

# Status and Distribution of Amphibians in the Bighorn Mountains of Wyoming

Prepared by

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## EXECUTIVE SUMMARY

The Bighorn Mountains are an isolated mountain range in north-central Wyoming (Figure 1). Due to their isolation, the Bighorn Mountains contain disjunct populations of several wildlife species having low dispersal capabilities, including the glacial relict populations of the Columbia Spotted Frog and the Wood Frog that were first discovered in 1974. Northern Leopard Frogs also occur in the Bighorn Mountains, and the Bighorn populations are some of the few high-elevation populations remaining for this species in Wyoming. Other amphibians occur in low densities along the periphery of the Bighorn Mountains (i.e., Boreal Chorus Frog, Tiger Salamander), but occurrences in the mountains themselves are either sparse or non-existent. Therefore, the rest of this report focuses on the three previously mentioned target species: Columbia Spotted Frog, Wood Frog and Northern Leopard Frog.

Despite the disjunct and restricted distribution of Bighorn Mountain amphibians, the three target species have received little attention until recently. Efforts to survey for and record observations in the region have increased in the past 20 years, but have not been synthesized since the first account of Bighorn amphibians in 1977. The following report summarizes data from numerous sources to 1) update our current understanding of the distribution of amphibians in the Bighorn Mountains, 2) identify key population centers for amphibian species in the area, 3) identify information gaps, 4) highlight areas for future survey efforts, and 5) provide recommendations to help land managers protect and maintaining healthy amphibian populations in the Bighorn Mountains.

Information on the distributions of the 3 target amphibian species in the Bighorn Mountains began increasing in the 1990s with survey and reporting efforts by the Bighorn National Forest, the Wyoming Natural Diversity Database, and others. Targeted amphibian surveys by the Wyoming Game and Fish Department began in 2009 and have further expanded the known distributions of Bighorn amphibians and documented new breeding sites.

The Columbia Spotted Frog has the northern-most distribution of the Bighorn amphibians, originally known from a single location at Sibley Lake. The species is now known to occur in the South Tongue River, Big Goose Creek, and Little Goose Creek drainages in the Bighorn National Forest. Bighorn populations of the Wood Frog were originally documented at 2 locations near Sawmill Lakes in the Big Goose Creek drainage. The species is now known from the upper portions of the South Tongue River, Big Goose Creek, and Little Goose Creek drainages on the east slope and from the upper Shell Creek drainage on the west slope of the Bighorn Mountains. Wood Frogs also have been documented in the southern tip of the Bighorn National Forest in the Middle Fork Crazy Woman Creek drainage. Northern Leopard Frogs were originally documented in the Bighorn Mountains by George Baxter in 1940. The Northern Leopard Frog is now known to occur in the Tensleep Creek, Rock Creek, Upper Clear Creek, and Big Goose Creek drainages in the Bighorn National Forest, though the species is known from only a few locations within each drainage.

Historically, populations of the 3 amphibian species were not thought to overlap in the Bighorn Mountains, however, recent surveys document distribution overlap of all 3 species (Figure 21). The Bighorn Mountains are the only location in Wyoming and one of only a few

sites in most of the western United States where the Columbia Spotted Frog, Wood Frog, and Northern Leopard Frog co-occur. All 3 species currently occur together at a few sites in the Big Goose Creek and Little Goose Creek drainages. In general, the Columbia Spotted Frog appears to be the most common amphibian in the north-central portion of the Bighorn Mountains, the Wood Frog the most common in the central portion, and the Northern Leopard Frog the most common species in the southern portion of the Bighorn Mountains.

## INTRODUCTION

The Bighorn Mountains in north-central Wyoming are a unique and isolated mountain range separated from the main Rocky Mountain range to the west by the Bighorn Basin. Because the Bighorn Mountains are isolated, populations of several montane vertebrate species with limited dispersal capabilities, such as the Bighorn Mountain Pika (*Ochotona princeps obscura*) and the Bighorn Mountain Snowshoe Hare (*Lepus americanus seclusus*), are considered distinct from populations in other parts of the species' ranges (Clark and Stromberg 1987). Included in this group of isolated or disjunct Bighorn populations are several amphibian species. Populations of both the Columbia Spotted Frog (*Rana luteiventris*) and the Wood Frog (*Lithobates sylvaticus*) in the Bighorn Mountains are entirely isolated from other populations of these species. The Northern Leopard Frog (*Lithobates pipiens*) also occurs in the Bighorn Mountains despite declines and local extinctions in high elevation populations in other parts of the western United States.

