# US Geological Survey Amphibian Research and Monitoring Initiative
# Rocky Mountain Region, 2004 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, and Rocky Mountain national parks,. Studies in Yellowstone and Grand Teton were funded in 2004 by the National Park Service Greater Yellowstone Inventory and Monitoring Network (GRYN) to Chuck Peterson at Idaho State University. Inventories include a large collaborative effort on National Forests in Montana, conducted by Bryce Maxell at the University of Montana.

**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 | *Bufo boreas* |
| Lubrecht Experimental Forest, Jones Pond | MT | Univ Montana | 2004 – ongoing | *Bufo boreas* |
| Glacier National Park, three catchments | MT | National Park Ser vice | 1999 – ongoing | *Bufo boreas* |
| Bitterroot National Forest, Lost Horse Marsh | MT | US Forest Service | 1999 – ongoing | *Pseudacris regilla, Rana luteiventris* |
| Bitterroot National Forest, Selway-Bitterroot Wilderness, Little Rock Creek Basin | MT | US Forest Service/Univ Montana | 2001 – ongoing | *Rana luteiventris* |
| Bitterroot National Forest, six streams | MT | US Forest Service | 2003 – ongoing | *Ascaphus montanus* |
| Yellowstone National Park, Lodge Creek | WY | National Park Service/Idaho State Univ | (1953 –1955)<br>1992 – ongoing | *Rana luteiventris* |
| Bridger-Teton National Forest, Black Rock Ranger Station | WY | US Forest Service/Idaho State Univ | 2003 – ongoing | *Bufo boreas* |
| National Elk Refuge, Nowlin Creek & Romney Pond | WY | USFWS/Idaho State Univ | 1998 – ongoing | *Bufo boreas* |

| Location | State | Agency/Collaborator | Period | Primary Species |
|---|---|---|---|---|
| Arapaho-Roosevelt National Forest, Lily & Matthews ponds | CO | US Forest Service | (1961 – 1973) 1986 – ongoing | *Pseudacris maculata* |
| Rocky Mountain National Park, North Fork Big Thompson River, Spruce Lake | CO | National Park Service | 1991 – ongoing | *Bufo boreas* |
| Rocky Mountain National Park, Kawuneeche Valley | CO | National Park Service/Colorado State Univ | 2002 – ongoing | *Rana sylvatica* |
| San Isabel National Forest, Collegiate Peaks Wilderness, Denny Creek | CO | US Forest Service/Colorado Division of Wildlife | Ongoing | *Bufo boreas* |
| **Mid-level Monitoring Sites** | | | | |
| Glacier National Park | MT | National Park Service | 1999 – ongoing | *Ambystoma macrodactylum, Ascaphus montanus, Bufo boreas, Rana luteiventris* |
| GYE (Yellowstone & Grand Teton national parks, JD Rockefeller Parkway) | MT, WY | National Park Service/Idaho State Univ | 2000 – ongoing | *Ambystoma tigrinum, Bufo boreas, Pseudacris maculata, Rana luteiventris* |
| Rocky Mountain National Park | CO | National Park Service | 1988 – 1990, 1994, 2000 – ongoing | *Ambystoma tigrinum, Bufo boreas, Pseudacris maculata, Rana sylvatica* |
| Lost Trail National Wildlife Refuge | MT | USFWS | 2001 – ongoing | *Ambystoma macrodactylum, Bufo boreas, Rana luteiventris* |
| Theodore Roosevelt National Park | ND | National Park Service | 2002 – 2003, *2005 – 2007 (proposed)* | *Ambystoma tigrinum, Bufo cognatus, Bufo woodhousii, Pseudacris maculata, Rana pipiens, Spea bombifrons* |
| **Base level Inventories** | | | | |
| National Forests and BLM lands in Montana | MT | US Forest Service, Bureau of Land Mangement/Univ Montana | 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 – ongoing | |
| Florissant Fossil Beds National Monument | CO | National Park Service | 2001 – 2002 | |
| Arapaho NWR | CO | USFWS | 2004 | |

Research projects in the Rocky Mountain region in 2004 include two studies funded competitively by ARMI in 2003: effects of wildfire on amphibians in Glacier National Park; 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 the boreal toads. 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.

