REPORT
ON
THE STATUS AND CONSERVATION
OF
THE BOREAL TOAD
Bufo boreas boreas
IN
THE SOUTHERN ROCKY MOUNTAINS

1997

Prepared By The Boreal Toad Recovery Team
Chuck Loeffler, Coordinator/Editor

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Colorado Division of Wildlife
6060 Broadway
Denver, CO 80216

April, 1998

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INTRODUCTION AND SUMMARY

This report is intended to provide a comprehensive summary of boreal toad conservation work in the southern Rocky Mountains, and to serve as a status report on progress made to date towards recovery of this species.

Once common in the southern Rocky Mountains, the boreal toad has experienced dramatic declines in population over the past 15 to 20 years. Reasons for declines have not been definitely identified, but may be various, including effects of acidification of water, effects of heavy metals and other toxins in waters, new or more virulent strains of pathogens, habitat disturbance, or a combination of factors, leading to stress-induced immunosuppression, and hence increased susceptibility to naturally occurring pathogens.

The boreal toad is presently listed as an endangered species by both Colorado and New Mexico, and is a protected species in Wyoming. The U.S. Fish and Wildlife Service has classified the southern Rocky Mountain population of the boreal toad as a candidate species which is "warranted but precluded" for federal listing - meaning there is adequate justification and information to warrant federal listing as threatened or endangered, but listing has been postponed, as there are presently other species in greater need of listing, and the US Fish & Wildlife Service has limited resources to prepare and process listing packages. Also, in 1995, the State of Colorado and the US Department of the Interior entered in to a Memorandum of Agreement which committed the State of Colorado and agencies in the Department of the Interior to collaborate and cooperate in management and conservation of declining populations of fish and wildlife, such as the boreal toad, and their habitat. Pursuant to these actions, a recovery plan for the boreal toad was developed by the Colorado Division of Wildlife in 1994 (revised Jan. 1997), and an interagency recovery team was formed that same year. In 1998, the existing Recovery Plan will be updated and combined with an existing draft Conservation Strategy to create a comprehensive Boreal Toad Conservation Plan for the southern Rocky Mountains. A draft Conservation Agreement will be presented to the involved state and federal agencies for approval and confirmation of their respective roles in implementing the Conservation Plan.

For the past three years, the recovery team has worked on plans and actions to implement recovery and conservation efforts for the boreal toad. Work to date has involved several state and federal resource management agencies, personnel from universities, and various other interested parties - including local land use planners and private land owners. Management activities to date have included (1) the conducting of surveys of historic and potential suitable habitats for new toad populations, (2) the annual monitoring of known breeding populations, (3) research work to identify and evaluate both biotic and abiotic limiting factors to toad survival, (4) research to better define good boreal toad habitat and boreal toad biology/ecology, (5) development and testing of techniques and protocols for captive breeding and rearing of boreal toads, (6) experimental reintroductions of toads to vacant historic habitat, (7) protection of boreal toads and their habitats via coordination with land management agencies - in particular with the US Forest Service, (8) work with local land use planners and developers aimed at avoiding or

minimizing potential impacts of private land development on boreal toads and their habitat, and (9) efforts to increase public awareness of this species and its plight via informational/educational activities & public involvement in searches for new populations of boreal toads.

As of the end of 1997, the boreal toad is known, or believed, to still occur in at least 15 counties in Colorado, two counties in Wyoming, and one county in New Mexico. This is based on surveys, monitoring of breeding sites, and on confirmed or reliable observations of individual boreal toads. Breeding populations have been documented during the past five years in 12 counties in Colorado, and at one location in Wyoming. There are presently 37 known breeding localities - some having more than one breeding site - located in nine of the geographic areas, or "mountain ranges of historic occurrence". Two of the historic areas of occurrence (White River Plateau and Grand Mesa, Colorado) have no recent confirmed records of occurrence of boreal toads. Only three of the 37 breeding sites meet all the criteria, presently spelled out in the Boreal Toad Recovery Plan, to qualify them to be counted towards fulfilling the delisting or downlisting criteria. Existing recovery criteria are somewhat vague, and will undergo a critical review and revision in 1998. Significant progress has been made with the boreal toad recovery and conservation effort in the past two to three years, and it is anticipated that much can be accomplished towards recovering this species in the next three to five years, provided adequate funding and personnel time is available. The recovery team recognizes that both time and funding are in short supply, and will pursue innovative approaches to accomplish needed work, including solicitation of volunteer help, partnerships, and other cooperative efforts. However, *without* a significant commitment of funds and time from all the involved agencies, recovery will be difficult, if not impossible, to achieve in the foreseeable future.

ACKNOWLEDGMENTS

The Boreal Toad Recovery Team appreciates the assistance of Colorado Division of Wildlife WRIS biologists, Pam Schnurr and Dave Lovell, and research biologist, Mark Jones, with the production of the maps of boreal toad breeding localities included in this report. Also much appreciated is the funding which has been provided by Great Outdoors Colorado (GOCO) in support of the boreal toad conservation and recovery effort.

* * *

MANAGEMENT STATUS AND ADMINISTRATION

LEGAL STATUS OF THE BOREAL TOAD

The boreal toad is presently state listed as a state endangered species in New Mexico since 1976 and in Colorado since November, 1993. It is a protected species in Wyoming, and is federally classified as a candidate species which is "warranted but precluded" - meaning there is adequate data to warrant federal listing as threatened or endangered, but listing has been postponed, as there are presently other species in greater need of listing, and the US Fish & Wildlife Service has limited resources to prepare and process listing packages.

THE RECOVERY TEAM

The Recovery Team for the Southern Rocky Mountain Population of the Boreal Toad was formed in late 1994, although a loosely organized group of people, from various agencies, had been working on boreal toad issues for two to three years prior to that time. Since 1994, it has evolved in to a multi-agency team, consisting of a core recovery team and a technical advisory group. At this time, the team consists of the following personnel:

Boreal Toad Recovery Team

This group has primary responsibility for the development and implementation of a recovery/conservation plan, and represents all agencies who have legal responsibility and authority to implement management actions. Members of this group have the "voting" authority to make decisions and recommendations for, and to, their agencies regarding management actions. It is composed of one representative from each such agency:

Colorado Division of Wildlife	Chuck Loeffler, Denver, CO
New Mexico Game & Fish Dept.	Charles Painter, Santa Fe, NM
Wyoming Game & Fish Dept.	Robert Pistono, Cheyenne, WY
US Fish & Wildlife Service	Terry Ireland, Grand Jct., CO
US Forest Service	(Presently Vacant)
Bureau of Land Management	(Presently Vacant)
USGS/Bio. Resources Division	Stephen Corn, Missoula, MT
NPS/Rocky Mtn. National Park	Therese Johnson, Estes Park, CO
Environmental Protection Agency	Ed Stearns, Denver, CO

Boreal Toad Technical Advisory Group

This group is composed of persons who have specialized or technical expertise and knowledge regarding the species, habitat, and/or other specific areas of knowledge which are vital to the implementation of recovery and conservation efforts. In the process of plan development, formulation of guidelines and protocols for implementation, and weighing of alternatives in decision making, this group will be relied on to help guide and advise the recovery team. As a general rule,

technical/biological recommendations which represent a majority consensus of this group will be accepted and followed by the Recovery Team, unless there are overriding socio-economic and/or political factors which dictate other courses of action. The present recognized composition of this group is as follows, and is open to other qualified and interested participants:

Paul Bartelt	Waldorf College, Forest City, IA
Ron Beiswenger	University of Wyoming, Laramie, WY
Cynthia Carey	University of Colorado, Boulder, CO
Anna Goebel	University of Colorado, Boulder, CO
David Felley	US Fish & Wildlife Service, Cheyenne, WY
Mark Jones	Colorado Division of Wildlife, Ft. Collins, CO
Don Kennedy	Denver Water Board, Denver, CO
Lauren Livo	University of Colorado, Boulder, CO
Erin Muths	USGS/Biological Resources Division, Ft. Collins, CO
Mike Wunder	Colorado Natural Heritage Program, Ft. Collins, CO

The Recovery Team meets at least twice each year - once in the Spring and once in the Fall - to review and plan needed field work and other management actions. A mailing list of numerous interested parties is used to disseminate information on Recovery Team actions and boreal toad conservation efforts. Minutes of Recovery Team meetings are available upon request from the team coordinator (see below).

The Colorado Division of Wildlife (CDOW) has assumed the responsibility for leadership and coordination of the Boreal Toad Recovery Team, and at this time, CDOW Wildlife Manager, Chuck Loeffler, is the coordinator for the group. Contact with the Recovery Team may be made via Mr. Loeffler as follows:

By Mail:	Chuck Loeffler, Aquatic Resources Section, Colorado Division of Wildlife, 6060 Broadway, Denver, CO 80216.
By Phone:	303-291-7451 (Denver, CO) OR 719-481-1902 (Monument, CO)
By E-Mail:	chuck.loeffler@state.co.us OR LoeffCC@aol.com

RECOVERY AND CONSERVATION PLANS

Present boreal toad recovery work is based primarily on the existing Boreal Toad Recovery Plan, which was prepared by, and for, the State of Colorado pursuant to the listing of the boreal toad as a state endangered species. The Recovery Team, with primary direction from the US Fish & Wildlife Service, has also developed a draft Conservation Strategy, which focuses on actions needed to protect and conserve boreal toad habitats on public lands - primarily US Forest Service lands. In addition, a draft Conservation Agreement, designed to articulate and confirm the commitments of various resource management agencies to the boreal toad recovery effort, has been drawn up, and is expected to be finalized and signed by participating parties in 1998.

The Recovery Team recently agreed that it would be in the best interest of the recovery effort to revise and combine the existing State recovery plan and the draft Conservation Strategy in to a single, comprehensive document. The existing recovery plan focuses primarily on the species, while the draft Conservation Strategy focuses more on the habitat. In addition, some corrections and updates of the existing Recovery Plan are needed. The plan is to combine these two documents in to a single "Conservation Plan" in 1998. It has been recommended by some members of the Recovery Team that the draft of the combined document should be reviewed by one or more nationally recognized experts in the field of amphibian conservation prior to finalization.

RECOVERY OBJECTIVES AND STATUS

Recovery objectives for the boreal toad are described in the Boreal Toad Recovery Plan for the State of Colorado, and are presently being pursued by the Boreal Toad Recovery Team for the entire southern Rocky Mountain population of the boreal toad. The objectives, as presently written, are as follows:

1. To prevent extirpation of the southern Rocky Mountain population of boreal toad, *Bufo boreas boreas*, from historic habitat in Colorado, Wyoming, and New Mexico.

2. To restore perennial breeding populations of boreal toads within all mountain ranges of its historic distribution in Colorado, Wyoming, and New Mexico (downlisting).

3. To secure habitat necessary to maintain self-sustaining boreal toad populations in its known historic mountain ranges throughout Colorado, Wyoming, and New Mexico (downlisting).

4. To maintain three self-sustaining populations of boreal toad within each of the historically occupied mountain ranges according to the following criteria (delisting):

    a. Participation in breeding at a given site by multiple age groups;
    b. Production of toadlets prior to hibernation in at least two sites per wetland area;
    c. Breeding and reproduction criteria achieved at least 2 out of every 5 years (delist)

These objectives will undergo a critical review in conjunction with the development of the comprehensive Conservation Plan, in 1998, and will be revised to provide better definition and clarity, and to make them more measurable.

The table on page 5 presents a summary of presently known breeding populations in the eleven "historically occupied mountain ranges", or defined geographic areas, and their status in relation to the present recovery objectives.

MONITORING & STATUS OF BREEDING POPULATIONS

Based on various historic reports and observations since the early part of the 20th century, boreal toads were considered to be fairly common in much of the southern Rocky Mountain area, from southern Wyoming to Northern New Mexico. One of the earliest published reports of boreal toads in Colorado is from the Buena Vista area, in Chaffee County, where numerous toads were seen under street lights and along irrigation ditches. (Ellis and Henderson, 1915). Records of boreal toad observations over the years are somewhat sparse and scattered. Most are associated with a few specific studies, such as James Campbell's work in the late 1960's and early 1970's (Campbell, 1970; Campbell, 1972).

By the early 1980s, the boreal toad was still considered fairly common throughout its known range in Colorado (Hammerson and Langlois 1981), but evidence of dramatic declines had already been noted. Carey (1993) observed the disappearance of 11 populations of boreal toads between 1974 and 1982 in the West Elk Mountains. Subsequent surveys have shown no recolonization of these former breeding sites. Surveys of 38 historic breeding locations in eight national forests in Colorado covering Boulder, Chaffee, Delta, Gunnison, Jackson, Larimer, Mesa, and Summit counties from 1982 to 1992 revealed only one occupied site in Chaffee County (Lauren Livo, pers. comm.). In 1989, Hammerson (1989) surveyed 143 sites in the Arapaho Lakes, Big Creek Lakes, and Lone Pine Creek areas of Jackson County; 31 sites in the White River plateau within Garfield and Rio Blanco counties; five sites in the Elkhead Mountains in Moffat and Routt counties; 49 sites on the Grand Mesa including Delta and Mesa counties; and 22 sites in Chaffee, Clear Creek, Gilpin, Gunnison, and Park counties. Boreal toads were found in only two of these 250 sites, in Chaffee and Garfield counties. In 1991 Hammerson (1992) surveyed 377 sites in the following Colorado locations or river basins: Upper Alamosa, Upper Arkansas, Conejos, Upper Eagle, Grand County, Grand Mesa, Upper Gunnison, Upper Rio Grande, San Juan, San Luis Valley, Upper San Miguel, and Upper South Platte, and observed only a single population of boreal toads which was subsequently confirmed in 1992 by Livo. Corn et al. (1989) found that toads were absent from 83 percent of historic locations in Colorado and 94 percent of the historic sites in Wyoming. This represented a decline from 59 to 10 known localities from 105 sites surveyed in 1986-1988 in Boulder and Larimer Counties, Rocky Mountain National Park, and in the Park Range in Colorado, and in Albany and Carbon Counties in Wyoming. Boreal toads were thought to be extirpated from the southern periphery of their range in the San Juan Mountains in New Mexico (Stuart and Painter 1994; New Mexico Department of Game and Fish 1988), but a report of a sighting of one adult boreal toad and one boreal toad tadpole in September 1996 gives hope that a breeding population may still exist in New Mexico (C. Painter, unpubl. 1996).

Since the listing of the boreal toad as a state endangered species in Colorado, in 1993, efforts to survey known historic and potential toad habitats, and to monitor known existing breeding populations, has been intensified. The following is a detailed summary of what is known about boreal toad occurrence, distribution and status as of late 1997.

