Charles R. Peterson - Research Activities

(revised July 2002)

Introduction

Throughout my life, I have been interested in the ecology of reptiles and amphibians, especially their spatial distribution. During the first half of my career, my research was motivated almost solely by personal curiosity and fascination with these animals. I began my scientific career by studying the biogeography of amphibians and reptiles in the Black Hills of South Dakota and Wyoming for my master's degree at the University of Illinois - Urbana. Although I was able to describe interesting patterns of distribution, I was unable to explain the basis for the patterns. My fieldwork, however, suggested that physical factors, such as heat and moisture, played an important role in determining where amphibians and reptiles occur and when they are active. Consequently, I decided to focus on the thermal biology of a single species, the Wandering Garter Snake (*Thamnophis elegans vagrans*), which provided a model system for my doctoral and postdoctoral studies at Washington State University and the University of Chicago, respectively. Since I came to Idaho State University in 1988, I have become increasingly aware of the numerous threats to amphibian and reptilian biodiversity. Correspondingly, my research program has expanded to include conservation biology and has become increasingly applied. I am now convinced that it is not only interesting but essential to study and understand the ecology of amphibians and reptiles in order to detect and mitigate the threats to the survival of their populations and the ecological systems of which we are all a part. My long-term goal is to use our studies of individual organisms and populations to understand the mechanistic determinants of animal distributions and to apply that information to the conservation of these animals. In this document, I try to provide a guide to my research program in physiological ecology and conservation biology. I have included citations to my work and the studies of my students; please see my CV for the full references. These citations include peer-reviewed journal articles, books and book chapters, theses, and reports.

Physiological Ecology (Figure 1)

Many of my studies have focused on temperature because it is such an important ecological variable (Peterson et al. 1993). Using snakes as a model system for ectothermic vertebrates (Figure 1), my colleagues, students, and I have explored the following basic questions in thermal ecology:

(1) How do possible and selected body temperatures vary under natural conditions?
(e.g., Peterson 1987, Cobb 1994, Dorcas and Peterson 1997, 1998)

(2) What proximate factors influence thermoregulatory behavior?
(e.g., Cobb 1994, Arnold et al. 1995, Dorcas et al. 1997)

(3) What are the functional consequences of variation in body temperature?
(Stevenson et al. 1985, Arnold and Peterson 1989, Clark 1995, Dorcas et al. 1997, Arnold and Peterson, 2002)

(4) What are the ecological consequences of variation in body temperature?
(Huey et al. 1989, Grothe 1992, Cobb 1994)

(5) How have thermal physiology and behavior evolved, and to what extent have they influenced the evolution of other animal characteristics (morphological, physiological, and behavioral)? (Peterson et al. 1993, Dorcas, 1995, Arnold and Peterson, 2002*,* Dorcas and Peterson*, in prep.*)

We use a variety of techniques to address these questions, including:
(1) biophysical and GIS modeling to describe thermal environments;
(2) radiotelemetry of body temperatures and movements;
(3) mark-recapture studies to obtain natural history data (e.g., movements, habitat selection, growth rates, and longevity);
(4) laboratory studies of the thermal dependence of development, physiology, and behavior; and

