

**US Geological Survey Amphibian Research and Monitoring Initiative
Rocky Mountain Region, 2005 Progress Report
Northern Rocky Mountain Science Center, Missoula, Montana
Fort Collins Science Center, Fort Collins, Colorado**

Amphibian monitoring and research in the Rocky Mountains is conducted through two Science Centers. The Northern Rocky Mountain Science Center, Aldo Leopold Wilderness Research Institute in Missoula, Montana and partners, including faculty and graduate students at Idaho State University and the University of Montana, conduct studies in the northern part of the region. The Leopold Institute is an interagency center, hosted by the US Forest Service, with the mission to develop the knowledge needed to improve management of wilderness and other natural areas. Why conduct amphibian research at a research center devoted to wilderness? Although amphibian diversity in western wilderness is typically low, amphibians occupy important ecological niches, and declines have been excessively severe in the western U.S. This includes designated wilderness and backcountry areas of National Parks, which are generally considered to be refuges for protecting species. In the south, the Fort Collins Science Center (FORT) is located on the Natural Resources Research Campus (NRRC) at Colorado State University in Fort Collins, Colorado. The NRRC is a partnership of six federal agencies and CSU and was established to support and enhance cooperative research on natural resource issues.

ARMI monitoring projects in the Rocky Mountains include base-level inventories, mid-level long-term monitoring, and intensive population studies at Apex sites (Table 1). The Great Divide transect, distributed over 8° of latitude, with gradients of climate, development, and status of amphibian populations (Corn et al. 2005), comprises Glacier, Yellowstone, Grand Teton (collectively the Greater Yellowstone Ecosystem, or GYE), and Rocky Mountain National Parks. Studies in Yellowstone and Grand Teton were funded in 2005 by the National Park Service Greater Yellowstone Inventory and Monitoring Network (GRYN) to Chuck Peterson at Idaho State University. Inventories include a collaborative effort on National Forests and Department of Interior lands in Montana, conducted by Bryce Maxell at the Montana Natural Heritage Program, and funded in 2005 for 3 years through the ARMI competitive grants program.

Table 1. Monitoring locations in the Rocky Mountain region.

Location	State	Agency/Collaborator	Period	Primary Species
Apex Monitoring Sites				
Lost Trail NWR, Dahl Lake & several ponds	MT	USFWS	2003 – ongoing	<i>Bufo boreas</i>
Lubrecht Experimental Forest, Jones Pond	MT	Univ Montana	2004 – ongoing	<i>Bufo boreas</i>
Glacier National Park, three catchments	MT	National Park Service	1999 – ongoing	<i>Bufo boreas</i>
Bitterroot National Forest, Lost Horse Marsh	MT	US Forest Service	1999 – ongoing	<i>Rana luteiventris</i>
Bitterroot National Forest, Selway-Bitterroot Wilderness, Little Rock Creek Basin	MT	US Forest Service/ Montana Heritage Program	2001 – ongoing	<i>Rana luteiventris</i>
Bitterroot National Forest, six streams	MT	US Forest Service	2003 –2004	<i>Ascaphus montanus</i>
Yellowstone National Park, Lodge Creek	WY	National Park Service/Idaho State Univ	(1953 –1955) 1992 – ongoing	<i>Rana luteiventris</i>
Bridger-Teton National Forest, Black Rock Ranger Station	WY	US Forest Service/Idaho State Univ	2003 – ongoing	<i>Bufo boreas</i>