The disjunct nature of amphibian populations in the Bighorn Mountains was first recognized by Dunlap (1977), who suggested that populations of certain species in the Bighorn Mountains may represent glacial relicts. Dunlap also noted the limited distribution of both the Wood Frog and the Columbia Spotted Frog in the Bighorn Mountains. Both species were only documented at a few neighboring locales that did not appear to overlap. Despite Dunlap's (1977) recognition of the distinctness and highly restricted distribution of amphibian populations in the Bighorn Mountains, these species have received little attention until recently.

Amphibian surveys conducted in the Bighorn Mountains by the Wyoming Game and Fish Department (WGFD) and other entities, as well as reports of species occurrences from United State Forest Service (USFS) biologists, researchers at the Wyoming Natural Diversity Database (WYNDD), and others have expanded our knowledge of the distribution and status of Bighorn amphibian populations in the past 20 years. However, reports of amphibian occurrences in this region have not been synthesized since Dunlap's first account of Bighorn amphibians in 1977. Thus, the purpose of this paper is to 1) update our current understanding of the distribution of amphibians in the Bighorn Mountains, 2) identify key population centers for amphibian species in the area, 3) identify information gaps, 4) highlight areas for future survey efforts, and 5)

provide recommendations to help land managers protect and maintaining healthy amphibian populations in the Bighorn Mountains.

## THE BIGHORN MOUNTAINS OF WYOMING

The Bighorn Mountains are located in north-central Wyoming, with the northern tip of the range extending into south-central Montana. Much of the area is managed by the Bighorn National Forest (Figure 1). The Bighorn National Forest is approximately 1,115,000 acres in size and ranges from 1700m to 4000m in elevation (USDA Forest Service 2005a). Dominant forest vegetation consists of lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), and subalpine fir (*Abies lasiocarpa*). Lower elevation species include Ponderosa pine (*Pinus ponderosa*), limber pine (*Pinus flexilis*), and Douglas-fir (*Pseudotsuga menziesii*). Non-forested lands are dominated by grassy meadows, shrub lands, and alpine tundra. Riparian corridors are primarily dominated by willow (*Salix spp.*).

Amphibian habitat within the Bighorn Mountains includes moist areas along riparian zones, wet meadows, lake margins, fens, and kettle ponds. Kettle ponds, or potholes, formed when huge blocks of ice broke off from retreating glaciers and were buried in moraines. As the blocks melted, depressions were created (Knight 1994), some of which fill with water from surface runoff, precipitation, or groundwater. Fens are peatlands that are maintained by groundwater, tend to be nutrient rich, and usually have a high pH (Heidel 2011). Fens can provide habitat for amphibians but are relatively uncommon throughout the Bighorn National Forest (Heidel 2011).

Despite the presence of amphibian habitat in the Bighorn Mountains, several montane amphibians common in other parts of the Rocky Mountains are noticeably missing from the Bighorn National Forest. These include the Boreal Toad (*Anaxyrus boreas boreas*), the Tiger Salamander (*Ambystoma mavortium*), and the Boreal Chorus Frog (*Pseudacris maculata*). Both the Tiger Salamander and the Boreal Chorus Frog occur in the foothills of the Bighorn Mountains, but are not known to inhabit the Bighorn National Forest. Currently, the only record of the Boreal Chorus Frog in the Bighorn National Forest is of a single individual seen in the southern tip of the Bighorn National Forest. Toads (*Anaxyrus spp.*) have occasionally been reported from the forest, but observations have not been verified (Golden 2009, personal communication).