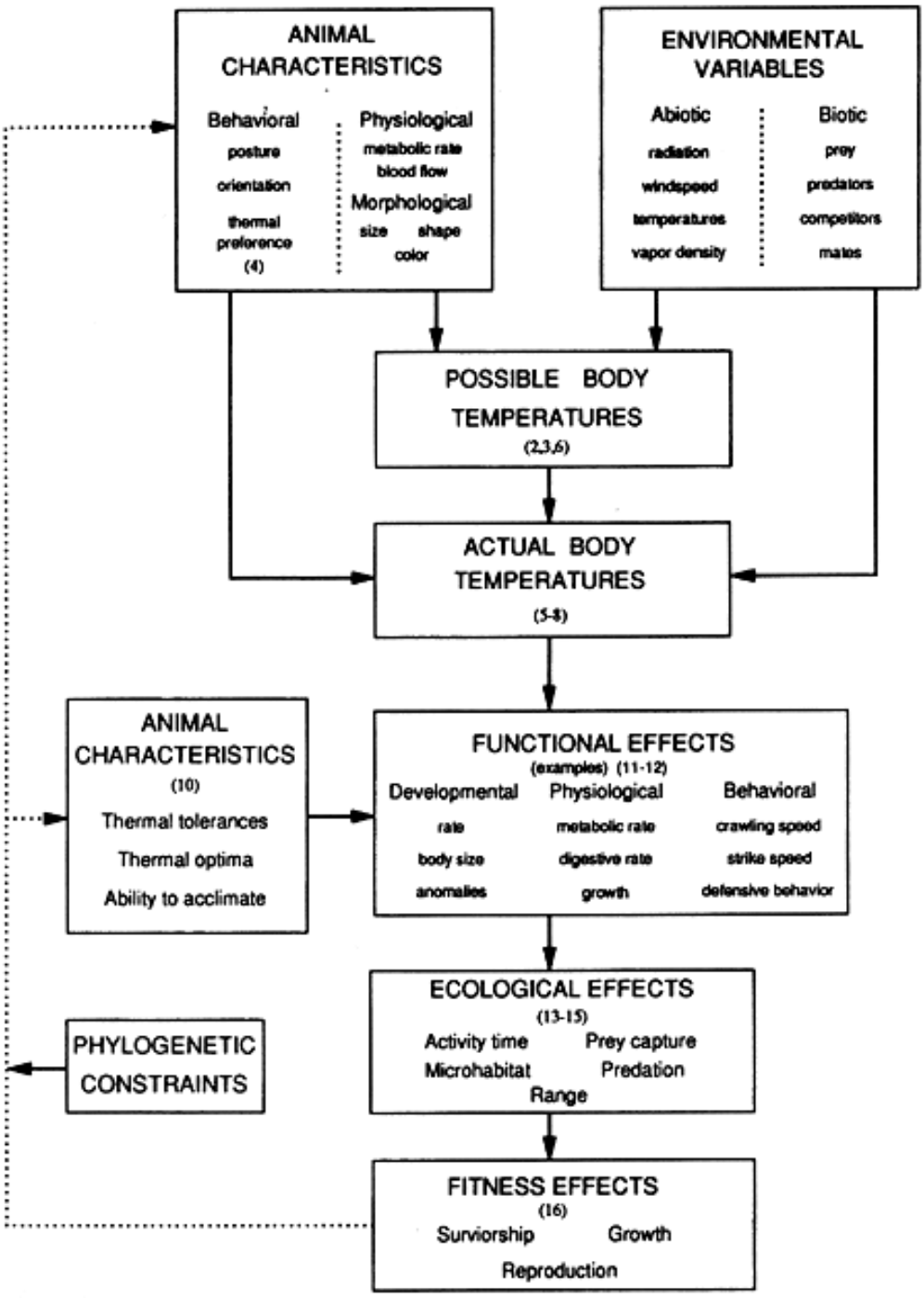

Figure 1. The causes and consequences of snake body-temperature variation (Peterson et al. 1993).

(5) computer modeling of the consequences of body temperature variation.

One of my former doctoral students expanded this approach to include water relationships as well as temperature for Western Toads (Bartelt 2000).

To make the needed environmental and animal measurements, we have had to develop or refine several techniques, including automated data acquisition of environmental data (Peterson and Dorcas 1994), biophysical modeling of animal temperatures (Peterson et al. 1993), drift fence and funnel trap arrays (Beck 1997, Lee and Peterson 2001), radiotelemetry harnesses for anurans (Bartelt and Peterson 2001), automated radiotelemetry (Peterson and Dorcas 1994), automated recording of animal activity and vocalizations (Grothe 1992, Peterson and Dorcas 1992, 1994), and GIS habitat models for amphibian and reptile distributions (Beck 1997, Hart et al. 1999, Peterson et al. *in press*).

Conservation Biology (Figure 2)

Since the late 1980's, many studies of amphibian and reptile populations have indicated considerable declines or extinctions. Reports of these declines raised my concern over the health of amphibian populations in the Northern Intermountain West. Therefore, over the past 11 years, an increasing amount of my laboratory's effort has been devoted to conservation biology. Our research program addresses the following questions:

1. What species occur in the Northern Intermountain West and how are they spatially distributed?

We have developed a herpetological database for Idaho and the Greater Yellowstone Ecosystem (GYE). This database includes over 14,000 records from North American museums, herpetological surveys, and contributed observations. The coordinates and attributes for all of these records are being digitized and stored in a GIS. Data from our herpetological surveys are also being incorporated in the Idaho Conservation Data Center, National Park Service, and USGS databases.

We have conducted herpetofaunal surveys throughout Idaho and the Greater Yellowstone Ecosystem. (e.g., Clark et al. 1993, Peterson et al. 1995, Patla and Peterson 1996, Llewellyn and Peterson 1997, Burton et al. 1997, Beck et al. 1998, Yeo and Peterson 1998, Hamilton et al. 1998, Shive and Peterson 2000, Beck et al. 2001). Based on writing reports for these surveys, I developed a chapter on report writing for a book on sampling amphibians in lentic habitats (Peterson 1997). Our laboratory also conducts herpetological surveys for the USGS Amphibian Research and Monitoring Initiative and the Greater Yellowstone and Northern Semi-arid Park Networks.