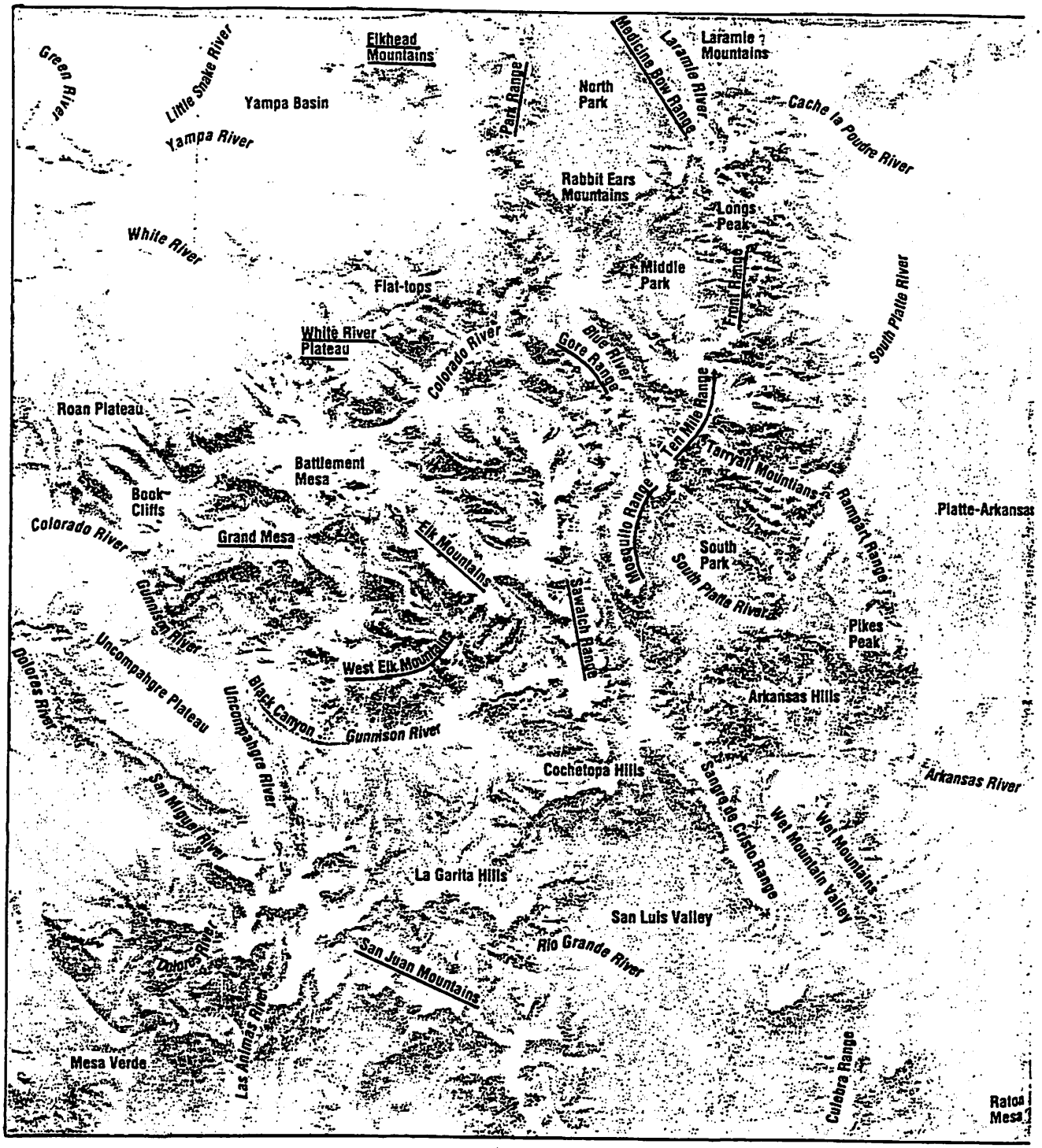
BREEDING POPULATIONS BY GEOGRAPHIC AREA

The objectives for recovery of the boreal toad in the southern Rocky Mountains, as outlined in the Recovery Plan, are based on the documentation and/or establishment of a certain number of secure populations within each of the "mountain ranges of its historic distribution". These are presently recognized to include the Park Range, Elkhead Mountains, Medicine Bow Range, Front Range, Gore Range, Mosquito & Ten-Mile Range, Sawatch Range, White River Plateau, Grand Mesa, Elk & West Elk Mountains, and the San Juan Mountains. The "mountain ranges of historic occurrence" are presented in this report in roughly geographic order from north to south. See page for a map of general locations.

The borders or limits of these mountain ranges are often difficult to define precisely. For the purpose of boreal toad recovery, and for clarification, the following descriptions will serve to define these areas, and provide a summary of boreal toad status in each. In cases where toad populations may be found which do not fit neatly in to one of these areas, the Boreal Toad Recovery Team will make a determination as to which "mountain range of historic distribution" the population is most closely linked.

Interpretation of Breeding Site Tables

Site Numbers: These are assigned chronologically to sites on a county by county basis (See appendix A for county maps of breeding localities). All breeding sites within a specific county may not fall within the same geographic area, or "mountain range of historic occurrence".
Breeding Activity: A "Yes" entry means that either a reliable observer reported seeing adult toads in amplexus, eggs, tadpoles, and/or newly metamorphosed toadlets at the site, or breeding activity can be extrapolated based on the fact that there were one year old toadlets seen at the site during the following year. A "No" entry means that the site was surveyed, but none of the elements indicating breeding activity were observed. A "Unk" entry means there is insufficient information available to determine if there was breeding activity at the site.
Recruitment: A "Yes" entry means that one-year-old toadlets were observed at the site in the Spring of the following year. For example; one year old toadlets in June, 1997, would indicate successful recruitment from the 1996 breeding season, and would be so noted by a "Yes" entry in 1996. Therefore, *all sites will, at this time, show either a "Unk" (unknown) entry or a "No" entry for 1997, as success can not be determined until the Spring or Summer of 1998, or it is known that there were no metamorph toadlets produced at the site in 1997.*
Age Classes: The first number in the entry indicates the minimum number of age classes observed/reported at a specific site. Numbers within parentheses indicate which age classes were observed: M = Metamorphs (young of the year), 1 = one year olds (new "recruits"), S = Subadults (generally two to three year old toads), 2 or 3 = Subadults which were specifically identified as either two or three year old toads, A = Adult toads (4 years old and older).



MOUNTAIN RANGES IN WESTERN COLORADO

(Mtn. ranges of historic occurrence of boreal toads shown underlined)

SUMMARY OF BOREAL TOAD BREEDING SITES/POPULATIONS IN THE SOUTHERN ROCKY MOUNTAINS **Dec. 1997**

Geographic Area	Total	Minimum # Active Breeding Sites					Minimum # Sites With Recruitment					"Secure"
(Mtn. Range of Historic Occurence)	Sites	1993	1994	1995	1996	1997	1993	1994	1995	1996	1997	Populations
Park Range	2				2	2				1	Unk	0
Elkhead Mountains	1			1	1	0			1	Unk	Unk	0
Medicine Bow Range	1	1	1	1	1	1	1	1	1	1	Unk	1
Front Range	15	4	7	8	9	11	Unk	2	1	3	Unk	1
Gore Range	2			1	2	2			Unk	1	Unk	0
Mosquito & Ten-mile Range	2			1	1	2			Unk	1	Unk	0
Swatch Range	10	Unk	2	6	8	9	1	Unk	Unk	3	Unk	1
White River Plateau	0											0
Grand Mesa	0											0
Elk & West Elk Mountains	2	1	Unk	2	2	2	Unk	Unk	Unk	1	Unk	0
San Juan Mountains	2			Unk	2	1			Unk	1	Unk	0
TOTALS	37	6	10	20	28	30	2	3	3	12	Unk	3

Total Sites: Total number of localities where breeding has been recorded in at least one of the past five years.
Active Breeding Sites: Number of localities where breeding activity has been documented for that year and geographic area.
Sites with Recruitment: Number of sites where toadlets from that years production have survived through the first winter.
Recruitment for 1997 is all shown as unknown, as it can't be determined until surveys are done in 1998.
Secure Populations: Populations which meet all the criteria to qualify being counted towards delisting goals.
Unk (Unknown): Indicates years and geographic areas where breeding activity or recruitment is suspected, but data is lacking.
NOTE: Shaded blocks indicate years and locations with no known breeding sites - mainly due to lack of survey information.

Park Range

This area extends from south-central Carbon County, WY, through western Jackson County and eastern Routt County, CO, along the continental divide to approx. Rabbit Ears Pass. It is located primarily on the Routt and Medicine Bow National Forests.
There are presently two known, monitored boreal toad breeding localities in the Park Range (Diamond Park and Soda Creek), although observations of toads in other areas indicate that more breeding sites are likely to exist.

ROUTT COUNTY

Site #RO-2 - Soda Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	Yes	Unk	3 (M,2,A)	Four metamorphs seen
1997	Yes	Unk	2 (M,A)	Numerous Metamorphs

Site #RO-3 - Diamond Park

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	Yes	Yes	2 (M,A)	Metamorphs present
1997	Yes	Unk	3 (M,1,A)	Few metamorphs seen

Elkhead Mountains

This mountain area is in western Routt County and eastern Moffat County, CO, northeast of Craig. It is located primarily on the Routt National Forest.

The only area where boreal toad breeding is presently known to occur is in the California Park area. There is one known and monitored breeding site at this time (First Creek), but evidence of at least one other possible breeding site in the area was found along Elkhead Creek in 1997. More intensive surveys, early in the breeding season, need to be conducted in this area in order to better identify where breeding is occurring.

ROUTT COUNTY

Site #RO-1 - First Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Yes	2(2,3)	Numerous sub-adults
1996	Yes	Unk	2(1,A)	One sub-adult seen
1997	No	Unk	2(S,A)	Toads along Elk Cr.

Medicine Bow Range

This is an area extending from southeastern Carbon County and western Albany County, WY, south through eastern Jackson County and western Larimer County, CO, to approx. Cameron Pass. It is situated primarily on the Routt and Roosevelt National Forests and on the Colorado State Forest.

At this time, there is only one known and monitored breeding site. This is the Bird Creek site, which is located in Albany County, WY. Based on historic and recent observation reports of toads, it is very likely that other breeding populations will be found in the Medicine Bow Range, given adequate survey effort.

ALBANY COUNTY, WY

Site #WY-1 - Bird Creek (aka Albany)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Yes	Yes	1(A)?	
1994	Yes	Yes	3(1,S,A)	
1995	Yes	Yes	3(1,S,A)	
1996	Yes	Yes	3(1,S,A)	
1997	Yes	Unk	3(1,S,A)	Some eggs collected

This site is the source for stock used for reintroductions at Lake Owen

Front Range

This is an extensive area in northern Colorado, which includes southwestern Larimer County, eastern and southern Grand County, the western portions of Boulder, Gilpin, and Clear Creek counties, and eastern Summit County. It extends from the Mummy Range, in the north, south through Rocky Mtn. National Park to Loveland Pass and the Mt. Evans Wilderness Area. Much of the area is situated within the Arapahoe/Roosevelt National Forest.

There are fourteen (14) known breeding localities within the Front Range area at this time, with several localities having more than one breeding site in close proximity. The breeding localities are located in four counties, as follows:

LARIMER COUNTY

Site #LR-1 - Lost Lake (RMNP)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Yes	Unk	1(A)	
1994	Yes	Unk	1(A)	
1995	Yes	Unk	1(A)	
1996	Yes	No	1(A)	
1997	Yes	No	3(M,2,A)	

Site #LR-2 - Kettle Tarn (RMNP)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Yes	Unk	(M,A)	
1994	Yes	Unk	(M,A)	
1995	Yes	Unk	(M,A)	
1996	Yes	Unk	3(M,2,A)	
1997	Yes	No	1(A)	

Site #LR-3 - Spruce Lake (RMNP)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1994	No	Unk	Unk	Specific data lacking
1995	Unk	Unk	Unk	
1996	Presumed	Yes	Unk	
1997	Unk	Unk	3(1,S,A)	Limited survey

This site appears to have a substantial population, but more intensive surveys are needed.

Site #LR-4 - Glacier Basin (RMNP)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	Yes	Yes	1(A)	Transplant site
1997	No	Unk	2(1,A)	

BOULDER COUNTY

Site #BO-1 - Lost Lake

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	No	No	1(M,A)	Toadlets introduced
1997	Yes	Unk	2(M,1,A)	Toadlets introduced

GRAND COUNTY

Site #GR-1 - Jim Creek (Population indicates breeding, but no actual breeding observed)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Unk	Unk	4(S,A)	Substantial population
1996	Unk	Unk	4(S,A)	Substantial population
1997	No	Unk	Unk	

Site #GR-2 - Pole Creek (On Pole Creek Golf Course, near holes #4 and #15)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	1(M,A)	
1996	Yes	Unk	1(M,A)	Some metamorphs
1997	Yes	No	1(A)	No metamorphosis

SUMMIT COUNTY

Site #SU-2 - Montezuma

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	1(A)	
1996	No	No	1(A)	Up to 9 adults seen.
1997	Yes	Unk	1(A)	New site, vs. '95 & '96

Site #SU-3 - Peru Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	Yes	Unk	3(M,3,A)	May be > 3 age classes
1997	Yes	Unk	1(M,A)	Good recruitment.

CLEAR CREEK COUNTY

Site #CC-1 - Vintage

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	2(M,A)	Prob. few metamorphs
1996	Yes	Unk	1(A)	Some eggs collected
1997	Yes	Unk	1(A)	Eggs froze

Site #CC-2 - Urad/Henderson (Comprised of several closely associated breeding sites)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1994	Yes	Yes	2(M,A)	
1995	Yes	Yes	4(M,1,S,A)	
1996	Yes	Yes	4(M,1,S,A)	
1997	Yes	Unk	4+(M,1,S,A)	Recruitment likely

Site #CC-3 - Herman Gulch

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Yes	Unk	2(M,A)	
1994	Yes	Yes	2(M,A)	At least 11 egg masses
1995	Yes	Unk	2(S,A)	
1996	Yes	No	1(A)	
1997	Yes	Unk	2(S,A)	Many metamorphs

Site #CC-4 - Mount Bethel

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Yes	Unk	2(M,A)	Many metamorphs
1994	Yes	Unk	2(M,A)	
1995	Yes	No	2(S,A)	
1996	Yes	Unk	1(M,A)	Few metamorphs
1997	Yes	Unk	1(M,A)	

Site #CC-5 - Bakerville

Year	Breeding Activity	Recruitment	Age Classes	Comments
1994	Yes	Unk	2(M,A)	
1995	Unk	Unk	Unk	Site not monitored.
1996	No	No	None seen	
1997	Unk	Unk	Unk	Site not monitored.

Site #CC-6 - Silverdale (Clear Creek South)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Unk	Unk	Multiple	No specific data
1994	Yes	Unk	Multiple	No specific data
1995	Unk	Unk	Unk	Site not monitored.
1996	No	No	Unk	Max. of 5 toads seen.
1997	No	No	None observed	Insufficient monitoring

Gore Range

This is a geographic area extending from west-central Routt County and northwestern Grand County south to western Summit County, including the Eagle's Nest Wilderness Area. Much of this area is on the White River and Arapahoe National Forests.

As of 1997, there were only two known breeding localities in the Gore Range - both in east-central Summit County. Each of these have two or more breeding sites. Additional survey work is needed in this area.