## 2004 Progress and Results

*Mid-level Monitoring*—At the north end of the Great Divide Transect, we conducted 454 surveys of 295 sites in randomly selected GLAC watersheds. Detection probabilities for the three common pond-breeding species were high (0.87 – 0.88). Adjusted for detection probability, occupancy by these species was 0.05 (SE = 0.01; boreal toad), 0.26 (SE = 0.03; Columbia spotted frog), and 0.55 (SE = 0.03; long-toed salamander) of sites surveyed. Including our continuing fire research and boreal toad apex sites, we conducted 966 surveys of 565 sites.

Field work in the GYE in 2004 was designed to provide information requested by the GRYN Vital Signs monitoring program for establishment of long-term amphibian monitoring in Yellowstone and Grand Teton national parks. Data collection targeted remaining questions about detectability estimates, site definition, and time budgets. Surveys were conducted 154 sites in 4 selected watersheds that were previously surveyed; 138 of these sites were surveyed 2–4 times. Adjusted for detection probabilities that varied from 0.51 to 1.0, occupancies by four species was 0.02 (SE = 0.01; boreal toad), 0.22 (SE = 0.03, Columbia spotted frog), 0.33 (SE = 0.05, tiger salamander), 0.68 (SE = 0.04, boreal chorus frog).

At the south end of the Great Divide Transect, we conducted 212 surveys of 99 sites in 8 randomly selected watersheds in Rocky Mountain National Park. Adjusted for detection, occupancy of boreal chorus frogs was 0.09, and occupancy of boreal toads was 0.01. Additional surveys of 106 sites in the Kawuneeche Valley on the west side of the park, selected based on historic records rather than randomly, found greater naïve occupancy (unadjusted for detection) of boreal chorus frogs (0.55). Naïve occupancy of wood frogs, which only occur on the west side, was 0.33.

*Inventories*—The number of inventories in 2004 was reduced from previous years, because we have been shifting to a greater emphasis on the mid-level monitoring (a trend which will continue in 2005) and because we received no additional funding to support base level surveys. In Montana, we continued to inventory sites at the Lost Trail National Wildlife Refuge. In Colorado, we initiated an inventory at the Arapaho National Wildlife Refuge. We detected boreal chorus frogs, wood frogs, and northern leopard frogs.

The inventory of Montana national forests by Bryce Maxell at the University of Montana has resulted so far in surveys of 284 watersheds ($6^{th}$-code HUCs) and more than 4,571 water bodies. This has resulted in over 5000 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*—Monitoring of boreal toads had mixed results. At Lost Trail NWR in Montana, we observed only 9 toads, after having marked 358 individual adults in 2003. Whether this represents a catastrophic reduction in population size, such as we have observed in Colorado, is unknown.

The chytrid fungus is present at this site, but the weather in 2004, a warm, dry April followed by a cold, wet May, may have affected toad breeding behavior. For example, breeding activity may have been compressed to a period when we were not present to sample. We had greater success at other locations, in Montana and Wyoming. At the Lubrecht Forest, 111 toads were marked in 2 nights of effort, and at Black Rock in Wyoming, we have marked 552 adult toads in 2003 and 2004, and this population appears to be robust, despite the presence of the chytrid fungus in both years. 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. Dead toads were found occasionally (results of pathology tests not yet available), but no mass mortality events have been observed. Monitoring continued at four sites in Rocky Mountain National Park. Fourteen sampling sessions at 4 ponds, produced 55 toads (8 new and 47 recaptures). At these sites, there are few toads to be captured, due to, or at least affected by, the presence of chytrid fungus. We also observed breeding activity and multiple life stages at a new site on the west side of ROMO where boreal toads have not been detected since 1988.

Boreal chorus frogs were monitored for the 19$^{th}$ consecutive year at two sites in northern Colorado using capture-recapture and automated frog call recorders. A 3$^{rd}$ year of capture-recapture of wood frogs was completed in Rocky Mountain National Park, and movements of five frogs were monitored using radio telemetry.