We develop statistical and GIS habitat models for predicting amphibian and reptile distribution. (Bartelt and Peterson 1994, Beck and Peterson 1995, Beck 1997, Hamilton et al. 1998, Hart et al. 1998, Burton 2001, Peterson et al. *in press*, Lee, in progress). We are currently collaborating with scientists at the EROS Data Center and the Environmental Statistics Program at Montana State University to develop habitat models for amphibians in Yellowstone National Park. We also are participating in preparing an NSF Biocomplexity grant, "Complexity Across Boundaries – Coupled Human and Natural Systems in the Yellowstone Northern Elk Winter Range," that will include modeling amphibian habitat.

2. What are the phylogeographic relationships of these populations?

Recent developments in molecular genetics have dramatically improved our ability to determine evolutionary and biogeographical histories of animal populations, which is critical to identifying levels of biodiversity. In the past we have contributed to this effort primarily by supplying specimens and tissue samples to other scientists. I hope to become more involved in the area by receiving training in molecular techniques during my sabbatical and collaborating with other scientists (especially, Jack Sullivan, J. Michael Scott, and Lisette Waits at the University of Idaho).

3. What are the status and trends of these amphibian and reptile populations?

Our first monitoring study involved amphibian populations in the GYE, began in 1991, and is ongoing (Peterson et al. 1992). In 1994, we began a long-term reptile monitoring program on the INEEL (Lee et al. 1998). We have conducted historical comparisons of amphibian and/or reptile populations in the GYE

(Patla 1997, Patla and Peterson 1999, *in prep.),* at the INEEL (Cooper and Peterson 1994), and at the Snake River Birds of Prey Area (Cossel, *in prep*.). Each of these studies has indicated significant population declines in some formerly common species of amphibian or reptile. I am using the comparative approach from these studies to develop a collaborative, state-wide, long-term monitoring program for Idaho amphibians and reptiles. In 1999, we began a BLM funded project to use GIS modeling of habitat change to monitor reptile populations in southern Idaho (Peterson and Jenkins, in progress). We also are participating in the Department of Interior's Amphibian and Research Monitoring Initiative by surveying and monitoring amphibian populations in the GYE. We are hoping that the NPS GYE Network will decide to incorporate amphibians as part of their long-term monitoring program.

4. What are the habitat requirements and relationships of these species?

There is a critical need for detailed habitat information for most species of amphibians and reptiles in the Northern Intermountain West. Examples of our studies involving amphibian habitat relationships include Bartelt and Peterson 1994, Bartelt 2000, Beck and Peterson 1995, Huey et al. 1990, Pilliod 2001, and Vander Haegen et al. 2000.

5. How do these species respond to natural and anthropogenic disturbances? Which of these factors threaten amphibian and reptilian populations?

To properly manage populations of amphibians and reptiles, we need information on how populations are affected by various natural and anthropogenic disturbances. In my laboratory, we have studied disease (Hawk 2001), fire (Burton, *in prep*.), grazing (Bartelt and Peterson 1996), habitat fragmentation (Patla and Peterson 1994, 1999, *in prep*.), introduced species (Pilliod et al. 1996, Pilliod and Peterson 1997, Pilliod and Peterson 2001; Murphy, *in prep*.), logging (Bartelt, *in prep*.), and roads (Patla and Peterson 1994, Patla 1997). Our laboratory recently received funding from the USDA Forest Service and Idaho Department of Fish and Game to prepare a report reviewing the effects of roads on amphibians and reptiles. This report will emphasize the adverse biological and ecological effects of roads on amphibians and reptiles and how to mitigate those effects, and will be included in a chapter in a Federal Highway transportation book.

6. How can amphibian and reptile populations and their ecosystems be managed to minimize the loss of amphibian and reptilian biodiversity?

One of our goals is to develop herpetological information systems (databases, geographic information systems, decision support systems, etc.) that will assist managers in making decisions that will help to protect and restore amphibian and reptile populations (Figure 2).

Restoration: In 1997, we became involved in our first habitat restoration project. We provided recommendations for habitat restoration and monitoring of Columbia Spotted Frogs along a 12-mile section of the Provo River to the Utah Reclamation, Mitigation, and Conservation Committee (Ross and Peterson 1998, Ammons et al., *in review*). In 1998, our lab began conducting amphibian surveys for Yellowstone National Park as part of their habitat restoration program involving the removal of non-native fish from streams. I anticipate that we will become increasingly involved with restoration projects in the future.