SUMMIT COUNTY

Site #SU-4 - Upper North Tenmile

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	1(A)	
1996	Yes	Unk	3(M,3,A)	
1997	Yes	Unk	2(M,A)	

Site #SU-5 - Lower North Tenmile

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	Yes	Yes	1(M,A)	Few metamorphs
1997	Yes	Unk	2(1,A)	

Mosquito and Ten-Mile Range

This is an area extending from southern Summit County south to the Buffalo Peaks Wilderness Area in western Park County and northeast Chaffee County. Much of it is situated within the Arapahoe and Pike/San Isabel National Forests.
As of 1997, there are only two known boreal toad breeding localities in this geographic area, as follows:

SUMMIT COUNTY

Site #SU-1 - Cucumber Gulch

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	2(S,A)	Mult. age classes seen
1996	No	No	2(S,A)	Mult. age classes seen
1997	Yes	Unk	2(A)	Recruitment doubtful

CHAFFEE COUNTY

Site #CF-7 - Fourmile Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	No	No	1(A)	4 adult toads seen.
1996	Yes	Yes	1(M,A)	Numerous metamorphs
1997	Yes	Unk	3(M,1,2,A)	Recruitment likely

Sawatch Range

This geographic area includes western Lake and Chaffee counties and eastern Pitkin and Gunnison counties, and extends from the Holy Cross Wilderness Area south to Monarch Pass, and includes the upper Fryingpan drainage and eastern Taylor Park. It is situated primarily on the White River, San Isabel and Gunnison National Forests.
There are ten (10) known breeding localities within this area. Eight (8) of these are located in the Collegiate Peaks area of Chaffee County, and two in southern Eagle County.

CHAFFEE COUNTY

Site #CF-1 - Collegiate Peaks Camp Ground

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Presumed	Yes	Unk	No survey data
1994	Yes	Unk	4(1,2,3,A)	
1995	Yes	Unk	3+(M,S,A)	Subadults not aged.
1996	Yes	Unk	3(M,S,A)	Few metamorphs.
1997	Yes	Unk	3(M,S,A)	Numerous metamorphs

Recruitment likely for most years at this site, but data lacking.

Site #CF-2 - Denny Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Unk	Unk	Unk	No survey data
1994	Yes	Unk	2(S,A)	Probably metamorphs
1995	Yes	Unk	3(M,S,A)	
1996	Yes	Yes	3(M,S,A)	
1997	Yes	Unk	3(1,2,A)	Few, if any, metamorphs

Site #CF-3 - Hartenstein Lake

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	1(A)	Possibly metamorphs.
1996	Yes	Yes	2(M,A)	
1997	Yes	Unk	2(M,1,A)	Many metamorphs

Site #CF-4 - South Cottonwood Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	3(M,S,A)	Numerous metamorphs
1996	Yes	Yes	2(M,A)	Good recruitment
1997	Yes	Unk	4(M,1,2,A)	Numerous metamorphs

Site #CF-5 - Brown's Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	2(S,A)	Metamorphs unlikely
1996	Yes	Unk	3(M,S,A)	Few metamorphs
1997	Yes	Unk	2(M,2,A)	Fair metamorphosis

Site #CF-6 - Kroenke Lake

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	1(A)	Metamorphs unlikely
1996	Yes	Unk	2(M,A)	Fair metamorphosis
1997	Yes	Unk	1(A)	Metamorphs unlikely

Site #CF-8 - Morgan's Gulch

Year	Breeding Activity	Recruitment	Age Classes	Comments
1997	Yes	Unk	2(M,A)	Many metamorphs

Site #CF-9 - Sayre's Gulch

Year	Breeding Activity	Recruitment	Age Classes	Comments
1997	Yes	Unk	1(A)	Site found late in season

EAGLE COUNTY

Site #EA-1 - Holy Cross City

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	Yes	Unk	1(A)	Predation & late season
1997	Yes	Unk	1(A)	Recruitment unlikely

Site #EA-2 - East Lake Creek (Two closely associated breeding sites at this locality)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	Yes	Unk	3(M,S,A)	
1997	Unk	Unk	Unk	Site not surveyed

White River Plateau

This geographic area includes southwestern Routt County, western Rio Blanco County, and northwest Eagle County. It includes the Flat Tops Wilderness and is situated primarily on the White River National Forest.

There are presently no known breeding sites in this area, although there have been reports of toad observations in recent years - primarily from the Trapper's Lake area. It is very likely that breeding sites will be located in this area, given adequate survey effort.

Grand Mesa

This area incorporates western Gunnison County, northern Delta County, and eastern Mesa County, and is located primarily on the Grand Mesa and Gunnison national forests.

Grand Mesa, historically, had an abundance of boreal toads. However, no toads have been seen in this area in recent years. A survey of suitable breeding habitat and searches for boreal toads will be done over the next two to three years. If no toads are found, and suitable habitat still exists, this will be a high priority site for a reintroduction effort.

Elk and West Elk Mountains

This area consists of parts of western and northern Gunnison County west of Taylor Park, and southwest Pitkin County. It includes the Maroon Bells/Snowmass and West Elk wilderness areas.

There are two known boreal toad breeding sites in this area. One is in southern Pitkin County, and the other in northern Gunnison County. There have been recent, reliable reports of toads from other localities within this area, such as Mt. Crested Butte, and with additional survey effort it is likely that more breeding populations will be located - especially in the Elk Mountains.

PITKIN COUNTY

Site #PI-1 - Conundrum Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Yes	Unk	Multiple	No detailed data
1996	Yes	Unk	Multiple	Many metamorphs
1997	Yes	Unk	1(A)	Poor production

GUNNISON COUNTY

Site #GU-1 - Triangle Pass (aka White Rock Basin)

Year	Breeding Activity	Recruitment	Age Classes	Comments
1993	Yes	Unk	1(A)	Metamorphs unlikely
1994	Unk	Unk	Unk	No data
1995	Yes	Unk	2(S,A)	Metamorphs unlikely
1996	Probable	Yes	Unk	Not monitored
1997	Yes	Unk	4(M,1,S,A)	Many metamorphs

San Juan Mountains

This is a large area in southern Colorado and northern New Mexico, which includes portions of Hinsdale, Archuleta, Mineral, Saguache, western Rio Grande, and Conejos counties in Colorado, and Rio Ariba County in New Mexico. It extends along the Continental Divide from Poncha Pass in to northern New Mexico. Most of the boreal toad habitat in this area is located on the Gunnison, Rio Grande, San Juan, and Carson national forests.

As of 1997, there were two breeding sites known and being monitored in this area. Both are in Mineral County, CO. One of the two sites (Trout Creek) is questionable, as the tadpoles observed there in 1996 may have been the result of an unauthorized translocation from the Jumper Creek site, rather than natural breeding at that location.

There have been several good reports of observations of boreal toads from other localities in the San Juan Mtn. area - notably from the Elk Creek drainage in Conejos County, and from near Chama, New Mexico. Additional survey work needs to be conducted in the San Juan Mountain area, and is likely to result in the eventual location of additional breeding populations.

MINERAL COUNTY

Site #MI-1 - Jumper Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1995	Unk	Unk	Unk	Breeding likely
1996	Yes	Yes	2(M,A)	
1997	Yes	Unk	3(M,1,A)	Many metamorphs

Site #MI-2 - Trout Creek

Year	Breeding Activity	Recruitment	Age Classes	Comments
1996	Yes	Unk	1(A)	
1997	No	No	None seen	

NOTE: This site is questionable. 1996 observations may have been result of unauthorized transplant from Jumper Creek.

* * *

BOREAL TOAD SURVEYS

In addition to annual monitoring of known breeding sites, surveys of historic and other suitable boreal toad habitats are conducted each year. The amount of survey work is constrained by the availability of qualified personnel to conduct and supervise the work. Areas where surveys have concentrated over the past three years include the Park Range, Front Range, Gore Range, and Saguache Range, with initiation of surveys in the San Juan Mountains in 1997. There have been relatively few recent surveys in the other geographic areas.

Data regarding areas surveyed, where no toads were found, is in the process of being gathered from various sources and compiled, and will be used to plan future survey efforts. In 1998, survey work will continue to be constrained by limited personnel and time, but initiatives to increase survey work in the Medicine Bow Range, Elk & West Elk Mountains, and Grand Mesa are planned.

PUBLIC INFORMATION AND INVOLVEMENT

The use of trained volunteers is being pursued as a remedy to the lack of time and personnel for survey and monitoring work. In 1996, an initial effort was made to recruit and train volunteers, but the level of participation in surveys was minimal. Approximately 30 individuals attended the workshops, but only 3 subsequently did survey work and submitted data forms. In the Spring of 1998, four or five volunteer "workshops" will be conducted at various locations in Colorado, and additional effort will be made to gain active involvement by volunteers subsequent to the training they receive at the "workshops".

Other ongoing efforts to involve the general public in the search for boreal toad populations include the production and distribution of picture post cards, which provide basic information about the toad, and directions on how, and where, to report toad observations. In addition, a toad "wanted" poster was produced and distributed to inform the public, and personnel in various resource management agencies, about the boreal toad, and to provide information on how & where to report toad observations. Responses due to the cards and posters has been minimal, but the number of reports received in 1997 did increase from the number in 1996.

Several news releases and public information videos have been produced to help inform the public about the boreal toad and about ongoing conservation efforts. These have been well received by most news media, and widely distributed. In addition, a 30-minute slide presentation on the boreal toad and its management was produced in 1996, and has been presented to various groups.

CAPTIVE PROPAGATION AND TRANSLOCATIONS

Reintroduction or translocation of animals are tools which may be used in the recovery of threatened or endangered species. These actions may involve captive propagation and/or rearing. Preliminary work with experimental translocations and captive rearing of boreal toads has been done in the southern Rocky Mountains. However, it has been decided by the Boreal Toad Recovery Team that this approach will, from now on, be used only in cases where no other viable alternatives exist to re-establish boreal toads in areas where they are known to be extirpated. The following guidelines to determine if/when translocations should be done were agreed on by Recovery Team members in December, 1997:

1. Boreal toads are determined to be extirpated from a historically occupied mountain range, based on thorough surveys*, and suitable habitat for toads still exists in that area.
   (* Will be defined in more detail by Recovery Team in 1998)
2. The chances of natural recolonization of the unoccupied area is minimal.
3. There is no known, significant and imminent environmental threat in the area which would preclude successful reintroduction and survival of boreal toads.
4. Available source stock of toads for transplants is sufficient to provide the numbers needed without doing harm to the source population(s).
5. There is a firm commitment from involved agencies to make the reintroduction effort a top priority for long-term funding, and to do long-term monitoring and evaluation. Ideally, such commitment should be stated in the form of a Cooperative Agreement or Memorandum of Understanding.

Captive Propagation and Rearing

During the early 1990's, techniques and procedures for captive rearing and breeding of boreal toads were developed by both the Wyoming Game & Fish Department and the Colorado Division of Wildlife. At Sybille, Wyoming, boreal toads were reared in conjunction with efforts to raise captive Wyoming toads, and captive reared boreal toads were subsequently released at the Lake Owen site (see 'Experimental Translocations', below). In Colorado, a small number of tadpoles were reared to toadlet stage at the University of Colorado in 1993 and 1994, for a subsequent experimental release in Boulder County (see below), and numerous toads were reared in captivity by the Colorado Division of Wildlife, at its Fish Research Hatchery in Bellvue, CO, from 1995 through 1997. The Division of Wildlife effort resulted in the development of standard practices for rearing of boreal toads, and the "Hatchery Manual for the Rearing and Propagation of Captive Boreal Toads", March, 1997. Captive propagation and rearing of toads in Colorado has been discontinued as of late 1997, and the only boreal toads still in captivity are a small number of animals at the CDOW toxicology lab, which will be used in toxicological and immunological research. There are still boreal toads in captivity in Sybille, Wyoming, which continue to be used for captive breeding and rearing work.

In 1993 and 1996, respectively, the Cheyenne Mtn. Zoo, in Colorado Springs, and the Henry Doorly Zoo, in Omaha, NB, obtained boreal toads for experimental propagation projects. The Cheyenne

Mtn. Zoo collected three yearling toadlets and 17 tadpoles from the Denny Creek site, in Chaffee County, Colorado. These tadpoles were reared to metamorphs at the zoo, and some were over-wintered in a Percival Environmental Chamber. As of late 1997, all boreal toads at the Cheyenne Mtn. Zoo had died due to unknown causes. The Henry Doorly Zoo received 40 toadlets, originating from Mineral County, CO. Most of these died within the first two to three months due to unknown causes. As of late 1997, three boreal toads (one male and two females) remain in captivity at Henry Doorly Zoo, and plans are to attempt captive breeding of these animals.

Although there are no plans for captive breeding and/or rearing of boreal toads in Colorado in 1998, the CDOW is planning to begin construction of a native aquatic species hatchery in the near future. This facility, to be located in the San Luis Valley, will be primarily geared towards propagation and rearing of native fish species, but will also be designed to accommodate rearing of amphibians, should there be a need to do so.

Experimental Translocations

Prior to recent development of specific guidelines for translocations and reintroductions of boreal toads, some translocations did take place. Although these were, in general, done according to acceptable standards, they did not follow strict and consistent protocols, which should be adhered to for any future translocations.

In August of 1993 and 1994, 44 and 200 boreal toadlets, respectively, were released near **Caribou**, in Boulder County, CO, to determine if such releases could ultimately result in creation of a new breeding population at a site at which toads historically existed, but at which no toads had been seen in 20 years. The source of the tadpoles was a breeding site along Interstate Hwy. 70, west of Denver, in Clear Creek County. The toadlets were released about a month after metamorphosis. They were fed as much as possible during the entire time they were being raised in order to maximize their growth and their chances of surviving the first winter. One-day surveys in 1995 and 1997 indicated that sub-breeding sized individuals were still present in the area. In 1998, males from the first cohort should be of breeding size and surveys will be done to determine if they select a breeding area.

Glacier Basin, in Rocky Mountain National Park, is the site of an experimental translocation of boreal toads, which began in 1995. It is a cooperative effort between Rocky Mtn. National Park and the USGS/Biological Resources Division. Toadlets (n=800) were released in 1995, and egg masses and 100 captive-reared toads were translocated in 1996. The stock for this transplant came from the Lost Lake breeding site, in Rocky Mtn. National Park.

In 1997, NPS and USGS-BRD staff continued to monitor the Glacier Basin site. The site was monitored between 21 May and 8 August, 1-3 days/week, for a total of 25 survey days. Site visits consisted of 1-10 person hours of search effort (mean=5.8 hours), for a total effort of 152 hours over the season. During each survey all or part of the wet meadow surrounding Glacier Creek, and extending approximately 200 m upstream and 400 m downstream of the release sites, was searched for egg masses, tadpoles, toadlets and toads. Individuals found were caught, weighed, measured, and

checked for marks (toe clips on toadlets released in 1995, and a subsample of 333 toadlets metamorphosed from eggs translocated in 1996; and PIT tags in toads released in 1996).

No egg masses or tadpoles were found. Captures ranged from 0 to 9 toads per survey, for a total of 40 captures. Catch rates declined steadily over the season. Thirty six individuals with SVL 18-31 mm were found, none with any sign of prior toe clip. Only 4 individuals with SVL 70-92 mm were found; none with a PIT tag (on one occasion no PIT tag reader was available). Interpretation of results is confounded by the fact that a resident (unmarked) toad was found near the release site after the final release in 1996. It is possible that individual(s) in the smaller size class were from the cohort of translocated egg masses (the majority of which were not marked), or that toe clips regenerated (as documented by Kirsta Scherff-Norris at Lost Lake, Boulder County). But, in the absence of marks there is no evidence that any individuals found resulted from our translocations. Monitoring will continue in 1998 and coming years.

