

## **Field Herpetology goes Environmental: Proposal for an ACS Environmental Curriculum Development Award**

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### 1. Introduction and Goals

The principle goal of this project is to transition our six-week Field Herpetology course to a new, long-term project related to species conservation in the Southern Appalachians. Field Herpetology is a research-based course offered during Washington & Lee's unique spring-term. For six weeks, from mid-April to early June, twelve students take only this one course and work full-time on a group research project. In past years, our projects have focused on various aspects of salamander ecology, and many of these projects have led to research publications (Marsh and Goicochea 2003; Marsh and Beckman 2004; Marsh 2007). However, our previous projects have generally focused on very common species, and therefore have not always been specifically relevant to environmental or conservation issues.

This spring, we are hoping to set up a new project related to long-term monitoring of the rare Peaks of Otter salamander (*Plethodon hubrichti*). Peaks of Otter salamanders have a range that is restricted to one single 20 km stretch of ridge-top habitat that parallels the Blue Ridge Parkway in Virginia (Petranka 1998). Although the distribution of the Peaks of Otter salamander falls largely within protected areas (i.e. National Park Service and Forest Service land), the long-term persistence of the species may be threatened by climate change and incursion by the more common red-backed salamanders. Climate change could be important because Peaks of Otter salamanders are confined to single ridgetop and are therefore unable to shift their elevational range upslope as the climate warms. Red-backed salamanders may be an important piece of the puzzle because they are successful at lower elevations and are very common below the current elevational range of the Peaks of Otter salamander. When Peaks of Otter salamanders move out of an area, even temporarily, red-backed salamanders are likely to move in and compete with Peaks of Otter salamanders for food and shelter sites (Wicknick 1995). Thus, understanding what is happening at the lower range limits of the Peaks of Otter salamander is critical for tracking the survival of this endemic Appalachian species.

This proposal is relevant to several of the listed priorities for ACS Environmental Curriculum Development Grants. First, this course is cross-listed with our Environmental Studies program and offers one of the few opportunities for Environmental Studies students to gain field research experience in conservation biology. The new version of the course will be advertised to environmental studies students, as well as the biology students who have traditionally enrolled. Second, this is a course that has not previously received any development funding from ACS. Because this is essentially "start-up" funding for a long-term course project, we don't have many other obvious possibilities for funding.

## 2. Project Description

We will establish 12 long-term monitoring sites for Peaks of Otter salamanders. Six of the monitoring sites will be near the lower range limit of the species and where the distribution overlaps with that of red-backed salamanders. The other six sites will be reference sites at higher elevations, where only Peaks of Otter salamanders will be present. Each site will consist of a 20 m by 20 m plot; precise locations for the plots will be randomly selected from larger suitable areas (e.g. Marsh and Beckman 2004). Within each plot, we will estimate the population density of Peaks of Otter salamanders using mark-recapture methods. Specifically, salamanders will be individually marked in the field using elastomer tags, which are widely recognized as safe for salamanders (Davis and Ovaska 2001; Gillette 2003) and which we have used many times previously with red-backed salamanders (e.g. Marsh et al. 2005). We will also determine the size class and sex of each salamander, as well as particular types of cover objects used by both Peaks of Otter salamanders and red-backed salamanders. This will help us to determine whether Peaks of Otter salamanders are effectively “pushed out” of more desirable cover objects by red-backed salamanders. We will additionally experiment with nighttime surveys for surface activity (e.g. Kramer et al. 1993) to ensure that all methods give a similar picture of any changes in Peaks of Otter salamander populations. Using these methods, we should be able to cover 2-3 plots per day and survey each plot 4-6 times during the six-week field herpetology course.

In the first year of the project, we can compare the density, body condition, age distribution, and habitat use patterns of Peaks of Otter salamanders between sites with and sites without red-backed salamanders. This will help us to determine whether Peaks of Otter salamanders are generally faring better higher in their elevational range. Over time, if climate change is reducing the suitable habitat for Peaks of Otter salamanders, we expect to see a gradual decline in their populations at low elevation sites relative to high elevation sites. If red-backed salamanders are competing with Peaks of Otter salamanders at lower elevations, we expect to see red-backed salamanders increase in density as Peaks of Otter salamanders decrease at low elevation sites. We also expect to see changes in the body condition and patterns of habitat use of Peaks of Otter salamanders.

## 3. Timetable

March, 2008: Determine locations for monitoring plots in consultation with NPS and Forest Service officials.

Mid-April, 2008: Train Field Herpetology students in methods for capturing, marking, and data collection

Mid-April to early June, 2008: Carry out surveys of monitoring plots

Early June, 2008: Data Analysis

Summer 2008: Write up results for submission to a scientific journal

2008 onwards: Repeat surveys of monitoring plots to determine changes in Peaks of Otter salamander populations over time. We are hoping to be able to carry out this project for a very long time.

