CONSERVATION PLAN AND AGREEMENT

FOR THE MANAGEMENT AND RECOVERY OF THE SOUTHERN ROCKY MOUNTAIN POPULATION OF THE

BOREAL TOAD

(Bufo boreas boreas)

Prepared by
The Boreal Toad Recovery Team and Technical Advisory Group
Chuck Loeffler, Colorado Division of Wildlife, Coordinator/Editor

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U.S. Fish & Wildlife Service
U.S. Forest Service, Region 2
U.S. Forest Service, Carson National Forest
Colorado Division of Wildlife
Wyoming Game & Fish Department
New Mexico Department of Game & Fish
U.S. Bureau of Land Management
USGS/Biological Resources Division
NPS/Rocky Mountain National Park
U.S. Environmental Protection Agency
Colorado Natural Heritage Program

DEDICATION

This Conservation Plan is dedicated to Mr. Chris Garber who died in an avalanche on January 7, 1996, while cross-country skiing in the Snowy Range Mountains of Wyoming. Chris spent many hours searching for the boreal toad and was a key source of information on the toad in Wyoming. The Boreal Toad Recovery Team and his many friends and colleagues will sorely miss him, and the world will miss his dedication to wildlife conservation. We hope his spirit has found the joy and tranquility he sought in life.

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ACKNOWLEDGEMENTS

This document was produced by the Boreal Toad Recovery Team and Technical Advisory Group, with Chuck Loeffler, Colorado Division of Wildlife, serving as coordinator. The document is based on two earlier documents; the State of Colorado's *Boreal Toad Recovery Plan*, and a draft *Conservation Strategy for the Southern Rocky Mountain Population of the Boreal Toad*, which were also produced by members of the Recovery Team and Advisory Group. The following are members of the Recovery Team and Advisory Group as of February, 2001:

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EXECUTIVE SUMMARY

During the past 20 to 25 years, dramatic declines and disappearances of amphibian populations have been observed and documented worldwide. One of the species that has experienced such a dramatic decline is the southern Rocky Mountain population (SRMP) of the boreal toad (*Bufo boreas boreas*). Although once considered fairly common in most mountainous areas in southern Wyoming, much of Colorado, and northern New Mexico, it is much less common today, and absent from some of the areas where it occurred historically. Reasons for the decline are being investigated. Although causes for the decline have not all been completely investigated or clearly identified, discovery of boreal toad die-offs due to the chytrid fungus (*Batrachochytrium dendrobatidis*) in 1999 point to this pathogen as the proximate cause of deaths of boreal toads in at least two populations. In general, lack of suitable habitat does not appear to be a significant limiting factor for boreal toads in the southern Rocky Mountains.

As a result of the observed decline in population, the boreal toad has been listed as endangered by both New Mexico and Colorado, and the Wyoming Game and Fish Department lists the boreal toad as status NSS1 (Native Species Status 1)[1]. It is presently considered "warranted but precluded" for federal listing under the Endangered Species Act (ESA), and is considered a "Sensitive Species" in the Rocky Mountain Region of the USFS. An interagency recovery team was formed in late 1994, and has been working on the conservation and recovery of this species since that time. These actions led to the writing of a boreal toad recovery plan for Colorado, a draft Conservation Strategy, and a draft Conservation Agreement. The various documents resulting from the actions and agreements described above created redundancy and confusion about the purpose and intent of each document as related to the other. Therefore, it was agreed in 1997 that it would be advisable to combine the components of the various documents into one comprehensive *Boreal Toad Conservation Plan and Agreement* (Conservation Plan). The first edition of the Conservation Plan was produced in 1998, and this document is the first revision of that plan.

The intent of this document is to provide comprehensive guidance for the recovery and management of the boreal toad and its habitat in the southern Rocky Mountains, and to provide a means for all involved and interested parties to make a formal commitment to the implementation of the actions recommended in this plan. Federal, State, and private parties wishing to commit to participating in the implementation of parts of, or the entirety of this plan, can make that commitment through Conservation Agreements, which are appended to this document. These agreements will be brief and concise statements that can be edited, deleted, or appended at any time, without the need to revise the entire plan. This approach will expedite the process of implementing the Conservation Plan, as it does not require the "up front" approval of all potentially involved agencies before implementation. If some agencies are not willing or able to sign an agreement immediately, they can

[1] The "Native Species Status 1" (NSS1) classification means the species is rare, declining in numbers, and habitat has also declined. In Wyoming the boreal toad is protected by Commission order (Chapter 52, Section 11, Wyoming Game & Fish Commission Regulations).

do so at a later date without holding up the work of those agencies that are ready to make an immediate commitment and begin implementing the plan.

Work on boreal toad recovery and management has been going on since about 1994, based on the guidance of the Recovery Team, the State of Colorado's *Boreal Toad Recovery Plan*, and subsequently, the *Boreal Toad Conservation Plan and Agreement*. 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 to locate toad populations, (2) the annual monitoring of known breeding populations, (3) research to identify and evaluate biotic and abiotic limiting factors to toad survival, (4) research to better define 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 USFS, (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 and public involvement in searches for new populations of boreal toads.

As of the summer of the year 2000, the boreal toad is known to still occur in eleven counties (Routt, Larimer, Grand, Eagle, Summit, Clear Creek, Pitkin, Gunnison, Chaffee, Hinsdale, and Mineral) in Colorado, and one county (Albany) in southern Wyoming. Unconfirmed but reliable reports indicate that boreal toads may also still occur in Jackson, Garfield, Boulder, Lake, Park, Saguache, and Conejos counties in Colorado, and in Rio Arriba County, New Mexico. Significant progress has been made with the boreal toad recovery and conservation effort in the past five years, and it is anticipated that much can be accomplished towards recovering this species in the next five to ten years, provided adequate funding and personnel are available. The discovery of the chytrid fungus and its role in the decline of boreal toads has introduced a significant new factor into the recovery and conservation effort, and will require additional research and possible modification of management approaches. The Recovery Team recognizes that both personnel and funding are in short supply, and will pursue innovative approaches to accomplish needed work, including partnerships and other cooperative efforts. However, *without* a significant commitment of funds and time from all the involved agencies, recovery may be difficult, if not impossible, to achieve in the foreseeable future.

Additional copies of this plan may be obtained from:

Colorado Division of Wildlife
Species Conservation Section
6060 Broadway
Denver, CO 80216
(303) 291-7451

The plan may also be accessed via the Internet at: http://www.dnr.state.co.us/wildlife/aquatic/boreal/index.html

Literature citations should read as follows:

Loeffler, C. (ed.), 2001. Conservation plan and agreement for the management and recovery of the southern Rocky Mountain population of the boreal toad (*Bufo boreas boreas*), Boreal Toad Recovery Team. 76 pp. + appendices.

BACKGROUND, BASIS & PURPOSE

Once considered common in the southern Rocky Mountains, the boreal toad (*Bufo boreas boreas*) has experienced dramatic declines in population over the past 20 to 25 years. In September of 1993, the USFWS was petitioned to list the SRMP of the boreal toad[2] as endangered. The USFWS determined that listing was "warranted but precluded"[3]. In November 1993, the Colorado Wildlife Commission listed the boreal toad as an endangered species in the state of Colorado. The boreal toad has been listed as endangered by the state of New Mexico since 1976, and is a listed as NSS1 (Native Species Status 1)[1] in the state of Wyoming.

Pursuant to the listing of the boreal toad as an endangered species by the state of Colorado, and the USFWS finding that the species was warranted for federal listing under the Endangered Species Act (ESA), Colorado developed a state recovery plan in 1994 (revised in 1997), and an interagency Recovery Team was established to investigate potential causes of decline, as well as institute practices aimed at the recovery and protection of the species. Personnel on the Recovery Team from CDOW, NPS, BLM, USFS, USGS/BRD and USFWS developed a draft Conservation Strategy, aimed primarily at the management of boreal toad habitat. At the same time, a draft Conservation Agreement, intended to confirm roles and commitments of the various agencies in the recovery and management of boreal toads, was prepared.

In 1994, several Federal agencies signed a Memorandum of Understanding (94-SMU-058) to establish a general framework for better cooperation and participation among these agencies in the management and conservation of species at risk, which are tending towards federal listing as threatened or endangered. In 1995, the State of Colorado and the U.S. Department of the Interior entered into a Memorandum of Agreement (DOI/CO MOA) that 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 and their habitat. The DOI/CO MOA defined two important task, which state that "The State and the Department agree to develop and implement programs to determine and monitor the status of species at risk;" and "The State and the Department will encourage partners and stake holders to take a leadership role in working with the State and the Department to develop and implement conservation actions through Conservation Agreements and Recovery Agreements." A list of species for which the Department and the State would initially focus conservation actions on was written, and this list specifically mentioned the

[2]Boreal toads here after refer to the southern Rocky Mountain population (SRMP) unless stated otherwise.

[3] Section 4(b)(3)(B)(iii) of the Act states that the Service may make a warranted but precluded finding if it can demonstrate that (1) an immediate proposed rule is precluded by other pending proposals, and (2) expeditious progress is being made on other listing actions. The SRMP of the boreal toad is assigned a listing priority of 3. There are candidate species in Colorado that appear to be more in need of listing, thus precluding the listing of the SRMP of the boreal toad at this time.

SRMP of the boreal toad. Although the DOI/CO MOA has expired, the State of Colorado is continuing its effort towards proactive management of "species at risk", and threatened & endangered species, including the boreal toad.

The various documents resulting from the actions and agreements described above created some redundancy and confusion about the purpose and intent of each document as related to the other. Therefore, it was agreed in 1997 that it would be advisable to combine the components of the various documents, pertaining to recovery and management of boreal toads, into one comprehensive *Boreal Toad Conservation Plan and Agreement*. That document was first produced in 1998, and this is its first revision. It is intended to provide recommendations to all resource management agencies that are involved in the management and recovery of boreal toads in the southern Rocky Mountains, which incorporates the historic range of this species from northern New Mexico to southern Wyoming. Most state and federal agencies have specific documents that provide important management direction. Examples of such documents are the CDOW's Long Range Plan, the NPS's and BLM's Resource Management Plans, and the USFS's Forest Land Management Plans. Unless and until incorporated into such documents, information from this document will serve as recommendation only. Federal agencies can implement this guidance where consistent with existing and future plans that have been subjected to review under the National Environmental Policy Act (NEPA).

* * *

BIOLOGICAL INFORMATION AND STATUS

Species Description and Taxonomy

This subspecies of the western toad (*Bufo boreas boreas*) has dark, brown-black, warty skin with a white to cream-colored dorsal stripe that may sometimes be broken or incomplete. Dark spots blotch the light underside over the chest and abdominal area. The adult toads lack cranial crests and have oval parotoid glands. Adults are large in size, with males being 2.4 to 3.2 in. (60 to 80 mm) long and females being 3 to 4 in. (75 to 100 mm) long from snout to vent. Eggs are laid in shallow waters. Round black eggs are linearly spaced in two rows within long strings of two-layered jelly. Tadpoles are jet black in color, though sometimes turning brown, and generally aggregate in shallow water. Toadlets are similar in appearance to adults but have reddish-orange coloration on the toes and often lack the middorsal stripe, especially when small (Stebbins 1985).

The boreal toad (*Bufo boreas boreas*) is one of two subspecies of the western toad that is found throughout much of western North America. The SRMP is geographically isolated from boreal toad populations to the north by dry, non-forested intermountain valleys. It is genetically differentiated and probably represents an independently evolving lineage or species (Goebel 1996; Hammerson 1999). Earlier mtDNA analyses indicated that boreal toads in Utah are closely related to those in the SRM population, more recent tests, using nDNA suggest they may be genetically distinct from the toads in the SRMP, but additional data are needed to confirm that hypothesis (Goebel 2000).

Habitat Requirements and Life History

The southern Rocky Mountain boreal toad occupies forest habitats between approximately 7,500 and 12,000 feet (2250–3600 m) in Colorado, southeast Wyoming, and north-central New Mexico (Campbell 1970b; Baxter and Stone 1985; Hammerson 1999; Degenhardt et al. 1996). Boreal toads occupy three different types of habitat during the course of the year: breeding ponds, summer range, and overwinter refugia. All of these specific habitats occur within lodgepole pine or spruce-fir forests (Campbell 1970c). Few boreal toads have been recorded from lower-elevation ponderosa pine forests or willow/sage communities.

The known elevational range of toad species in Colorado indicates that potential overlap between the boreal toad and other species is most likely to occur between 7,000 and 8,000 feet (2,135 and 2,440 m) (Hammerson 1982), but interaction appears minimal due to the scarcity of each species at the interface. In south-central Colorado east of the San Juan Mountains in the San Luis Valley, Great Plains toads (*Bufo cognatus*) and Woodhouse's toads (*B. woodhousii*) occur between the elevations of 7,500-8,000 feet (2,290 and 2,440 m). The only location that the boreal toad and Woodhouse's toad were known to occur together is in Archuleta County west of the San Juan Mountains in southwest Colorado. Generally, boreal toads are found between 8,000 and 11,000 feet (2,440 and 3,350 m); however, some have been found at nearly 12,000 feet (3,660 m) (Livo and Yackley 1997).

Distribution is restricted to areas with suitable breeding habitat in lodgepole pine, spruce-fir forests, and alpine meadows. Breeding takes place in shallow, quiet water in lakes, marshes, bogs, ponds, and wet meadows, often with egg placement optimizing thermal effects of the summer sun. There

are no empirical data that suggest a pattern in selection of water body type or size. Breeding has been recorded from large permanent lakes, glacial kettle ponds, man-made ponds, beaver ponds, marshes, and roadside ditches.

Breeding generally occurs in late May and early June, but may be as late as July at higher elevations (S. Corn and E. Muths, pers. comm., 1998), coinciding with the melting of the winter snowpack. At some lower elevation sites (<9,000 feet) breeding has been observed in early to mid April (C. Loeffler, pers. comm, 2000). Egg masses are formed from paired strings, one from each ovary, extruded while the toads are in amplexus. Female adult toads may not breed every year (Campbell 1970a). Egg and tadpole development is temperature dependent, and hatching to metamorphosis may take as long as 92 days (Livo 1999). At 66° F (19° C), J. Goettl (unpubl. 1996) found eggs hatching in five to seven days and the completion of metamorphosis 45 days post-breeding. Reproductive efforts often fail at high elevations due to lack of time to metamorphose before the onset of winter (Campbell 1970c, 1976; Baxter 1952; Fetkavich and Livo 1998). Metamorphosis occurs from late July to mid-August (Burger and Bragg 1974; Lillywhite and Wassersug 1974; Campbell 1972; Hahn 1968; Blair 1951).

Young toads are restricted in distribution and movement by available moist habitat (Jones 1998), while adults can move several miles and reside in marshes, wet meadows, or forested areas. Boreal toads readily colonize new sites (Livo 1999; Zimmerman 1993). Hibernacula, or hibernation chambers, are reported to need a continuous flow of ground water beneath the chamber floor to prevent freezing of hibernating adults (Campbell 1970b). However, Goettl (unpubl. 1996) found boreal toads avoid freezing by using ground squirrel burrows, descending below the frost line to an average temperature of 40° F (4.5° C), and Jones (1998) reports that the boreal toads in the Henderson/Urad metapopulation depend extensively on golden-manteled ground squirrel (*Spermophilus lateralis*) burrows as hibernacula. Other possible hibernation sites, particularly for newly metamorphosed toadlets, are beaver lodges and dams. Toads emerge from hibernacula during early May to early June, depending on elevation, and return in late August to mid September. They may re-emerge to bask near the hibernacula entrance during warm days in September and October. Fewer data are available on summer habitats than for breeding habitats of adult toads, but recent radio-telemetry studies in Colorado indicate that there is considerable use of upland montane forests and rocky areas, with an affinity for locations with spring seeps (Jones 1998). Patterns of habitat use by adult toads after breeding may vary according to sex of the toad and composition of the terrestrial landscape (Campbell 1970c; Campbell 1976). Available evidence indicates that female toads disperse farther and into drier habitats than do males For example, to reach summer range a radio-telemetered female toad in Idaho traveled 1.5 mi (2.5 km) uphill through dry forest following breeding (Bartelt 2000). In RMNP, a female toad marked at a breeding site in July, 1993 was found 2.5 mi (4 km) away in May, 1994 (P.S. Corn, USGS/BRD, unpubl.). The landscape surrounding the breeding site is also important. At one location in RMNP, extensive wetlands surround the breeding site, and most male toads can be captured within 300 ft. (100 m) of water. A second location in the same drainage has little wetland associated with the breeding pond, and toads are difficult to locate after the end of breeding activity (P.S. Corn, USGS/BRD, unpubl.). Jones et al. (1998) also reported that females move farther from breeding sites, and in a more linear fashion, than do males. Males appear to have a home range within 300 meters of breeding sites and show high site fidelity.
Mortality in boreal toads through the second year of life has been estimated to be as high as 95 to

99% (Samallow 1980). Predation and adverse environmental conditions are largely responsible for mortality during the early life stages (Campbell 1970; Livo 1999). Boreal toads are predominately insectivorous and use olfactory clues to recognize prey (Dole et al. 1981; Shinn and Dole 1979). Adult toads can live to nine years or older (Hammerson 1982; Campbell 1976). Although past speculation among researchers was that the boreal toad may live as long as 20 years, recent skeletochronology studies indicate that the maximum life span of boreal toads in the SRMP is about 12 years (M. Jones and C. Fetkavich, Pers.Comm., 2000).

Natural predators of the boreal toad include, but are not restricted to, the common raven (*Corvus corax*) (Corn 1993; Olson 1989), gray jay (*Perisoreus canadensis*) (Beiswenger 1981), western garter snake (*Thamnophis elegans*) (Jennings et al. 1992; Arnold and Wassersug 1978), tiger salamander (*Ambystoma tigrinum*) (Hammerson 1982), badger (*Taxidea taxus)* (Long 1964), spotted sandpiper (*Actitis macularia)*, red fox (*Vulpes vulpes*), robin (*Turdus migratorius*), racoon (*Procyon lotor*) (Jones et al. 1999), red-tailed hawk *(Buteo jamaicensis)* (Jones and Stiles 2000), and predacious diving beetle larvae (*Dytiscus* sp.) (Livo 1998). The latter prey only on the toad larvae. Introduction of game fish to historically fish-less waters has reduced many amphibian populations throughout western North America (Bradford 1989; Bradford et al. 1993; Corn 1994), but there is no direct evidence that this has contributed to the decline of boreal toads in the southern Rocky Mountains. Informal tests at a CDOW fish hatchery showed that trout will avoid eating boreal toad tadpoles, even in the absence of other food (Jones et al. 1999). Boreal toad eggs and tadpoles are toxic or distasteful to most predators (Licht 1969; Brodie and Formanowicz 1987; Hews 1988), and although this does not render them immune from predation, there are several current and former boreal toad breeding sites that also contain fish.

Distribution and Abundance

In the United States, boreal toads occurred historically from southeastern Alaska south to northern California, and east to Montana, Wyoming, Colorado, and New Mexico (Stebbins 1985). In Canada, they occur in Alberta, British Columbia, and the Northwest Territory. West of the Rocky Mountains to sea level, the boreal toad is found in dry habitats (Stebbins 1985). In Colorado and Wyoming this toad is found near surface waters along foothills, mountain meadows, and mesic sub-alpine forests. With the possible exception of New Mexico, boreal toads continue to be found throughout their historic range. However, within this broad historic range, some areas of distribution have been greatly reduced. This trend has also been well documented with numerous other species of amphibians throughout the world (Phillips 1994). These world-wide declines of amphibians have often been perplexing because causes of decline are not always obvious. However, recent discovery of the role of the chyrtid fungus in amphibian declines point to this pathogen as the proximate cause of the deaths for at least some species, such as the boreal toad.

Boreal toads found in New Mexico, Colorado, and southeastern Wyoming form the SRMP; a group of toads that is geographically separate from boreal toad populations in Utah, northwestern Wyoming, and the Pacific Northwest (USFWS 1994).

Southern Rocky Mountain boreal toads were once considered common to abundant throughout the

higher elevations of Colorado and southeastern Wyoming along the Snowy and Sierra Madre ranges (Medicine Bow, Sierra Madre, and Pole mountains) (USFWS 1994; CDOW 1994). The southern periphery of the species range was located in New Mexico along the San Juan Mountains at Lagunitas, Canjilon, and Trout Lakes (USFWS 1994; Stuart and Painter 1994). Specifically, the geographic areas, or mountain ranges, of historic occurrence of the boreal toad in the southern Rocky Mountains are:

Park Range/Sierra Madre Range
This area extends from south-central Carbon County, WY, through western Jackson County and eastern Routt County, CO, along the continental divide to approximately Rabbit Ears Pass. It is located primarily on the Routt and Medicine Bow National Forests.