Location	State	Agency/Collaborator	Period	Primary Species
National Elk Refuge, Nowlin Creek & Romney Pond	WY	USFWS/Idaho State Univ	1998 – ongoing	<i>Bufo boreas</i>
Arapaho-Roosevelt National Forest, Lily & Matthews ponds	CO	US Forest Service	(1961 – 1973) 1986 – ongoing	<i>Pseudacris maculata</i>
Rocky Mountain National Park, North Fork Big Thompson River, Spruce Lake	CO	National Park Service	1991 – ongoing	<i>Bufo boreas</i>
Rocky Mountain National Park, Kawuneeche Valley	CO	National Park Service/Colorado State Univ	2002 – ongoing	<i>Rana sylvatica</i>
San Isabel National Forest, Collegiate Peaks Wilderness, Denny Creek	CO	US Forest Service/Colorado Division of Wildlife	Ongoing	<i>Bufo boreas</i>
Mid-level Monitoring Sites				
Glacier National Park	MT	National Park Service	1999 – ongoing	<i>Ambystoma macrodactylum</i> , <i>Ascaphus montanus</i> , <i>Bufo boreas</i> , <i>Rana luteiventris</i>
GYE (Yellowstone & Grand Teton national parks, JD Rockefeller Parkway)	MT, WY	National Park Service/Idaho State Univ	2000 – ongoing	<i>Ambystoma tigrinum</i> , <i>Bufo boreas</i> , <i>Pseudacris maculata</i> , <i>Rana luteiventris</i>
Rocky Mountain National Park	CO	National Park Service	1988 – 1990, 1994, 2000 – ongoing	<i>Ambystoma tigrinum</i> , <i>Bufo boreas</i> , <i>Pseudacris maculata</i> , <i>Rana sylvatica</i>
Lost Trail National Wildlife Refuge	MT	USFWS	2001 – ongoing	<i>Ambystoma macrodactylum</i> , <i>Bufo boreas</i> , <i>Rana luteiventris</i>
Theodore Roosevelt National Park	ND	National Park Service	2002 – 2003	<i>Ambystoma tigrinum</i> , <i>Bufo cognatus</i> , <i>Bufo woodhousii</i> , <i>Pseudacris maculata</i> , <i>Rana pipiens</i> , <i>Spea bombifrons</i>
Base level Inventories				
National Forests and BLM lands in Montana	MT	US Forest Service, Bureau of Land Management/Montana Heritage Program	2001 – ongoing	Inventories target all species at a location
National Bison Range	MT	USFWS	2001 – 2003	
Swan River NWR	MT	USFWS	2001	
Medicine Lake NWR	MT	USFWS	2001 – 2002	
Grant-Kohrs Ranch NHS	MT	National Park Service	2001–2002	
Little Bighorn National Battlefield	MT	National Park Service/Idaho State Univ	2001 – 2002	
Red Rock Lakes NWR	MT	USFWS/Idaho State Univ	2001	
Grays Lake NWR	ID	USFWS/Idaho State Univ	2001	
National Elk Refuge	WY	USFWS/Idaho State Univ	2001	
Great Sand Dunes National Monument and Preserve	CO	National Park Service	2001 – 2002	
Blanca Wetlands NWR	CO	USFWS	2002 – 2004	
Florissant Fossil Beds National Monument	CO	National Park Service	2001 – 2002	
Arapaho NWR	CO	USFWS	2004	

Research projects in the Rocky Mountain region in 2005 include two studies funded competitively by ARMI in 2003: effects of wildfire on amphibians in Glacier National Park (enhanced and expanded with additional Forest Service funding to the University of Montana), and establishing distribution of chytrid fungus in the Rocky Mountains and evaluating threats to boreal toads. Two 3-yr studies, funded in 2002 by the Forest Service and Joint Fire Sciences Program, use an ecosystem approach to study the effects of prescribed and wildland fires on stream ecosystems by monitoring amphibians, invertebrates, periphyton, and aquatic habitat conditions. Two graduate student projects at Montana and one at CSU are in progress. Topics include population biology of Columbia spotted frogs, effects of wildfire on habitat use by boreal toads, and the effects of fragmentation and loss of habitat for wood frogs driven by changing water regimes in protected areas. The Idaho State University Herpetology Laboratory is collaborating with the USGS Eros Data Center and Montana State University to develop wetland and amphibian habitat models for Yellowstone National Park.

2005 Progress and Results

Mid-level Monitoring—We are implementing a subtle shift in the study design for mid-level monitoring. Previous efforts have analyzed occupancy rates of each species at individual wetland sites in relatively large watersheds. However, the small number of large watersheds made obtaining a representative sample in the GYE impossible. Also, analyzing occupancy at the wetland level potentially ignores population processes and may result in greater variation that can hinder detection of significant changes in abundance. To address these problems, we reduced watershed size and selected a larger number to sample. We will continue to analyze occupancy at the site level, but we will also estimate occupancy at the watershed (or catchment) level, with the expectation that there will be less year-to-year variation and a greater ability to detect changes at the landscape level. This new design was tested in the GYE and Rocky Mountain using new GIS layers created at USGS-EROS. No mid-level monitoring was conducted in 2005 at Glacier, because the new data layers were not ready and low winter snow pack was expected to result in sub-optimal habitat condition.