#### 4. Budget and justification

Budget items are related to costs for establishing plots and carrying out salamander surveys. Other costs that are normally incurred in Field Herpetology (e.g. vehicle use, fuel, etc.) will be covered by the course budget.

Elastomer supplies sufficient for marking salamanders on 12 plots (four colors of elastomer, curing agent, syringes): \$920

Battery-powered fiber optic light, needed for distinguishing male from female salamanders and adults from non-reproductive juveniles, and lamp: \$720

Two O-haus Scout field balances, needed for accurately weighing animals and determining their body condition: \$340 each, \$680 total.

Total amount requested: \$2420.

#### 5. Evaluation and Dissemination

There are three primary audiences for the results of this project. The first audience is the National Park Service and Forest Service officials who are charged with managing and protecting Peaks of Otter salamander populations (see attached). As part of the permitting process I will be required to submit an official project report detailing our findings and how they pertain to management and conservation objectives. The second audience is the scientific community, particularly conservation biologists who study amphibians and/or climate change. We will reach this audience through publication of our findings in a suitable journal (e.g. Biological Conservation, Journal of Herpetology). We expect that the first-year results will produce one paper and then a future paper will be published as we become able to document changes in Peaks of Otter salamander populations over time. The third audience is other ACS institutions. We will post our results and final report on the CFD website in the hope that our project will inspire more courses that are based on environmental research projects carried out by students at ACS institutions. We will consider the project to be a success as long as we are able to provide useful information to each of three audiences (which we expect to be able to do).

6. Institutional Approval: This project has been approved by the Dean of the College, Hank Dobin (see attached).

7. Disclosure statement. Because this project will be carried out during the spring-term of our academic year, there is no current or pending support that will coincide with the timetable for this project.

## References

- Davis, T.M. and Ovaska, K. Individual recognition of amphibians: effects of toe clipping and fluorescent tagging on the salamander *Plethodon vehiculum*. *Journal of Herpetology* 35: 217-235.
- Gillette, J.R. 2003. Population ecology, social behavior, and intersexual differences in a natural population of red-backed salamanders: a long-term field study. PhD dissertation, University of Louisiana Lafayette.
- Kramer P., Reichenbach, N., Hayslett M., and Sattler P. 1993. Population dynamics and conservation of the peaks of otter salamander, *Plethodon hubrichti*. *Journal of Herpetology* 27: 431-435.
- Marsh, D. M. and Goicochea, M. A. 2003. Monitoring terrestrial salamanders: biases due to frequent sampling and choice of cover objects. *Journal of Herpetology* 37: 460-466.
- Marsh, D. M. and Beckman, N. G. 2004. Effects of forest roads on the abundance and activity of terrestrial salamanders in the Southern Appalachians. *Ecological Applications* 14:1882-1891.
- Marsh, D. M., Milam, G. S., Gorham, N. P., and N. G. Beckman. 2005. Forest roads as partial barriers to terrestrial salamander movement. *Conservation Biology* 19: 2004-2008.
- Marsh, D.M. 2007. Edge effects of gated and ungated forest roads on terrestrial salamanders. *Journal of Wildlife Management* 71: 389-394.
- Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian University Press, Washington, DC.
- Wicknick, J.A. 1995. Interspecific competition and territoriality between a widespread species of salamander and a species with a limited range. Dissertation, University of Louisiana, Lafayette.

## CURRICULUM VITAE

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### POSITIONS:

Assistant Professor of Biology, Washington and Lee University, 2000-2006  
Associate Professor of Biology, Washington and Lee University, 2006-present  
Sabbatical Fellow, National Center for Ecological Analysis and Synthesis, 2006-2007

### EDUCATION:

University of California, Davis, Ph.D. in Population Biology, June 2000  
University of Virginia, B.A., Biology, w/ distinction, 1993

### RECENT FELLOWSHIPS AND GRANTS:

National Center for Ecological Analysis and Synthesis Sabbatical Fellowship: Optimal Design of Population Monitoring Programs, \$30000 (2006-2007)  
National Science Foundation RUI: Fragmentation of terrestrial salamander populations by forest roads: ecological and genetic effects, w/ Paul R. Cabe, \$375,000 (2003-2006)  
National Science Foundation REU supplements: \$7200 (2004-2005)  
ACS: Biodiversity and Conservation in the Western Ghats of India, \$3000 (2004)  
Glenn grants for research, Washington and Lee University, \$8400 (2001-2005)

**COURSES TAUGHT:** Biostatistics, Tropical Ecology, Field Herpetology, Management of Temperate Forests, Disease Ecology, Animal Behavior, Intro to Behavioral Ecology