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.

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 approximately Cameron Pass. It is situated primarily on the Routt and Roosevelt National Forests and on the Colorado State Forest.

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 Mountain National Park to Loveland Pass and the Mt. Evans Wilderness Area. Much of the area is situated within the Arapahoe/Roosevelt National Forest.

Gore Range
This area extends 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.

Mosquito and Ten-Mile Range
This area extends 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.

Sawatch Range
This 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.

White River Plateau

This 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.

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.

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.

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 Arriba County in New Mexico. It extends along the Continental Divide from Poncha Pass into 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.

In Colorado, reports from the early 1900s to 1950s described this species as common to abundant at sites in the upper Arkansas River Basin, the Elk Mountains, and elsewhere in Colorado (Smith et al. 1965; Stebbins 1954; Blair 1951; Burger and Bragg 1947; Ellis and Henderson 1915). The boreal toad was known to occur in 25 of 63 counties, and was believed likely to occur in seven others. This species was considered common in eight counties including Boulder, Chaffee, Gilpin, Grand, Gunnison, Hinsdale, Jackson, and Larimer.

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.). 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. Two years later, 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 L. 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, RMNP, 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 an unconfirmed report of a sighting of one adult boreal toad and one boreal toad tadpole in September 1996, near Chama, and recent observations of boreal toads in Colorado, within 20 miles (29 km) of New Mexico, gave hope that a breeding population might still exist in New Mexico (C. Painter, unpubl. 1996). However, several survey efforts from 1997 to 2000 have failed to find any boreal toads in either Rio Arriba County, New Mexico, or adjacent Conejos County, Colorado.

In Wyoming, boreal toads were found in the Medicine Bow and Sierra Madre ranges, and the Pole Mountain area of the Laramie Mountains (Garber 1995). The one known breeding population, at Bird Creek, in Albany County, has been regularly monitored, but no breeding activity was documented there from 1998 through 2000. The southern Rocky Mountain boreal toad is currently considered the second rarest amphibian in Wyoming.

As of February, 2001, the boreal toad (SRMP) is known to occur in eleven counties (Routt, Larimer, Grand, Eagle, Summit, Clear Creek, Pitkin, Gunnison, Chaffee, Hinsdale, and Mineral) in Colorado, probably one county (Albany) in southern Wyoming. Indications are that boreal toads may also still occur in Jackson, Garfield, Boulder, Lake, Park, Saguache, and Conejos counties in Colorado, and in Rio Arriba County, New Mexico. The latter is based on unconfirmed but reliable reports of observations of individual boreal toads from 1995 through 2000. Breeding populations have been documented during the past five years in 12 counties in Colorado, and at one location in Wyoming. There are presently 56 known breeding localities - some having more than one breeding site - located in nine of the geographic areas, or "mountain ranges", of historic occurrence (See Figure 3), and representing 30 distinct populations. During the 2000 breeding season, at least 33 of the 56 breeding localities were active. Two of the historic areas of occurrence (White River Plateau and Grand Mesa, Colorado) have no recent confirmed records of the occurrence of boreal toads.

Status

The boreal toad has been state listed as an endangered species in New Mexico since 1976, and in Colorado since November 1993. It is listed as "Native Species Status 1" in Wyoming[1], and is federally classified as a candidate species that is "warranted but precluded" for listing under the ESA. Under the Natural Heritage Program ranking system, the SRMP of the boreal toad is rated as rare in Wyoming (Finch 1992), critically imperiled (S1) in Colorado (Colorado Natural Heritage Program 1997), and of historic occurrence (SH) in New Mexico (New Mexico Natural Heritage Program 1998). The boreal toad is listed as a sensitive species in the Rocky Mountain Region of the Forest Service. Sensitive species status is appointed to species in which a downward trend in population or habitat is observed or predicted to occur on Forest Service lands.

Factors Leading to the Decline

Various possible reasons for the decline of the boreal toad have been investigated over the past several years. Most habitat alterations from timber harvest, grazing, recreation, and water development would likely not be beneficial to long-term enhancement of boreal toad habitats. However, none of these activities have been shown to be primary causative agents for the population decline in the southern Rocky Mountains. Resource management activities that negatively affect quality or quantity of alpine wetlands potentially have detrimental effects on boreal toads. Specific protection of lentic, intermittent water is generally not considered in comprehensive resource use plans, and as a result, marshes, wet meadows, and intermittent wetlands that form much of the primary habitat for this species may be affected by increased evaporation, altered seepage flow from reduced snowpack on exposed cut areas or road bed alteration, physical destruction of wetland vegetation, and deterioration of water quality due to runoff from roads and highways. In general, lack of suitable habitat does not appear to be a significant limiting factor for boreal toads in the southern Rocky Mountains.

Effects from aerial spraying of pesticides to control various forest insect pests are uncertain. Rotenone and antimycin, two commonly used piscicides, are toxic to boreal toad tadpoles (Bruce Rosenlund, USFWS, pers. comm.). However, the use of these chemicals is closely regulated by the CDOW, and a fish reclamation project using these chemicals in boreal toad breeding sites would not be permitted. No evidence exists linking the introduction of nonnative predators (e.g., Salmonidae or bullfrogs *[Rana catesbeiana]*) with the range-wide decline of the boreal toad. However, possible impacts of human-induced range expansion of the native tiger salamander (*Ambystoma tigrinum*) may warrant consideration as a possible factor in boreal toad declines, particularly in the Grand Mesa area of Colorado. Acidic deposition in the Rocky Mountains was not considered significant enough in scope to be a primary factor in the range-wide decline of the boreal toad (Vertucci and Corn 1996; Corn and Vertucci 1992). Although UV-B radiation is thought to effect embryo survival in the northwest U.S., investigations in Colorado have shown no effects of UV-B on boreal toad egg hatching success or embryo survival (Corn, 1998). Additional experiments on boreal toad eggs from Colorado, Utah, Montana, and Washington showed no differences in hatching success with varying amounts of UV-B exposure (Corn and Muths, unpublished data).

A working hypothesis explaining the widespread boreal toad decline concerns stress-induced mortality caused by one or more pathogens. This hypotheses originally focused on the bacteria *Aeromonas hydrophila* and the fungus *Basidiobolus ranarum,* which are known to cause mycotic dermatitis (Sharon K. Taylor, Wyoming State Veterinary Laboratory, pers. comm.). However, recent findings indicate that the newly described chytrid fungus (*Batrachochytrium dendrobatidis*) is the primary pathogen causing the die-offs of amphibians, including the boreal toad. The major elements of the hypothesis forwarded by Carey (1993) are that (1) some environmental factor or factors cause sublethal stress; (2) stress directly causes suppression of the amphibians' immune system; and (3) immunosuppression, coupled with the effect of cold body temperature on the ability of the immune systems of ectothermic animals to fight disease, leads to infection and subsequent widespread mortality. The causative environmental factors are not well understood, and are being investigated. Viruses have also been implicated in amphibian epizootics (Jancovich 1997), and will be tested for when die-offs of boreal toads are encountered.

B. dendrobatidis, was first identified and implicated in amphibian declines in Central America and Australia (Berger et al. 1998). Subsequently it has been found in several locations in North America, including the southern Rocky Mountains. In 1999, it was discovered that unusually high numbers of adult boreal toads at a study site in Clear Creek County, Colorado, were dying (Jones 2000). The dead toads were examined by D. Earl Green, DVM, at the USGS National Wildlife Health Center, Madison, WI, and found to have heavy infections of *B. dendrobatidis*. Dead toads from RMNP, where populations declines had been apparent since 1996 (Corn et al. 1997; E. Muths, unpublished data), also tested positive for chytrid fungus. Preserved specimens of leopard frogs and at least one boreal toad, which were collected in Colorado in the 1970s, have also tested positive for *D. dendrobatidis* (C. Carey pers. comm.) indicating the pathogen has been present in at least some locations in the southern Rocky Mountains since at least that time, and that the declines that occurred in the mid to late 1970s and early 1980s *may* have been caused by the chytrid fungus (Milius 2000).

* * *

SOUTHERN ROCKY MOUNTAIN BOREAL TOAD CONSERVATION OBJECTIVES & CRITERIA

The objectives of the management and conservation actions outlined in this plan are to (1) prevent the extirpation of boreal toads from the area of their historic occurrence in the southern Rocky Mountains, which includes eleven mountain ranges, or geographic areas, covering southern Wyoming, northern New Mexico, and much of Colorado, (2) to recover the species to a population and security level that will allow it to be de-listed from its present endangered status in Colorado and New Mexico, and (3) to avoid the need for federal listing of the boreal toad under the ESA.

The recovery objectives and criteria presented in this plan are based on objectives for boreal toad recovery formulated and previously approved by the interagency Boreal Toad Recovery Team. The CDOW has already adopted these criteria, and conservation actions described in this plan, for recovery of the boreal toad in Colorado. Should federal listing of this species occur, these criteria should be incorporated into any subsequent federal recovery plan for this species.

The following are recommended criteria for downlisting and delisting of the boreal toad in the State of Colorado:

> **To downlist** from "endangered" to "threatened", there must be at least two (2) viable breeding populations of boreal toads in each of at least six (6) of the eleven (11) areas, or mountain ranges, of its historic distribution, AND, statewide, the number of viable breeding populations must total at least fifteen (15).
>
> **To delist** the boreal toad in Colorado, there must be at least two (2) viable breeding populations of boreal toads in each of at least nine (9) of the eleven (11) areas, or mountain ranges, of its historic distribution, AND, statewide, the number of viable breeding populations must total at least twenty-five (25).

For a population of boreal toads to be considered "viable", it must meet the following criteria:

1. There must be documented breeding activity *and* recruitment to the population in at least four (4) out of the past ten (10) years. However, if breeding activity has not been documented in the past four (4) years, there must be reliable observations of toads, including at least one sub-adult age class, in the locality during at least two (2) of those four years.

OR

2. There has been an average observed total of at least twenty (20) breeding adults at the breeding locality, producing an average of at least four (4) viable egg masses per year, and the number of breeding adults observed at the locality has remained stable or increased over a period of at least ten (10) years, based on visual surveys..

AND

3. The population faces no known, significant and imminent threat to its habitat, health, and environmental conditions.

For the purpose of interpreting the above criteria, the following definitions will apply:

Breeding population:

Toads associated with one or more breeding localities that are located within a common second or third order drainage, and separated by no more than five (5) miles (approx. 8 km).

Breeding Locality:

A geographic area containing one or more breeding sites that are separated by a distance of no more than ½ mile (approx. 0.8 km).

Breeding Site:

A specific location in any body of water where toads congregate to breed and deposit eggs.

Recruitment:

The presence of one-year-old toads in any given year will be considered to be successful recruitment from the previous year's breeding activity.

It is recommended that the above criteria and definitions be considered in any process to list, downlist, or delist the boreal toad in Wyoming, New Mexico, and/or under the Endangered Species Act, with the understanding that species status determination within each specific State will need to include consideration of historic population levels and distribution within the State.

These criteria and definitions may be amended by the Boreal Toad Recovery Team as new and better information on boreal toad biology, ecology, and population dynamics becomes available.

* * *

MANAGEMENT ACTIONS & RESEARCH

1.0 Survey, evaluate, and monitor breeding populations of boreal toads and habitat.

Although considerable effort has already been expended to search for and document existing populations of boreal toads in the southern Rocky Mountains, a great deal of historic and suitable habitat remains unsurveyed, or has not been adequately surveyed. To obtain more accurate and reasonably complete data on the extent of suitable habitat, population size, distribution and trend, additional survey work is needed, and known breeding populations must be monitored to document their stability and productivity. Additional information may be needed on the genetics of known and newly discovered populations, and on the population dynamics and viability of these populations.

1.1 Identify potentially suitable habitat.

Potentially suitable habitat will be identified using existing data such as wetland inventory, elevation, and historical distribution from the boreal toad data base. Field personnel will help to develop more specific habitat criteria so that subsequent survey efforts are focused only in suitable habitats.
Progress as of December 2000: Studies in Clear Creek County and in RMNP have provided much new information regarding habitat utilization and preferences, and habitat characteristics of newly discovered breeding localities have reinforced previous concepts of what is good toad habitat. A comprehensive effort to apply this information to development of a range-wide survey plan is still needed.

1.2 Develop and distribute amphibian field guide for inventory purposes.

An amphibian field guide developed by the CDOW will be distributed to agency personnel, field personnel, and interested parties to aid in proper identification of the boreal toad and other amphibian species. The guide will be reprinted as necessary.
Progress as of December 2000: This task has been completed. The field guide has been revised and reprinted once, and will continue to be distributed as needed or requested.

1.3 Survey for boreal toads in suitable habitat.

Suitable habitat will be surveyed for toads using standardized protocol. The recovery team will identify and prioritize areas needing additional inventories.
Progress as of December 2000: This is an ongoing task. Numerous surveys have been done since 1998, but many more areas need to be surveyed. Results of survey efforts - both positive and negative - are being entered in a database, which will be used to guide plans for future survey efforts. In addition, random and incidental observations or boreal toads are used as a guide to direct subsequent survey efforts.

1.4 Monitor isolated non-breeding adults and juveniles.

Areas where only adults or juveniles were found will be monitored in future years to determine site status and trend, and to search for additional juveniles, adults, and possible breeding sites.

Progress as of December 2000: This is an ongoing process, and done on an opportunistic basis. Several new breeding sites have been located in years subsequent to original observations as a result of follow-up survey efforts.

1.5 Determine status and trend of boreal toad populations.

All breeding sites will be monitored annually. This information will provide for rapid identification of changes in abundance (either declines or increases) that could affect recovery. Population size will be estimated at selected sites throughout the range of the toad using capture-recapture techniques. Indices of population size (e.g., number of males counted during one night, number of egg masses) will be calibrated against known population size and used to help monitor population trends at all sites. Data collection will be standardized through the use of established protocols and common data forms.

Progress as of December 2000: This is an ongoing process, and every effort is made to adequately monitor all known breeding sites every year. Due to the large number of sites now being monitored, and difficult access to some, only about 90-94% of sites have been monitored adequately during the past three years. Large numbers of toads have been PIT (passive integrated transponder) tagged in three populations (RMNP/North Fork of the Big Thompson, Clear Creek County/Urad-Henderson, and Chaffee County/Cottonwood Creek drainage). This has provided significant information about actual population size vs. visual counts of adults during the breeding season.

1.6 Create and maintain a population database and maps of occupied, unoccupied, suitable, and unsurveyed suitable habitat.

Data pertaining to boreal toad populations, distribution, and habitat will be maintained and made available to parties engaged in management and research activities. The CDOW, in cooperation with the CNHP will compile and maintain data on boreal toad locations and other relevant information. The database will include location as well as information describing the breeding status, approximate site size, and habitat occupied. The CNHP and CDOW will make the database information available to agencies to enable them to know where sensitive areas are in the event that management actions or projects are proposed for those areas. The database will also help identify and rank areas suitable for protective designations, which may prompt agencies to provide greater protection. Maps of existing and historical breeding sites, isolated adult or juvenile sites, areas that have been inventoried, and areas that remain to be inventoried will be key products from this

database.

Progress as of December 2000: Databases to capture and manage data on boreal toad breeding site monitoring, boreal toad observation reports, and survey efforts have been established. Data entry is ongoing.

1.7 Conduct genetic analysis and determine phylogenetic diversity within and between populations.

Early studies of the *B. boreas* species group found that mitochondrial DNA from *B. b. boreas* in the east-central portion of the United States represented a genetically unique and highly divergent lineage (Goebel 1996). Mitochondrial DNA divergence was larger between this group and western toads in the rest of the range than between any pair of recognized taxa in the group (*Bufo nelsoni, B. exsul,* and *B. boreas*). Furthermore, substantial divergence was found within this southeastern mtDNA clade, but the relationship of toads in the southern Rocky Mountains (toads in northern New Mexico, central Colorado, and southern Wyoming) to the rest of the group was unresolved.

Progress as of December 2000:

Recent studies of nuclear data (AFLP restriction site polymorphisms, Goebel 1999 and 2000) from toads in the southeastern portion of the toad's range identified the same divergent clades as did the mtDNA data. Nuclear data also identified toads in the southern Rocky Mountains as genetically distinct from toads in Utah. This distinction was based on data from very few toads and more data are needed to increase confidence in this hypothesis. However, current data suggest that if species are independently evolving lineages, the southern Rocky Mountain group is a species as identified by both genetic differentiation and geographic isolation.

1.8 Monitor disease/health status of populations

Although it has not been determined with certainty that disease-causing pathogens are the primary cause of amphibian declines, there is strong evidence that the chytrid fungus (*Batrachochytrium dendrobatidis*) is the proximate cause of declines of boreal toads in the southern Rocky Mountains. Therefore, all breeding populations and habitats should be monitored for presence of chytrid fungus, and other pathogens, via collection and testing of tissue and/or tadpole samples.

Progress as of December 2000: During the 2000 field season, samples were collected from boreal toads from numerous breeding populations throughout Colorado to be examined via a PCR test, which is expected to be available for use before mid-2001, for presence of chytrid fungus.

2.0 Conduct population viability analysis.

There is very little current information available to predict the demographic behavior of existing populations of boreal toads, anticipate their response to external threats, or to

evaluate the suitability of proposals for reintroductions. Population viability analysis (PVA) is a tool in the search for correlates of amphibian declines and could suggest cause(s) for those declines as well as appropriate management action. It is a process whereby data and models for a population are examined to anticipate the likelihood that a population will persist for some chosen time into the future (Boyce, 1992). There are two general types of PVA. The first approach is to estimate the genetic minimum viable population (MVP) size, which is based on the rate at which genetic variation in a population is lost, and hence fitness decreased, through random genetic drift. The second approach is to estimate the demographic MVP size, which is concerned with the probability of extinction of a population through random demographic forces. Given a time frame and desired probability of persistence, a PVA establishes the MVP size. This is done by integrating information on population parameters, external threats, and stochastic variation (which individually are insufficient for predicting fates of populations) into a predictive model that can provide more precision than arbitrary "rules of thumb". PVA is an important tool for risk assessment.

2.1 Estimate genetic minimum viable population

Research will be conducted on the degree of genetic variation within and among populations to attempt to answer what were historical effective population sizes, and if *B. boreas* have the genetic pattern of an expanding population or a pattern suggesting frequent population declines. Existing tissue samples as well as additional samples need to be analyzed and the results inserted into a computer model to determine long-term viability.

2.2 Estimate demographic minimum viable population

Demographic data will be analyzed to derive estimates, along with their associated variance, of key population parameters. An analysis of covariance will be performed using the parameter estimates and data that represents potential environmental covariates. This analysis should provide insights into the external threats and relative impacts of these threats on the boreal toads' demographic behavior. Population models will be built based on the analysis above and on information from the literature. These models will be evaluated based on their fit to the data and the "best" model(s) will be used in simulations that will provide the necessary information for estimation of MVP.

2.3 Integrate genetic and demographic models into a predictive population viability analysis

A robust model combining both genetic and demographic data will be developed. Further refinement of recovery objectives, such as number and distribution of boreal toad sites, should be provided by this model.

Progress as of December 2000 (Tasks 2.1 - 2.3): A graduate student at Colorado State University, Ft. Collins, (B. Noon and E. Muths, advisors) is exploring baseline models, using

a ten-year data set from the boreal toad population at RMNP (Corn and Muths, unpublished).

3.0 Protect and manage existing breeding sites, occupied habitat, and unoccupied suitable habitat.

Immediate and long-term protection of boreal toad habitats is an essential component of achieving the recovery and conservation goals for this species. Federal, state, and private interests must work towards this objective by agreeing to implement actions and guidelines prescribed in this plan, and by utilizing other programs and land status designations that will serve to protect and enhance boreal toad habitat.

3.1 Develop Conservation Agreements/Partnerships with Stakeholders

All appropriate resource management agencies and private interests will be recruited and encouraged to sign Conservation Agreements stating their commitment to help implement all, or certain portions of, this Conservation Plan. Agreements will be tailored to the specific roles and capabilities of each signatory, and will be appended to this plan.

Progress as of December 2000: As of January 2001, eleven agencies and organizations have signed conservation agreements to participate in the boreal toad recovery and conservation effort (see Appendix A).

3.2 Encourage land designations to conserve boreal toad habitat.

There are programs and land designations available to Federal, State, and private interests that will help protect boreal toad habitat. Some of the protection tools include registries, conservation easements, management agreements, fee simple acquisitions, and designation of State Natural Areas, Areas of Critical Environmental Concern, Special Interest Areas, and Research Natural Areas. Inclusion of designated sites in forest and resource management plans can provide additional protection.