Educational Outreach If our research efforts are going to be effective in helping conserve amphibian and reptile populations, I believe that it is critical to educate resource mangers, government officials, and the public about threats to amphibian and reptile populations. Consequently, a significant portion of our lab's effort has gone into education and outreach. These activities have included the publication of books (Koch and Peterson 1995, Storm et al. 1995), development of a web-based course on the conservation of amphibians and reptiles for wildlife and fisheries biologists, an Idaho Amphibian and Reptile Website, a digital atlas of the natural history of Idaho for teachers, workshops for agency biologists, and short courses for teachers (Yellowstone Institute, Sawtooth Science Institute).

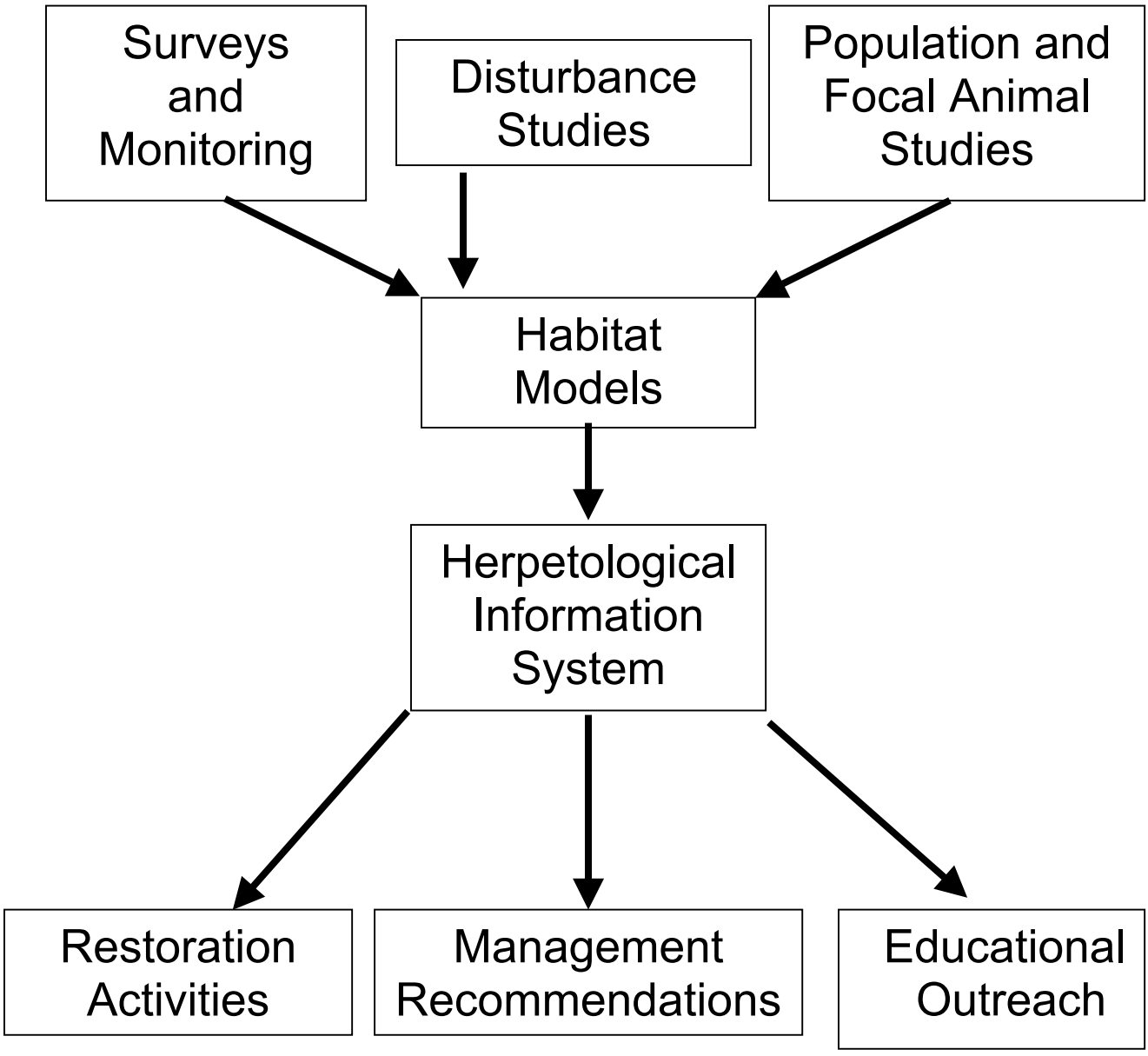

Figure 2. Relationships of herpetological conservation studies and activities.