### RELEVANT RECENT PUBLICATIONS:

- Marsh, D.M., and Trenham, P.C. Tracking changes in plant and animal monitoring programs. *Conservation Biology*, in press.
- Marsh, D.M., Page, R.B., Hanlon, T.J., Corritone, R., Little, E.E., Seifert, D.E., and Cabe, P.R. 2007. Effects of roads on patterns of genetic differentiation in red-backed salamanders, *Plethodon cinereus*. *Conservation Genetics*, in press.
- Marsh, D.M. and Hanlon, T.J. 2007. Seeing what we want to see: confirmation bias in animal behavior research. *Ethology*, in press.
- Marsh, D.M. 2007. Edge effects of gated and ungated forest roads on terrestrial salamanders. *Journal of Wildlife Management* 71: 389-394.
- Marsh, D.M., Page, R.B., Hanlon, T. J., Bareke, H., Corritone, R., Jetter, N., Beckman, N.G., Gardner, K., Seifert, D.E., and Cabe, P.R. 2007. Ecological and genetic evidence that low-order streams inhibit dispersal by red-backed salamanders (*Plethodon cinereus*). *Canadian Journal of Zoology* 85: 319-327
- Cabe, P.R., Page, R.B., Hanlon, T.J., Aldrich, M.E., Connors, L., and D. M. Marsh. 2007. Fine-scale genetic population structure and gene flow in a terrestrial salamander living in continuous habitat. *Heredity* 98: 53-60.

- Marsh, D. M., Milam, G. S., Gorham, N. A., and Beckman, N. G. 2005. Forest roads are partial barriers to salamander movement. *Conservation Biology* 19: 2004-2008
- Marsh, D. M., Thakur, K. A., Bulka, K., and Clarke, L. B. 2004. Dispersal and colonization through open fields by a woodland salamander. *Ecology* 85: 3396-3405.
- Marsh, D. M. and Beckman, N.G. 2004. Effects of forest roads on abundance and activity patterns of terrestrial salamanders in the Southern Appalachians. *Ecological Applications* 14:1882-1891.
- Marsh, D. M. and Hanlon, T. E. 2004. Gender and observation bias in animal behavior research: experimental tests with red-backed salamanders. *Animal Behaviour* 68:1425-1433.
- Marsh, D. M. and Goichochea, M. A. 2003. Monitoring terrestrial salamanders: biases due to frequent sampling and choice of cover objects. *Journal of Herpetology* 37: 460-466.
- Marsh, D. M. 2001. Amphibian population fluctuations: a meta-analysis. *Biological Conservation* 101: 327-335.
- Marsh, D. M. 2001. Behavioral and demographic responses of tungara frogs to variation in pond density. *Ecology* 82: 1283-1293.
- Marsh, D. M. and Borrell, B. 2001. Flexible oviposition strategies in tungara frogs and their implications for tadpole spatial distributions. *Oikos* 93: 101-109.
- Trenham, P.C. and Marsh, D.M. 2001. Amphibian translocation programs: reply to Seigel and Dodd. *Conservation Biology* 16: 555-556.
- Marsh, D. M. and Trenham, P.C. 2001. Metapopulation dynamics and amphibian conservation. *Conservation Biology* 15: 40-49.
- Marsh, D. M., Rand, A. S., and Ryan, M. J. 2000. Effects of inter-pond distance on the breeding ecology of tungara frogs. *Oecologia* 122: 505-513.
- Marsh, D. M. and Pearman, P. B. 1997. Effects of habitat fragmentation on the abundance of two species of Leptodactylid frogs in an Andean montane forest. *Conservation Biology* 11: 1323-1328.

### **Manuscripts:**

- Marsh, D.M. Evaluating methods for sampling stream salamanders across multiple observers and habitat types. *Journal of Herpetology*, submitted.
- Marsh, D.M., and Haywood, L.E. Plot Censuses for Terrestrial Amphibians. Chapter 14 in: *Conservation and Ecology of Amphibians. A Handbook of Techniques*. Oxford University Press, under contract.

### **Invited Seminars:**

- University of Kentucky, Lexington, KY. Department of Biology. September 2006.
- Vassar College, Poughkeepsie, NY. Department of Biology. November 2005.
- James Madison University, Harrisonburg, VA. Department of Biology. September 2005.
- San Diego State University, San Diego, CA. Department of Biology. February 2005.
- Virginia Tech, Blacksburg, VA. Department of Biology. September 2004.
- University of Richmond, Richmond, VA. Department of Biology. April 2004.
- University of Florida, Gainesville, FL. Department of Zoology. February 2003.
- College of William and Mary, Williamsburg, VA. Department of Biology. May 2002.
- Old Dominion University, Norfolk, VA. Department of Biology. May 2002.
- University of Virginia, Boyce, VA. Blandy Experimental Farm, July 2001.