Based on past reports and observations (Muths et al. in prep) and relative success with translocating egg masses, investigators suggest that the best strategy for the boreal toad is to translocate eggs in the wild. *Bufo boreas* require 3 to 5 years to reproduce, and therefore translocation of eggs to the same site, every year for a minimum of five years is recommended to attempt the establishment of a breeding population.

In 1995, 1996, and 1997, several thousand boreal toad toadlets, and several adult toads, and some tadpoles were released at **Lost Lake, Boulder County**, to determine if translocation of large numbers of young toads is an effective reintroduction method, to monitor the dispersal behavior and habitat use by the reintroduced toadlets, and to assess the survival rates of various age classes of toads. The transplanted animals originated from eggs taken from the Henderson Mine site, in Clear Creek County, and reared at the CDOW's Research Hatchery, in Bellvue, CO. Dispersal and habitat preferences of toadlets was monitored by visual encounter surveys (Crump & Scott, 1994). Habitat preference was recorded based on whether individuals were found on grass, log, moss, mud, or rock substrate. There was no discernable consistency in habitat preferences of the various cohorts of toadlets, and they appeared to disperse over relatively long distances within a few days after release. No differential rate of survival was detected among the various age classes of released toadlets. Adult toads which were radio-marked were difficult to follow and had poor survival rates. Preliminary information seems to indicate that reintroduction of toadlets may prove to be more effective than reintroduction of eggs or adults in establishing a viable population. This site will continue to be monitored for several years to determine the result of the translocation.

In Wyoming, an experimental reintroduction at the **Lake Owen** site, in Albany County, was initiated. In 1996, 4000 captive reared tadpoles, which originated from eggs taken at the Bird Creek breeding site, were released at Lake Owen. In 1997, an additional 1500 captive-reared tadpoles were released, and three one-year-old toads were observed, indicating that there was some survival of toadlets from the 1996 release. Plans are to release tadpoles at the Lake Owen site for at least one more year, and to monitor the site for the next few years to determine the success of the reintroduction effort.

Love Lake, in Mineral County, CO, was the site of a release of approximately 300 newly metamorphosed toadlets in early August, 1996. These were captive reared toadlets from tadpoles collected at the nearby Jumper Creek site in Mineral County. Subsequent searches during late summer of 1996 found some live and some dead toadlets at the site. No toadlets were seen during surveys at the site in 1997. Monitoring at this location will continue, however.

* * *

RESEARCH

Various areas of research are being pursued in order to achieve recovery goals outlined in the Boreal Toad Recovery Plan. These are being addressed to the extent that time and available resources allow. The following is a summary of research work through 1997.

Studies of the Boreal Toad Population in the Henderson Mine Area - Mark Jones, CDOW

Site Description and Background

The Henderson Mine boreal toad breeding sites consist of numerous ponds and wetlands in an area which is heavily disturbed due to molybdenum mining by the Climax Molybdenum Company. The mine is located west of Empire, Colorado at an elevational range of 10,000 to 10,500 feet. The specific breeding sites have been designated as follows: 2-pond, Power Alley, Hesbo, Treatment Pond, Donut, Ann's Pond, and Upper Urad (See page). Research in this area is focusing on habitat and hibernacula use, toad movements, and population structure and dynamics.

Hesbo and ***2-Pond*** were the main breeding locations in 1995 and 1996. Hesbo was the primary breeding site in 1997 with eleven egg masses. In 1995 and 1996 both sites were influenced by pre-treated mine effluent running through them at an elevated temperature of 19-21°C. Climax has just finished a new water treatment facility on the Urad side of the facility; untreated mine effluent now flows into 2-Pond and then through Hesbo in a plastic pipe. As a result, 2-Pond is no longer an active breeding site and Hesbo has reduced water temperatures in the spring and no long term source of water. Hesbo has the largest population of adult toads during breeding but has not recruited in the last three years.

Power Alley is a beaver pond complex along the west branch of Clear Creek and is the most natural breeding site in the area. It is not influenced by mine water and therefore the water temperature is colder than the two previously mentioned sites and breeding occurs one to two weeks later.

Treatment is the eastern most of several ponds used to treat water from the tailings dams in this valley. It does not have a large number of adults during breeding but produced 10,000-15,000 toadlets in both 1996 and 1997.

Donut is a newer pond above the water treatment facility. This site typically has 5-6 egg masses but because it is higher in elevation than the other sites, breeding occurs later and the toadlets froze in 1995 and 1996. We believe that some toadlets survived in 1997.

Ann's Pond is a small wetland area above Donut which is fed by ground water and runoff. Because the average depth is less than 10 cm, the water temperature stays warm and tadpoles grow quickly. In 1996 this pond had several thousand tadpoles but dried up in July. At our request, the Henderson Mine personnel put in a pipe to keep the water level constant which aided successful recruitment in 1997.

Upper Urad is a large wetland area at the west end of the valley at an elevation of 10,500 ft. Due to the elevation, this is the last site for breeding activity each year. It produced toadlets in 1995 and 1996 but they froze in 1995 and were eaten by sand pipers in 1996. No successful reproduction occurred in 1997 at this site.

Radio Tracking of Adults

Five male toads and five female toads were radioed during the last week in May from the Hesbo area. During the course of the summer, four toads were replaced, three of these came from the Donut site. We monitored weekly locations for each toad using GPS. This data was imported into ARC/INFO for analysis. Habitat and slope coverages were created in ARC/INFO from CAD files obtained from the Henderson Mine and extensive field mapping.

Preliminary analysis of the data indicates that females moved longer distances away from the breeding locations than did the males in a more linear fashion. During the week of July 21, two females moved over a mile. There was heterogeneity among individuals for habitat selection, although there was selection by all toads for wet areas. There was also selection for upland aspen/conifer and conifer areas by both the Hesbo and Donut toads. Other habitat elements were essentially used in proportion to their availability at each site. Slope was not a factor which influenced toad habitat use or movement, the radioed individuals used slopes up to 80% frequently. All radioed toads were re-fitted with winter temperature sensing radios in October and are being monitored monthly throughout the winter.

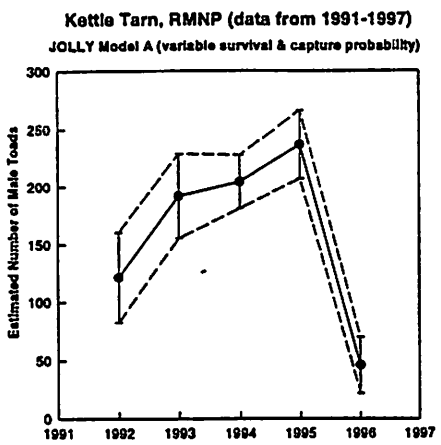
Ongoing Data Analyses and Planned Activities at Henderson-Urad for 1998
- Population estimates are being calculated using mark-recapture techniques.
- Toad aging techniques are being investigated.
- Breeding site fidelity and sex ratios will be calculated for 1995-1997.
- A comprehensive research progress report will be completed in April, 1998.
- Twenty adult toads will be radio tagged in 1998.
- More detailed habitat use information will be collected on these toads.

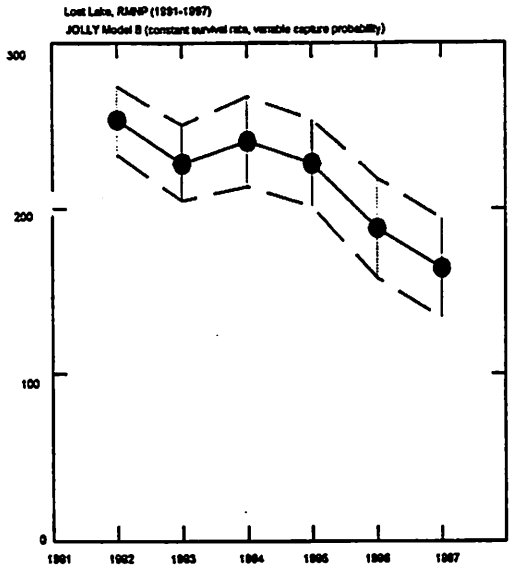
Boreal Toad Research in Rocky Mtn. National Park

Stephen Corn, USGS/BRD and Aldo Leopold Wilderness Research Institute, and Erin Muths, USGS/BRD.

We have been studying boreal toads in the Northfork drainage of the Big Thompson River in Rocky Mountain National Park and the Comanche Peak Wilderness since 1988 (Corn et al. 1997). The Lost Lake population (3265 m) and the Kettle Tarn population (2810 m) have been the focus of these studies. Date have been collected on water quality and temperature and air temperature each season. Our mark-recapture program, begun in 1991, has captured 1081 toads in the North Fork drainage. Population estimates for the two main breeding sites - Kettle Tarn and Lost Lake - are illustrated below. In addition to the breeding site population estimation, we monitor boreal toad movements within the drainage and search other known and potential breeding locations from 3380 m down the

drainage to the trailhead. We plan to continue our population monitoring in the Northfork, and initiate more detailed movement and use of habitat studies using radio telemetry. 1998 will be the pilot year for the radio telemetry study. We will focus on mapping, with radio tracking limited to few toads at one to two breeding sites. We will use protocol similar to that used in Glacier Basin (Muths et. al. in prep) and used by M. Jones at Henderson Mine. Our focus will be the use of habitat by boreal toads, movement distances and movement between breeding sites in the North fork drainage putative matapopulation.





Effects of ultra-violet radiation have been considered as a potential threat to amphibians worldwide. We have been examining the effects of UV-B radiation in the Rocky Mountains since 1994 (Corn, 1997 in press). Results from this study do not support UV-B radiation alone as the cause of the decline of Bufo boreas during the past 20 years in the southern Rocky Mountains, but UV-B cannot be dismissed because of contradictory results from other studies. We have also more recently been involved in looking at the geographic variation of the effects of UV-B radiation on the hatching success and development of boreal toad embryos from four states - Washington, Montana, Colorado, and Utah (Corn et al. in prep). Preliminary analysis show no significant differences between states or between treatments, again suggesting that it is not UV-B alone acting to depress boreal toad populations.

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This summary focuses on three primary areas of research in 1997: tadpole predators, the functions of post-metamorphic aggregations for newly metamorphosed toadlets, and fluctuating asymmetry.

Tadpole predators

A single boreal toad egg mass contains thousands of eggs. If all these eggs survived to metamorphosis, a breeding site with even one egg mass would yield more than 3,000 toadlets by the end of summer. However, the number of toadlets observed at breeding sites typically is much less. For example, at one site with a single egg mass in 1997, only a couple of dozen tadpoles survived to become toadlets. Another site with several egg masses produced only about 400 toadlets. In situations like these, predators may be consuming tadpoles, reducing the number that survive to metamorphosis. This is despite the belief that most predators avoid toad tadpoles because of distasteful compounds in their skin. My studies sought to determine which species might be important tadpole predators and to document whether these species also consumed boreal toad tadpoles at current breeding areas.

To determine which species might be important predators of boreal toad tadpoles, laboratory experiments were conducted with a number of species. Three of the species were defined as important tadpole predators since they consumed large numbers of tadpoles and/or newly metamorphosed toadlets in laboratory trials: predaceous diving beetle larvae (*Dytiscus* sp.), tiger salamander larvae, and western terrestrial garter snakes. As examples of the effects of these predators, in one laboratory trial a single predaceous diving beetle larvae consumed 26 of 27 boreal toad tadpoles within 11 hours. By the end of the 24-hour trial, all 27 tadpoles had been consumed. In trials with newly metamorphosed toadlets and garter snakes, one garter snake consumed all 10 of the toadlets in the container before the end of the 10-minute trial. Even newly born garter snakes consumed tadpoles and toadlets.

In laboratory trials, boreal toad tadpoles were much more likely to be killed by predaceous diving beetle larvae than were chorus frog tadpoles of approximately the same size and stage of development (Chi square=26.25, $df=1, p < 0.01$). The difference in vulnerability to predation appeared to be due to the active avoidance of this predator by chorus frog tadpoles compared to boreal toad tadpoles. In contrast, boreal toad and chorus frog tadpoles were equally vulnerable to predation by tiger salamander larvae (Chi square=1.16, $df=1, p > 0.05$).

Medium-sized predaceous diving beetle adults were minor boreal toad tadpole predators, with small tadpoles generally more vulnerable to predation than large tadpoles. The species tested were *Agabus tristis*, *Rhantus binotatus*, and *Graphoderus occidentalis*. A variety of other invertebrates did not consume tadpoles in the laboratory trials. These species included the leech *Nephelopsis obscura*, backswimmer *Notonecta undulata*, caddis fly larva, and two small odonate species (*Lestes* sp. and *Symperium* sp.).

Predaceous diving beetle larvae and western terrestrial garter snakes occupy several boreal toad breeding sites. In 1997 I confirmed that both species prey on boreal toad tadpoles or toadlets in the field. Predaceous diving beetle adults were sometimes observed consuming tadpoles in the field, but they may have been acting as scavengers rather than as predators.

Historical records appear to indicate that tiger salamanders occupied many boreal toad breeding sites. However, there are no records more recent than 1988 that document tiger salamander larvae and boreal toad tadpoles being at the same site simultaneously.

Because predaceous diving beetle larvae, western terrestrial garter snakes, and tiger salamander larvae are efficient tadpole predators, current boreal toad breeding sites should be examined for these predators. Opportunistic removal of these predators from toad breeding sites should be implemented where possible. Finally, these predators should be among the factors considered when evaluating potential reintroduction sites.

In 1998, I plan to conduct additional studies to compare predator abundances in ponds that represent historical boreal toad breeding sites, current boreal toad breeding sites, and sites without either current or historical records of boreal toad breeding.

Post-metamorphic aggregations

Boreal toads are among the amphibians that sometimes form dense aggregations of newly metamorphosed individuals, called post-metamorphic aggregations (PMAs). Previous observations of several breeding sites in Clear Creek County, Colorado, indicated that toadlets formed large and enduring PMAs at a breeding area called the Donut site, while at other sites PMA formation is transitory if it occurs at all. This study was conducted to learn about the factors that were associated with formation of PMAs.

Several environmental and behavioral factors may influence the formation of post-metamorphic aggregations: *(i)* deteriorating larval environment, *(ii)* inability to disperse, *(iii)* protection from desiccation, *(iv)* enhancement of insolation or thermal environment, *(v)* selfish herd/predator saturation, and *(vi)* for PMAs of distasteful anurans, the aggregations may enhance apomatic functions. These functions are not mutually exclusive, i.e., more than one function may be in operation for PMA formation.

Several of these factors were examined by measuring temperatures of PMAs at study sites, placing small agar blocks at two study sites at standard distances from shore to examine the possible role of desiccation, and recording toadlet dispersal from breeding sites.