3.3 Promote and encourage application of habitat management strategies.

Known boreal toad habitats occur primarily on public lands (USFS and NPS), but also on some private lands. Land managers, owners, and developers will be encouraged to implement the recommended management strategies for boreal toad habitat that are presented in this Conservation Plan. These strategies should be incorporated in the land and resource management plans of federal, tribal, and state land management agencies, and in the local land use decision processes of counties where boreal toad habitat occurs. Information will be provided to local land use planners and other interested parties to promote consideration of boreal toad habitats in land use decisions.

Progress as of December 2000: Fewer than 10% of the known boreal toad breeding localities are located on private lands. However, efforts have been made, or are ongoing, to provide long-term protection for some of these sites. USFS, CDOW, and the Town of Breckenridge have worked in cooperation with local land developers and with Vail Associates to protect wetland habitat at Cucumber Gulch, in Summit County, Colorado; a Conservation Agreement is being negotiated between the USFWS and the Climax Molybdenum Company, in Clear Creek County, to protect toad breeding habitat at on the Henderson Mine property; and in Grand County, negotiations are underway with the Board of Directors of the Pole Creek Golf Course to provide long term protection and improvement of toad breeding habitat there.

3.4 Protect currently occupied habitat.

Boreal toad habitat may be subject to long-term degradation or short-term impacts. Actions to protect boreal toad habitat and reverse long-term degradation are the responsibility of the land management agency. These actions will be recommended to the Recovery Team for evaluation. Such contact may be made via the Boreal Toad Recovery Team Coordinator, Species Conservation Section, Colorado Division of Wildlife, 6060 Broadway, Denver, CO 80216. Short-term impacts likely require immediate action, and when observed, the recovery team coordinator should be contacted to consult with appropriate parties on possible corrective actions. Currently occupied breeding or adult sites should not be altered unless enhancement is planned that would clearly benefit the species.

Progress as of December 2000: The Recovery Team, or individual members of the team, have provided advice and recommendations to the USFS and RMNP on numerous occasions in regard to proposed land management actions and impact assessments, and will continue to do so as needed or requested.

3.5 Develop and refine knowledge of suitable habitat

Until recently, habitat preferences of all life stages of boreal toads were poorly known. Research in this area during the past three to five years has provided new information (Jones 1998; Livo 1999; Jones and Livo, Submitted) but additional research would be useful to better define boreal toad habitat preferences and use, and to confirm recent findings. Data collection and research should focus on evaluating potential differences in breeding habitats in occupied vs. suitable unoccupied sites, use of upland terrestrial habitats, preferred hibernacula sites, and effects of habitat alteration on toad habitat.

Progress as of December 2000: Work is currently in progress to evaluate breeding site selection by comparing the physical characteristics of known breeding sites with adjacent sites where breeding has not been documented. In general, previous concepts of what is good boreal toad habitat have been reinforced by examination of the physical characteristics of new breeding localities found during the past three years.

4.0 Research and manage limiting factors

Both biotic and abiotic factors may be limiting the boreal toads' survival and recovery. Abiotic factors may be responsible for increased biotic effects, such as disease, and adverse abiotic and biotic factors should be identified and efforts made to eliminate or control them. Research has been, and will continue to be, conducted on suspected adverse factors and if any are discovered, appropriate management actions will be taken.

4.1 Monitor environmental factors at breeding sites.

It is necessary to identify factors that cause changes in abundance. These factors could be abiotic (e.g., air and water pollution or climate) or biotic (e.g., native or introduced predators). Water samples will be collected at all breeding sites at least twice annually (early and late in the breeding season) and analyzed for standard constituents (e.g., alkalinity, pH, conductivity, hardness, and trace metals). Climatic data will be obtained from either local National Weather Service records or from dedicated instrumentation at selected breeding sites. Weather conditions and air and water temperature will also be recorded during population monitoring. Other abiotic factors will be measured if determined appropriate. Field personnel will look for evidence of dead or moribund toads, eggs, and tadpoles to help determine if adverse environmental factors are present. Water and sediment samples will be obtained for contaminant analysis at sites where significant mortality is observed.

Progress as of December 2000: Data on various biotic and abiotic factors are collected on an ongoing basis at known breeding localities. To date, no significant environmental factors, other than the pathogenic chytrid fungus, have been identified in relation to die-offs of boreal toads.

In addition, work is in progress to evaluate the role of water temperature on larval growth, development, and metamorphosis. This will allow the evaluation of potential and existing breeding sites in terms of the probability, given the deposition of eggs, that boreal toad larvae will successfully metamorphose. Larval density, water level stability, and productivity are confounding factors in this relationship that are also being modeled.

4.2 Investigate UV-radiation impacts.

Although there is evidence from other amphibian studies that UV-radiation may have an adverse impact on the development of amphibian eggs, recent studies in the southern Rocky Mountain area indicate that UV-radiation does not have direct significant negative impacts on the development or survival of boreal toads (Corn

1998). In later studies, effects of UV radiation on egg and larval development of boreal toads from Colorado, Utah, Washington and Montana were monitored in situ and at a site in Colorado. No adverse impacts were noted during this study (Corn et al. unpub. data). However, additional study may be warranted, especially on possible synergistic effects of UV-radiation in combination with other stressors leading to immunosupression (see 4.5 below). UV-radiation may effect the production of food (freshwater algae) for tadpoles. Additionally, an evaluation of the importance of climate-induced variability in dissolved organic carbon (DOC)-mediated UV-B exposure to amphibians, within the context of existing stressors of disease and surface water acidification may be valuable. DOC provides the major control on the depth to which UV radiation penetrates in surface water (Schindler et al. 1996; Williamson 1996) but the attenuation of UV radiation by DOC is due primarily to the highly photoreactive hydrophobic fraction of DOC (Thurman 1985; Mcknight et al. 1995), most of which originates in soil environments (Wetzel 1992). Recent research has demonstrated that variability in this hydrophobic fraction is much more important than the total DOC pool in controlling UV attenuation in amphibian habitats in RMNP, CO (Brooks et al. 2000).

Progress as of December 2000: Studies have been completed (see above) which indicate there are no direct adverse effects of UV-radiation on boreal toads in the southern Rocky Mountains. Additional studies to examine possible secondary effects via impacts on toad food sources and suppression of the toads' immune response, and to evaluate DOC variability in water bodies in RMNP, are in progress or planned.

4.3 Determine potential contaminants present in boreal toads and their habitat.

Research must be conducted to determine if one or more contaminants is impacting the boreal toad, and if so, what medium (air, water, soils) transfers the contaminant(s) to the toads. Comparisons between contaminants found in currently occupied and unoccupied historic sites are appropriate and desirable. Samples may be collected and preserved for later analysis in the absence of timely funding. If specific contaminants are found to be present in elevated concentrations in the environment or in boreal toad tissues, toxicity research should be conducted on all life stages of the boreal toad and on the contaminants.

Progress as of December 2000: The CDOW Toxicology Laboratory has conducted analysis of water samples collected from current and historic breeding ponds, developed techniques to measure effects of toxicants (heavy metals, pesticides, deicing compounds) on tadpoles, and conducted experiments to determine toxicity of selected metals to boreal toad tadpoles (Jones et al. 1998).

4.4 Prevent environmental contaminant impacts.

If it is determined that one or more contaminants are responsible for decline of the boreal toad, the sources must be determined. Organizations, such as EPA, with regulatory authority over the use of potential environmental contaminants, should be contacted to discuss means of limiting or altering use of the sources of

contamination. Significant findings regarding environmental causes of boreal toad declines will be disseminated as rapidly as possible in peer-reviewed journals and via international organizations that communicate findings on amphibian declines. If necessary, the Recovery Team should write position documents to state agencies, federal agencies, and the U.S. Congress detailing research results and requesting limitation or alteration of uses of the affecting contaminants.

Progress as of December 2000: To date, no unusually high levels of contaminants have been found in any of the boreal toad breeding populations or their habitats. However, in one study some contaminants were present at higher levels at sites where the boreal toad was extirpated versus where toads were still present (Carey et al. 1999). Monitoring for possible contaminant effects will continue, and appropriate testing will be done if and where contaminants are suspected to be a causative factor in boreal toad declines.

4.5 Determine immunological impacts by various factors.

Laboratory research is proposed that will test effects of cold, pH, and trace metals on the immune system of boreal toads and other amphibians. Combinations of cold and pH, and low pH and trace metals will also be tested. Immunological responses to the above may be tested by injecting bacteria into toads and by testing egg jelly for antibacterial and antifungal properties then exposing egg masses to different regimens of cold, pH, trace metals, and UV-radiation.

Progress as of December 2000: The relationship between chytrid fungi and boreal toads is being tested on several fronts. Antimicrobial peptides, the only likely immune defense in the skin against this fungus, have been extracted from boreal toad skin and tested against the fungus for activity. At least several were found to be effective and they are being purified and sequenced to identify them. Assuming the purified peptides are also effective at killing the fungus, the next steps are to determine why they are not working in the field.

The relationship between temperature, pH, metals, the chytrid fungus, and boreal toads are being tested. In each case, the effect of a variable on the activity of the antimicrobial peptide, on boreal toads alone, and on the boreal toad plus fungus will be tested.

4.6 Investigate pathogens that impact boreal toad health and survival.

Researchers have hypothesized that adverse environmental factors may weaken boreal toad immune systems rendering them susceptible to disease. Chytridiomycosis, a skin disease of amphibians caused by the newly described fungus *Batrachochytrium dendrobatidis*, has been found to be the proximate cause of death of numerous boreal toads from three locations in Colorado. Although this fungus is currently thought to be the most serious disease threat to boreal toad recovery efforts, other pathogens such as bacterial infections and viruses are also of concern. Diseases of potential concern, in addition to amphibian chytridiomycosis, were found during diagnostic examinations of boreal toads from Colorado. Several

adult toads had abnormalities in the dermal glands and Jacobson's organ consistent with a herpesvirus infection (David Green DVM, pers. comm.). Additional research needs to be conducted on chytrid fungus as well as other pathogens in boreal toads.
Progress as of December 2000: Current research efforts include the development and testing of a PCR test for chytrid fungus, investigation of immune response to environmental factors that could effect susceptibility to chytrid infection, response of chytrid to environmental factors, drug treatments for identified pathogens including chytrid, and health management techniques for captive boreal toad stocks. Personnel monitoring breeding sites have been provided with "death kits" that provide instruction and materials to collect sick or dead amphibians in the field as well as instructions on where to send specimens for pathology and necropsy work (Livo and Jones 2000).
A project to collect baseline data on amphibian health in RMNP and vicinity will be initiated by USGS and RMNP in 2001. It will focus on boreal toads, but will also collect data on other amphibian species.

4.7 Determine if/how predation is limiting the survival of boreal toads.

Research and documentation of factors influencing predation needs to be conducted. Predation effects should be components of other studies. For example, does reduction of cover increase risk of predation, or do specific contaminants alter behavior resulting in increased risk of predation?
Progress as of December 2000: Observations and studies have shown that, although some predator species can have a significant impact on a local population of boreal toads by limiting reproductive success, predation does not seem to be a major causative factor in the decline of boreal toads in the southern Rocky Mountains. Examination of stomach contents of brook trout at sites replete with boreal toad larvae have shown no predation by trout, and informal experiments at a fish hatchery indicated that non-native trout do not eat boreal toad larvae (Jones et al. 1999).
Western terrestrial garter snakes and birds (including mallard ducks, spotted sandpipers, robins, Steller's jays, grey jays, crows, and ravens) can be important predators of tadpoles and recently metamorphosed toadlets (Beiswenger, 1981; Campbell, 1970a; Jones et al. 1999; Livo, 1999). High densities of predaceous diving beetle larvae can cause sharp declines in tadpole numbers at some boreal toad breeding sites (Livo, 1999). Tiger salamanders are important predators in laboratory experiments, but at present rarely are found at the same sites inhabited by *Bufo boreas* (Livo, 1999).

4.8 Limit predation.

Although predator control should not be considered a primary management tool, if predation appears to be substantially reducing the number of boreal toads at a site, and that site represents a small, marginal, or isolated population, measures should be considered to reduce the effects of predation.
Progress as of December 2000: Relatively little action has been taken to reduce or

mitigate predation at boreal toad breeding sites. In some instances predator species have been reduced via physical removal from a site as part of an investigation into effects of predation, or to reduce predation at an isolated breeding site where the toad population is already very small (For example, relocation of western terrestrial garter snakes at the Brown's Creek site in Chaffee County).

5.0 Conduct research and management actions associated with translocation and reintroduction of toads.[4]

It is unlikely that boreal toads will naturally recolonize vacant historical areas distant from existing sites. Consequently, reintroduction may be necessary to provide adequately dispersed, yet genetically interacting, groups of boreal toads to maintain the entire population in the future. Research of existing sites and historical locations for contaminants, pathogens, or other deterrents to translocation of toads should reveal whether a reintroduction is likely to be successful. Both translocation of wild stock and release of captive reared or propagated stock may be used for reintroduction actions. Translocations may include various life stages (i.e., eggs, tadpoles, and toadlets). The genetic composition and relationships of populations should be considered prior to any translocations being conducted.

The potential introduction and possible impacts of various disease organisms - particularly *B. dendrobatidis* - must be considered prior to initiation of any translocation of toads. Ongoing studies to determine how ubiquitous the chytrid fungus is should be completed prior to the initiation of any experimental translocations or reintroductions.

Some research to develop and test rearing and propagation techniques has been conducted in both Colorado and Wyoming. However, further development and testing of techniques is warranted to ensure successful reintroductions, should they become necessary. Conducting experimental translocations will allow involved parties to refine techniques and evaluate whether wide scale reintroduction will be successful. Determining factors limiting survival at reintroduction sites will allow involved parties to know whether reintroduction at the proposed site is prudent and likely to succeed.

Translocations of toads to or from the wild, and reintroductions should be conducted only after consultation with the recovery team, consultation with all potentially effected interests and stake holders, and in compliance with the guidelines presented elsewhere in this Conservation Plan.

[4] In the context of this plan, the term "translocation" refers to any movement of individuals of any life stage of toads from one locality to another by intentional human action. The term "reintroduction" means the intentional translocation of individuals of any of the life stages of the toad to a presumed unoccupied, suitable habitat within the known historical range of the species, with the intent of establishing a viable population.

5.1 Determine rearing and propagation techniques.

Captive rearing may allow for greater survival, faster growth, and availability of toads for reintroduction and research. Present research needs to continue on appropriate techniques and methodology for husbandry and maintenance of toads in captivity.

Progress as of December 2000: Development of husbandry techniques for boreal toads has been done at the wildlife research facility at Sybille, WY, and at the CDOW's research hatchery in Ft. Collins, CO, resulting in basic guidelines for rearing of boreal toads. Cooperative efforts to develop and refine propagation and rearing techniques are being pursued by the states of Wyoming and Colorado, and various AZA zoos (see comments under 5.2, below).

5.2 Rear and propagate toads.

Once the appropriate environmental factors, rearing, and propagation techniques have been determined, an approved protocol for rearing and propagation should be followed by all captive rearing facilities. The number of toads to be taken out of the wild, numbers to be maintained in the rearing facilities, the number of rearing facilities necessary, and numbers and disposition of animals produced via captive breeding should be discussed and approved by the Recovery Team.

Progress as of December 2000: After the discovery of the chytrid fungus in Colorado boreal toads, the Recovery Team decided that placement of "clean" toad stock in to captivity was a high priority, and developed a priority list of populations to be represented in captive stock to maximize genetic diversity. In 2000, boreal toads were placed in and reared at the CDOW's new Aquatic Species Restoration Facility, near Alamosa, Colorado, and small lots of boreal toads are being placed at various qualified zoos, including, as of December, 2000, the Henry Doorly Zoo in Omaha, the Cheyenne Mountain Zoo in Colorado Springs, and the Detroit Zoo. In addition, captive stock at Sybille, Wyoming, continues to be maintained. A cooperative effort with the American Zoological Association (AZA), to establish a formal "studbook" record keeping system for captive southern Rocky Mountain boreal toads, is in progress. A detailed accounting of captive stock will be included in the annual status reports.

5.3 Conduct experimental reintroduction.

Some research has being conducted to evaluate the effectiveness of reintroduction and translocation as management tools (e.g., what is the optimum life stage for reintroduction-- translocated eggs, tadpoles, or captive-reared toads?). Recent studies in Albany County, Wyoming (Lake Owen), in RMNP, and in Boulder County, Colorado (Lost Lake), are providing some useful data that indicate that early life stages (eggs and/or toadlets) may be the most appropriate and effective life stages to utilize for reintroductions (Jones et al. 1998). Muths et al. 2001 indicates that translocation of eggs is the most cost effective method for boreal toads, and equally

as successful as other life stages. An additional experimental reintroduction should be considered in the Grand Mesa area of Colorado, provided that all criteria for such a reintroduction are met. Reintroductions or translocations for management purposes should not take place until this research has been completed and peer-reviewed.

Progress as of December 2000: As of the end of 2000, previous reintroductions do not appear to be successful, indicating that there may be limiting factors at work, such as continued presence of chytrid fungus at historic sites, which need to be defined. Therefore, a carefully planned and closely monitored experimental reintroduction needs to be done prior to initiation of further translocations for management purposes. The proposed experimental reintroduction to Grand Mesa was put on indefinite hold in late 1999, after discovery of *B. dendrobatidis* in boreal toads in Clear Creek County. Until extensive testing can be done for presence of chytrid fungus, via a PCR test, in other amphibians and in the environment on Grand Mesa, this reintroduction should not proceed.

5.4 Monitor reintroduced toads.

A protocol should be established to monitor the outcome of any reintroduction attempt. Toads should be uniquely marked to facilitate monitoring and so that reintroduced individuals can be distinguished from resident individuals that might subsequently be discovered. Monitoring should include data on movements, survival, reproduction, and cause of death of any recovered mortalities.

5.5 Develop marking technique for larvae and small toads

The life stages that will most likely be most effective for reintroduction efforts are eggs, larvae, and metamorph toadlets. An important component of proper monitoring of reintroductions is the ability to identify animals from different lots, groups, or age classes. Marking eggs, larvae and small toadlets is problematic, and various methodologies, such as have been developed for marking small fish, need to be tested for use on boreal toads. Marking with oxytetracycline was found unsatisfactory for batch marking of *Bufo boreas* (Muths et al. 2000). Visible implant elastomers have been used on adult anurans (Nauwelaerts et al. 2000) and preliminary studies indicate they have potential application for marking toadlets (Jones and Livo, pers. obs.). The use of other marking technologies, such as microchips and dyes, will be evaluated as they become available.

5.6 Evaluate genetics of captive toads and explore cryogenic storage of *Bufo boreas* genetic material

Long-term maintenance of genetic variability in captive populations requires management of distinct genetic lineages. Record keeping via "stud books", and other breeding management tools should be employed. Variability of captive populations may be enhanced if genetic material (especially sperm or eggs) can be stored

cryogenically. Cooperate with zoos and other organizations to assist with the development and evaluation of techniques for cryogenic storage.

6.0 Conduct public education.

Public education should be included in day-to-day relations with interested publics as well as at critical points in the recovery process to inform the public why certain management actions are being taken. Public education will be especially important if limitation or alteration of use of timber, water bodies, mining operations, recreational facilities, and/or chemical contaminants is necessary. Information packets, posters, and other informational materials have been developed and will continue to be used for distribution at participating organization offices, agency offices, campgrounds, or other areas that stakeholders may visit. Public meetings, perhaps coupled with National Environmental Policy Act review, and short informational videos on television may be necessary if management actions impact a large number of people.

7.0 Continue recovery team activities.

To ensure that coordination among participating organizations is being maintained and that the recovery endeavor is being pursued, the Recovery Team will meet at least twice each calendar year. Meetings will generally be held early in the Spring and during the Fall to facilitate both planning and review of field activities. Additional meetings and/or communications will be utilized as necessary to address urgent issues and to disperse pertinent information to team members in a timely manner.

* * *

ESTIMATED COST OF IMPLEMENTATION

Work on boreal toad conservation and recovery in the southern Rocky Mountains is ongoing. Several state and Federal agencies have participated in this work, with the CDOW (including funds from "Great Outdoors Colorado"), the USFWS, USGS/BRD, NPS/Rocky Mountain National Park, and the USFS contributing the large majority of funds and time expended to date.

The following table provides an estimate of funding required to implement the boreal toad conservation and recovery effort, as outlined in this plan, throughout the southern Rocky Mountains over the next five years. These figures are best estimates, and are subject to change as a result of changing circumstances and new information. Needed funds may come from all of the involved agencies and possibly from various "outside" grants. The Recovery Team recognizes that both personnel time and funding are in short supply, and will pursue innovative approaches to accomplish the needed work, including solicitation of volunteer help, partnerships, and other cooperative efforts. However, without a significant commitment of funds and time from all of the involved agencies, recovery may be difficult, if not impossible, to achieve in the foreseeable future.