Six streams on the Bitterroot National Forest in Montana were sampled for tailed frogs in 2003 and 2004. Frogs were marked with elastomer pigments in 2003 and PIT tags in 2004. Poor weather hampered sampling efforts in 2004.

Dissertation research by Bryce Maxell since 2001 in the Selway-Bitterroot Wilderness, Montana has included more than 30,000 captures of at least 12,000 individual Columbia Spotted frogs in three study basins. We intend to continue monitoring in one of these basins (Little Rock Creek) to take advantage of this valuable data set.

A small project on Department of Interior Land in New Mexico was initiated in 2004 in collaboration with Cecil Schwalbe (USGS ARMI), Randy Jennings (Western New Mexico University), Charlie Painter (New Mexico Department of Game and Fish) and Bruce Christman (Turner Enterprises, the Ladder Ranch). Preliminary data on the occurrence of chytrid fungus at this site included one positive PCR test from six Chiricahua leopard frogs. Four plains leopard frogs and six canyon treefrogs all tested negative. Depending on funding, we will continue studies of Chiricahua leopard frogs, disease prevalence and the role of thermal micro-habitat differences.

*Research*—Analysis of factors affecting detection probabilities is pertinent to finalizing sampling design in the GYE. Larissa Bailey assessed the effect of sampling period on detection probabilities in Hayden Valley, 2002–2004, using time periods as covariates in model testing. Models including time-variation were consistently the best model for tiger salamanders and occasionally the best for boreal chorus frogs and Columbia spotted frogs. Similar analysis for another watershed sampled in 2004 provided more consistent results among species; time-variation models garner at least 25% of model weight for all three species. These results suggest that repeat visits for at least a subset of sites should be distributed through the sampling season to account for the influence of seasonal variation, to break any confounding that might occur between seasonal variation in detection probability and the more important spatial variation in both occupancy and detection probabilities.

The distribution of chytrid fungus in the Rocky Mountains was studied in 2003–2004 from a sample of 518 toads at 153 sites. Ventral skin swabs were subjected to PCR analysis (Pisces Molecular, Boulder, CO) for presence of rRNA from *Batrachochytrium dendrobatidis*. Boreal toad populations in all 3 states tested positive, including 42% of sites in Montana, 47% in Wyoming, and 48% in Colorado. However, in Montana and Wyoming 45–50% of 414 toads tested positive

for chytrid whereas only 13% of 104 toads tested positive in Colorado. A similar pattern was observed at apex sites, where 43–50% of 96 toads tested positive for chytrid in ponds on the Lost Trail NWR and Black Rock Pond in Wyoming, but only 6% of 61 toads tested positive for chytrid at Denny Creek in Colorado. Ongoing investigations will further investigate how chytrid influences population dynamics in these toad populations, especially in relation to other environmental stressors. Of utmost importance is distinguishing between presence of *B. dendrobatidis* and presence of the chytridiomycosis, the disease caused by the fungus, which is usually lethal. Over the next several years, we will be able to estimate survival rates of toads that tested positive for chytrid compared to those that tested negative. As methodologies improve, we hope to use these apex population studies to understand the mechanisms of resistance to and resilience from chytridiomycosis in individual toads and how this influences susceptibility of populations to virulent strains of the disease.

A pilot study of the effects on chytrid fungus on boreal toads in Grand Teton National Park was completed in 2004 in collaboration with the park and with funding from the Rocky Mountain Cooperative Ecosystems Studies Unit, Missoula, MT. Despite a high proportion of toads testing positive for presence of *B. dendrobatidis* during the breeding season (15 of 18 and 6 of 20 at two sites), we observed no mortality of toads or other evidence of chytridiomycosis. Twelve toads were fitted with radio transmitters in early July; four of these tested positive for presence of chytrid at that time. One of these toads had the largest home range, and these toads selected locations with higher shrub cover, but there were no other differences compared to toads that tested negative for chytrid. No toads tested positive for presence of chytrid when radios were removed in September. The disappearance of the chytrid fungus from individual toads during the summer raises interesting questions about either the pathogenicity of the fungus in the central Rockies or the ability of toads in this region to withstand chytridiomycosis.