I observed three general patterns after toadlet metamorphosis:

1) At one site with extensive vegetation and moist soils around periphery of the breeding pond, toadlets formed small and transitory PMAs, but often remained near the breeding site where they could successfully overwinter. Minimal toadlet mortality was observed.

2) At two sites with limited vegetation around the periphery of the breeding pond, toadlets formed small and transitory PMAs and then rapidly dispersed from the site, usually via inlet or outlet streams. Minimal toadlet mortality was observed.
3) At the Donut site, which lacked vegetation around the edge of the pond and lacked a natural inlet or outlet, large and enduring PMAs formed, and high mortality of toadlets was observed.

At the Donut site, there were significant correlations between PMA size and temperature on three of four occasions, indicating that the PMAs offered thermal advantages to the toadlets. Based on the results from the agar blocks, I calculated the amount of time toadlets could survive desiccation at various locations. Along the shore, toadlets could survive indefinitely, as the agar blocks did not desiccate. Depending on how big a toadlet was, it could survive at least 11 to 18 hours in a PMA, but only 1.7 to 2.6 hours 1 meter from shoreline at Donut. In the agar block desiccation experiments, the Donut site was significantly more desiccating than the Anne's Pond site at distances of 80 or more cm from shore. The maximum survival time would be expected to be along the shoreline and within PMAs, which are also the locations at which most toadlets are found. The active movement by toadlets to aggregations and within aggregations may serve an additional function: minimization of excessive exposure to dangerous levels of UV radiation in an area with scant shade. Under sunny conditions, boreal toad metamorphs at this elevation approach their tolerance level to UV-B (C. Carey, pers. com.). Also in contrast to other sites, there was little evidence of dispersal at the Donut site. Although toadlets at this site frequently sought shelter under rocks or other surface objects, no toadlets were found under objects >3m from the shoreline. In comparison, toadlets at other sites were found > 50m from the breeding pool.

This investigation provides field evidence that for newly metamorphosed boreal toadlets, PMAs may be associated with a desiccating environment, thermal advantage, and inability of the toadlets to disperse. Where large and enduring PMAs are observed, field personnel should consider alterations to the habitat to permit the toadlets to disperse successfully from the site or to find suitable overwintering shelters. Such alterations could include construction of an inlet or outlet, increasing the amount of vegetation along the shore, or constructing artificial burrows close to shore.

Fluctuating asymmetry

There are four major patterns of asymmetry in paired structures in bilateral organisms: 1) Directional asymmetry, in which one side is always larger, 2) Antisymmetry, in which one side is always asymmetric, but it can be either the left side or the right side, 3) Alternating asymmetry, in which one side is always asymmetric, but within an individual the side that is larger alternates through time, and 4) Fluctuating asymmetry (FA), in which there is no tendency for one side to be larger than the other. A fifth pattern, of cyclical asymmetry, is a type of fluctuating asymmetry in which there are temporary within-individual variations in asymmetry, often related to periodic biological cycles.

FA has been suggested as a way to measure developmental stress. To date the population declines in boreal toads have not been linked to any specific factor or factors. If these toads were subjected to increasing levels of environmental or genetic stress that resulted ultimately in the reported declines

in this species, it may be possible that examination of variation of FA will show biologically meaningful differences between populations.

The purpose of this preliminary study was to assess the detectability of FA in boreal toads for a variety of external morphological features. If variation in FA is detected in museum specimens, it may be possible to compare levels of FA in specimens from both historical and existing populations. Further, definition of a useful subset of traits could be used to assess FA rapidly in field populations.

I measured external characters on museum specimens and on a sample of live male boreal toads from current breeding sites. Although a complete suite of statistical tests was not conducted, initial evaluation indicates that detectable levels of fluctuating asymmetry are present in bilateral characters of museum specimens of boreal toads.

As mentioned earlier, increased environmental or genetic stress may be related to variation in levels of FA in declining boreal toad populations. By comparing levels of FA from museum specimens preserved at different times, it may be possible to detect increasing levels of FA as the period of reported toad declines is approached. Also, comparisons of toads collected within the central portion of the elevational range versus marginal (high and low elevation) sites may show biologically meaningful variation in FA.

Comparisons of FA levels of individuals within populations is being attempted for various fitness correlates. One possible fitness correlate is a comparison of whether males found in amplexus have different levels of FA than males not observed in amplexus. Also, growth over the activity season and likelihood of survival over winter may be related to FA level and will be tested in the upcoming field season.

Assessment of FA may provide an "early warning" system indicating the health of boreal toad and other amphibian populations.

Boreal Toad Genetics Studies - Anna Goebel, CU/Boulder

Overview

Recent declines of *Bufo boreas* across much of its distribution identified the need for comprehensive systematic analyses for the species group for conservation purposes. Analyses that included specimens from across the full distribution, especially specimens from the eastern half of the toads range were lacking. Therefore, genetic analyses for the *B. boreas* species group were initiated in 1992. In general, the goals of analyses have been to describe genetic diversity in the *B. boreas* group at three levels; first, among deep relationships, specifically among the *Bufo boreas* species group and other *Bufo* species in North America; second, among recognized species and potential unidentified

immune function, the following studies have been done to learn about how amphibian immune systems are affected by various stressors.

pH

Evidence exists that pH of rain and snow declined precipitously between 1974-1980 in the Colorado Rockies. In fact, data exist that rainfall as low as pH 2.0 fell in Gunnison, CO, during the years in which boreal toads were becoming extinct upstream, in the East River Valley. Tests to examine the effects of low pH were done with Rana pipiens, which declined during the same years in the Colorado Rockies, and Bufo marinus, a toad which is not declining world-wide. Two-week exposure to low pH (3.8) resulted in significant stimulation of immune function in both species (Carey, et al., 1996, and Carey, et al., unpublished data). Immunologists are aware that some short-term stressors cause immunostimulation rather than immunosuppression, but the meaning of the former for immune function and the health of the animal is unknown, even for humans.

Cold

While cold temperature in montane habitats is not a man-made stressor, cold is known to profoundly affect immune function in ectothermic animals, and could act synergistically with other stressors to weaken an animal's ability to defend against pathogens. Exposure of Rana pipiens for 5 months to 5 degrees C significantly decreased immune function (Maniero et al., 1997), but had no significant effect on immune function in Bufo marinus (Carey et al., 1996).

UV-B Radiation

Measurements of UV-B exposure in breeding locations of tiger salamanders, leopard frogs, boreal toads and Woodhouse's toads have been made in the field and are being compared with morbidity and mortality measurements of eggs, larvae, and metamorphosed individuals of these species from those same locations. Preliminary data indicate that pond-to-pond variation in exposures exist and that adaptations to exposure levels vary from pond to pond within the same species. Eggs are the most vulnerable to UV-B, followed by larvae, followed by metamorphosed individuals, which are exposed to the largest levels of UV-B radiation and thus are the most potentially vulnerable to the three life stages (Carey et al., unpublished data. Funded by National Biological Survey).

Organochlorines

Exposure to low levels of a wide variety of organochlorines can cause immunosuppression in birds and humans, but no studies on amphibians exist. Sediment samples from a number of historical boreal toad breeding sites and tissue samples from a few tadpoles and metamorphosed boreal toads were tested for the presence of a number of organochlorines, but no detectable levels were found. This work was funded by the US Fish & Wildlife Service.

Heavy Metals

Exposure to low levels of a wide variety of heavy metals causes immunosuppression in birds and mammals, but studies on amphibians are very limited. Sediment samples from a variety of historical and current breeding sites of boreal toads and tiger salamanders and tissue samples from toads and salamanders were assayed for a wide variety of heavy metals. Statistical analysis of the data is

ongoing, but historical sites at which boreal toads had been extirpated had significantly higher levels of cadmium, selenium and arsenic (all immunosuppressors) than do sites currently occupied by boreal toads. This work was also funded by the US Fish & Wildlife Service.

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Toxicology Studies - Steve Brinkman, CDOW

The Colorado Division of Wildlife Aquatic Toxicology Laboratory is assisting with investigations into possible causes of the decline of Boreal toads by evaluating water quality characteristics that may limit survival and distribution of boreal toad tadpoles. These efforts consist mainly of analysis of water samples collected from current and historic breeding ponds, developing techniques to measure effects of toxicants to tadpoles, and conducting experiments to determine toxicity of selected compounds to boreal toad tadpoles. To date, effects of tadpole exposure to the metals cadmium, copper, manganese and zinc have been studied. The toxicity of a highway de-icing compounds, used by the Colorado Department of Transportation, to two stages of tadpoles have also been examined. The results of each of these studies are briefly summarized below.

Cadmium

Cadmium was not found to be particularly lethal. Concentrations in excess of 250 μg/L are required to cause mortality. However, cadmium causes sublethal effects at much lower concentrations. These effects, which include an inhibition of growth and development can occur at concentrations as low as 5 μg/L. Whole body cadmium content was dose-dependent and a sensitive indicator of cadmium exposure.

Copper

Copper was lethal at a concentration of about 30 μg/L. Unlike cadmium copper only mildly inhibited growth. As with cadmium, copper accumulation was dose-dependent.

Manganese

Mortality occurred in tadpoles exposed to manganese concentrations at about 5 mg/L (5,000 μg/L). Sublethal effects were not investigated due to the brief duration of exposure (10 days).

Zinc

Zinc induced mortality at concentrations around 1100 $\mu g/L$. As with manganese, the duration of the exposure was too short to assess sublethal effects or accumulation.

De-icer

Two formulations of de-icer, used by the Colorado Department of Transportation, (CDOT) were tested. The 28% formulation used by CDOT in 1995-1996 was not found to kill tadpoles (approximate Gosner stage 42) at the levels tested. In 1996-1997, CDOT applied a stronger formulation of deicer (57%). Tadpoles (Gosner stage 20) exposed to a 5% solution of the new formulation died within 24 hours. Ninety-six hours of exposure to a 1% solution was required to achieve complete mortality. No mortality was observed in 0.1% solutions.

Except for copper, boreal toad tadpoles are fairly tolerant to the effects of compounds tested. Concentrations of metals in water samples collected so far do not indicate that metals are contributing to the decline of Boreal toad due to an effect at the tadpole stage. Levels of de-icer required to impact tadpoles at Gosner stage 20 would not be expected to exist in the environment. While the tests conducted to date have not identified a potential cause of boreal toad decline, they have provided an opportunity to develop background information on tissue levels and also develop techniques that can be used for future investigations into chemical effects on tadpoles. Detailed reports on the above research will be available in Federal Aid in Fish and Wildlife Restoration Job Progress Report. F-243R-5.

For the summer of 1998, we plan to evaluate the long term effects of manganese and zinc. We also plan to investigate the effects of low pH and CDOT deicer on boreal toad egg hatching success.

Effects of UV-B Radiation on Tadpole Food Quality

Karel Rogers, Grand Valley State University, MI.

During my early (since 1978) work on skeletochronology of boreal toads in southern Colorado, it became apparent that there was a problem regarding the lack of certain younger age classes in some of the breeding populations (i.e. Denny Creek, Chaffee County). Some tracking of larvae development showed that tadpole and metamorph growth was very slow, and there was poor recruitment to the population. The poor success seemed to be due to some factor that disrupted the pace of development of the tadpoles.

In the development of a hypothesis to test, more negative data from my hunt-but-not-find period was important. I had sampled and tested ponds, rainwater, and snow for acid deposition and other water abnormalities for over seven years with no results of importance. Thus, the hypothesis we developed and have been testing centers on ultraviolet radiation rather than on acid rain or other possible factors. In essence, we have been seeking to explain what has changed since the 1970's that could cause reproductive success to drop so quickly.

We hypothesize the decline of Boreal Toads to be due to the effects of UV-B radiation on primary productivity of the tadpole ponds. The rates of growth and development of tadpoles are constrained by low-food conditions (Wilbur, 1980); tadpoles will not metamorphose until they reach a certain minimal size (Wilbur and Collins, 1973). High UV-B causes the tadpoles' main food source, freshwater algae, to bleach photosynthetic pigment, to have decreased protein content, and to have decreased glutathione content (Agrawal, 1992). Because tadpoles live by scraping organic matter off surfaces, the quantity and quality of primary productivity will directly impact growth rate and timing of metamorphosis. Perhaps the food source of the Denny Creek tadpoles was too poor for them to grow quickly, thus delaying metamorphosis until it was too late in the season for the toadlets to amass fat before hibernation.

Other factors may also be operating on these populations (Blaustein et al., 1994; Carey, 1993; Corn, 1994). Nevertheless, we consider it important to test this hypothesis because if it is even partially true, it would be relatively simple to preserve populations of Boreal Toads by supplementing tadpole nutrition, especially during their early development (Tejeco and Reques, 1994).

During the summers of 1995, 1996, and 1997, we ran experiments on the algae in the ponds and lakes near the toads. The first two years were pilot experiments, developing techniques that would give reliable answers. During late June and early July of 1997, periphyton was grown at three locations, South Cottonwood, Denny Creek, and Morgan's Gulch. Sites were chosen to be near clutches of tadpoles and were chosen to be at differing altitudes. South Cottonwood is at 10,400' elevation and on the same drainage as Morgan's Gulch, which is at about 11,000' elevation. Denny Creek is in on a different mountain and is at ~10,600' elevation.

In each location, two sets of three plexiglass boxes were submerged in the water. Microscope slides were mounted vertically on stakes pushed into the substrate inside each box. Within each set, one box was covered with mylar, one was covered with acetate, and one was left open. After approximately two weeks, the microscope slides to be used for chlorophyll concentration were frozen on dry ice immediately after removal from the water, those to be used for protein analysis were air dried, and those to be used for species composition were preserved in an alcohol-formalin solution. Fifteen tadpoles from each locality were preserved in formalin for gut analysis.

Chlorophyll was extracted using acetone and concentrations were read using a fluorometer. Protein concentration was determined by using a NanoOrangeTM fluorescence microprobe and a fluorometer. For species composition, samples from preserved slides were prepped, sampled, and counted according to "Standard Methods for Water and Wastewater". Data completed to date have been analyzed with the non-parametric Kruskal-Wallis one way ANOVA and by the Mann-Whitney-U Test.

Protein concentration in algae samples decreases with increased exposure to ultraviolet radiation. The higher the elevation, the lower the protein concentration, and shielding with mylar causes a highly significant increase in protein concentration. The only exception to this is the mylar-shielded samples from Denny Creek.

Chlorophyll concentration increases with increased light. The concentration of chlorophyll is highest in mylar-shielded samples but the difference is not significant, possibly because we used two layers of mylar which may have served to shade the samples. The increase of chlorophyll with increased altitude is statistically significant.

Species identification of algae is not completed for one locality, but there are distinct differences, so far, in species and their relative abundance at the three sites. The gut contents of the tadpoles appears to be similar to the open treatment samples at each locality. These data have not yet been statistically analyzed so it is premature to draw any conclusions. Some species contain larger amounts of toxins and are less digestible than others. Our analysis will seek to determine whether species differences of this type are correlated with increased ultraviolet radiation.

We will be continuing and refining these studies during the summer of 1998 and the following year through another grant from the Michigan Space Grant Consortium. This work will be in collaboration with Larry Drzal, a chemical engineer from Michigan State University. Although ultraviolet radiation may not penetrate water bodies, it appears to cause chemical reactions at the water surface that increase the concentration of strong oxidizing agents in the water.