***Cost estimates do not include salaries of permanent, full-time agency employees or administrative overhead costs.*

Task #	Task Description	*YEAR* 2001	2002	2003	2004	2005	Totals
1.0	**Survey, evaluate, and monitor breeding populations of boreal toads and their habitat.**	**$165,000**	**$170,000**	**$185,000**	**$150,000**	**$140,000**	**$810,000**
1.1	Identify potentially suitable habitat.	$20,000	$20,000	$20,000	-0-	-0-	$60,000
1.2	Develop and distribute amphib. field guide for inventory.	-0-	-0-	$5,000	-0-	-0-	$5,000
1.3	Survey for boreal toads in suitable habitat.	$40,000	$40,000	$40,000	$40,000	$40,000	$200,000
1.4	Monitor isolated non-breeding adults and juveniles.	$10,000	$10,000	$10,000	$10,000	$10,000	$50,000
1.5	Determine status and trend of boreal toad populations.	$50,000	$50,000	$60,000	$60,000	$60,000	$280,000
1.6	Create and maintain population database and maps of habitats.	$5,000	$5,000	$5,000	$5,000	$5,000	$25,000
1.7	Conduct genetic analyses and determine phylogenetic diversity.	$15,000	$20,000	$20,000	$15,000	$5,000	$75,000
1.8	Monitor disease/health status of populations.	$25,000	$25,000	$25,000	$20,000	$20,000	$115,000

2.0	**Conduct population viability analysis.**	**$15,000**	**$20,000**	**$15,000**	**-0-**	**-0-**	**$50,000**
2.1	Estimate genetic minimum viable population.	$5,000	$10,000	$5,000	-0-	-0-	$20,000
2.2	Estimate demographic minimum viable population.	$10,000	$10,000	$10,000	-0-	-0-	$30,000
3.0	**Protect and manage existing breeding sites, occupied habitat, and unoccupied suitable habitat.**	**$25,000**	**$25,000**	**$25,000**	**$25,000**	**$25,000**	**$125,000**
3.1	Develop cons. agreements/ partnerships with stakeholders.*	-0-	-0-	-0-	-0-	-0-	-0-
3.2	Encourage land designations to conserve boreal toad habitats.*	-0-	-0-	-0-	-0-	-0-	-0-
3.3	Promote/encourage application of habitat mgmt strategies.*	-0-	-0-	-0-	-0-	-0-	-0-
3.4	Protect currently occupied habitats.	$5,000	$5,000	$5,000	$5,000	$5,000	$25,000
3.5	Develop and refine knowledge of suitable habitat.	$20,000	$20,000	$20,000	$20,000	$20,000	$100,000
4.0	**Research and manage limiting factors.**	**$80,000**	**$100,000**	**$100,00**	**$80,000**	**$80,000**	**$440,000**
4.1	Monitor environmental factors at breeding sites.	$5,000	$5,000	$5,000	$5,000	$5,000	$25,000
4.2	Investigate UV-radiation impacts.	$20,000	$20,000	$20,000	$20,000	$20,000	$100,000
4.3	Determine potential contaminants present in boreal toads & habitat.	$5,000	$5,000	$5,000	$5,000	$5,000	$25,000
4.4	Prevent environmental contaminant impacts.	Undetermined: Action will be taken on an "as needed" basis.					
4.5	Determine immunological impacts by various factors.	$25,000	$25,000	$25,000	$25,000	$25,000	$125,000
4.6	Investigate pathogens that impact boreal toad health and survival.	$25,000	$25,000	$25,000	$25,000	$25,000	$125,000
4.7	Determine if/how predation is limiting survival of boreal toads.	-0-	$20,000	$20,000	-0-	-0-	$40,000
4.8	Limit predation.	Undetermined: Action will be taken on an "as needed" basis.					

5.0	**Conduct research and management actions associated with translocation and reintroduction of toads.**	**$45,000**	**$105,000**	**$105,000**	**$100,000**	**$100,000**	**$455,000**
5.1	Determine rearing and propagation techniques.	$20,000	$20,000	$20,000	$20,000	$20,000	$100,000
5.2	Rear and propagate toads.	$15,000	$25,000	$25,000	$25,000	$25,000	$115,000
5.3	Conduct experimental reintroductions.	-0-	$30,000	$30,000	$30,000	$30,000	$120,000
5.4	Monitor reintroduced toads.	-0-	$20,000	$20,000	$20,000	$20,000	$80,000
5.5	Develop marking techniques for larvae and small toads.	$5,000	$5,000	$5,000	-0-	-0-	$15,000
5.6	Evaluate genetics of captive toads and explore cryogenic storage of *B. boreas* genetic material.	$5,000	$5,000	$5,000	$5,000	$5,000	$25,000
6.0	**Conduct public education.**	**$2,000**	**$2,000**	**$2,000**	**$2,000**	**$2,000**	**$10,000**
7.0	**Conduct recovery team activities.**	**$2,500**	**$1,500**	**$1,500**	**$1,500**	**$2,500**	**$9,500**
ANNUAL ESTIMATED TOTALS:		**$334,500**	**$423,500**	**$433,500**	**$358,500**	**$349,500**	**$1,899,500**

** Cost estimates do not include salaries of permanent, full-time agency employees or administrative overhead costs.*

* * *

RECOMMENDED PROTOCOLS FOR SPECIES MANAGEMENT

The standard protocols presented here are based on the best available information at the time of the writing of this plan, and they may be changed or updated periodically based on new information and field experience. All agencies and personnel working on boreal toad management and recovery should adhere to these protocols to assure uniform and comparable data collection and evaluation.

I. DAPTF FIELDWORK *CODE OF PRACTICE*

It is recommended that all field personnel use the following *Code of Practice*, prepared by the Declining Amphibian Population Task Force (DAPTF), in all situations where it is appropriate and practicable. The primary objective of this *Code of Practice* is to minimize the spread of disease agents and parasites between study sites.

1. Remove mud, snails, algae and other debris from nets, traps, boots, vehicle tires and all other surfaces. Rinse cleaned items with sterilized (e.g. boiled or treated) water before leaving each study site.

2. Boots, nets, traps etc. should then be scrubbed with 70% ethanol solution and rinsed clean with sterilized water between study sites. Avoid cleaning equipment in the immediate vicinity of a pond or wetland.

3. In remote locations, clean all equipment as described above (or with a bleach solution of 1 part bleach to 32 parts water, or stronger) upon return to the lab or "base camp". Elsewhere, when washing-machine facilities are available, remove nets from poles and wash with bleach on a "delicate" cycle, contained in a protective mesh laundry bag.

4. When working at sites with known or suspected disease problems, or when sampling populations of rare or isolated species, wear disposable gloves and change them between handling each animal. Dedicate sets of nets, boots, traps and other equipment to each site being visited. Clean and store them separately at the end of each field day.

5. When amphibians are collected, ensure the separation of animals from different sites and take great care to avoid indirect contact between them (e.g. via handling, reuse of containers) or with other captive animals. Isolation from unsterilized plants or soils that have been taken from other sites is also essential. Always use disinfected/disposable husbandry equipment.

6. Examine collected amphibians for the presence of diseases and parasites soon after capture. Prior to their release or the release of any progeny, amphibians should be quarantined for a period and thoroughly screened for the presence of any potential disease agents.

7. Used cleaning materials (liquids, etc.) should be disposed of safely and if necessary taken back to the lab for proper disposal. Used disposable gloves should be retained for safe disposal in sealed bags.

* * *

II. SURVEYS & MONITORING

It is primarily the responsibility of state wildlife management agencies (Wyoming, Colorado, and New Mexico) to conduct surveys to determine current distribution of boreal toad populations and collect information about this species and its use of habitat. USGS/BRD and federal land management agencies will assist in these surveys where appropriate and feasible or where gaps exist.

Determining presence is conclusive if one sees a boreal toad, its eggs or larvae. Photographic documentation of observations at new locations is recommended. Lack of observation of boreal toads is never conclusive evidence that toads are not present. A single visit to a location is not reliable since toads are cryptic and sub-adults usually do not congregate at breeding sites. It becomes substantially more difficult to detect adult boreal toads after the breeding season, although searching for tadpoles can be an effective survey method in mid to late summer.

Survey forms and equipment

A copy of the area to be surveyed from a USGS 1:24,000 quadrangle or other detailed map should be made before going into the field. The portions of the site surveyed, the exact location of observed amphibians, and the date should be marked on the map. Other survey information (e.g., date, locality, observers) should be written in pencil or waterproof ink on the Amphibian Survey Form (see Appendix B). The Amphibian Survey Form and the map copy should be kept together. Many field workers find it convenient to keep a field notebook and add new survey maps and forms in chronological order throughout the field season.

It is important to complete the survey form for all sites visited, whether or not any amphibians are found. This is the only way that long-term information on the distribution and abundance of boreal toads and other amphibians can be determined because it allows researchers to separate 1) lack of records for a site because there were no surveys conducted and 2) lack of records because there were no amphibians found despite substantial survey efforts. **IMPORTANT**: At the end of the field season, copies of all survey forms should be sent to the Boreal Toad Recovery Team coordinator or other specified person.

Minimize capture or handling of toads, and use disposable rubber gloves whenever possible. If it is necessary to catch amphibians or larvae (e.g., to check PIT tags), a dip net is useful. Sites often have high water or deep mud, especially early in the season, making boots or waders useful. Boots, waders, and dipnets used at one site should be rinsed well and disinfected with chlorine before use at other sites (see DAPTF Field Work Code of Practice on previous page).

Other recommended field equipment (other than normal hiking gear) includes:

-- thermometer
-- Whirl-Paks or zip-lock bags
-- Pesola scale(s)
-- metric ruler
-- camera
-- flashlights/headlamps for nighttime surveys
-- water sample bottles
-- PIT-tagging equipment, as necessary
-- disposable rubber gloves
-- cooler with ice for water samples
-- polarized sunglasses (useful when surveying aquatic sites for larvae and eggs)
--"death kit" or clean jars/containers and preservation fluid (see field collection guidelines)

General Inventories/Surveys

Metamorphosed boreal toads usually are associated with wetland habitats above 8,000 feet (2440 m) elevation, including ponds, bogs, willow karrs, and streams. Toads use a wide variety of lentic areas for breeding, from tire ruts to large lakes. Eggs are usually deposited in shallow water, and during the day larvae tend to concentrate in shallow, sunny margins of the water body.

Daytime surveys are conducted by walking along the perimeter of ponds or other body of water, scanning for amphibians, eggs, or larvae. In ponds with extensive shallow aquatic vegetation, care should be taken when walking through the vegetation to avoid harming egg masses and/or toads. In general, it is not advisable to wade through the water in search of eggs or tadpoles, as this will stir up mud, cut down visibility, and may cause inadvertent damage to eggs.

In bogs and willow thickets, crew members should spread out and make broad zig-zags through the site to ensure good coverage of the area. If toads, larvae, or egg masses are found at a new site, a photograph should be taken of the specimen(s). This is especially important if the observations represent a population separated from other known populations by a significant distance. The photograph should be attached to the survey forms and submitted to the recovery team coordinator or other designated person.

TABLE 2. Crucial periods in the life cycle of the Southern Rocky Mountain boreal toad.

Breeding Period	2-4 weeks post appearance of open water	mid-May to mid-June (July at higher elevation)
Hatching	eggs hatch 1 to 2 weeks after being laid	late May to late June (late July at higher elevation)
Metamorphosis	tadpole metamorphose to toadlets in approx. 2 months	late July to late August (late Sept. in higher elevation)
Toadlet dispersal	toadlets leave natal area	variable
Overwinter Period	adults and juveniles in winter	late September to mid-May

	habitat	

Breeding site monitoring

During the breeding season, known breeding sites should be surveyed at least weekly during daylight hours to search for toads and to determine number of egg masses deposited, and the development and metamorphosis of larvae. Depending on complexity of the site location, it may be helpful to flag the location of egg masses as they are found so that new egg masses are readily distinguishable. The standard breeding site survey form is found in Appendix B.

Nighttime surveys should be conducted to determine numbers of adult toads present at the site at least once per week during the breeding season. Nighttime surveys should be conducted between one hour after sunset and midnight. Normally, nighttime surveys of breeding sites are limited to the immediate vicinity of water bodies and relative abundance is determined from a count of adults from a single circuit of the water body.

After the breeding season, if breeding activity has been observed, sites should be monitored at least once every two weeks during the remainder of the summer, or until all larvae have metamorphosed and metamorphs have dispersed. In addition to the survey sheet (see above), the area should be sketched and distribution of toads, tadpoles, and eggs should be noted. An aerial photo or map can also be used.

The *minimum* standard for adequate monitoring of a breeding locality, as determined by the Recovery Team, is that the site be thoroughly searched at least three times during the breeding season, with visits being at least five days apart, and including at least one nighttime survey.

Water quality samples

For each breeding site, take at least two water quality samples during the active season: one during the breeding season, and one at about the time of tadpole metamorphosis. If a new breeding site is located during the summer, take a water sample at the time the site is located and one at the time of tadpole metamorphosis. Each sampling will consist of two samples of water: (1) acid bottle and (2) cubitainer.

Procedure:

>Sample from surface of water near the middle of the dam or downstream hydraulic control (if applicable).
> Fill small acidified bottle first, taking care to minimize disturbance of the water surface. This bottle contains concentrated nitric acid, so take appropriate precautions with skin and clothing.
> Rinse cubitainer with water and fill it with the sample. Keep the cubitainer cold and shaded (i.e. in a cooler with ice).
> Take water temperature after collecting samples.
Label both the acidified bottle and the cubitainer with the county, site name, date, water temperature and collector's name.

> Take samples to designated individual (i.e. Recovery Team coordinator or other designated person).

III. PIT TAGGING / TOE-CLIPPING

Toads should be PIT tagged or toe clipped *only* as part of a specific, approved study. All such studies should be closely coordinated with and reviewed by the Boreal Toad Recovery Team to avoid duplication of effort and assure consistency in data collection.

Collection

For a given breeding locality, place collected toads in a damp bucket or clean, damp pillowcase. Buckets should be disinfected with chlorine and well rinsed before using them at a different breeding locality or on another date. Pillowcases should be laundered using bleach and rinsed thoroughly before use. At localities where presence of *B. dendrobatidis*, or other known pathogens, is known or suspected , it is recommended that individual toads be held in separate, clean containers, rather than placed together in a single container, in order to prevent spread of pathogens.

Handling

Use disposable latex gloves when handling toads. Change gloves between breeding sites, or after contact with any individual animal that shows signs of disease. If gloves are not available, wash your hands thoroughly before each site. This precaution is to minimize the possibility of spreading disease between populations and to avoid introducing potential toxins to the toads, such as sunscreen, insect repellent, or other substances that may be present on human hands.

PIT-tagging

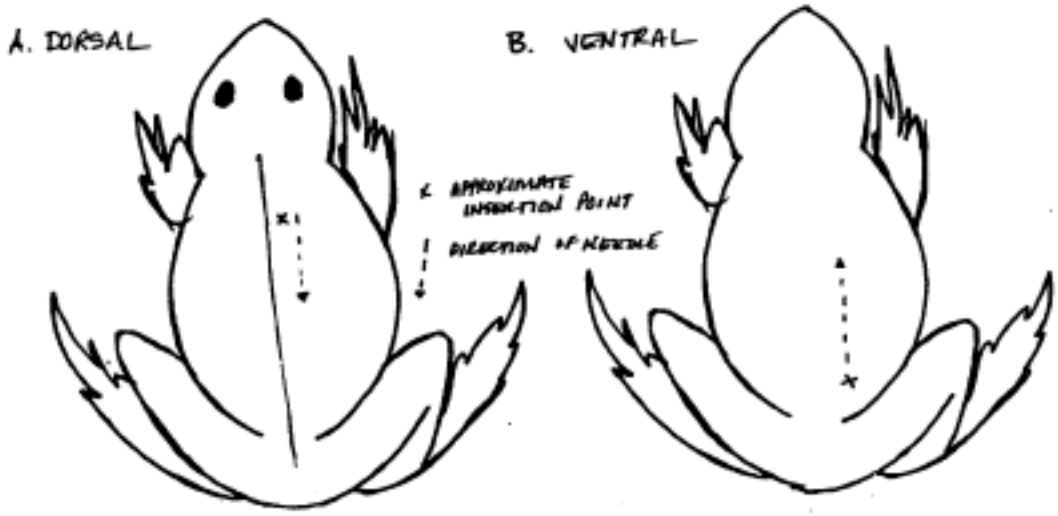
PIT-tagging is a microchip marking system consisting of a passive integrated transponder (PIT) encased in glass. Each 0.4 x 0.08 in (10 x 2.1 mm) tag is encoded with a 10 space alpha-numeric code. The PIT tag is inserted sub-cutaneously and the unique identification number is read using an electromagnetic scanning device that activates the transponder.

PIT-tagging should be avoided for toads weighing less than 10 grams.

The minimum amount of information that should be collected on PIT-tagged toads includes (see attached sample data sheet):

-- PIT tag number
-- snout-vent length
-- weight (mass in grams)

-- sex (if able to determine)



Procedure: Two methods have been used successfully in PIT-tagging boreal toads using 12-gauge needles and an implanting tool that is provided when tags are purchased. This system has been evaluated for amphibians by Camper and Dixon (1988).

Figure 4

A. Dorsal method (*recommended*): Grasp toad so that hind legs point away from your body and dorsal side is up. Pinch small amount of skin from behind the parotoid glands. about 2/3 of the way up the back from the cloaca, parallel to the vertebral column (see Figure 4) between fingers. With fine, sharp scissors, snip a very small horizontal hole through the skin, ensuring that all layers of the skin have been penetrated. Hold needle containing PIT tag horizontally to the toad's mid dorsal line, which is approximately over its vertebral column. Insert needle sub-cutaneously, but shallowly, through the opening in the skin. Be sure the PIT tag is inserted fully into the hole. Place finger over needle and slowly withdraw, making sure that the tag remains implanted.

B. Ventral method: Grasp the toad so that the hind legs point away from your body and the ventral side is up. About 0.78-1.17 in (2-3 cm) craniad and laterally from the cloaca (see Figure 4), pinch a small amount of ventral skin and with fine, sharp scissors, snip a very small horizontal hole through the skin, ensuring that all layers of the skin have been penetrated. Insert the needle sub-cutaneously, but shallowly, through the opening in the skin. Be sure the PIT tag is inserted fully into the hole. Place a finger over the needle and slowly withdraw, making sure that the tag remains implanted.

For both methods, the wound should be small and somewhat self-closing. However, the wound may be more securely closed using Nexaban or Vet Seal.

Upon capture of a toad, the scanner should be passed over the animal multiple times, as experience has shown that the orientation of the tag in the animal's body affects detection and the tag may not "read" on initial passes. PIT tags sometimes move, or "migrate", over time. Examine the toad for visual evidence of a tag, including the legs, before inserting a new tag. Some populations have been tagged using older tags that may be visible, but which current equipment does not read. If monitoring toads from one of these populations (such as Herman Gulch), you may need to remove an existing unreadable tag and replace it with a new tag. To remove an old tag, pinch the skin near the tag and use fine scissors to cut a small horizontal hole through all layers of the skin. Work the existing tag through the hole; insert a new tag through the same hole and close and seal the wound. Put the old tag in a small container with the number of the new tag and ensure that the records note that this is a recapture with a number reassignment.

Toe-Clipping

PIT tagging is the preferred and recommended marking method, although toe-clipping may be used to mark toads if PIT tagging is not feasible. Number combinations using no more than one toe per foot are used to produce unique identifiers for each toad. Equipment includes sharp scissors, alcohol to clean scissors and an antibiotic, such as Bactine, to clean the wound. Careful records should be kept when this method is used so that recaptures can be confirmed. This method is widely used and described in Heyer et al. (1994). It is recommended that any toes clipped should be placed in ethanol or isopropanol and retained for possible future genetic analyses.

IV. FIELD COLLECTION OF TOADS FOR TOXICOLOGY, PATHOLOGY AND GENETIC WORK

Collections for Pathology or Toxicology Testing

If dead or moribund boreal toads are found, the following people should be contacted as soon as possible. If the listed people can not be reached, or if the dead/moribund toads are at a remote site, then every effort should be made to preserve one or more specimens and relay them to one of the following listed people at the earliest convenience.