We continued our third year of pond surveys in the Moose fire (Glacier National Park), comparing pre- and post-fire occupancy of amphibians. We began post-fire pond surveys in the 2003 Robert and Lincoln Creek fires in Glacier NP, where we have up to 5 years of pre-fire data for some ponds. Initial results from the Roberts fire indicate a large increase (5–6 ×) in the number of boreal toad breeding sites, similar to what we observed in the Moose fire in 2002. Interestingly, we observed no breeding by toads at sites within the Moose fire, suggesting that toad responses to fire are complex. Greg Guscio, University of Montana initiated his thesis research using radio telemetry and biophysical models to determine causes for responses of toads to fire in Glacier National Park and on the University of Montana's Lubrecht Forest.

To understand stream community responses to wildland fire, the JFSP-funded project headed by David Pilliod sampled 15 burned and 15 unburned streams in Idaho and Montana in 2004. The Parks-Eiguren Prescription Burn on the Payette National Forest, Idaho was successfully burned in May 2004. We collected post-fire data on two burned streams (Reegan and Parks) and five nearby unburned reference streams. The Williams-Dutch Oven Prescription Burn on the Payette National Forest was not completed as planned in 2004, but will be completed in May 2005. Preliminary results from our retrospective wildland fire study suggest that tailed frogs generally have lower reproductive success following stand-replacing fire events, but responses were highly variable among watersheds and some populations showed signs of recovery after 2–4 years. Giant salamander populations appear to be less affected by fire. Macroinvertebrate communities showed negative responses to fire, particularly among ephemeropterans. Macroinvertebrate responses varied among streams and recovery appeared to begin within a few years of the fire. Some of the variability in abiotic and biotic responses to fire may be explained by variation in burn severity within riparian forests and across watersheds.

Three grad student projects, fully or partially funded by Rocky Mountain ARMI, were completed in 2004. W. Chris Funk received a PhD from the University of Montana; his dissertation was ti-

tled, "Patterns and consequences of dispersal in Columbia spotted frogs (*Rana luteiventris*)." Two papers from this work are in press. Aimee C. Wyrick received a MS, also from UM, with a thesis titled, "Demography of the Columbia spotted frog (*Rana luteiventris*) in the presence or absence of fish in the Absaroka-Beartooth Wilderness, Montana." Richard D. Scherer received a MS from Colorado State University with a thesis titled, "An evaluation of weather and introduced disease as causes of decline in two populations of boreal toads in Rocky Mountain National Park: an Information-theoretic approach."

## Plans for 2005

Monitoring will continue on the Great Divide transect; the GRYN will contribute $30,000 (to Idaho State University) to this effort. We will alter the sampling design to achieve better geographic balance in the sampling effort. The major changes will be a decrease in the size of watershed sample units and an increase in the level of effort in the GYE to allow better inference about occupancy of amphibians in this area. We will also shift from an emphasis on occupancy at sites to occupancy of sample units. We are also working with Theodore Roosevelt National Park to develop a proposal to initiate long-term monitoring using automated frogloggers. We intend to continue to collect population data at the apex sites listed in Table 1, but funding constraints may start to affect these efforts and prioritization will likely be necessary in the future. Already, we plan to scale back on the boreal toad sites in Rocky Mountain National Park with few animals and redirect some of our focus to the newly discovered site on the west side of the park. 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, radio telemetry and an investigation into the genetics of wood frogs. We will pursue funding sources for work at the Cuchillo Negro site in New Mexico. Fire research will continue in Glacier National Park. Numerous wetlands that have been surveyed during 1999-2003 burned in the extensive wildfires in GLAC in 2003, providing an enormously valuable data set that we are using to document the effect of wildfire on amphibians. David Pilliod is moving from his post-doctoral position with the Forest Service to a faculty position at Cal Poly–San Luis Obispo, but he will continue his fire research in Idaho. The USGS fire program has already committed $20,000 to this effort, and David has applied for an extension and additional funds from JFSP.