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HABITAT MANAGEMENT

Overview

Boreal toad habitat consists of areas with suitable breeding habitat in lodgepole pine, spruce-fir forests, and alpine meadows. Breeding habitat consists of shallow, quiet water in lakes, marshes, bogs, ponds, and wet meadows, often with egg placement optimizing thermal effects of the summer sun. Young toads are restricted in distribution and movement by available moist habitat, while adults can move several miles and reside in marshes, wet meadows, or forested areas. Protection of such habitats, and the preservation of reliable and stable water levels in breeding habitat is essential to the long-term survival of the toads.

Public Lands

The large majority of known existing and potential boreal toad populations and habitats in the southern Rocky Mountains are located on US Forest Service lands and in Rocky Mountain National Park (see summary by geographic areas, earlier in this publication). Therefore, efforts to protect and enhance habitat for boreal toads are focused mainly on these lands.

At this time, protection and consideration of boreal toad habitats on US Forest Service lands is achieved via management directions provided in various USFS documents, such as the Watershed Conservation Practices Handbook and the Region 2 Sensitive Species List. A significant number of known breeding populations are located within USFS Wilderness Areas and within Rocky Mtn. National Park, which provides additional protection of habitats from potential disturbance by disruptive land uses. In addition, cooperative efforts with individual forests are pursued in localities where boreal toad breeding populations exist. These efforts are focused at informing recreationists about boreal toads & habitats, making land managers aware of the toads' habitat needs, and incorporating considerations for boreal toad habitat protection in land use decisions on forests.

In 1997, the Colorado Department of Transportation (CDOT) cooperated with the Colorado Division of Wildlife to help improve habitat at the Herman Gulch boreal toad breeding site adjacent to Interstate Hwy. 70. The site was becoming increasingly choked with vegetation, resulting in reduction of water depth and little or no recruitment of toads. CDOT provided a backhoe and operator to clear the pool of excess vegetation and sediment, and as a result thousands of tadpoles successfully metamorphosed in 1997. This effort demonstrated not only that interagency efforts can be productive, but that habitat improvement for boreal toads can be an effective management tool.

Private Lands

There are some boreal toad populations and habitats located on private lands, particularly in the vicinities of ski resorts. In Colorado, the Colorado Division of Wildlife has been in contact with private land owners and developers, mainly in Summit and Grand counties, and has worked on cooperative efforts to protect existing toad populations and habitats. At the Cucumber Creek site, in Summit County, cooperative work with the town of Breckenridge and a local land developer has resulted in the adoption of a number of conditions and criteria which will help to minimize any potential impacts on boreal toads at that site. This effort will help to set a precedent for consideration of boreal toad habitats in other pending land developments in Summit County.

In Grand County, cooperative efforts with managers of the Pole Creek Golf Course have helped to gain consideration for boreal toads on that property, and managers of the golf course have agreed to pursuing cooperative efforts to preserve and enhance the habitat at the two known breeding sites.

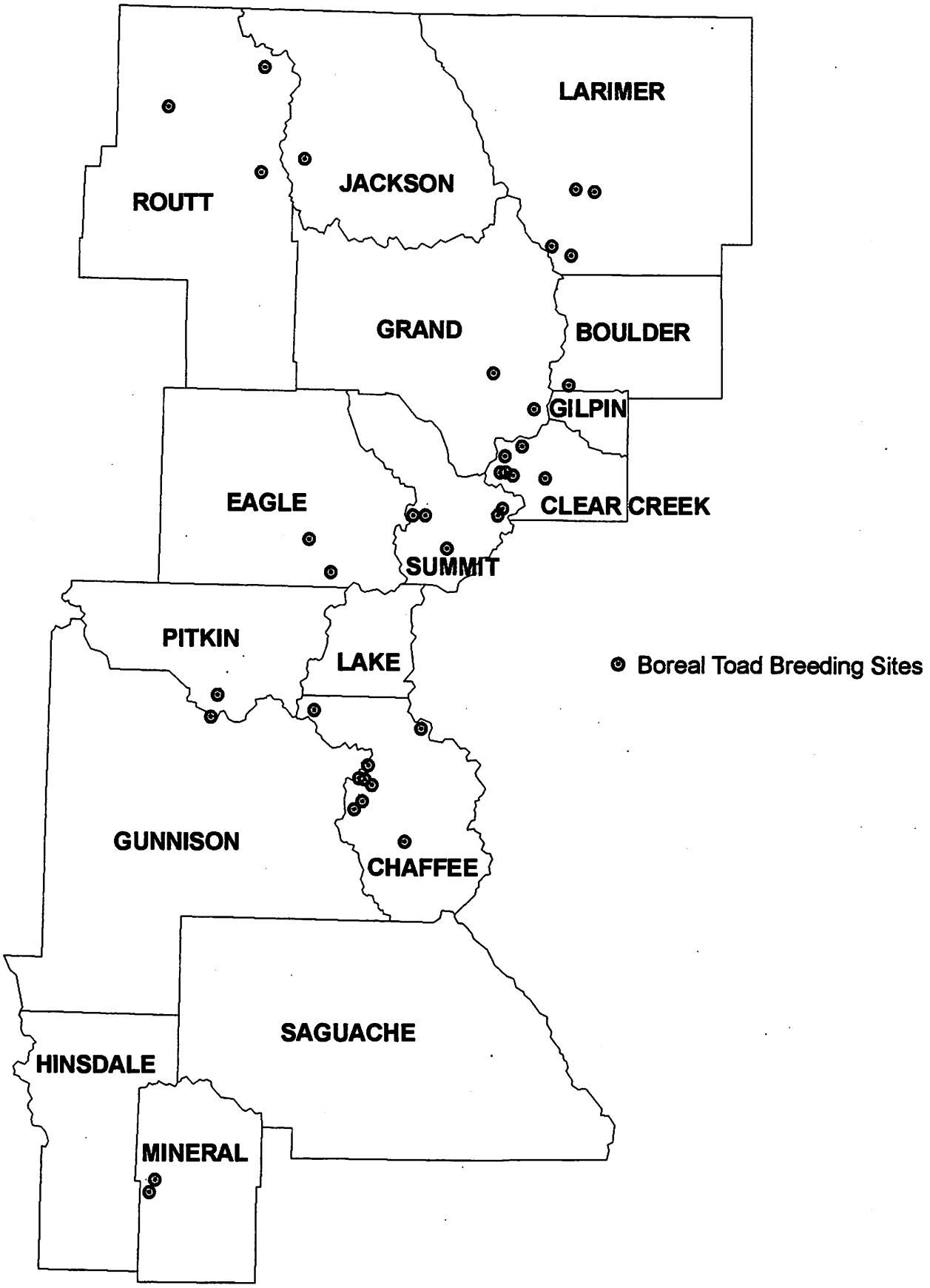
Although the boreal toad populations on private lands represent a very small portion of the total toad population and habitat, efforts will continue to protect such sites and to minimize and mitigate impacts of land development.

* * *

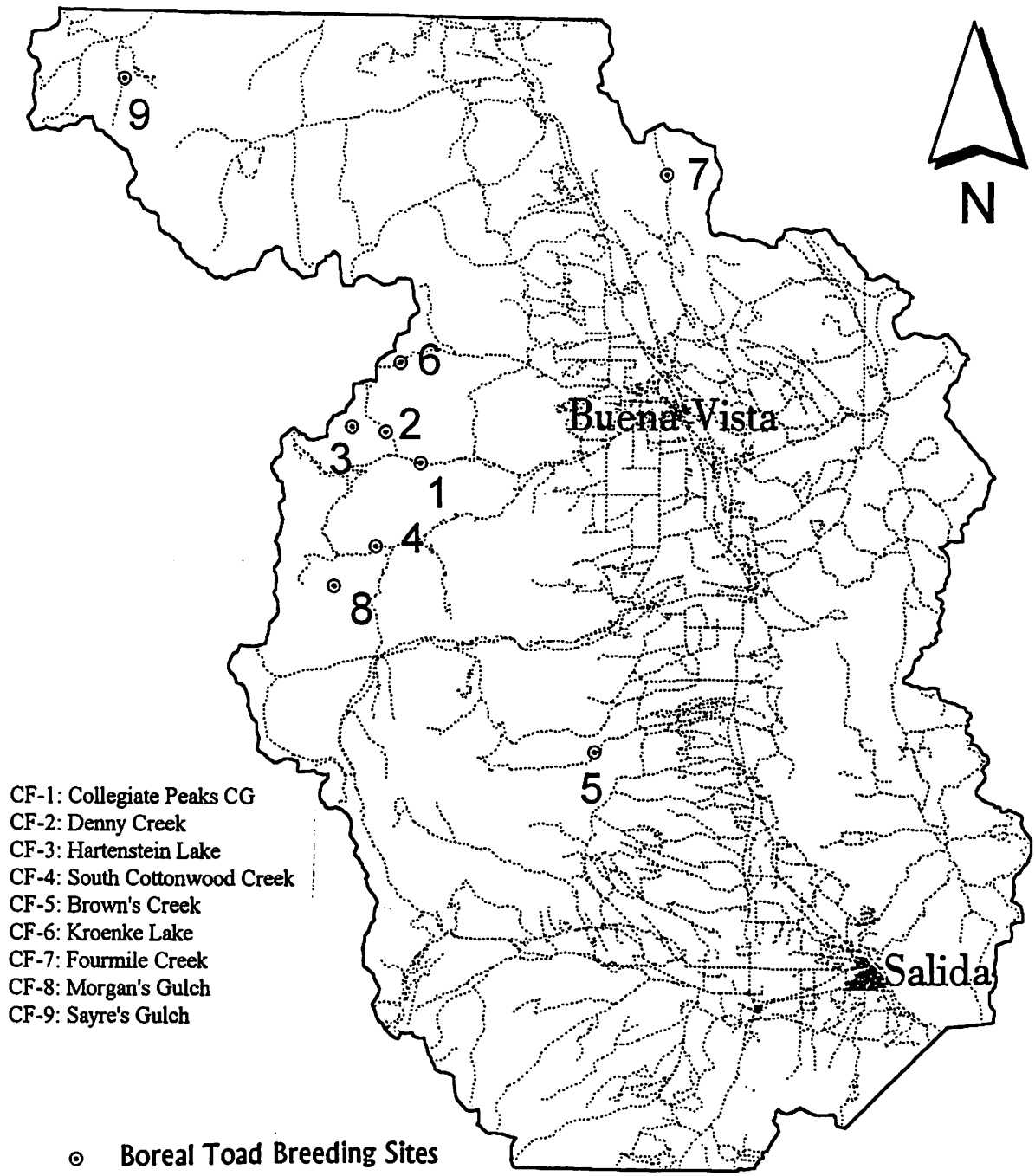
APPENDIX A

Toad Breeding Sites by County

Boreal Toad Breeding Sites (1990 - 1997)