In Colorado:	Mark Jones, CDOW 970-472-4361	
	Chuck Loeffler, CDOW	719-481-1902 or 303-291-7451
In Wyoming:	Don Miller, WGF	307-745-4046
In New Mexico	Charles Painter, NMGF	505-827-9901 or 505-294-2703

Still living, but sick, animals can be placed in a container that allows some air circulation, and kept moist. Dead animals, or portions thereof, should be preserved by freezing or placing in alcohol or formalin. Field personnel should be given "death kits" to carry as standard equipment. These kits contain instructions for preserving any dead animals encountered. The following instructions summarize procedures to use if a "death kit" is not available. If ice or snow is available on site, the specimen should be placed in a Whirl-Pak or plastic bag (only the specimen - no water, snow, or ice - should be placed in the bag), and the bag packed in ice or snow for transport or temporary storage. The bagged specimen should be frozen as soon as possible after collection.

If alcohol or formalin is available, these may also be used to preserve specimens. The preferred preservative is 90-95% ethanol or isopropanol (70% will also work for short-term storage), as it is difficult to extract DNA for PCR testing from specimens preserved in formalin. However, if freezing or preservation with alcohol are not feasible, and the specimen(s) can not be refrigerated or relayed to a laboratory within 12 hours, then formalin may be used. Another option for small samples, such as tadpoles, metamorphs, or small pieces of tissue, is to dry them thoroughly and place them in a clean container to prevent contamination. Such dried specimens are useable for DNA extraction, and should be kept cool and dry until they can be relayed to a laboratory. It is recommended that a small piece of tissue (toe clip, skin, etc.) be removed and dried from any animal that is to be preserved in formalin. The small piece of tissue can later be placed in alcohol and stored for future DNA analyses.

If the specimen(s) are found in or near water, standard water quality samples should be collected (see description of water sampling earlier in this section). Do not freeze the water samples.

All specimens should be clearly labeled, and include the following information:

Date and time of discovery
Location--be specific; county, drainage, nearest town and landmarks, and UTMs
Sex of specimen (if known)
Age of specimen (if known)
Body condition
Collector's name and contact information

The procedures described in the following two paragraphs are to be performed only by trained personnel:

Specimens for histopathology should be fully immersed in 10% formalin at a 10:1 formalin:tissue ratio. Wear gloves and be as gentle as possible in order to avoid harming tissues for histological examination. If the specimen is longer than 3 inches (7.6 cm) snout-urostyle length, make a ventral longitudinal slit to expose internal organs to the fixative. Eggs, tadpoles, metamorphs, and small adults can be placed in fixative without preparation. After placing the sample in the container, tape the lid shut to prevent spillage, and label with a permanent marking pen with the above information. Placing a

waterproof label, written in waterproof ink or pencil, in the specimen container is recommended.

Obtain blood smears from a foot web incision or cardiac puncture (for tadpoles, snip off the end of the tail). Air dry the slide and keep it in a protective plastic container until staining.

Tissue Collection for Genetic Analysis

Although a number of samples of boreal toad tissue from the SRMP have already been genetically analyzed, additional samples from most localities are still needed. Samples from newly discovered populations, which are geographically removed from known existing populations, are of particular interest for genetic analysis. Opportunistic collection of tissue samples is encouraged for possible future genetic analyses, both for toad genetics and detection of pathogens, but should be done in accordance with all applicable guidelines and regulations.

Ideally, 30 "adult equivalent" samples are needed for genetic analysis of a specific population of toads. An "adult equivalent" consists of one of the following:

Blood from one adult toad (10-50 micro liters)
Tissue sample from one toad
One to ten metamorph toadlets (more is better if they are very small).
Five tadpoles
Egg tissue (at least 10 eggs)[5]

Although live specimens are ideal, dried, preserved, or frozen tissue can be used for genetic analysis. If possible, preserve tadpoles or toad muscle tissue in 95% ethanol or isopropanol in a clean container. Change alcohol within 12 hours, and for longer storage immerse tissue in at least three times its volume of alcohol. Concentration of 90-95% is best, but 70% is OK if the higher concentration is not available. Both types of alcohol are available at most drug and grocery stores. Tadpoles, eggs, and small metamorphs can be preserved whole, but tissue must be cut from larger dead toads. If no alcohol is available, tissue may be frozen in water - the colder, the better. Blood tissue can be taken by cardiac puncture, and stored in tubes, although this method should only be use by appropriately trained or experienced persons. Alternatively, blood can be taken from a web foot incision. Small amounts of blood can be spotted on a slide for DNA analyses, but storage on special fungus resistant collection filter paper is better. Dried tissue can be used for DNA analyses. If a dried toad is found in the field, it is best to get it into alcohol as soon as possible to prevent the growth of fungus and prevent further damage by rehydration. Specimens in alcohol may be stored for several weeks before shipping, and frozen

[5] Egg tissue is an excellent source of mtDNA, but not nDNA. Collecting only eggs may not allow additional analysis of nDNA, which may be needed at a later time.

specimens should be relayed to a lab within a week, if possible. Blood tissue may be kept by refrigerating, but should be shipped within two weeks. Dried blood tissue should be kept dry, cool, and out of the sun.

To relay specimens for genetic analysis, or for more information regarding genetic sampling and testing of boreal toads, one of the following people should be contacted:

Mark Jones
Colorado Division of Wildlife
317 W. Prospect Street
Ft. Collins, CO 80526
Phone: 970-472-4361
E-mail: mark.jones@state.co.us

Chuck Loeffler
Colorado Division of Wildlife
6060 Broadway
Denver, CO 80216
Phone: 303-291-7451 or 719-481-1902
E-mail: chuck.loeffler@state.co.us

Do NOT ship or relay specimens to either of the above people without prior contact and notification.

V. REINTRODUCTIONS - Consideration & Planning

It is the recommendation of the Recovery Team that translocations of boreal toads for the purpose of reintroduction to vacant habitat should only take place if the following guidelines are met. Exceptions to these criteria, for translocation of toads in special circumstances, such as for research purposes, establishment of captive brood stocks, or local salvage actions, may be made by mutual consent of the members of the Recovery Team.

These guidelines are based primarily on information gathered concerning the SRMP of the boreal toad, and are directed at that population as a whole. If the status of this population changes discernibly for the worse, these guidelines will be reviewed and revised as appropriate.

A. It is determined, based on thorough surveys (as defined below), that boreal toads are believed to be extirpated from a large, historically occupied area.

1. Surveys of the area must be conducted for at least three consecutive years prior to the first translocation taking place, and must include sampling of all apparently suitable habitats within a range of up to 30 km of the proposed reintroduction site.

2. At least two daytime (between sunrise and sunset) and one nighttime (between 1 hr. after sunset and midnight) surveys must be

conducted at each survey site during the breeding season (usually May-June). Onset of breeding varies with general weather conditions, amount of snow cover, and elevation of the site. These factors should be considered in timing of these surveys. Two additional surveys at each survey site, in July and early August are recommended. Individual surveys at any given site should be at least one week apart.

3. Personnel conducting these surveys should be experienced in boreal toad surveying, and should, at minimum, have had training and orientation from experienced personnel. Specific protocols to be followed for surveys can be found elsewhere in this plan.

4. Any toads found in areas peripheral to the reintroduction site should be marked (PIT tagged) for future identification. Therefore, personnel conducting surveys should be trained/experienced in the use of PIT tagging equipment, and carry PIT tags and appropriate tools with them. Collection of tissue/blood sample for future genetic analyses is recommended.

5. Information on all surveys must be recorded on the Amphibian Survey Data Sheet, which is found in Appendix B of this plan.

B. Recolonization of the area by natural migration is considered highly unlikely. This means that migration from adjacent populations within three toad generations would not be expected to occur.[6]

C. It is determined that adequate suitable habitat to support a population of boreal toads still exists in the proposed reintroduction area. The reintroduction site(s) should meet the following criteria:

1. The reintroduction site should be within the historic range of the boreal toad.

2. The site is sufficiently remote to minimize inadvertent or intentional interference with breeding and tadpole/toadlet development by humans.

3. The site is accessible enough to allow adequate monitoring of the reintroduced population.

4. Physical characteristics of the proposed site should reflect what is

[6] With the information available currently, we define 3 toad generations as approximately 15 years, based on a 14-20 year life span with earliest reproduction occurring in 2 and 4 year-old males and females, respectively. Campbell, 1972, J. Colorado-Wyoming Acad. Sci. 7:114, D. Olson (USDA Forest Service, Oregon, pers. com.).

currently known about boreal toad habitat requirements for all life stages. This includes, in general, shallow sunny ponds with permanent water available, adjoining willow thickets, and upland montane forests within an elevational range between 8,000 and 11,000 feet (2,440 and 3,350 m).

D. There is no known, significant and imminent environmental threat in the area that would preclude successful translocation and survival of boreal toads. An imminent threat is, for the purpose of these guidelines, defined as one that would lead to probable extirpation within 3 years. The proposed site should be evaluated for the following factors:

1. Water quality, including pH and presence of toxic substances, such as heavy metals, organochlorides, and organopesticides.

2. Substrate sampling for heavy metals, organochlorides, and organopesticides.

3. Pathogens present in the environment and/or other amphibians or fish found in the area.

4. Introduced flora and fauna in the area which may have impacts on boreal toads.

5. Predator species occurrence and abundance (i.e. garter snakes, predaceous diving beetles, and tiger salamander larvae).

6. Present and anticipated land use and ownership, including stream flow and water rights information.

E. Available source stock of toads, tadpoles, and/or eggs is deemed sufficient to provide adequate numbers over at least a three-year period without doing harm to the source population. Criteria for evaluation and selection of sources for transplant stock are as follows:

1. Wild spawned and reared toads, tadpoles, and/or eggs should be used for reintroductions, unless no suitable wild source exists that will provide adequate numbers for translocation without risk of harm to the donor population. If no suitable wild donor population is available, captive bred/reared stock may be used.

2. All source stock - wild or captive reared - will be tested and examined for presence of potentially harmful pathogens prior to translocation.

3. If captive reared stock is used as a source for reintroductions, such animals and their eggs must be bred and reared in a facility where they can be adequately isolated from infection by foreign pathogens.

4. To maintain as much genetic integrity as possible, source populations for reintroductions should be as close to the reintroduction site as possible. Transplant stock for translocations within the southern Rocky Mountain area (from south-central Wyoming to north-central New Mexico) should come only from populations within the southern Rocky Mountain area. In the event that boreal toads become completely extirpated from their present southern Rocky Mountain range, toads from other locations, such as northern Utah, may be considered for reintroductions.

5. If transplant stock is to be taken from a wild population, the donor population must be stable and must produce, on the average, 12 egg masses each year during a minimum three-year period. Populations of toads that are smaller and/or do not produce an average of 12 egg masses per year may be used as transplant stock in situations where the extirpation of such a population is imminent and unavoidable due to human activity (i.e. development of private land). Also, eggs or tadpoles at existing breeding sites, which are not expected to be able to develop to a viable overwintering condition due to unusually late breeding and/or seasonal conditions (late snowmelt, drought, etc.), may be used as transplant stock. However, reintroduction projects should not depend solely on such a source.

F. There is a long-term commitment (at least five years after the first translocation takes place) from all involved agencies and individuals to make the reintroduction effort a high priority for funding and logistical support. Prior to the initiation of any reintroduction of boreal toads, approval for, and commitment to such action, in the form of a Conservation Agreement, Memorandum of Understanding, or similar document, should be in place and signed by all agencies and individuals who have authority over the wildlife, land, and/or water where the reintroduction is to occur.

V. REINTRODUCTIONS - Implementation

If and when the above described criteria and guidelines have been met, and a decision is made to proceed with a reintroduction of boreal toads, the following guidelines regarding the collection, movement, monitoring, etc. of animals should be followed. A detailed reintroduction plan should be developed and followed for each reintroduction project. Such plans should provide site-specific guidelines, timetables for implementation, and

identify costs and responsibilities to be assumed by the involved agencies. The guidelines presented here should be incorporated in the reintroduction plans, and edited to meet project specific needs and to incorporate the most current knowledge and methodology.

Collection and Movement of Donor Individuals from Original Habitat to Reintroduction Site or Captive Rearing Facility

Practical experience regarding best methods for physical collection and transportation of egg masses, larvae and adults is fairly limited, and methodology will be modified as more is learned. The methods described here have been used on a limited basis, and have resulted in very little (< 3%) mortality.

Egg masses and tadpoles are collected into large plastic "ziploc" bags or into large containers such as plastic buckets or tubs. Egg masses greater than 6 but less than 24 hours old appear to be the most resistant to movement trauma. Embryos close to hatching also appear to travel well. Containers should be almost completely filled with water from the collection site. Containers should be appropriately labeled with site name, date, time, and location of collection. If "ziploc" bags are used they should be packed into insulated coolers or other rigid boxes for transport. To minimize sloshing and jarring, and to avoid damage to the eggs or tadpoles, bags should be stabilized but not packed tightly. Containers should be kept out of direct sunlight and temperature in the containers should be maintained as close as possible to temperature measured at the collection point. This may require packing the containers in ice or snow as available. Transportation by vehicle (including helicopter) and foot as necessary, should be completed as quickly as possible.

Adult boreal toads are not recommended for use as transplant stock, as they seem to have a strong tendency to leave the area of release. However, young toadlets may be translocated in reintroduction efforts. The capture of adult toads may be necessary in some situations for establishment of a captive brood stock. Toads are collected by hand or by dip net where found. When transporting a short distance (2 hours or less) damp cotton bags are adequate. Bags should be quite damp, but not soaking wet, and a number of toads, depending on size, can be accommodated in one bag the size of standard pillowcase. When transporting adult toads over longer distances and for longer periods of time, a bucket or similar container should be used. Containers should have tightly sealed lids with small holes for air circulation. Sphagnum moss, damp paper towels or other similar substrate should be placed in the bottom of the container and soaked with water from or near the collection site to prevent desiccation of toads during transportation. Containers and substrates should be disinfected with chlorine and well rinsed if they are to be reused. Toads from different localities should always be isolated from each other and transported in separate containers to avoid possible transmission of pathogens.

At the release site, sealed containers should be placed in the local water to allow

equilibration between the transportation medium and the site medium. Egg masses should be photographed to aid in quantification for later use in approximating the numerical success or failure of the reintroduction. Tadpole and toadlet numbers, if too large to get an actual count, should be estimated before release. Release areas should be clearly identified to assist in subsequent monitoring efforts.

Monitoring

Translocated individuals must be clearly marked for identification in the field and/or in the laboratory. Standard toe-clipping and PIT tags are available for toadlets and adults (see above), and other techniques should be investigated for batch marking tadpoles and small toadlets. The use of oxy-tetracycline has been investigated, and is not considered a functional or practical marking technique for boreal toad larvae or metamorphs (M. Jones, pers. comm., 1998; Muths, et al. 2000).

The translocated individuals should be monitored as closely as possible during the season of translocation. The minimum assessment should be bi-weekly (for toadlets or toads) and weekly (for eggs). At least three surveys should be conducted during the breeding season after the reintroduction and should include searching for breeding toads (possible residents not found in previous surveys), egg masses, tadpoles, and toadlets. Suitable habitat for all metamorphs should also be routinely assessed. Follow-up surveys should continue for at least five years after the reintroduction.

Monitoring may be the most critical part of the reintroduction process. Response by the boreal toads to the translocation itself and to the new habitat may provide valuable information. Close field observation of the process and a critical review of the success or failure of each experiment will provide valuable insights to be used in future reintroductions and may provide insight into the recent decline of the boreal toad. Each translocation experiment should be carefully documented and made available to the Recovery Team. This information should also be appended to the CDOW's HERPDATA database and be presented in the Recovery Team's annual report.

For each reintroduction, the following specific information should be included:

- -- Geographic locality of the donor population
- -- Dates animals were taken from donor population
- -- Life stages and numbers of animals taken from donor population
- -- Summary of rearing conditions for animals involved in reintroduction
- -- Marking techniques used on reintroduced animals
- -- Geographic locality of the reintroduction site
- -- Dates of translocations
- -- Life stages and numbers of each life stage translocated

VI. CAPTIVE PROPAGATION

Although there is much to be learned regarding captive breeding and rearing of boreal toads, basic techniques have been studied and developed in Colorado and Wyoming. Protocols for captive breeding are included in the CDOW "Hatchery Manual for the Rearing and Propagation of Captive Boreal Toads", *Bufo boreas* (Scherff-Norris 1997). Following is a summary of the major components of rearing and propagating boreal toads. Anyone intending to rear or propagate toads should read the hatchery manual in its entirety before proceeding. Any person desiring more detail or clarification of the following should consult the hatchery manual as well. Consultation with personnel at the Colorado Native Aquatic Species Restoration Facility, the Sybille Wildlife Research Center, and various zoos which are doing experimental propagation of Bufo boreas is advised in order to learn about new developments and techniques. The following information is derived from the past work of Kirsta L. Scherff-Norris - CDOW, Mitch Bock - WGF, and Tom Mandis - CDOW.

While being experimentally reared in captivity in the mid-1990s, captive boreal toads in Colorado were housed at the CDOW Fish Research Hatchery, 5500 West County Road 50 E, Bellvue, CO. In Wyoming, captive boreal toads are housed at the Sybille Wildlife Research and Conservation Unit, 2362 Highway 34, Wheatland, WY. At the time of this writing, there are also small numbers of boreal toads from Colorado being kept at the Henry Doorly Zoo in Omaha, Nebraska; the Cheyenne Mountain Zoo in Colorado Springs, Colorado; and at the Toledo Zoo in Ohio, for captive rearing and experimental captive propagation. In May, 2000, the CDOW opened the Native Aquatic Species Restoration Facility (NASRF) near Alamosa, CO. This hatchery includes facilities to breed and rear boreal toads, and other amphibians. As a result of the discovery of chytrid fungus in at least two populations of boreal toads in 1999, eggs and a few adult toads were collected from the wild and placed at the NASRF in 2000. As of December, 2000, there were approximately 870 boreal toads, representing 35 distinct genetic lots from breeding sites throughout Colorado, at the NASRF.

Toads are extremely sensitive to direct contact with contaminants and to physical or indirect stressors. Extreme care should be taken where toads are housed or kept. Isolation from other species is ideal, as pathogens may be transmittable from one species to another. Toads must be handled with gloves at all times, and a different pair of gloves should be worn for each lot/tank of toads. Handling should be kept to a minimum, but when necessary, toads should be held gently, yet firmly around the mid-section. Also, avoid loud noises, bumping or moving of the toads' living quarters, and offensive or dangerous fumes. Toad supplies should be kept separate from fish supplies at all times, as mixing could be harmful to both.

Housing

ALWAYS keep toads separate by genetic groups and/or lots. It is best to keep toads grouped by size to reduce competition for food as well as prevent cannibalism of smaller toads by larger ones. Eggs, tadpoles, toadlets, and toads are kept in outdoor raceways or indoor glass aquaria (where toads are at lower densities to allow for protection from spread of infectious disease) or traditional hatchery troughs. Outdoor and indoor enclosures are designed to provide a variety of habitats by offering various temperatures, humidities, and hiding places (clay terrapot bottoms with holes for entrance, PVC pipes, and plastic reptile huts). Outdoor raceways have areas of open sunlight, a soil substrate with shallows along the shore to provide tadpoles a warm place to congregate, a "pond" with flowing water, and numerous enclosures and vegetation where the toads can hide. Indoor tanks are equipped with black lights, full-spectrum vita lights, incandescent directional 60-75 watt basking lights, running water, tile and moss substrates, plastic plants, and various hiding places.
Room temperature varies from 55°F to 86°F (13°C to 30°C) and water temperature ranges from 48°F to 57°F (9°C to 14°C). These temperature variances are desirable, as they emulate variations in the wild.

Cleaning

Toad tanks are cleaned by draining the water and rinsing off substrates, including tank, tile, and enclosures. Tiles, toad huts, and plastic plants are disinfected as needed, usually every 6-8 weeks in bleach and dried completely before being replaced into tanks or storage areas. Anything that is to be disinfected must first be cleaned and free of debris. Moss is also replaced as needed, usually every 2-3 weeks. Outdoor raceways may need to be scraped and/or raked to break up and/or remove excess algal growth.

Monitoring of toad health

Bi-monthly, snout-urostyle lengths and weights of adult toads are measured. Also, during routine cleaning of tanks, toads are physically examined for any abnormalities.

Feeding

Tadpoles are fed daily a combination of alfalfa pellets, Mazuri amphibian pellets, frozen lettuce, and various fish food. If tadpoles are feeding on algae growth and do not show interest in eating supplemental diet (Mazuri, alfalfa pellets, fish food, etc.), there is no reason to feed supplementally. A good indicator of properly fed tadpoles is a low activity level. If tadpoles are actively swimming around the tank searching for food, they should be fed more. Toadlets are fed five times per week. Their diet, depending on size, includes crickets, wingless fruit flies (*Drosophila melanogaster*), white worms (*Enchytraeus*), and waxworms. Adult toads are also fed five times per week crickets, Mazuri amphibian pellets, redworms, earthworms, and/or waxworms.