## Staff

**P. Stephen Corn**, Zoologist (Research), Northern Rocky Mountain Science Center and Aldo Leopold Wilderness Research Institute, Missoula, MT

**Erin Muths**, Zoologist (Research), Fort Collins Science Center, Fort Collins, CO

**Blake R. Hossack**, Zoologist, Northern Rocky Mountain Science Center, Missoula, MT

**Richard D. Scherer**, PhD candidate, Colorado State University, Fort Collins

**David S. Pilliod**, Ecologist, US Forest Service, Aldo Leopold Wilderness Research Institute, Missoula, MT (new address beginning January 2005: Biological Sciences Department, California Polytechnical State University, San Luis Obispo, CA)

**Collaborators**

Charles R. Peterson and Deb Patla Idaho State University
Lisa Eby, Chris Funk, Bryce Maxell, Aimee Wyrick, and Greg Guscio, University of Montana
Alisa Gallant, Paul Bartelt, and Robert Klaver USGS Eros Data Center; Dan Goodman, Montana State University
Rob Bennetts, Cathie Jean, National Park Service GRYN, Bozeman, MT
Steve Diamond, US EPA, Duluth, MN
Don Campbell, USGS Water Resources, Denver, CO
Sue Wolff, National Park Service, Grand Teton National Park
Jill Lucero, Blanca Wetlands National Wildlife Refuge, CO
Cecil Schwalbe, USGS, Western Ecological Research Center, Tucson, AZ
David Green, USGS National Wildlife Health Center, Madison, WI
Charlie Painter, New Mexico Department of Game and Fish, Santa Fe
Randy Jennings, Western New Mexico University, Silver City
Bruce Christman, Turner Enterprises, Ladder Ranch, NM

## Leveraged Funding

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. Funding received by these collaborators in FY2004 totaled about $343,000, or 134% of the USGS funding to the Rocky Mountain Region. Individual projects are listed below.

| Cooperator | Funding Source | Amount | Project |
|---|---|---|---|
| Bryce Maxell, Lisa Eby (University of Montana) | US Forest Service | $70,000 | Amphibian & reptile surveys on the Lolo & Flathead National Forests |
| Bryce Maxell, Lisa Eby (University of Montana) | Montana Department of Fish, Wildlife & Parks | $55,000 | Amphibian & reptile inventories in Montana |
| Bryce Maxell, Lisa Eby (University of Montana) | Bureau of Land Management/Plum Creek Timber | $15,000 | Amphibian & reptile inventories in west-central Montana |
| Lisa Eby, Greg Guscio (University of Montana | National Center for Landscape Fire Analysis | $40,098 | Response of western toads (Bufo *boreas)* to forest management practices |
| Chuck Peterson, Debra Patla (Idaho State University) | National Park Service, Greater Yellowstone I&M Network, USFWS National Elk Refuge | $62,840 | Evaluation of amphibians for vital signs monitoring in the GRYN, boreal toad monitoring on the NER |
| Susan Wolff (Grand Teton National Park) | Rocky Mountain Cooperative Ecosystem Studies Unit | $10,000 | Incidence of chytrid fungus and effects on boreal toads in Grand Teton National Park |
| David Pilliod (Cal Poly – San Luis Obispo) | USGS Fire Sciences | $20,000 | Effects of Prescribed Fire on Stream Ecosystems |
| David Pilliod (USFS Aldo Leopold Wilderness Research Institute) | Joint Fire Sciences Program | $70,000[a] | Effects of Prescribed Fire on Stream Ecosystems |

[a]Year 3 of a grant to RB Bury and DS Pilliod for $371,767 in FY2002

## Products

### Papers published in FY 2004

Boone MD, Corn PS, Donnelly MA, Little EE, Niewiarowski PH. 2003. Physical stressors. In: Linder G, Bishop CA, Sparling DA, editors. Global decline of amphibian populations: an integrated analysis of multiple stressor effects. Pensacola, FL: Society of Environmental Toxicology and Chemistry. p 129–151.