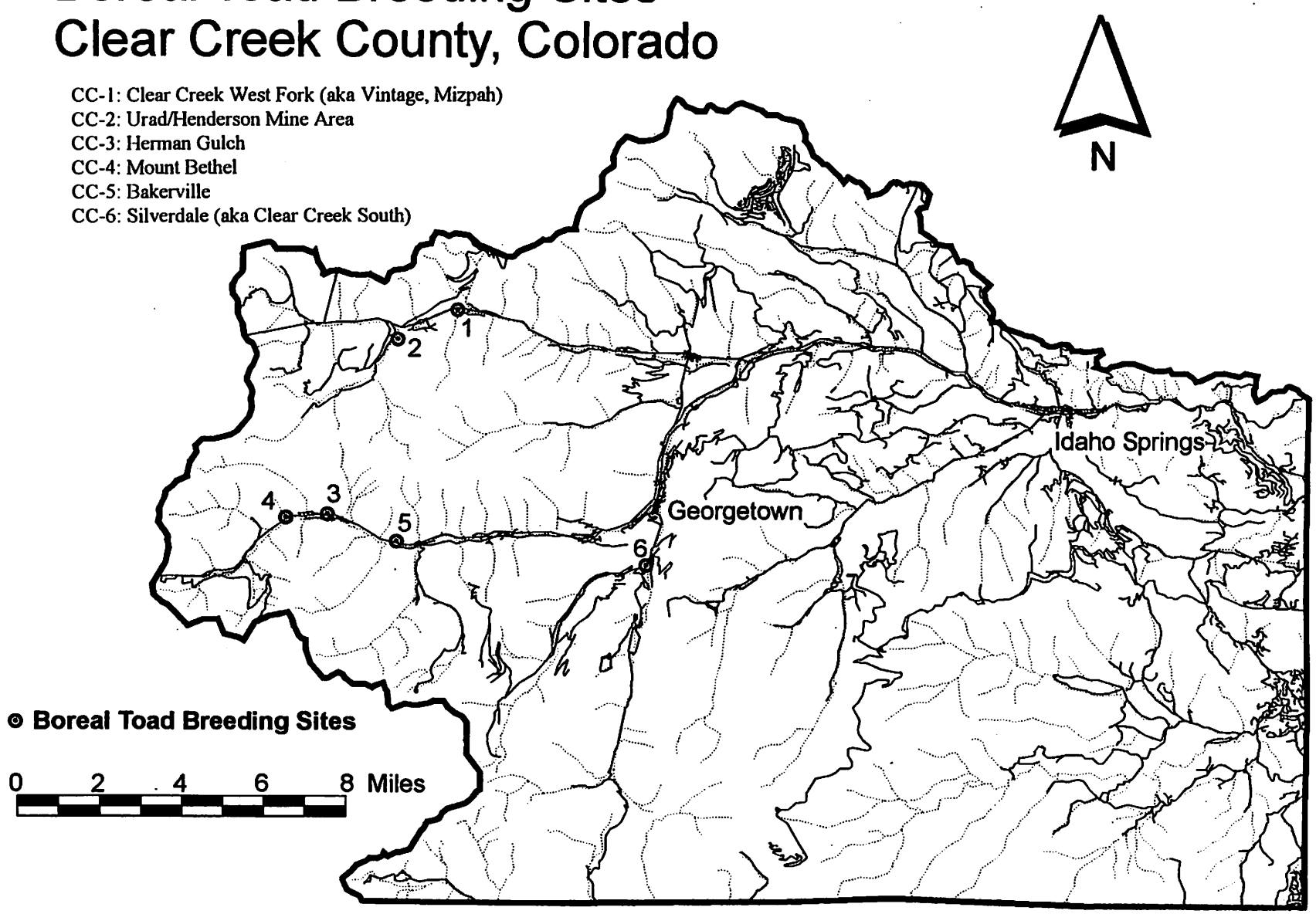


Boreal Toad Breeding Sites
Chaffee County, Colorado

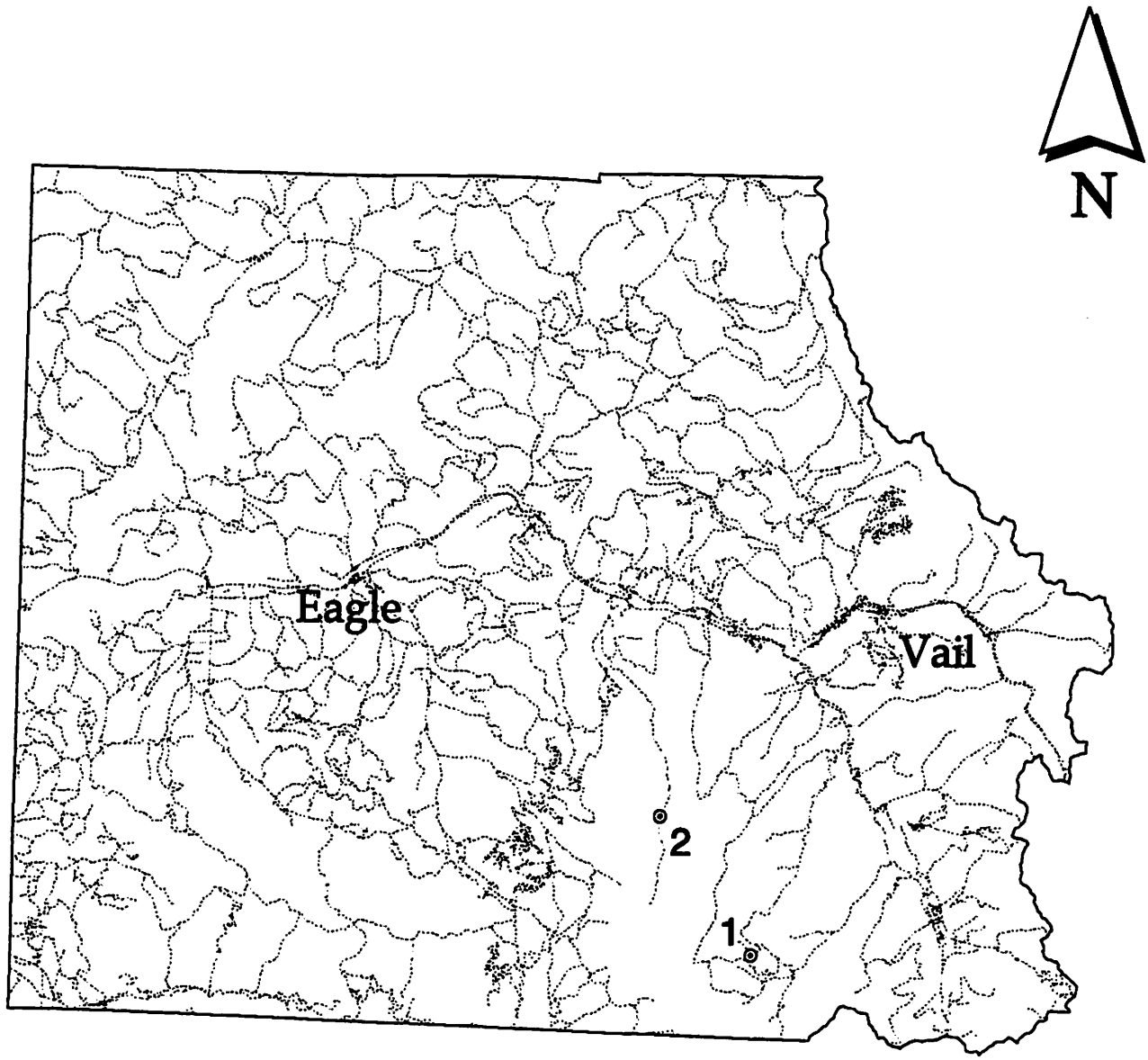


Boreal Toad Breeding Sites
Clear Creek County, Colorado

CC-1: Clear Creek West Fork (aka Vintage, Mizpah)
CC-2: Urad/Henderson Mine Area
CC-3: Herman Gulch
CC-4: Mount Bethel
CC-5: Bakerville
CC-6: Silverdale (aka Clear Creek South)



Boreal Toad Breeding Sites
Eagle County, Colorado

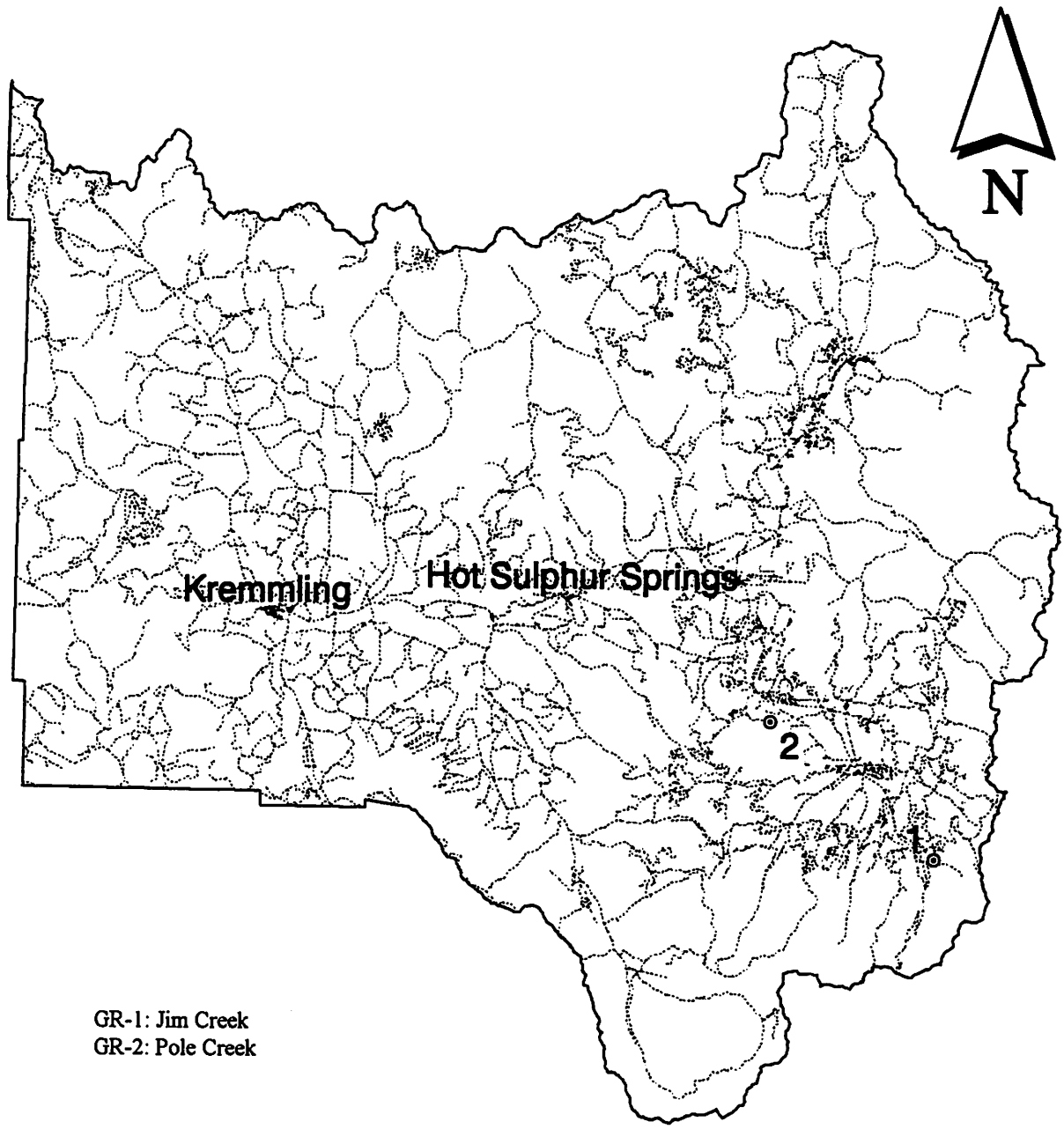


EA-1: Holy Cross City
EA-2: East Lake Creek

⊙ **Boreal Toad Breeding Sites**

0 4 8 12 16 20 Miles

Boreal Toad Breeding Sites
Grand County, Colorado

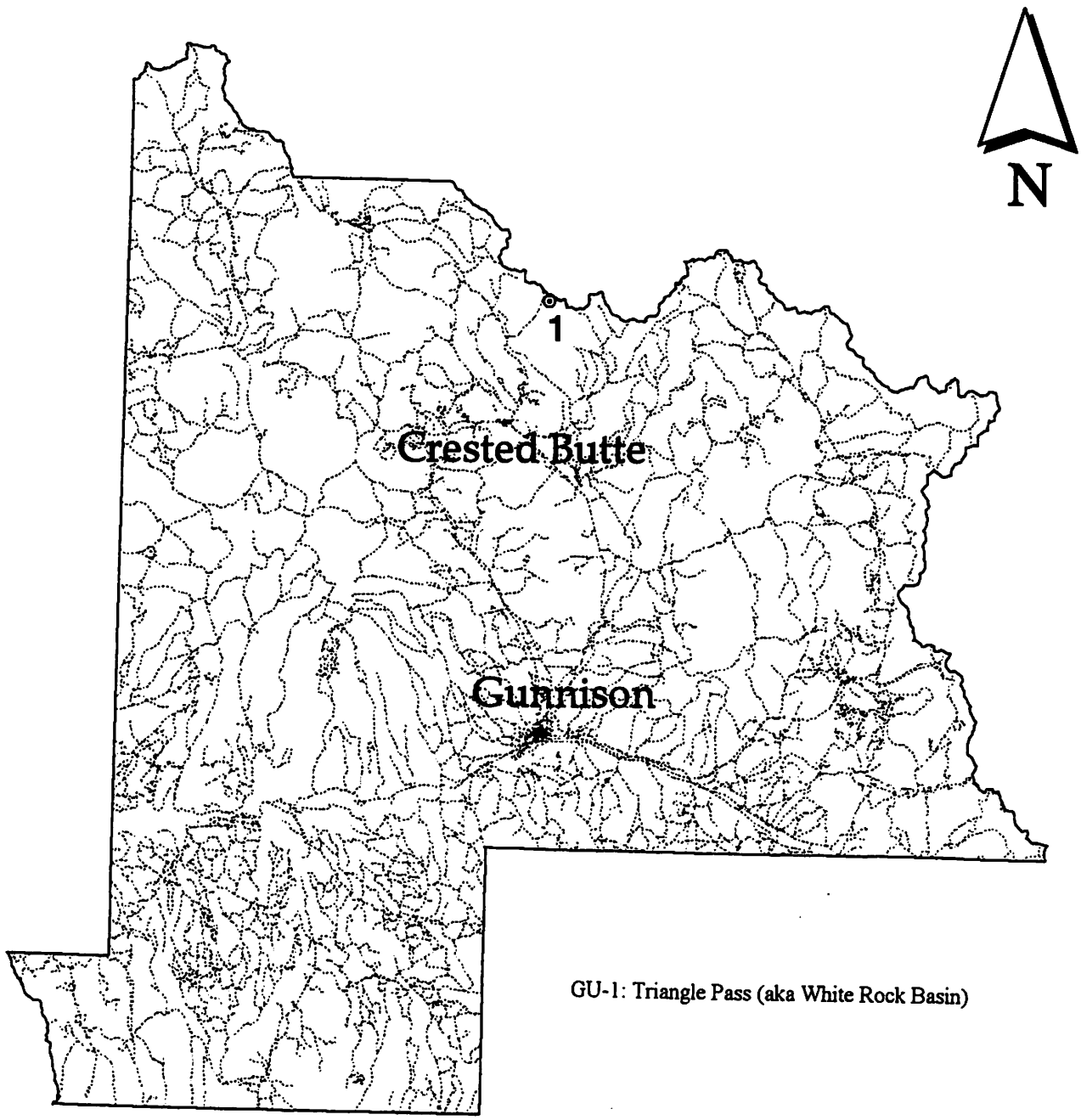


GR-1: Jim Creek
GR-2: Pole Creek

⊙ Boreal Toad Breeding Sites

0 4 8 12 16 20 24 Miles

Boreal Toad Breeding Sites
Gunnison County, Colorado

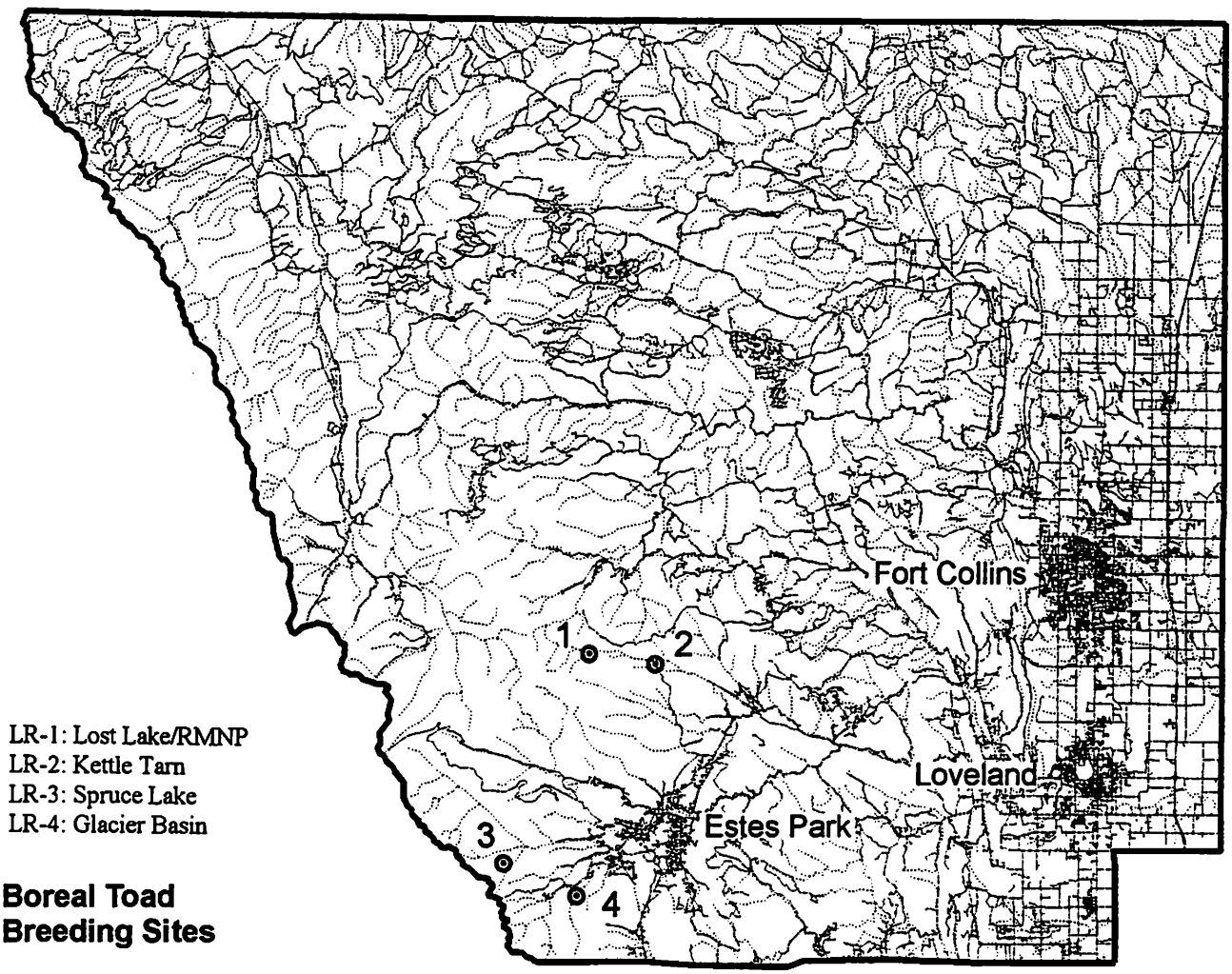


GU-1: Triangle Pass (aka White Rock Basin)