Individuals should be fed enough so that there are is only a small amount of food left the following day. The size of food item should be the largest that the individual can easily consume, but excessively large items of food may lead to prolapsing.

Medical treatments

Illness in boreal toads is often difficult to detect. However, some common signs include dark or cloudy/waxy skin, sloughing skin, and reddish or yellowish undersides. The appropriate veterinarian or pathologist should be contacted if these or other signs are observed. Toads must be closely observed, because an apparently healthy toad can become sick and die rapidly. Toads in captivity have become ill with bacterial infections, fungal infections, and prolapsing. There are numerous treatments for the above illnesses, and the hatchery manual should be consulted for drugs and dosages. After all infections, tanks should be disinfected with bleach to kill any remaining microorganisms. Quarantine (disinfected and isolated) tanks should be ready at all times to hold treated individuals.

Hibernation

Captive toads should be hibernated in a Percival Environmental Chamber from approximately 1 December- 1 May at 41°F (5°C), 80% relative humidity, and with no light cycle. This is necessary to attempt to mimic the toads' natural hibernation in the wild, which may be necessary to trigger physiological changes that allow for successful breeding.

Breeding

On approximately 1 May, the toads should be taken out of hibernation and allowed to readjust at room temperature before being placed into breeding tanks. Breeding tanks should be filled with 2-3 in. (5-7.5 cm) of water with glass wall blocks, smooth rocks, and plastic plants. Toads should be allowed to pair and breed without hormonal inducement if possible. If not, they may be injected with LHRH (des-Gly10[D-ALA6] Leutenizing Hormone Releasing Hormone Ethylamide). Successful pairings should be documented. Immediately after eggs have been laid, the pair should be removed from the breeding tank and water depth should be increased to eight inches. Eggs should not be disturbed during development.

* * *

RECOMMENDED STRATEGIES FOR HABITAT MANAGEMENT

This section provides land managers information on potential impacts of management actions, appropriate mitigation measures and directions where conservation efforts may best be applied. Not all management activities have the same potential for affecting boreal toads and their habitat. Some activities may have significant impacts but are unlikely to occur or occur within only a small portion of boreal toad habitat. Other activities may individually have a minimal impact but are more likely to occur over a large portion of the toad's range. Under these circumstances cumulative impacts could be significant.

We have provided distances that can be implemented as spatial buffers until more site specific information is collected. Table 2 provides periods of crucial life cycle events for the boreal toad. Please take the time to assess your individual situation and apply the most appropriate spatial and temporal buffers based upon information gathered at the site.

A. Air Quality and Atmospheric Deposition

Effects

Deposition of acid anions and heavy metals have most often been considered to be the main air-quality related threats to boreal toads. Although not strictly a problem of deposition, thinning of the atmospheric ozone layer and resulting increased incidence of ultraviolet (UV) radiation has also been investigated as a potential cause of declining populations of boreal toads.

It has been proposed that acid and heavy metal deposition and increased UV radiation all may cause developmental abnormalities or increased mortality of boreal toad embryos (Porter and Hakanson 1976; Corn et al. 1989; Blaustein et al. 1994). Deposition or UV radiation sufficient to kill adult toads would have detectable human health effects. Most research on atmospheric deposition and UV radiation has focused on effects on embryos (Corn and Vertucci 1992; Blaustein et al. 1994; Vertucci and Corn 1996), which are the most vulnerable life stages.

Studies to date indicate that UV radiation does not appear to have direct lethal effects on any life stages of the boreal toads in the southern Rocky Mountains. In two studies in Oregon, ambient levels of UV radiation has caused increased mortality of amphibian embryos, including boreal toads (Blaustein et al. 1994, 1995). However, replication of this experiment in Colorado failed to obtain the same results (Corn 1998). Increased UV radiation cannot yet be entirely dismissed as a cause of the decline of the boreal toad in the southern Rocky Mountains. There may be sublethal effects on adult toads, and these have not been adequately studied. Heavy metals and UV radiation, possibly acting synergistically with other stressors, may act to depress the immune system, which may allow infection and death from common pathogens (Carey 1993). Also, the possible effects of UV radiation on primary food production for boreal toad larvae warrants further study (K. Rogers *in* Boreal Toad Recovery Team 1998).

Acid deposition is not thought to be a significant problem for boreal toads in the Rocky Mountains. The LC_{50} pH, the hydrogen ion concentration at which 50% of boreal toad embryos die, was 4.4–4.5

in one laboratory study (Corn and Vertucci 1992). Breeding habitats of boreal toads rarely have pH less than 6.0. However, about one-half of known boreal toad breeding sites are sensitive to damage from acid deposition (acid neutralizing capacity [ANC] < 200 μequivalents per liter). Sulfate deposition > 10 kg per hectare per year has the potential to reduce ANC in these sensitive habitats to the point where pH may be reduced. If pH drops below 6, then changes may occur in algal communities which, in turn, may affect growth and development of tadpoles (Corn and Vertucci 1992). Although there is potential for buildup of acid anions in snow and an episode of acidification during snowmelt, this rarely happens with current levels of acid deposition. Boreal toads also breed later in spring than most other amphibians and embryos are usually not present when episodes of acidification might occur (Vertucci and Corn, 1996). Heavy metals deposited from copper smelter emissions were implicated in the extinction of the Tarahumara frog in southern Arizona, but there are few data supporting this hypothesis (Hale et al. 1995).

Recommendations

Assumptions - Any mitigation measures for acid and heavy metal deposition should focus on water or sediment chemistry of breeding ponds, because embryos are the life stage most sensitive to pollution (at least until more research is done on sublethal effects). This is a global problem, and participating entities should work however they can to solve this problem with other agencies and international groups.

Desired Future Conditions and Possible Management Actions – Regional sulfate deposition should range between 2-6 kg/ha/yr. The Park Range in northern Colorado currently is experiencing acid deposition sufficient to cause chronic acidification and damage sensitive aquatic systems, including boreal toads. Acceptable ranges for deposition of heavy metals are not known.

B. Water Management

Effects

1. New Water Diversion Structures and Canals

Headgates, dams, canals, or other structures associated with water diversion systems can directly destroy boreal toad habitat. Additionally, these structures may impede or alter water flow in such ways as to make areas unsuitable for breeding sites and hibernacula. Unsuitable habitat refers to riparian areas converted to upland sites and where shallow waters, less than 1 ft. (0.3 m) deep, no longer exist in breeding ponds. Disturbance, alteration, or contamination of areas may also occur due to dredging of sediments, vegetation cutting, and pesticide application for vegetation and insect control during maintenance activities.

2. Water Impoundments

Water impoundments may impact boreal toads in three ways: 1) by direct alteration of breeding or adult habitat sites through dam building and flooding; 2) by flooding egg development sites when

impounded waters exceed 1 ft. (0.3 m) in depth; and 3) by eliminating or reducing periodic flooding that creates breeding sites downstream of impoundments.

3. Stream Channelization and Bank Stabilization

Channelization and bank stabilization directly effect boreal toads through the loss of riparian and wetland habitat. Indirect effects include the loss of sediment catching capabilities, and loss of water quality and impediments to the natural hydrologic processes that create oxbows and flooded wetlands.

4. Wetland Draining and Filling

Filling or draining of wetlands can result in the direct loss of boreal toad breeding sites and hibernacula.

5. Fisheries management

Fisheries management activities may be harmful to boreal toads. Enhancing fish habitat by dredging or otherwise increasing water depth has been observed to destroy amphibian breeding habitat (Corn et al. 1989).

Recommendations

Assumptions - Maintaining standing water at boreal toad breeding sites until metamorphosis occurs is crucial for boreal toad existence. Failure to do so can result in significant direct effects since a good portion of the toad's life is spent in aquatic environments. Prior water rights may take precedence over implementation of appropriate recommendations, however, all applicable measures should be suggested for optional compliance.

Desired Future Conditions and Possible Management Actions -

1. New Water Diversion Structures and Canals

New diversion structures should be placed in areas that avoid occupied and suitable unoccupied boreal toad breeding habitat.

Water diversion structures outside of occupied toad habitat but in the same drainage as occupied breeding areas should be (re)designed so that water is not diverted from breeding habitat making them unsuitable.

It is recommended that water diversion structures be managed to divert no more than the minimal water necessary, meeting the intent of the permit, from occupied non-breeding areas because these drainages have the greatest potential for successful establishment of breeding colonies since adults are present.

Adults and juveniles may occupy upland sites. It is recommended that canals proposed for placement in upland sites should be constructed in a manner that allows passage of water into natural wetlands and stream corridors and avoids such sites so as not to serve as a drain. Canals should be designed in a manner that will allow "trapped" toads to escape.

Avoid placing fill material from water diversion and canal maintenance activities (including sediment or bank vegetation) in suitable boreal toad habitat.

Apply management recommendations at the time of permitting new water diversion structures and canals that occur in occupied or unoccupied but suitable toad habitat. Work within wetland habitat is permitted by the U.S. Army Corps of Engineers, and it is therefore appropriate to provide them pertinent information, maps, and mitigation measures during the early phases of project coordination.

2. Water Impoundments

Encourage land owners and managers to consult with the Boreal Toad Recovery Team prior to altering impoundments that occur in occupied breeding territories or in unoccupied but suitable habitats that are identified for boreal toad recovery.

Boreal toad habitat can be developed by creating shallow shoreline margins in newly constructed impoundments. If boreal toad egg masses are located within an impoundment maintain water levels to ensure successful hatching. Impacts can occur from both exposing and flooding egg masses. Small impoundments that regularly dry up and that are dry before tadpole metamorphosis should be deepened, retaining water at a depth of at least 1 ft. (0.3 m) with gently sloping banks so that water is sufficient for egg development. Prior to deepening habitat that typically dries up make certain that the water retained does not feed other more important downstream breeding areas.

Ensure that water flow out of impoundments in occupied drainages is adequate to maintain downstream boreal toad breeding habitat. Operate impoundment waterflow to mimic the natural hydrograph of the drainage.

Apply management recommendations at the time of permitting new construction at new and existing impoundments that occur in occupied or unoccupied but suitable toad habitat. Work within wetland habitat is permitted by the U.S. Army Corps of Engineers, and it is therefore appropriate to provide them pertinent information, maps, and mitigation measures during the early phases of project coordination.

3. Stream Channelization and Bank Stabilization

The most effective mitigation of stabilization and channelization effects is to avoid development in wetland habitats. Involve the Boreal Toad Recovery Team in work with private landowners who own habitat identified as crucial to the welfare of boreal toads.

Rip-rap or other bank stabilization materials should only be placed at bridge crossings or structures that cannot be placed outside of riparian sites or at structures that are water dependent.

Apply management recommendations at the time of permitting new construction on new and existing channelization and stabilization projects that occur in occupied or unoccupied suitable toad habitat. Work within wetland habitat is permitted by the U.S. Army Corps of Engineers, and it is therefore appropriate to provide them pertinent information, maps, and mitigation measures during the early phases of project coordination.

4. Wetland Draining and Filling

Avoid draining and filling wetlands in occupied boreal toad habitat and unoccupied suitable boreal toad habitats. If draining or filling is unavoidable lost wetlands should be mitigated (replaced) at a 2:1 ratio.

Buffer zones between human disturbances and wetlands can be an effective way to avoid trampling toadlets, disturbing egg masses, tadpoles, and adults, and avoid contamination and sedimentation of toad habitat. A 300 ft. (100 m) buffer is recommended around known or suitable toad habitat.

Apply management recommendations at the time of permitting new filling or draining of wetlands that occur in occupied or unoccupied but suitable toad habitat. Work within wetland habitat is permitted by the U.S. Army Corps of Engineers, and it is therefore appropriate to provide them pertinent information, maps, and mitigation measures during the early phases of project coordination.

5. Fisheries Management

Physical habitat improvements for fish, such as dredging of shallow, silted ponds, that would be detrimental to boreal toads or their habitat should be avoided in occupied toad breeding habitat or areas designated as essential habitat.

C. Minerals Management

Effects

Environmental contaminants have been indicated as a possible factor in the decline of boreal toads. Hardrock mining can produce acidic water and sediments (acid mine drainage) by releasing ground water transporting heavy metals and other contaminants, by mine tailing contact with rain, snow melt, and surface water, and through accidental or negligent release of cyanide or other chemicals used for mining purposes. Acid mine drainage also may leach additional metals out of stream and soil substrates causing increased effects to boreal toads. As discussed in the "Air Quality and Atmospheric Deposition" section pH values below 4.5 are likely to be detrimental to eggs and tadpoles and pH values less than 6.0 may be detrimental to algal communities that provide food to boreal toad tadpoles. Low pH values also may reduce aquatic insects preyed upon by juveniles and adults. Boreal toads have been known to occur in a few settling ponds with heavy metals accumulations. However, these ponds have artificially high temperatures and high pH, which precipitates some soluble elements from the water.

To determine if trace elements could impact boreal toads, whole body tissue and sediment samples were collected in Colorado in 1994 for contaminant analysis. Boreal toad tadpole tissues were collected at four sites, salamander tissue at one site and sediment was collected at five other locations. Cadmium, chromium, copper, mercury, manganese, nickel, lead, and zinc were found in large amounts in tissue and sediment samples. In some cases the amount of an element in the tissue was nearly as high as in the sediment samples, though stomach contents were not removed. This reconnaissance study indicated that the potential for uptake of detrimental trace elements was great and that further study was warranted (C. Carey unpubl.). Consequently, additional samples were collected in 1995 and 1996 and are awaiting analysis.

The CDOW's Aquatic Toxicology Laboratory has also been conducting short and long-term exposure tests to determine possible effects of cadmium, copper, zinc, and manganese on the development of boreal toad tadpoles. Study results indicate that copper is acutely toxic to boreal toad tadpoles, and that they seem be more resistant to the acute lethal effects of the other metals (Jones, et al. 1998). Most natural habitats probably do not have high enough concentrations of heavy metals to cause significant negative impacts on boreal toads.

Hardrock mining, coal mining, and the associated construction of roads and buildings can also cause direct destruction of boreal toad habitat and destabilization of soils resulting in sedimentation of streams and ponds. Sediments filtering out in natural ponds or slow water areas may eventually eliminate breeding habitat and can cover eggs making them non-viable. Tadpole food items and insects eaten by juveniles and adults also may be covered or their habitats changed such that they can no longer survive. Subsidence by underground mining can also cause changes in habitat that may be detrimental to boreal toad habitat.

Recommendations

Assumptions - Bioavailability of heavy metals and other mining produced contaminants to toads may vary based on temperature and pH of water, uptake mediums available, ease of release through substrates, and other factors (Albers and Comardese 1993). Since a variety of factors that determine bioavailability can exist within drainages where mining occurs, all release of acid mine drainage in occupied and suitable habitat is considered potentially harmful to boreal toads.

Desired Future Conditions and Possible Management Actions - Reduce opportunity for mine tailing caused sedimentation and acid mine drainage by seeking mining shafts with no groundwater connection to the surface for storage of mine tailings. If no dry shafts or shafts without groundwater contact are present the tailings should be stabilized with embankments or other means and runoff should be routed to settling ponds.

If settling ponds are necessary, set pH and temperature such that contaminants are precipitated out of settling pond water. The settling ponds should be of sufficient depth to store the sediments as well as diverted and natural water entering the ponds. Water intentionally drained from the settling pond should be routinely monitored for point discharges in compliance with State law. Use the best material available for lining ponds such that contaminants do not leak out of the ponds. Mining bonds should be set high enough so that cleanup of released contaminants can be funded.

If the precipitates and other elements in the settling ponds are not recovered for further use the sediments should be covered and stored in the settling basin or should be moved to storage sites with no opportunity for reentry into the environment. Settling ponds with high concentrations of contaminants should be covered with tarps to deter use by boreal toads and other species.

Due to habitat impacts the outer boundary of newly proposed mines should not be permitted within 1 mile (1.6 km) of boreal toad breeding habitat. All occupied and suitable riparian habitats should be avoided to the maximum extent possible and measures should be taken to minimize impacts for unavoidable riparian alteration. If a mine is in a valley that is a migration corridor, mining should be restricted to subsurface mining or should be placed so that it will not block the migration route. Subsurface mines should have braces installed or natural braces left in place to minimize subsidence. Sediment traps should be installed below roads, buildings, and other mining facilities.

D. Roads and Utility Corridors

Effects

Roads and utility corridors can cause the direct loss of boreal toads from impacts with vehicles using these travel routes. Roads often create barriers to water flow and root propagation which can indirectly result in alterations to adjacent plant communities with the potential of indirectly affecting boreal toad habitat. During road and utility corridor construction and maintenance phases vegetation is removed or altered, again having the potential of indirectly affecting boreal toads and their habitat. One indirect effect of roads comes from fragmentation of boreal toad populations, which ultimately results in loss of the population given a prolonged period of isolation. Roads have a greater potential of impacting toads than utility corridors, which are not as likely to occur in toad habitat.

Recommendations

Assumptions - Roads are often located along riparian zones and low lying landscapes. Mitigation of existing roads is difficult, though not impossible. At both the regional and local levels, roads and utility corridors have the potential for causing a significant impact to the southern Rocky Mountain boreal toad population.

Desired Future Conditions and Possible Management Actions - In areas of occupied toad habitat assess existing roads for their potential of creating barriers to toads and their movement. If it is determined such impacts exist, modifications of roads to provide safe and unaltered movement of toads between essential habitats is recommended. Culverts, or other structures toads may pass through, as well as bridges and seasonal closures, can provide effective mitigation.

Design new roads with appropriate measures to eliminate the potential of creating barriers to water flow and toad movements on either side of the road.

E. Recreation

Effects

Recreation is a widespread activity that can pose a significant threat to boreal toads and their habitat in the southern Rocky Mountains. Final recreational destinations are often riparian areas that may concurrently support boreal toad habitat. Recreational activities that may impact boreal toads or their habitat include camping, hiking, biking, skiing, fishing, and off-road vehicle use. Early boreal toad life stages, from egg to toadlet, are particularly susceptible to trampling, which can result in direct mortality. Indirect effects of fishing, camping, hiking, skiing, and off-road vehicle use are loss of vegetative bank cover from trail construction and trampling, reduction of water quality from bank or shoreline erosion, fecal contamination, and the deposition of other human refuse. Developing eggs and tadpoles are most sensitive to reduced water quality. Recreationists may attract animals such as ravens and jays, thereby increasing toad losses from predation. Recreational impacts can also reduce the potential of unoccupied but suitable boreal toad habitat. Although the mode of spread of chytrid fungus and other pathogens is unknown, it is possible that recreational activities may have a role in transporting pathogens from one area to another, for example if mud is transported from site to site on a vehicle or the soles of hiking boots or waders.

Fisheries management practices used to meet recreational uses may include removing undesirable fish species with the introduction of toxins that would kill any tadpoles present. Amphibians are known to transmit disease to fish. However, it is not known whether fish transmit disease to amphibians.

Recommendation

Assumptions - Recreational activities can be reasonably mitigated around breeding sites and toadlet habitat through the use of temporary or seasonal buffers. More permanent effects to boreal toads or their habitat may require more restrictive measures. Interpretive signs explaining modification of recreational activities can improve the public's acceptance of and compliance with such modifications. Monitoring recreational management is essential to determine the compliance and effectiveness of management measures and their contribution to the conservation of boreal toads. Many of the following management recommendations are similar to or very compatible with existing minimal impact camping guidelines and proper recreational management guidelines.

Desired Future Conditions and Possible Management Actions - Campsites in the vicinity of occupied breeding ponds should be closed seasonally, if necessary, to protect breeding adults, egg masses, tadpoles and/or toadlets as desired. Site specific closure dates will be determined.

In locations of unrestricted camping, fencing and signs should be used to seasonally restrict camping

in areas adjacent to occupied breeding sites if necessary. In suitable but unoccupied boreal toad habitat, camping in unrestricted areas should be directed at least 100 ft. (34 m) from riparian areas. Development of new campsites should occur outside of the vicinity of occupied boreal toad breeding habitat. In suitable but unoccupied boreal toad habitat, new campsites should be at least 100 ft. (34 m) from water sources.
To minimize potential impacts on toads and habitat, boreal toad breeding sites should be evaluated annually to determine the need for seasonal closures of trails that lead to occupied sites.

Newly constructed trails should avoid directing people to occupied breeding sites. Prior to collecting site specific information (how and where human disturbance is affecting toads and their breeding site) a 34 m (100 ft.) buffer should be placed between new trails and occupied breeding sites. Such buffering distances may need to be modified as adults and juveniles move further from the breeding site and onto upland sites.

Off-road vehicle use should be managed to avoid riparian and wetland habitats.
Development of new ski areas should avoid occupied boreal toad breeding and non-breeding habitats. New ski areas cannot have a net loss of naturally functioning riparian or wetland habitats in their permitted use area on public lands. Possible effects on wetland hydrology due to water removal for snowmaking should be considered and evaluated.