In the GYE, we considered average wetland area per catchment and amphibian occupancy data collected in previous years to determine an appropriate scale. Due to the diversity of topography and drainages in the GYE, catchment sample units (approximately 3500 catchments containing wetlands) at the selected scale show large variation in size (1–1260 ha) and amount of potential amphibian breeding habitat. We devised a probabilistic sampling scheme with stratifications for distribution of sampling units (among 5 main watershed basins), accessibility (2 classes: within 4 km of roads and more remote), and amphibian breeding habitat probability (high, medium, and low, based on National Wetland Inventory types and amounts within the catchment). Our goal is to monitor approximately 40 catchments, repeated annually.

In summer 2005, we sampled 17 catchments in the GYE, using two field crews. One catchment contained no wetlands, and one was incompletely surveyed, resulting in 15 catchments providing occupancy data: 4 in GRTE and 11 in YELL. Within the catchments, we visited 210 potential sites. Of these, 122 sites contained water and were surveyed for amphibians; 27 sites were dry but deemed potentially suitable at a future time. Most surveys were conducted by a single observer with a replicate survey by a second observer; approximately 116 of the 122 sites received replicate surveys. To collect additional information on detectability and wetland dynamics, three catchments that were surveyed in June were revisited in July. Survey protocols and data collection were standardized with the other ARMI Great Divide Transect units. Unadjusted occupancy of the catchments for breeding populations of the four species was: boreal toad, 0.13; tiger salamander, 0.20; boreal chorus frog, 0.53; Columbia spotted frog, 0.60. Detection probabilities and analysis of the effects of covariates are pending database quality control and determination of analysis procedures.

At the south end of the Great Divide Transect, surveys were conducted at 132 sites in 15 randomly selected catchments in Rocky Mountain National Park. Catchments were distributed east (10) and west (5) of the Continental Divide (wood frogs do not occur on the east side of the park). Sites were surveyed 1–4 times. Boreal chorus frogs were detected in 4 of 15 catchments (0.27), boreal toads were detected in 1 of 15 catchments (0.07), and wood frogs were detected in 1 of 5 (0.20) west-side catchments. An additional 247 surveys were conducted at 56 sites in the Kawuneeche Valley on the west side of the park, selected based on historic records rather than randomly.

Inventories—The number of inventories in 2005 was reduced from previous years, because we have been shifting to a greater emphasis on the mid-level monitoring (a trend which continues from 2004). In Montana, the inventory of national forests by Bryce Maxell shifted from the University of Montana to the Montana Natural Heritage Program. To date, 349 watersheds (6th-code HUCs) and more than 5600 water bodies have been surveyed. This has resulted in over 6200 species records with numerous extensions of known geographic ranges and maximum elevations. Boreal toads have been found breeding at only 1–3% of sites surveyed.

Apex sites—2005 featured a return of boreal toads to Lost Trail NWR in Montana. We observed only 9 toads in 2004, after having marked 358 individual adults in 2003. In 2005, 247 adult toads were captured, including 19 marked previously. At the Lubrecht Forest, 94 toads were marked, down slightly from the 114 marked in 2004. At Black Rock in Wyoming, we marked 259 adult toads in 2005, similar to numbers marked in 2003 and 2004, and this population continues to be the largest known in Wyoming and Montana. Populations of boreal toads on the National Elk Refuge show no overt signs of decline from 2002 to 2004, based on comparable numbers of adults at breeding sites, egg masses, and reproductive success, but results were inconclusive in 2005 at one of the two main toad breeding sites. Dead toads were found occasionally, and chytrid fungus has been detected at all apex sites in Montana and Wyoming, but no mass mortality events have been observed. Monitoring continued at 7 sites in Rocky Mountain National Park with at least 34 adult toads observed at 5 sites. Breeding was documented at 4 sites.

Boreal chorus frogs were monitored for the 20th consecutive year at 2 sites in northern Colorado using capture-recapture and automated frog call recorders. A 4th year of capture-recapture of wood frogs was completed in Rocky Mountain National Park.

Dissertation research by Bryce Maxell from 2001 to 2004 in the Selway-Bitterroot Wilderness, Montana included more than 30,000 captures of at least 12,000 individual Columbia Spotted frogs in 3 study basins. Monitoring in the Little Rock Creek continued in 2005 through an agreement with the Montana Natural Heritage Program. Dissertation research in Rocky Mountain National Park by Rick Scherer will provide estimates of occupancy by wood frogs and boreal chorus frogs in the Kawuneeche Valley. This research will also evaluate pond- and landscape-scale variables for their ability to explain variation in occupancy.