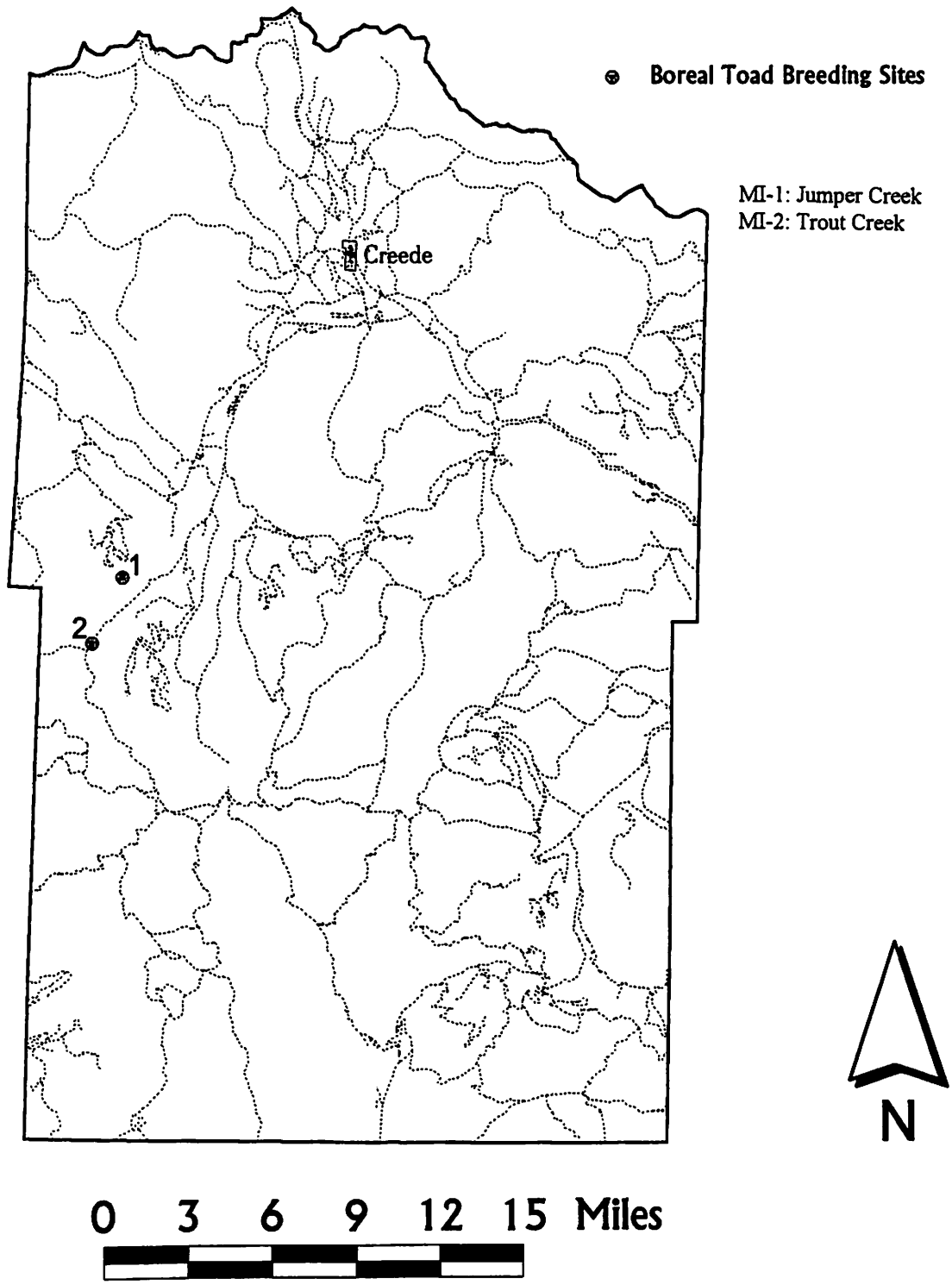
⊙ Boreal Toad Breeding Sites

0 4 8 12 16 20 24 28 Miles

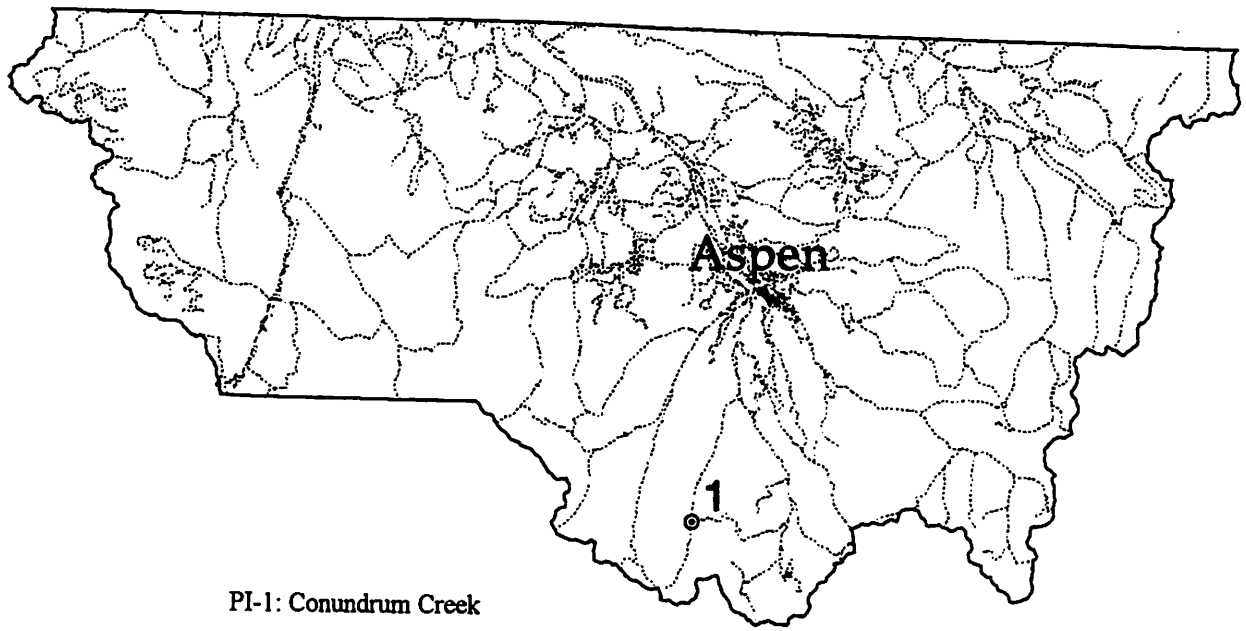
Boreal Toad Breeding Sites
Larimer County, Colorado



Boreal Toad Breeding Sites
Mineral County, CO



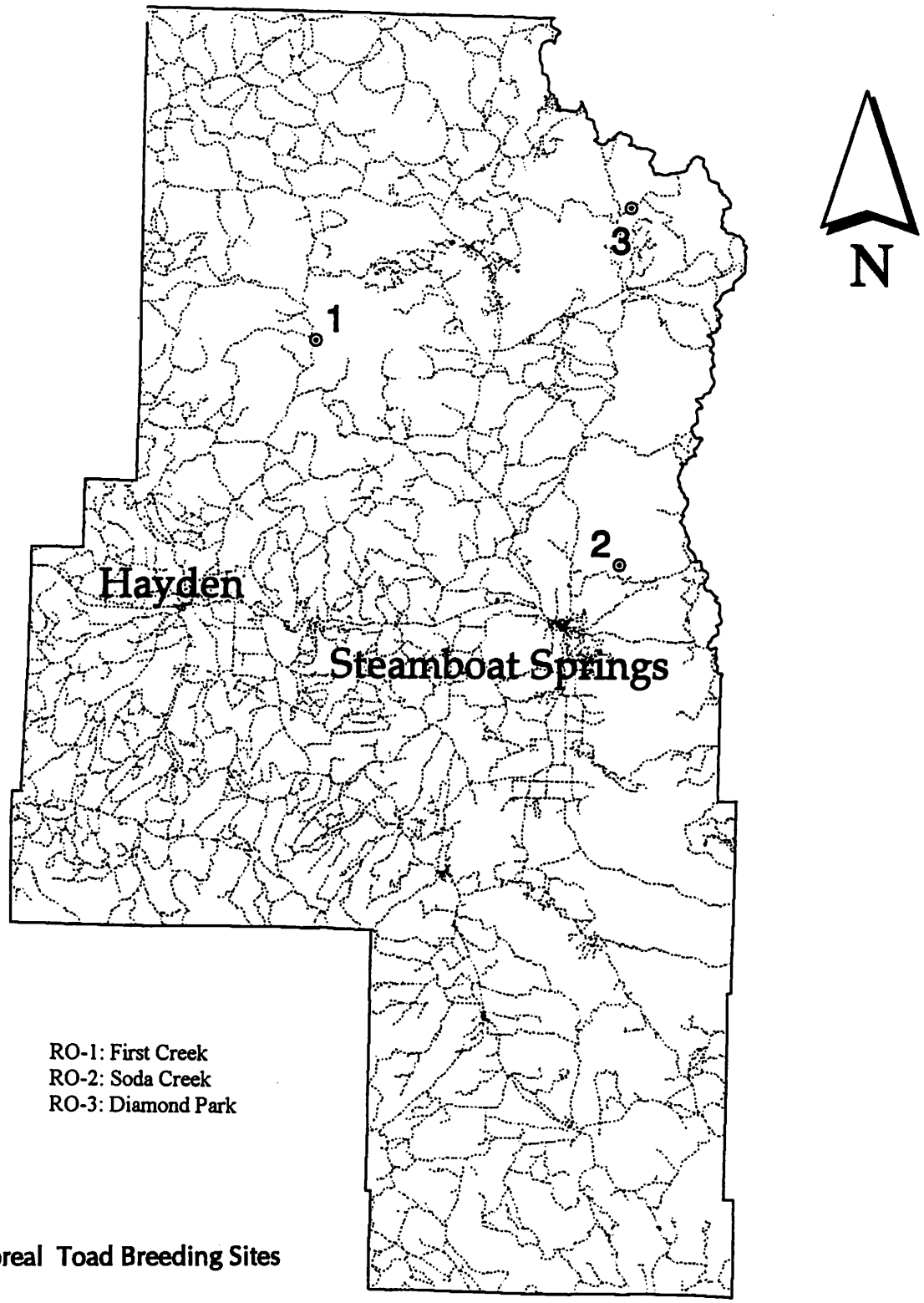
Boreal Toad Breeding Sites
Pitkin County, Colorado



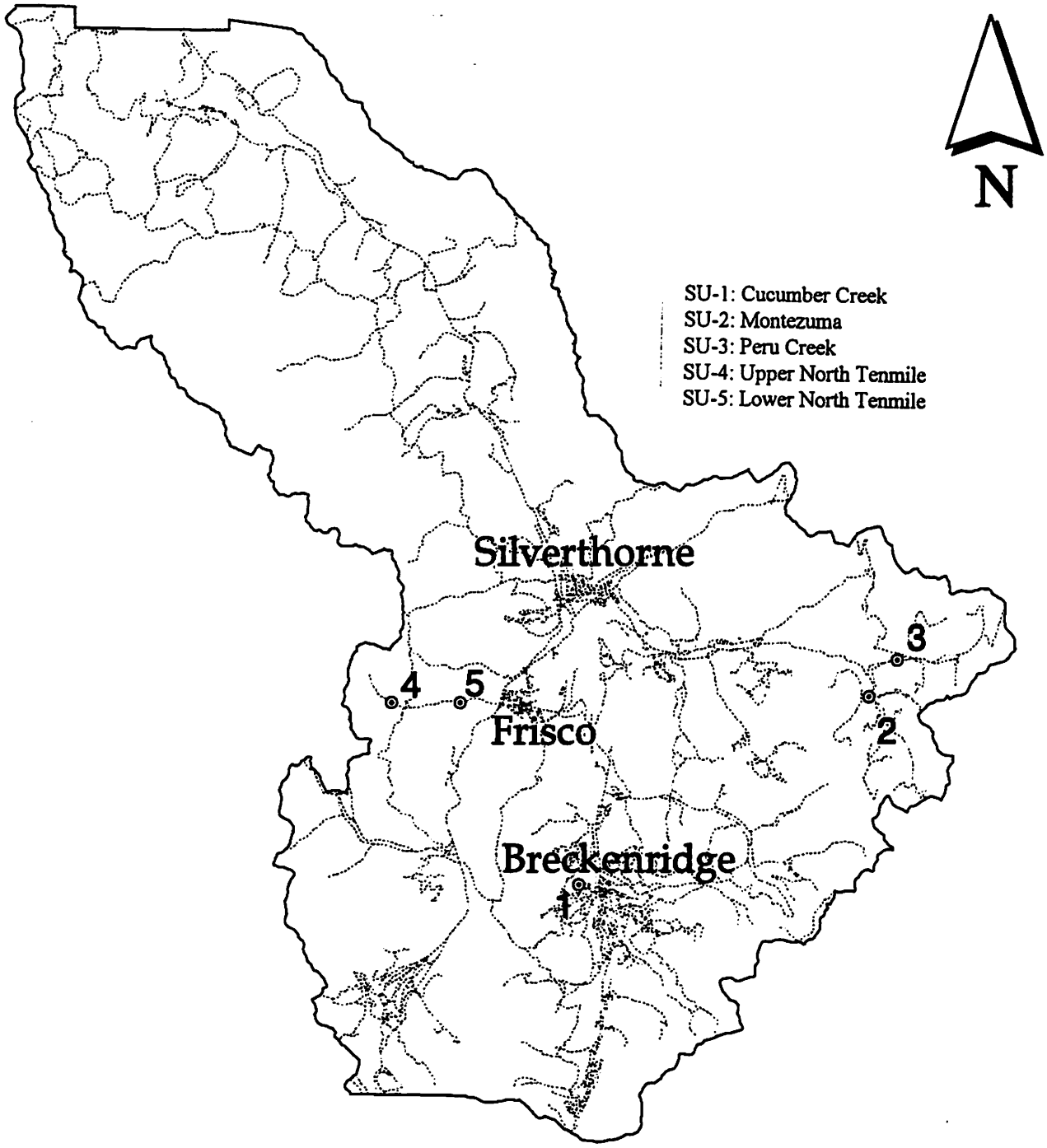
⊙ Boreal Toad Breeding Sites

0 4 8 12 16 20 Miles

Boreal Toad Breeding Sites
Routt County, Colorado



Boreal Toad Breeding Sites
Summit County, Colorado



⊙ Boreal Toad Breeding Sites

0 4 8 12 16 Miles