Seasonal fishing closures in occupied breeding habitat can be a tool for protecting breeding adults, egg masses, tadpoles or toadlets from human disturbance. Site specific dates could eventually be determined based upon site elevation, climatic conditions and the average annual snowpack melting date. The Colorado Division of Wildlife, New Mexico Department of Game and Fish, and Wyoming Game and Fish Department would be responsible for such action in most areas, and the National Parks Service would have this authority within Rocky Mountain National Park.

Fish toxins should only be used after tadpoles have metamorphosed. Such use should generally only be in the context of replacing non-native fish with native species. However, in some locations it might be applied to remove "rough" fish from a fishery.

Historically fish-less waters that are currently boreal toad breeding habitat or are designated as essential habitat should not be stocked with fish.

F. Livestock Management

Effects

Direct effects of livestock grazing may include mortality of toads from trampling. Toad trampling has been observed in areas of high cattle, sheep, or human use (Steve Corn, USGS/BRD, pers. comm., 1996; and Bartelt 1998). Indirect effects may include reduced survival of eggs and tadpoles resulting from suffixation (increased siltation and water temperatures), hydrologic changes from stock pond development, predation (loss of cover) and poisoning (from fecal contamination). A long-term indirect effect of improper livestock grazing is that of degrading riparian and wetland areas vital to boreal toad existence. Riparian vegetation functions as a "living filter" to trap

sediment, nutrients, chemical, and organic waste that are carried from the surrounding land during and following storms. Vegetation (trees, shrubs, and grasses) dissipates water energy by slowing the speed of surface runoff and increasing water absorbency into the soil and root systems. This increased capacity for streambank storage helps maintain year-round stream flow. Loss of this storage capacity results in lower than normal or intermittent stream flows.

Recommendations

Assumptions - Domestic livestock concentrate in riparian habitat and are widespread throughout the range of boreal toads. High densities of toads alleviates some concern with respect to loss of a few individuals from a particular deme though these concentrated use areas merit special consideration and protection. Concerns about trampling are primarily related to contact between animals in breeding or toadlet rearing habitat.

Habitat alteration from livestock grazing is presently not believed to be a primary cause of boreal toad declines. This assumption is based on consideration of the boreal toad's occurrence at higher elevation boreal forests that receive light cattle use except perhaps in openings and wet areas where livestock and toads may concentrate. Boreal toads share more overlap with domestic sheep that prefer similar habitats. However, today, domestic sheep grazing is comparatively sparse compared to stocking 20 years ago or more. Toads were considered ubiquitous in the 1940's through 60's at a time when livestock numbers on National Forests were high relative to today. Though scientists have speculated that there may be no single factor contributing to the toads decline (Corn et al. 1989; Blaustein and Olson 1991; Carey 1993) it is logical to avoid activities that aggravate or exacerbate current declines. Negative impacts from livestock grazing occur in riparian habitat where toads and livestock are most concentrated. It is assumed that standard practices intended to maintain healthy riparian habitat as related to livestock grazing will also contribute to management objectives for protection of boreal toad habitat.

Desired Future Conditions and Possible Management Actions-- Management objectives for domestic livestock grazing in boreal toad habitat are to:

(1) maintain riparian-wetlands in proper functioning conditions. Riparian/wetland areas are properly functioning when adequate vegetation, landform, or debris is present to (a) dissipate energies associated with stream flow, wind, and wave action; (b) filter sediment, capture bedload, and aid floodplain development; (c) improve flood-water retention and ground water discharge; (d) develop root masses that stabilize streambanks against cutting action; (e) develop diverse pond characteristics to provide habitat, water depth, duration, and temperatures to support a diversity of aquatic life (BLM 1993).

(2) maintain water quality and quantity at Clean Water Act standards as a minimum.

(3) maintain vegetative cover requirements necessary to meet the recovery needs of the boreal toad; locate and protect toad movement corridors from impacts of livestock grazing.

(4) minimize incidences of trampling by livestock.

Consideration should be given to the use of exclosures or fencing of springs and piping water to livestock watering facilities, and changes in the season and/or duration of livestock use as means to attain desired vegetation conditions.

Maintain proper functioning of riparian-wetland areas (as described in *Desired Future Condition*). Use short duration spring grazing to maximize regrowth and avoid continuous season-long grazing in riparian or wetland areas as appropriate.

If grazing is contributing to improperly functioning riparian-wetland areas, a total rest period should be implemented.

To maintain proper functioning riparian areas, remove livestock from grazing units when the average stubble heights of *Carex* spp. reach 3-4 inches (7-10 cm) in spring-use pastures and 4 to 6 inches (10 to 15 cm) in summer/fall use pastures.

Maintain a minimum of 75% of the streambank or shoreline in stable condition. A stable condition is attained by the streambank or lake shoreline being covered by vegetation in vigorous condition or by rocks or other channel characteristics adequate to prevent erosion. Remove or herd livestock when stream bank disturbance (trampling, exposed soils, etc.) from current year's grazing reaches 20-25% of the key area stream reach. Adjustments of percentages may be necessary based on highly variable site conditions.

To maintain proper functioning riparian areas, limit utilization of woody plants to no more than 15-20% and herbaceous plants to no more than 30% of the current season's growth.

Limit interaction between livestock and boreal toad during critical periods (Table 2). In known occupied breeding sites, minimize concentrations of livestock in breeding habitat throughout the breeding season. If livestock are retained on breeding habitat, initiate monitoring studies to determine effects on toads. Critical periods depend on the progression of snowmelt at different elevations but generally occur from May through July. Newly metamorphosed toadlets may be present in the vicinity of the breeding site from late July to about mid September.

G. Timber and Fire Management

Effects

Direct effects from timber sale activities include mortality of toads crushed by equipment used during pre-sale, harvest, or post-sale activities. Effects also come about through habitat changes that occur due to tree removal. For example, boreal toads may be blocked from migration by clearcuts due to lack of moisture and increased heat within the timber sale area (P. Bartelt, Waldorf College, pers. comm., 1996). Shrub understories may be either enhanced or reduced due to overstory tree removal depending on the habitat type, silvicultural treatment, and physiographic region. The shrub component of upland forest environments used by boreal toads is important as they increase retention

of water and heat energy necessary for amphibians (P. Bartelt, Waldorf College, pers. comm., 1996). Soil compaction, soil and landform disturbances (road construction), and reduced live root systems associated with tree harvesting alter the local hydrology, thus indirectly effecting boreal toads and their habitat. Soil compaction that comes about from harvesting activities effects toads by affecting their overwinter burrows. Timber harvesting can also have the beneficial effect of increasing small mammal habitat and thus increasing burrowing habitat. Boreal toads overwinter in burrows excavated by small mammals and may overwinter in slash piles. The permeable skin of amphibians makes them vulnerable to poisoning from direct contact with rodenticides such as strychnine, which are used to control rodents in tree plantations.

Fire management and wild fires can cause direct mortality of toads. However, fire is a natural event through which boreal toads, as a population or species, have historically survived. Fire and fire suppression indirectly affect boreal toad habitat by altering the course of vegetative changes. These changes in vegetation may result in either a positive or negative impact to boreal toads. Burning of downed woody materials 7-10 inch (17.8 to 25.4 cm) d.b.h. and slash piles is detrimental to boreal toads, which use these micro sites as refugia (P. Bartelt, Waldorf College, pers. comm., 1996). A positive impact can arise from an increased shrub component in the understory of a forest after fire.

Recommendations

Assumptions - Timber harvesting will continue to occur on a small portion (<5% of public lands will be affected by timber harvesting in a decade) of public lands within the southern Rocky Mountain boreal toad range. At a local level, timber harvesting can pose a risk to toads and their habitat. However, many of the impacts can be mitigated or eliminated. Prescribed fires are not a significant activity within the spruce-fir zone occupied by boreal toads and therefore present little risk of impact.

Desired Future Conditions and Possible Management Actions - Uneven-age stand management is the preferred method of tree removal in boreal toad habitat. This practice results in less disturbance to the understory and ground. Negative impacts caused by even-aged silvicultural prescriptions can be reduced with minimal or no post-sale treatment (scarification, fire) and road closures.

Harvest prescriptions that require little or no post-sale treatment are recommended for use since slash disposal treatments such as fire and the use of heavy equipment cause direct toad mortality.

Restricting location or changing the timing of vehicle use of skid trails and haul routes that cross boreal toad habitat can reduce mortality of toads. Consider the level of risk based on numbers of toads, and timing and location of activity.

Boreal toads are known to disperse considerable distances (2.5 mi. [4.0 km]) from breeding to upland forest sites (P. Bartelt, Waldorf College, pers. comm., 1996; Steve Corn, USGS/BRD, pers. comm., 1996; Jones et al 1998). The most protective measure that can be applied would be to eliminate all timber treatment activities within 2.5 mi. (4.0 km) of known breeding sites. The least protective measure is to protect the immediate riparian area from disturbance.

Minimize risk from wild or prescribed fire around known occupied boreal toad breeding sites.

In known occupied boreal toad breeding sites, design burning prescriptions to protect habitats and forest stands adjacent to and within 2.5 mi. (4.0 km) of the site. Direct loss of toads to prescribed fires can be mitigated by restricting burning to late fall through early spring when toads are inactive, or by establishing a maximum rate of spread, which would allow toads to escape the flames. Without increasing risk to human safety, protect known occupied boreal toad breeding sites in the event of wildfire.

H. Land Exchanges

Effects

Boreal toads may be affected by land exchanges when land parcels that support toad habitat are relinquished by public land management agencies that are responsible for the management of wildlife resources. However, opportunities for enhancing and protecting boreal toad habitat also exist during land exchanges.

Recommendation

Assumptions - Exchange of public lands is directed by agency policy. One such policy is for the enhancement and protection of habitat for threatened and endangered species and rare resources. Many land exchange programs state that any one individual land exchange must contribute to a broader-level management plan such as Forest Land Management Plans. It is at this broader level of planning that resource coordination takes place to ensure that land exchange priorities do not conflict with boreal toad management. It is also assumed that individual land management units have the information available to them to identify occupied and suitable but unoccupied boreal toad habitats or any other lands deemed essential for the recovery of the species.

Desired Future Conditions and Possible Management Actions - Public land exchanges are desirable if it can be demonstrated that the acquired lands provide greater resource values to the recovery of the boreal toad than those values lost with the lands traded out of and that they contribute to meeting broader level planning documents (ie. Forest Land Management Plans).

Generally, because of the scarcity of breeding sites, land exchanges involving the loss of historic or existing breeding sites are not recommended.

* * *

HABITAT SURVEYS

It is the primary responsibility of land management agencies to determine whether toad habitat is present in areas of a proposed activity and monitor the effects of the project as necessary. If the proposed project will adversely affect a species' presence, reproduction, or survival, then site specific information on occurrence (presence) and habitat quality is probably needed. If the proposed project can be refined to avoid impacts, then surveys may not be necessary. However, surveying may contribute information on the viability of toad populations and habitat.

Survey to:

- confirm the existence of suitable boreal toad habitat in areas where toad habitat could be altered;
- determine whether toads occupy an area of suitable habitat;
- determine effectiveness of an action or to validate management assumptions.

Surveys are not necessary:

- outside of the known historic range of the toad, particularly in habitat types (such as sagebrush) where toads have not been known to occur;
- where the activity will not have negative impacts on the toads or their habitat.

Recommended priorities for surveying:

1. Known historic locations;
2. Areas expected to be affected by management activities;
3. Areas with suitable habitat.

Information on known locations can be obtained by State and Federal agencies from a database maintained by the CNHP or from the CDOW. Suitable habitats are defined as any habitat potentially capable of being used by toads throughout their life cycle (see prior description of toad habitat). Monitoring the implementation of a management activity and its effects must be designed around specific questions or aspects of the project to be evaluated. A general monitoring design cannot be laid out in this Conservation Plan.

Surveys of habitats should begin by determining the area to be surveyed from within which sample survey sites will be established. A survey area may be an entire drainage basin, which would include multiple riparian and wetland sites. Surveying an entire drainage provides a more complete picture of the status of the amphibian and its habitat. Dispersal corridors, seasonal habitats, and barriers can often all be defined and assessed within a drainage. When surveying for toads in a drainage, the surveyor(s) may choose to sample only selected sites, rather than the entire survey area. Select sample sites by either a random or representative process. Representative sites should include examples of the variety of habitats that could be considered boreal toad habitat (wetland or upland habitats) found in the drainage. Random selection of sample sites allows for statistical extrapolation of the data from the sample site to the entire survey area if all assumptions are met (Fellers and Freel 1995).

Management or project areas are another scale at which surveys are conducted and range in size from a campground to an entire wilderness area. This is the most likely scale at which boreal toad surveys will be performed. When working at this scale it is important to survey potential dispersal corridors and other potential habitat components that lie outside of the project area but may influence or be influenced by what happens in the surveyed area.

Specifics regarding protocols, timing, etc. of boreal toad surveys are presented in this plan under "Recommended Protocols for Species Management - Surveys". Suggested forms to be used for collection of data during surveying are found in Appendix B.

* * *

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* * *

APPENDIX A

This appendix contains copies of the signed agreements of all of the agencies, and other partners, who have made commitments to participate in the implementation of this Conservation Plan. Agreements will be added, deleted, and edited as appropriate and when needed.

CONSERVATION AGREEMENT

The **Colorado Department of Natural Resources, Division of Wildlife**, hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To provide one staff person as a representative to, and coordinator of, the Boreal Toad Recovery Team, which will be made up of representatives from various agencies, as described in the Conservation Plan.

2. To assume lead responsibility for the inventory and monitoring of boreal toad populations in the State of Colorado, and to annually compile and report inventory and monitoring information and provide such information to all participating agencies and parties.

3. To implement and enforce specific State statutes and Wildlife Commission Regulations (Colorado Revised Statutes, Title 33, Article 2, and Colorado Wildlife Commission Regulations, Chapter 10.), which control and prohibit the "taking, possession, and harassment" of the boreal toad in Colorado.

4. To make recommendations to the U.S. Army Corps of Engineers regarding the issuing of 404 permits for any land development proposals that would negatively impact key boreal toad habitats, and to work cooperatively with private land owners, land developers, and local land use planners in Colorado to avoid, minimize and/or mitigate negative impacts of land development on boreal toad habitat.

5. To continue to conduct and support research to collect information on biotic and abiotic limiting factors of boreal toad populations, and on boreal toad habitat and ecology.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory agency. This agreement shall not prohibit the signatory agency from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party.

Russell George, Director Date

Colorado Division of Wildlife

CONSERVATION AGREEMENT

The U.S. Forest Service, Rocky Mountain Region, hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To evaluate the compatibility of all applicable national Forest Land and Resource Management Plans (Forest Plans within this Region) and the Boreal Toad Conservation Plan (Conservation Plan). Whether or not one or more Forest Plan amendment(s) are appropriate will be determined through the NEPA and National Forest Management Act (NFMA) process in compliance with the Federal Advisory Committee Act. The Rocky Mountain Region will initiate the review under the NFMA and NEPA process within six months of the Conservation Plan completion date. Until the evaluation and potential amendment process is completed, the Conservation Plan will be considered as potential "new information" under NEPA and NFMA planning by the Forest Service. In the interim, where compatible with existing Forest Plans or other Plans subjected to NEPA, the Strategy is available for land managers to incorporate concerns for the boreal toad in reducing negative impacts and enhancing opportunities for mitigation or habitat improvement. This Conservation Plan is also available for consultation if populations are known or discovered which are unrelated to a project.

2. To utilize agency air quality expertise to further inquiries into toad declines; provide potential sites for toad reintroduction consistent with Forest Service - State Fish & Wildlife Agency Memoranda of Understanding; provide a representative to the Boreal Toad Recovery Team; and assist with the survey and monitoring of boreal toad populations on Forest Service lands, as reasonable and appropriate within the scope of Forest Service roles and responsibilities.

3. To exercise authority for the maintenance of biological diversity on national forests and for the protection and management of sensitive species (including the boreal toad) as provided in the Forest Service manual (FSM). The FSM requires that a "Biological Evaluation" be prepared for each proposed Forest Service Program or activity to ensure that Forest Service actions do not contribute to loss of viability of the boreal toad and ensure that activities do not cause this species to move toward federal listing.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory agency. This agreement shall not prohibit the signatory agency from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party.

Rick Cables, Regional Forester Date
U.S. Forest Service, Region 2

CONSERVATION AGREEMENT

The **U.S. Fish & Wildlife Service (Region 6)** hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To provide funding through the ESA Section 6 process to the Recovery Team and/or involved states for implementation of the Conservation Plan.

2. To provide a representative to the interagency Boreal Toad Recovery Team.

3. To review and provide comments during informal consultation under authority of section 7 of the Endangered Species Act for any projec ts federally authorized, funded, or carried out that may impact the boreal toad,and under authority of the Fish & Wildlife Coordination Act, on projects requiring a Clean Water Act section 404 permit issued by the U.S. Army Corps of Engineers, or on water developments created by the Bureau of Reclamation or by private water development projects regulated under the Federal Energy Regulatory Commission.

4. To use the Service's authority to protect boreal toads from land and water altering activities on Service lands that may harbor the boreal toad.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory agency. This agreement shall not prohibit the signatory agency from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party.

Ralph Morgenweck, Regional Director Date
U.S. Fish & Wildlife Service, Region 6

CONSERVATION AGREEMENT

The **Wyoming Game & Fish Department** hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To provide a representative to the Boreal Toad Recovery Team, which will be made up of representatives from various agencies, as described in the Conservation Plan.

2. To assume lead responsibility for conducting surveys for boreal toads in historic habitats, and the inventory and monitoring of boreal toad populations in the State of Wyoming, and to annually compile and report inventory and monitoring information and provide such information to the Boreal Toad Recovery Team.

3. To implement and enforce applicable laws and regulations (Chapter 52, Section 11, Wyoming Game & Fish Commission Regulations), which prohibit the "take" of the boreal toad.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory agency. This agreement shall not prohibit the signatory agency from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party.

John Baughman, Director — Date
Wyoming Game & Fish Department

CONSERVATION AGREEMENT

The **National Park Service (Rocky Mountain National Park)** hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To provide a representative to the Boreal Toad Recovery Team, which will be made up of representatives from various agencies, as described in the Conservation Plan.

2. To assume lead responsibility for conducting surveys for boreal toads and monitoring of known boreal toad populations in Rocky Mountain National Park, and to annually compile and report inventory and monitoring information and provide such information to the Boreal Toad Recovery Team.

3. To protect boreal toads and all suitable habitat in Rocky Mountain National Park from undue human disturbance by managing to protect and/or restore natural conditions and processes to the extent authorized by law, and as is consistent with legislative mandates.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory agency. This agreement shall not prohibit the signatory agency from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party.

During performance of this agreement, the participants agree to abide by the terms of Executive Order 11246 on non-discrimination and will not discriminate against any person because of race, color, religion, sex, or national origin. The participants will take affirmative action to ensure that applicants are employed without regard to their race, color, religion, sex, or national origin.

No member or delegate to Congress, or resident Commissioner, shall be admitted to any share or part of this agreement, or to any benefits that may rise therefrom, but this provision shall not be construed

to extend to this agreement if made with a corporation for its general benefit.

A. Durand Jones, Superintendent Date
Rocky Mountain National Park, NPS

CONSERVATION AGREEMENT

The **U.S. Bureau of Land Management (Colorado)** hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To provide a representative to the Boreal Toad Recovery Team, which will be made up of representatives from various agencies, as described in the Conservation Plan.

2. To conduct a review of BLM lands in Colorado which may occur within the historic range of the boreal toad, and determine if any such lands contain suitable habitat for boreal toads.

3. If boreal toads or suitable boreal toad habitats are found on BLM lands, work in cooperation with the Colorado Division of Wildlife to complete survey and monitoring of boreal toad populations and/or to evaluate habitat condition.

4. To protect any boreal toad populations and suitable habitat which may be located on BLM lands from negative impacts which may be caused by other land use activities. Authority for the protection of the toad and its habitat is pursuant to provisions in the BLM Policy Manual and the Federal Land Policy and Management Act.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory agency. This agreement shall not prohibit the signatory agency from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party.

Ann Morgan, Colorado State Director Date

U.S. Bureau of Land Management, USDI

CONSERVATION AGREEMENT

The **USGS/Biological Resources Division** hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To provide a representative to the Boreal Toad Recovery Team, which will be made up of representatives from various agencies, as described in the Conservation Plan.

2. To conduct research and provide information related to global warming, including effects of ultra-violet radiation on boreal toads, boreal toad population declines, methods for reintroducing boreal toads to historically occupied habitats, and other research related to global amphibian declines.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory agency. This agreement shall not prohibit the signatory agency from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party..