Campbell DH, Muths E, Turk JT, Corn PS. 2004. Sensitivity to acidification of subalpine ponds and lakes in northwestern Colorado. Hydrological Processes 18:2817–2834.

Corn PS. 2003. Deteriorating status of western amphibians: can we generalize about causes? In: Linder G, Bishop CA, Sparling DA, editors. Global decline of amphibian populations: an integrated analysis of multiple stressor effects. Pensacola, FL: Society of Environmental Toxicology and Chemistry. p 249–255.

Corn PS, Muths E. 2004. Variable breeding phenology affects the exposure of amphibian embryos to ultraviolet radiation: reply. Ecology 85:1759–1763.

Funk WC. 2004. Patterns and consequences of dispersal in Columbia spotted frogs (*Rana luteiventris*) [dissertation]. Missoula: University of Montana. 140 p.

Hossack BR, Corn PS. 2004. Responses of pond-breeding amphibians to wildfire in Glacier National Park [abstract]. Northwestern Naturalist 85:78.

Karraker NF, Pilliod DS, Bull EL, Corn PS, Diller LV, Dupuis LA, Hayes MP, Hossack BR, Hodgson GR, Hyde EJ, Lohman K, Norman BR, Ollivier LM, Pearl CA, Peterson CR. 2004. Taxonomic and geographic variation in the oviposition of tailed frogs (*Ascaphus* spp.) [abstract]. Northwestern Naturalist 85:79.

Muths E. 2003. A radio transmitter belt for small ranid frogs. Herpetological Review 34:345–348.

Pilliod DS, Corn PS. 2003. Changes in stream amphibian populations following large fires in Idaho [abstract]. Northwestern Naturalist 84:110–111.

Pilliod DS, Corn PS, Bury RB, Hyde EJ. 2004. Effects of wildland fires on stream amphibian populations in the greater Northwest [abstract]. Northwestern Naturalist 85:85–86.

Scherer RD. 2004. An evaluation of weather and introduced disease as causes of decline in two populations of boreal toads in Rocky Mountain National Park: an Information-theoretic approach [thesis]. Fort Collins: Colorado State University.

Werner JK, Maxell BA, Flath D, Hendricks DP. 2004. Field guide to amphibians and reptiles of Montana. Missoula, MT: Mountain Press. 268 p.

Wyrick AC. 2004. Demography of the Columbia spotted frog (*Rana luteiventris*) in the presence or absence of fish in the Absaroka-Beartooth Wilderness, Montana [thesis]. Missoula: University of Montana. 118 p.

### Papers in press

Adams MJ, Hossack, BR, Knapp RA, Corn PS, Diamond SA, Trenham PC, Fagre D. 2005. Distribution patterns of lentic breeding amphibians in relation to ultraviolet radiation exposure in western North America. Ecosystems 8: (in press).

Brooks PD, O'Reilly CM, Diamond SA, Campbell DH, Knapp RA, Bradford, DM, Corn PS, Hossack BR, Tonnessen KA. 2005. Spatial and temporal variability in the amount and source of dissolved organic carbon: implications for UV exposure in amphibian habitats. Ecosystems 8: (in press).

Corn PS. 2005. Climate change and amphibians. Animal Biodiversity and Conservation 28: (in press).

Corn PS, Adams MJ, Battaglin WA, Gallant AL, James DL, Knutson M, Langtimm CA, Sauer JR. In press. Amphibian Research and Monitoring Initiative: concepts and implementation. Reston, VA: U.S. Geological Survey. Biological Science Report.

Corn PS, Hossack BR, Muths E, Patla D, Peterson CR, Gallant AL. 2005. Status of amphibians on the Continental Divide: surveys on a transect from Montana to Colorado. Alytes 22: (in press).

Corn PS, Muths E, Adams MJ.2005. The U. S. Geological Survey's Amphibian Research and Monitoring Initiative. Alytes 22: (in press).

Diamond SA, Trenham PC, Adams MJ, Hossack, BR, Knapp RA, Bradford, DM, Corn PS, Czarnowski K, Breen B, Fagre D, Detenbeck NE, Tonnessen KA. 2005. Estimated ultraviolet radiation doses in wetlands in six national parks. Ecosystems 8: (in press).