Research—The distribution of chytrid fungus in the Rocky Mountains was studied in 2003–2004 from a sample of 518 toads at 153 sites. Chytrid occurred at similar rates among sites in all 3 states (42–48%), but individual toads from Montana and Wyoming showed higher incidence of chytrid (45–50%) than did toads in Colorado (13%). Analyses of these data are ongoing. A study by Sophie St.-Hilaire and Peter Murphy at Idaho State University to compare the virulence of chytrid strains from Wyoming and Colorado was funded for 2006–2007 through the Park-Oriented Biological Support program.

We continued our 3rd year of pond surveys in the Robert fire (Glacier National Park), comparing pre- and post-fire occupancy of amphibians. Initial results indicate the same pattern seen in the area burned by the Moose fire in 2001: an immediate increase in the number of boreal toad breeding sites (from ~10% occupancy to 30%), with a decline in occupancy the 2nd year after the fire,

similar to what we observed in the Moose fire in 2002. Greg Guscio, University of Montana is using radio telemetry and biophysical models to determine causes for responses of toads to fire in Glacier National Park, the University of Montana's Lubrecht Forest, and on lands owned by the Plum Creek Timber Co. Greg has found that adult toads continue to use burned forests after the breeding season, and that toads are able to maintain higher nocturnal body temperatures without suffering increased evaporative water loss, which potentially makes burned forests better foraging habitat.

To understand stream community responses to prescribed fire, the JFSP-funded project headed by David Pilliod sampled 2 burned and 7 unburned streams on the Payette National Forest, Idaho for amphibians, invertebrates, periphyton, water chemistry and various habitat characteristics. A 2nd burn, which has been scheduled for some time, was postponed until May 2006. This project received additional funding from JFSP to complete field work in 2006. The Robert fire in Glacier National Park provided us with an opportunity to compare effects of fire on tailed frogs, using 8 streams that had been sampled in 2002, 4 of which occurred in watersheds severely burned in 2003. Fire appears to have reduced abundance of tadpoles in burned streams relative to unburned streams, with the largest effect on 1st-year tadpoles.

Plans for 2006

We expect to fully implement the new mid-level monitoring design throughout the Great Divide transect; the GRYN will continue to contribute \$35,000 (to Idaho State University) to this effort. We have funding sufficient for this year, but the long-term success of this effort will require additional funds. We intend to continue to collect population data at the apex sites listed in Table 1, but funding constraints may also affect these efforts and prioritization will likely be necessary in the future. Graduate work on wood frogs and chorus frogs at the apex site on the west side of Rocky Mountain will continue and expand, including capture-recapture and an investigation into the genetics of wood frogs. David Pilliod will conclude the JFSP project. Inventories by the Montana Natural Heritage Program will continue.

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 Randy Jennings, Western New Mexico University, Silver City
 Bruce Christman, Turner Enterprises, Ladder Ranch, NM

Reimbursable and Leveraged Funding

Rocky Mountain National Park provided \$15,000 to Erin Muths in 2005 for boreal toad monitoring. Collaborators in the Rocky Mountain Region have been highly successful in developing projects that interact with ARMI by sharing data, or which have similar objectives and make use of methods developed by ARMI, or collaborate in studying causes of amphibian declines. Total reimbursable and leveraged funding received in FY2005 totaled about \$372,000, or 146% of the USGS funding to the Rocky Mountain Region. Individual collaborative projects are listed below.

Recipient/Cooperator	Funding Source	Amount	Reimbursable (R) or Leveraged (L)	Project
Stephen Corn (NRMSC)/ David Pilliod (Cal Poly-San Luis Obispo)	Joint Fire Sci- ences Program	\$75,000	R	Effects of Prescribed Fire on Stream Ecosys- tems
Erin Muths (FORT)	National Park Service	15,000	R	Boreal toad monitoring in Rocky Mountain National Park
Bryce Maxell (Montana Natu- ral Heritage Program)	Montana Depart- ment of Fish, Wildlife & Parks; US Forest Ser- vice/University of Montana; Mon- tana Natural Heri- tage Program; Montana Depart- ment of Environ- mental Quality	\$193,685	L	Amphibian & reptile inventories in Montana
Lisa Eby, Greg Guscio (Uni- versity of Montana)	US Forest Service (McIntire-Stennis)	\$54,576	L	Response of western toads (<i>Bufo boreas</i>) to forest management practices
Chuck Peterson, Debra Patla (Idaho State University)	National Park Service, Greater Yellowstone I&M Network	\$34,975	L	Evaluation of amphibi- ans for vital signs monitoring in the GRYN, boreal toad monitoring on the NER

Products

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