Dr. J. Larry Ludke, Chief Biologist — Date
Central Region, USGS/BRD

CONSERVATION AGREEMENT

The **U.S. Forest Service, Carson National Forest,** hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To provide a representative to the Boreal Toad Recovery Team, which will be made up of representatives from various agencies, as described in the Conservation Plan.

2. To work in cooperation with the Boreal Toad Recovery Team and the New Mexico Department of Game & Fish to conduct surveys for boreal toads in historic and suitable habitats on the Carson National Forest, and to assist with the monitoring of any breeding populations of boreal toads which may be found on the Carson National Forest.

3. To consider possible impacts of forest management decisions and plans on boreal toads and their habitat, and to take measures to avoid and/or mitigate such impacts whenever possible within constraints of Forest Service policy and regulations.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory agency. This agreement shall not prohibit the signatory agency from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party.

Martin Chavez, Forest Supervisor — Date
Carson National Forest

CONSERVATION AGREEMENT

The **Colorado Natural Heritage Program** (CNHP) hereby states its intent and commitment to assist with and participate in the implementation of the *Conservation Plan for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad*, as prepared by the interagency Boreal Toad Recovery Team. Specific commitments made hereby are as follows:

1. To provide a representative to the Boreal Toad Recovery Team, which will be made up of representatives from various agencies and organizations, as described in the Conservation Plan.

2. To work in cooperation with the Colorado Division of Wildlife, the US Forest Service, and other involved agencies, as appropriate, to help conduct boreal toad surveys and monitoring of breeding populations throughout Colorado.

3. To incorporate boreal toad occurrence records in the CNHP database, and share such data with other agencies involved in the boreal toad conservation effort in the southern Rocky Mountains.

Performance of all activities described above is contingent on adequate funds being made available and allocated to the signatory organization. This agreement shall not prohibit the signatory organization from engaging in management actions regarding boreal toad conservation beyond those described in this agreement and in the Conservation Plan. Such management actions should be coordinated with the Boreal Toad Recovery Team.

This agreement shall become effective on the date of signature by the participating party, and shall remain in effect until the signatory party chooses to terminate the agreement, or the agreement is terminated by consent of the Boreal Toad Recovery Team. Either the signatory party or the Boreal Toad Recovery Team may terminate the agreement by providing 90 days written notification to the other party.

Boyce Drummond, PhD - Director Date
Colorado Natural Heritage Program

APPENDIX B

SURVEY AND MONITORING FORMS

BOREAL TOAD BREEDING POPULATION MONITORING FORM

Rev. 11/98

(See back of form for instructions)

Date:	Observer(s):	
Site Name:		Site No:
Start Time: AM PM	End Time: AM PM	

Samples Collected(Circle): Water Pathology Other:

Disposition of sample(s):

Air Temp. °F °C	Water Temp. °F °C	**Weather:** Rain?_____ Snow? Percent Cloud Cover:	**Wind**: 0 5-20 (MPH) <5 >20

NUMBER OF TOADS OBSERVED

Adults			Sub-Adults				Pairs in Amplexus	TOTAL SEEN
M	F	Unk.	YOY	1 Yr.	2 Yr+	Unk.		
Ave. S/V length of subadult toads:								

Notes/comments on toads, incl. predation, behavior, etc:

EGG MASSES

Number Observed	Number new since last visit.	Notes(est. hatch date, development, etc.):

TADPOLES

Est. Number (Circle): <100 100-500 500-1000 1000-2000 2000-3000 >3000 >5000

Notes/Comments (est. date metamorphosis, predation, etc):

Additional Comments(other species observed, etc). Use back for additional notes:

Please return completed forms, photos, water samples, specimens to Mark Jones, Colorado Division of Wildlife, 317 W. Prospect St., Ft. Collins, CO 80526. Phone 970-472-4361. FAX 970-472-4457.

BOREAL TOAD BREEDING POPULATION MONITORING FORM - INSTRUCTIONS

This form was designed by the Recovery Team for the southern Rocky Mountain population of the boreal toad, and should be used for recording of information when boreal toad breeding populations are being monitored. Any sites monitored, using this form, should have a prior Amphibian Survey Data Sheet on file.

Date: The date the site was monitored.

Observers: The name(s) of the person(s) who monitored the site and completed the form.

Site Name: The name assigned to the site after initial discovery and completion of the Amphibian Survey Data Sheet.

Site Number: The number assigned to the site after initial discovery and completion of survey.

Start Time & End Time: Enter standard time and circle AM or PM, as appropriate.

Samples Collected: Circle appropriate category and describe location and/or disposition of sample(s).

Air Temperature: Check with thermometer, or best estimate, and fill in °F or °C.

Water Temperature: Use thermometer to check temp. in shallow water, where eggs or tadpoles are.

Weather & Wind: Check if precipitation occured, and estimate percent cloud cover. Comment at bottom of form, if needed.

Numers of Toads Observed:

Indicate number of adults (gen. >3" length) at or near breeding site, and break down by sex, if possible.
Sub-adults: YOY=Young of the year (metamorphs), 1 Yr. generally less than 1" SVL.

Average SVL (Snout to vent length): Measure, or estimate, for sub-adults seen. If various, break down numbers by category (i.e. 2 @ 1½-2", 5 @ 2½-3", etc).

Egg Masses: Note number of masses seen at breeding site, and how many new since last visit to site.

Tadpoles: Make best estimate if large numbers, and circle appropriate category. If very few, note # in comments.

Additional Comments:

AQUATIC/RIPARIAN AMPHIBIAN SURVEY DATA SHEET

(non-shadedareas area required, circle single choices where provided) (ver. 1/20/97 CDOW)

LOCATION DESCRIPTION:

State: CO	COUNTY:	Topo Map Name	Owner	Elevation m ft

Township N S	Range E W	Section	Quarter Section	UTM Zone	UTM X Easting (Longitude)	UTM Y Northing (Latitude)

SITE DESCRIPTIONS - (SKETCH SITE AND/OR PUT PROTECTION, MANAGEMENT AND ADDITIONAL COMMENTS ON BACK OF SHEET)
OMIT THIS SECTION IF DATA HAVE BEEN COLLECTED ON A PREVIOUS VISIT | SITE PHOTO?

ORIGIN: NATURAL MAN-MADE | DRAINAGE: PERMANENT OCCASIONAL NONE

DESCRIPTION: PERMANENT LAKE/POND TEMPORARY LAKE/POND MARSH/BOG STREAM SPRING/SEEP ACTIVE BEAVER POND INACTIVE BEAVER POND

SITE LENGTH (M)	SITE WIDTH (M)	SITE MAXIMUM DEPTH: < 1 M 1 – 2 M > 2 M

STREAM ORDER 1 2 3 4 5+

PRIMARY SUBSTRATE (CIRCLE ONE) SILT/MUD SAND/GRAVEL COBBLE BOULDER/ROCK OTHER:

% OF LAKE MARGIN WITH EMERGENT VEGETATION: 0 1 – 25 25 – 50 > 50

EMERGENT VEGETATION SPECIES (LIST IN ORDER OF ABUNDANCE)				

NORTH SHORELINE CHARACTERS: SHALLOWS PRESENT SHALLOWS ABSENT EMERGENT VEG PRESENT EMERGENT VEG ABSENT

DISTANCE (M) TO FOREST EDGE	TREE SPECIES:				

DATE:	START TIME:	END TIME:	OBSERVERS:

PHYSICAL AND CHEMICAL ENVIRONMENT (CHEMISTRY VARIABLES OPTIONAL - USE EXTRA SPACES FOR ADDITIONAL MEASUREMENTS)

WEATHER: CLEAR OVERCAST RAIN SNOW | WIND: CALM LIGHT STRONG

AIR TEMP (circle scale) °C °F	WATER TEMP (circle scale) °C °F	COLOR: CLEAR STAINED	TURBIDITY: CLEAR CLOUDY

pH	Dissolved Oxygen ppm	Conductiviy mhos/cm	Hardness ppm	Total Alkalinity ppm	PHTH Alkalinity ppm

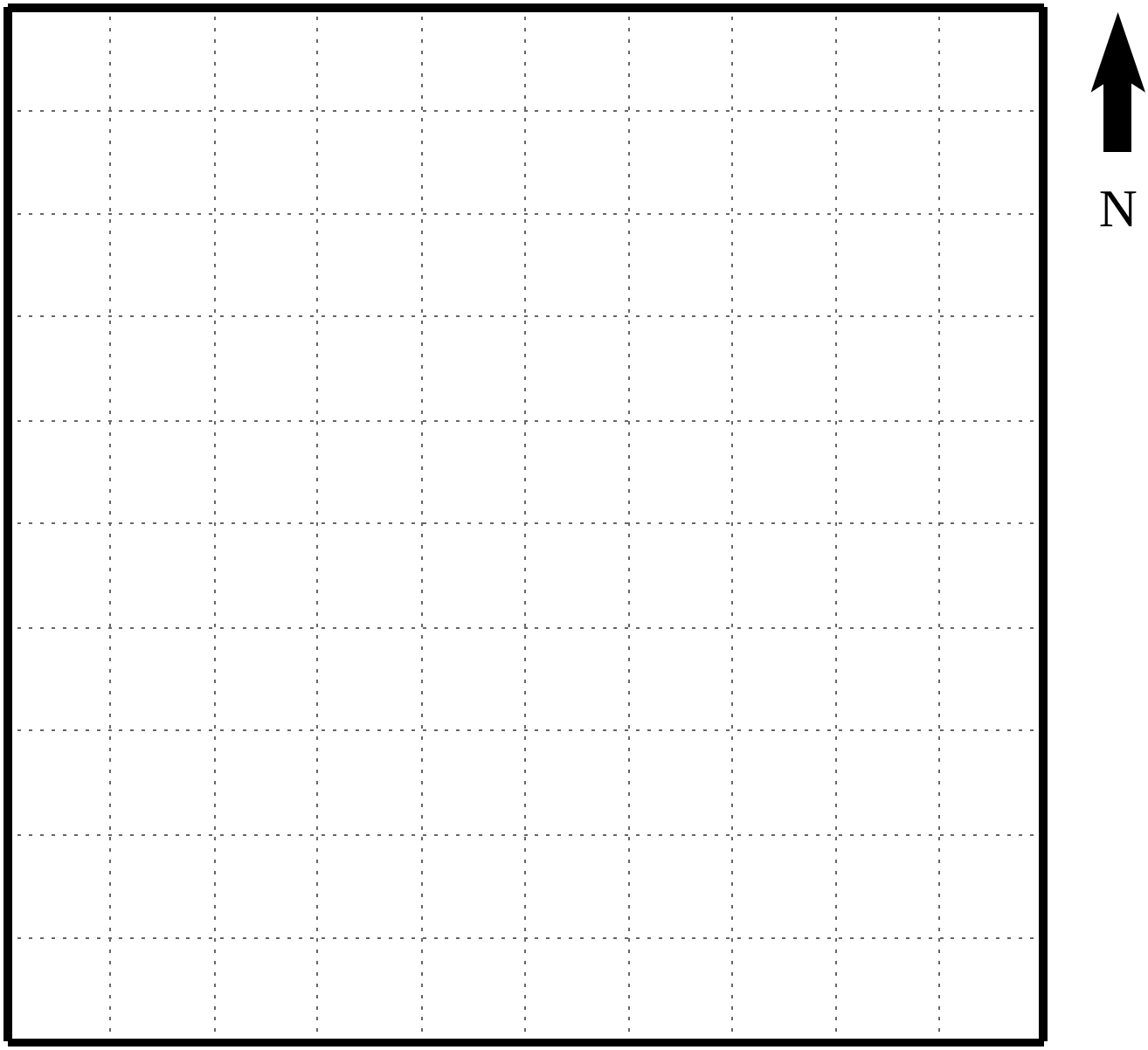
SPECIES OF INTEREST: ☐ **Check for inventory survey**	**WAS IT FOUND AT THIS LOCATION:** **YES** **NO**
ENTIRE SITE SEARCHED? **YES** **NO** **IF NO, INDICATE AREA ON REVERSE**	**METERS OF SHORELINE:** **M² OF HABITAT**

AMPHIBIAN AND/OR REPTILLIAN SPECIES PRESENT (INDICATE NUMBERS IN CATEGORIES IF POSSIBLE) | CIRCLE METHOD AND INDICATE IF VOUCHER SPECIMEN WAS COLLECTED

SPECIES	ADULTS/JUVENILES	CALLING?	TADPOLES/LARVAE	EGG MASSES	METHOD:	
		Y N			VISUAL/AURAL ID IN HAND DIP NET/SEINE TRAPPED VOUCHER COLLECTED? YES NO	PHOTO? YES NO
		Y N			VISUAL/AURAL ID IN HAND DIP NET/SEINE TRAPPED VOUCHER COLLECTED? YES NO	PHOTO? YES NO
		Y N			VISUAL/AURAL ID IN HAND DIP NET/SEINE TRAPPED VOUCHER COLLECTED? YES NO	PHOTO? YES NO
		Y N			VISUAL/AURAL ID IN HAND DIP NET/SEINE TRAPPED VOUCHER COLLECTED? YES NO	PHOTO? YES NO
		Y N			VISUAL/AURAL ID IN HAND DIP NET/SEINE TRAPPED VOUCHER COLLECTED? YES NO	PHOTO? YES NO

FISH PRESENT? YES UNKNOWN NO FISH SPECIES:

Rough sketch of site Grid spacing is ___ m



Additional Notes:

Management comments (past/present/future reccomendations):

Protection comments (Are there any protection plans or stategies in place):

General comments (concerning the site or the survey):

AMPHIBIAN SURVEY DATA SHEET: INSTRUCTIONS This data sheet is designed to facilitate quick recording of data from field surveys of amphibians and their habitats. It can be completed in a short amount of time after a minimum amount of training. Many variables require only the correct choice to be circled, and the remaining variables are numerical and easy to determine. The data sheet is divided into five sections, divided by double lines. Each section describes a cohesive set of variables. In addition the back of the sheet includes a grid for a rough sketch of the site and space for comments concerning in-place protection plans or strategies, past/present/future management reccomendations or additional site information. The map is optional, but the future value of the data is enhanced if it is supplied. If available, a photo copy of the portion of the USGS 7½' topo map identifying the location is desirable.

SECTION 1 – LOCALITY *These data are essential. Many amphibian surveys have been hampered by the inability to relocate exact locations in the historical record. Some of this information can be completed in the office after the survey.*

LOCATION DESCRIPTION: Describe the *specific* geographic location of the site. Use air distance in two directions (e.g., 5km N and 7.5 km W) of a map landmark that likely will not change (distance from a large town or city is not all that helpful).

STATE: Use the 2-letter abbreviation.

COUNTY:

MAP NAME: List the name of the U.S.G.S. quadrangle or other map used to locate the site.

OWNER: List the public land manager (e.g., Roosevelt Nat. Forest or Rocky Mtn NP), or name of the owner if the site is on private land (listing the owner's name will make it clear that you did not trespass to survey the site).

ELEVATION: Circle the scale used; meters are preferred.

TOWNSHIP; RANGE; SECTION; QUARTER SECTION: Circle the directional indicators. Describe the location of the site within the section (e.g., NE ¼ of SE ¼)

UTM ZONE, NORTHING, EASTING: Universal Transverse Mercator coordinates are preferred over longitude and latitude. The UTM zone is listed on newer topographic maps. If you are using a map without the UTM grid, substitute latitude for Northing and longitude for Easting.

SITE PHOTO?: whether a photo of the location was taken. If a photo exists (in any format) you may be asked for a copy or the original for scanning.

SECTION 2 – HABITAT DESCRIPTION *These data are important for developing hypotheses to explain changes in abundance of amphibians. This section needs to be filled out only once for each site (a reasonable amphibian survey should include at least 2 – 3 visits to each site in one season).*

ORIGIN: Decide whether the lake is a natural geologic formation or man-made. Bodies of water enlarged by a dam are problematic. List them as man-made, but add an explanation in the space for additional notes on the back of the form.

DRAINAGE: Circle whether the site has permanent drainage, no drainage, or occasional drainage. Determining the potential for occasional drainage requires judgement. Look for clues in the topography and vegetation.

DESCRIPTION: Decide how best to describe the site. If there is evidence of past or present beaver activity, circle one of these choices in addition to your choice.

LENGTH, WIDTH: Record the maximum length and width of lakes and ponds. For streams, record the length and average width of the reach searched.

MAXIMUM DEPTH: Most times, you will not have access to a boat, so estimate depth (deep lakes are usually not important to amphibians).

STREAM ORDER: This is an index of stream size, and you will need a topographic map to determine it. First-order streams have no tributaries, second-order streams are formed by the confluence of two 1st-order streams, third-order streams are formed by the confluence of two 2nd-order streams, and so on.

PRIMARY SUBSTRATE: Circle the type that covers the majority of the bottom of the site.

EMERGENT VEGETATION: Circle the percentage of the margin of the site with emergent vegetation present, and list the dominant species. If you are botanically-disadvantaged, list the categories of the dominant species (e.g., cattail, sedges, etc.).

NORTH SHORELINE CHARACTERS: Describe the north shore of a lake or pond in terms of shallow water and emergent vegetation. This is important in evaluating quality of breeding habitat in some mountain locations.

FOREST CHARACTERS: List the closest distance between the water and the surrounding forest, and list the most common tree species. Leave these fields blank if there is no forest. Describe other surrounding habitat types in the notes section on the back of the form.

SECTION 3 – SURVEY DATE,TIME and OBSERVERS

DATE: Use the format DD–MMM–YY (e.g., 05-APR-92).

BEGIN TIME: List the time survey of habitat for amphibians began in 24 hour format.

END TIME: List the time the survey ended in 24 hour format. (The total time (END TIME - BEGIN TIME) should reflect only the amount of time spent searching for amphibians. Total time plus number of observers may be used to assess relative abundance.)

OBSERVERS: List names or initials of all persons involved in searching.

SECTION 4 – PHYSICAL AND CHEMICAL DATA *Water chemistry data are difficult to collect accurately without thorough planning and quality equipment; these data are optional. Weather data are important for determining the quality of the observations (e.g., was an absence of amphibians due to observations made during a blizzard?)*

WEATHER, WIND: Indicate general atmospheric conditions.

AIR TEMPERATURE: Take at chest height in shade. The Celsius scale is preferred.

WATER TEMPERATURE: Take 1 meter from margin and at 2 cm depth, or where egg masses are observed.

COLOR: This is a qualitative assessment of whether the water clear or tea-colored from organic (humic) acids.

TURBIDITY: This is a qualitative assessment of whether the water clear or clouded from suspended particulate matter.

pH, DISSOLVED OXYGEN, CONDUCTIVITY, HARDNESS, TOTAL and PHTH ALKALINITY: Record available measurements from these field tests in the specified units of measure (e.g., hardness is recorded in parts per million or ppm.)

SECTION 5 – SPECIES DATA *List all amphibian and/or reptillian species observed. A second page for additional species and comments is provided.*

SPECIES OF INTEREST: Species for which the survey was initiated. Use a 4-letter code made up of the first 2 letters of the genus and species (e.g., *Rana sylvatica* would be RASY). If the survey was not concerned with a species of interest, check the box for a general survey.

WAS IT FOUND AT THIS LOCATION: Circle yes or no as to wheter the Species of Interest was found at this location.

ENTIRE SITE SEARCHED?: If no, list either the meters of shoreline or the area (m^2) of habitat (e.g., amount of wet meadow) searched.

SPECIES: Use a 4-letter code made up of the first 2 letters of the genus and species (e.g., *Rana sylvatica* would be RASY).

ADULTS/JUVENILES: Indicate presence with a check, but numbers seen are more valuable data

CALLING?: Circle Y if frogs are vocalizing in a breeding chorus, of if a breeding aggregation of species that don't call (e.g., *Bufo boreas*) is observed.

TADPOLES/LARVAE: Same as for adults/juveniles

EGG MASSES: Same as above. Numbers of egg masses are especially valuable data. If possible, describe the developmental stage of eggs in the space for additional notes on the back of the form.

METHOD: Circle how observations were made: VISUAL/AURAL ID – species identified without picking it up, either by sight or by recognition of the breeding call; HAND COLLECTED – animal was picked up and identified in the field (higher confidence than visual id); DIP NET/SEINE – the usual method of collection for larvae; TRAPPED – minnow-type traps are also used for larvae; VOUCHER COLLECTED? – circle yes or no (voucher specimens are recommended for every site, *especially if identification is uncertain and for larvae*). Indicate voucher status in addition to method used.

PHOTO?: Whether a photo of the specimen was taken for identification purposes. If a photo exisits (in any format) you may be asked for a copy or the original for scanning.

FISH PRESENT?: If yes, list species if you can. Circle the question marks if you are not certain, but suspect that fish are present.