Funk WC, Alford RA. 2004. Balancing the costs and benefits of research methods for amphibian conservation.. Nature (in press).

Funk WC, Blouin MS, Corn PS, Maxell BA, Pilliod DS, Amish S, Allendorf FW. 2005. Population structure of Columbia spotted frogs (*Rana luteiventris*) is strongly affected by the landscape. Molecular Ecology (in press).

Funk WC, Greene AE, Corn PS, Allendorf FW. 2005. High dispersal in a frog species suggests that it is vulnerable to habitat fragmentation. Biology Letters (in press).

Green DE, Muths E. 2005. Health evaluation of amphibians in and near Rocky Mountain National Park. Alytes 22: (in press).

Muths E, Jung RE, Bailey L, Adams MJ, Corn PS, Dodd CK Jr, Fellers GM, Sadinski WJ, Schwalbe CR, Walls SC, Fisher RN, Gallant AL, Battaglin WA, Green DE. In press. The U.S. Department of Interior's Amphibian Research and Monitoring Initiative: a successful start to a national program. Applied Herpetology.

## Reports

Maxell BA. 2004. Preliminary report on amphibian and aquatic reptile inventories conducted on and around the Ashland District of the Custer National Forest in 2002 and 2004. Report to US Forest Service (Ashland District, Custer National Forest and Region 1) and Montana Department of Fish, Wildlife, and Parks. Missoula: Montana Cooperative Wildlife Research Unit and University of Montana Wildlife Biology Program. 93 p.

Maxell BA. 2004. Amphibian and aquatic reptile inventories conducted on and around the Bitterroot National Forest 2000–2003. Report to US Forest Service (Region 1 and Bitterroot National Forest), Montana Department of Fish, Wildlife, and Parks, and USGS-ARMI. Missoula: Montana Cooperative Wildlife Research Unit and University of Montana Wildlife Biology Program. 128 p.

Maxell BA. 2004. Report on amphibian and aquatic reptile inventories conducted on and around the Beaverhead-Deerlodge National Forest 2001–2003. Report to US Forest Service (Region 1), Bureau of Land Management (Montana State Office), and Montana Department of Fish, Wildlife, and Parks. Missoula: Montana Cooperative Wildlife Research Unit and University of Montana Wildlife Biology Program. 260 p.

Maxell BA. 2004. Preliminary report on amphibian and aquatic reptile inventories conducted in the West Boulder River area during summer 2003. Report to US Forest Service (Region 1) and Montana Department of Fish, Wildlife, and Parks. Missoula: Montana Cooperative Wildlife Research Unit and University of Montana Wildlife Biology Program. 27 p.

Patla D, Peterson CR. 2004. Final report: amphibian and reptile inventory and monitoring, Grand Teton and Yellowstone National Parks 2000–2003. Report to National Park Service (Greater Yellowstone Inventory and Monitoring Network, Yellowstone and Grand Teton National Parks) and USGS-ARMI. Pocatello: Herpetology Laboratory, Dept of Biological Sciences, Idaho State University. 59 p + appendices.

Spear S, Maxon N, Wolff S, Corn S. 2004. Final report: incidence and effects of chytrid fungus on boreal toads (*Bufo boreas*) in Grand Teton National Park. Report to the Rocky Mountain Cooperative Ecosystem Studies Unit. Missoula, MT: USGS-ARMI; and Moose, WY: Grand Teton National Park. 11 p.

## Presentations & Posters

Aquatic chemistry of amphibian breeding habitats in the mountains of western North America. DH Campbell, E Muths, BR Hossack, DS Pilliod, EJ Hyde, and PS Corn. Society of Environmental Toxicology and Chemistry, Austin, TX. 10 November 2003.

Amphibian monitoring on the Great Divide transect [poster]. E Muths, PS Corn, BR Hossack, D Patla, and CR Peterson. Society of Environmental Toxicology and Chemistry, Austin, TX. 10 November 2003.

