is possible to conduct ecological and conservation-related research at a small teaching college. This research not only provides our students with much needed hands-on experience, but also provides the type of general, good old-fashioned natural history that often gets overlooked by the large research universities and yet is critical to the field of conservation biology.

The Glade

attn: Michelle Boone

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When one tugs at a single thing in nature, he finds it attached to the rest of the world. --John Muir

Membership Information

The goal of MOSCB is to promote communication among conservation biologists throughout the state of Missouri. Membership in MOSCB is free. Please visit our MOSCB web page for more detailed information (http://www.snr.missouri.edu/moscb).

The Glade Vol. 5, No. 2 was edited by Michelle Boone. Special thanks to the authors in this issue for their time and thought in writing their articles.