History, organization, and key elements of the Amphibian Research and Monitoring Initiative. PS Corn, WA Battaglin, RB Bury, CK Dodd, Jr., GM. Fellers and AL Gallant. Society of Environmental Toxicology and Chemistry, Austin, TX. 10 November 2003.

USGS-ARMI amphibian surveys in Yellowstone National Park: methods, results, and applications. DA Patla and CR Peterson. Society of Environmental Toxicology and Chemistry, Austin, TX. 10 November 2003.

Detection of *Batrachochytrium dendrobatidis*, the Chytrid fungus associated with global amphibian declines, in Montana amphibians. BA Maxell. Montana Chapter of the American Fisheries Society, Whitefish, MT. 4 February 2004.

Using amphibians in monitoring and assessment of wetlands. BA Maxell. Invited presentation to the U.S. Environmental Protection Agency Western Bioassessment Workgroup, Rapid City, SD. 24 February 2004.

Detection of *Batrachochytrium dendrobatidis*, the chytrid fungus associated with global amphibian declines, in Montana amphibians. BA Maxell. Montana Chapter of the Wildlife Society, Bozeman, MT. 23 February 2004.

Taxonomic and geographic variation in the oviposition of tailed frogs (*Ascaphus* spp.). NF Karraker, DS Pilliod, EL Bull, PS Corn, LV Diller, LA Dupuis, MP Hayes, BR Hossack, GR Hodgson, EJ Hyde, K Lohman, BR Norman, LM Ollivier, CA Pearl, and CR Peterson. Northwest Science Association and Society for Northwestern Vertebrate Biology, Ellensburg, WA. 25 March 2004.

Effects of wildland fires on stream amphibian populations in the greater Northwest. DS Pilliod, PS Corn, RB Bury, and EJ Hyde. Symposium, Fire and Hazardous Fuel Reduction Effects on Wildlife, held at the annual meeting of the Northwest Science Association and Society for Northwestern Vertebrate Biology, Ellensburg, WA. 26 March 2004.

Responses of pond-breeding amphibians to wildfire in Glacier National Park. BR Hossack and PS Corn. Symposium, Fire and Hazardous Fuel Reduction Effects on Wildlife, held at the annual meeting of the Northwest Science Association and Society for Northwestern Vertebrate Biology, Ellensburg, WA. 26 March 2004.

Erin Muths and Steve Corn organized the symposium, "Amphibian Research and Monitoring Program (ARMI): Research Results and Monitoring Progress", sponsored by the American Society of Ichthyologists and Herpetologists and the International Society for the Study and Conservation of Amphibians, and held 31 May 2004 at the joint annual meeting of ASIH, the Herpetologists' League, and the Society for the Study of Amphibians and Reptiles, in Norman, Oklahoma. Presentations from the Rocky Mountain Region included:

> Estimation of the propensity of male toads to return to the breeding site. E Muths, RD Scherer, and PS Corn.
>
> Health evaluation of amphibians in Rocky Mountain National Park. DE Green and E. Muths.
>
> The role of nonnative fishes on amphibian distributions in the northern Rocky Mountains DS Pilliod, BR Hossack, PF Bahls, EL Bull, PS Corn, G Hokit, BA Maxell, JC Munger, P Murphy, and AC Wyrick.
>
> Status of amphibians on the Continental Divide: surveys on a transect from Montana to Colorado. PS Corn, BR Hossack, E Muths, D Patla, and CR Peterson.

Days of our toads: The continuing saga of the boreal toad in Rocky Mountain National Park. E. Muths. Rocky Mountain National Park Continental Divide Research and Learning Center, Research and Resources Days. Estes Park, CO

Amphibians and snow: estimated changes in breeding phenology in the mountains of the western United States. PS Corn, WA Battaglin, BR Hossack, E Muths, DH Olson, DA Patla, DS Pilliod, and VT Vredenburg. Ecological Society of America, Portland, OR, 3 August.

Amphibian research in Glacier National Park. PS Corn and BR Hossack. Glacier Science Conference, Glacier National Park, 12 August 2004.