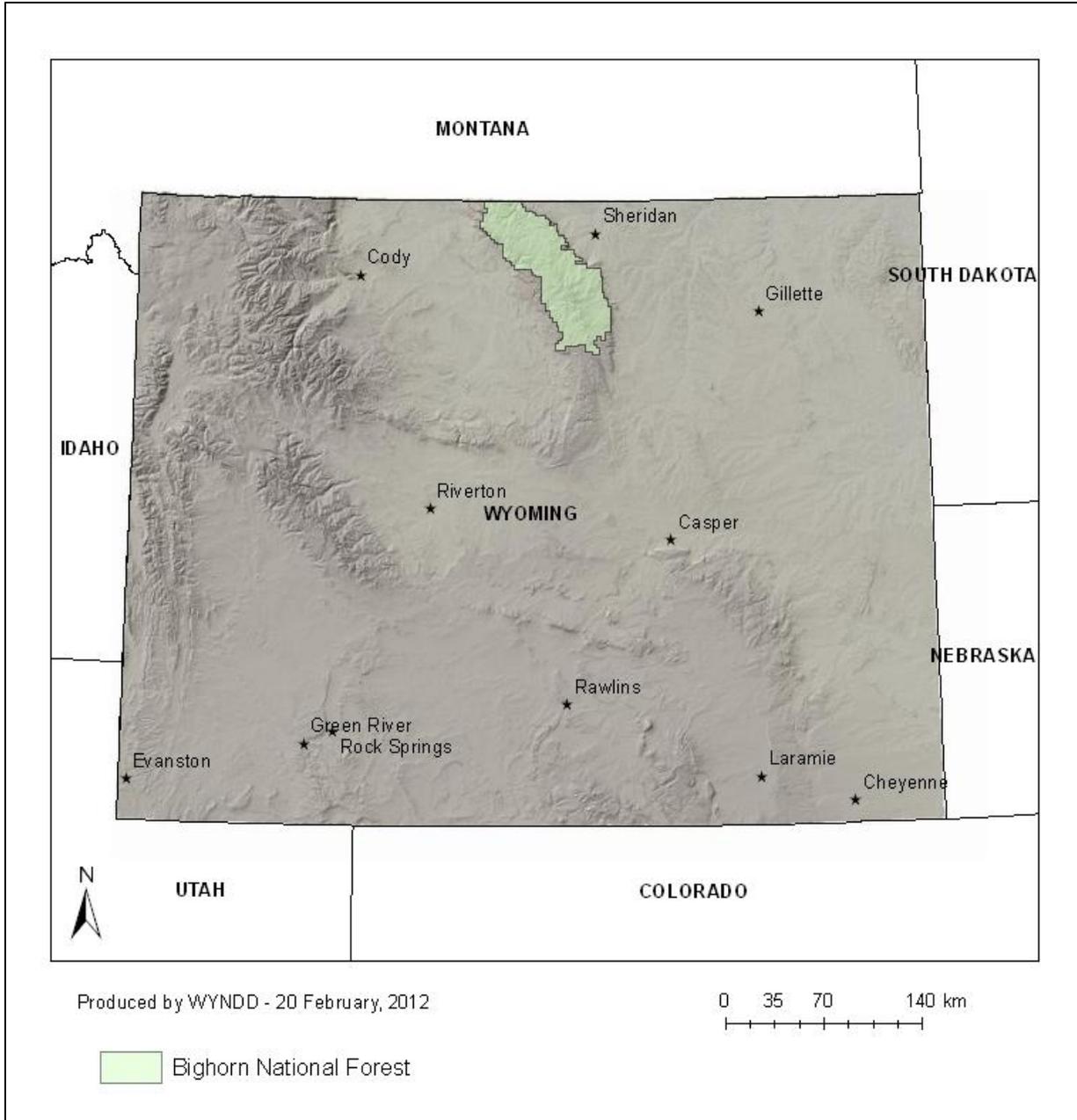


Figure 1. Map showing the location of the Bighorn National Forest in Wyoming.

# BIGHORN AMPHIBIAN MANAGEMENT STATUS, NATURAL HISTORY, AND DISTRIBUTION

## **Columbia Spotted Frog**

### *Taxonomy and Management Status*

Although the Bighorn population of the Columbia Spotted Frog is disjunct from the rest of the species' range, no subspecies or distinct population segment has yet been designated. The genus *Rana* underwent a major revision in 2006, with many species being reassigned to the genus *Lithobates*. However, the Columbia Spotted Frog was retained in the genus *Rana* (Frost et al. 2006).

The Bighorn population of the Columbia Spotted Frog primarily occurs on lands administered by the Bighorn National Forest and is considered a sensitive species by the USFS (USDA Forest Service 2005a). Throughout its distribution in Wyoming, the species is ranked as NSS3 (Native Species Status 3) by the WGFD, indicating that populations of the spotted frog are considered vulnerable due to restricted or declining population size or distribution, and that limiting factors are severe (WGFD 2010). The species also is a Species of Greatest Conservation Need (SGCN) in Wyoming (WGFD 2010). The Columbia Spotted Frog is given a global heritage rank of G4 (apparently secure) and a Wyoming state heritage rank of S3 (vulnerable) by the Wyoming Natural Diversity Database (NatureServe Explorer 2011, Keinath et al. 2003). A global rank of G4 means that species is uncommon across its range with some cause for long-term concern. A state rank of S3 means that the species is considered vulnerable, with a moderate risk of extinction in Wyoming due to a restricted range and relatively few populations.

### *Description*

The Columbia Spotted Frog is a medium-sized frog that reaches a snout-to-vent length of approximately 6.6 cm (Baxter and Stone 1980). The dorsum is typically light to dark brown or olive green in color, with irregular black spots of varying size (Figure 2). The back and sides are often covered with small bumps. Dorsolateral folds are present along the sides of the back but may be indistinct in adults. A white or cream lip line extends from the snout, under the eye, to the front legs (Patla and Keinath 2005). The ventral throat and upper abdominal coloration varies from white to cream. The lower abdomen and ventral leg coloration ranges from red to orange (Figure 2). This reddish coloration distinguishes the species from other native frogs. For a detailed description of the different life-stages, natural history, and ecology of the Columbia Spotted Frog, see Patla and Keinath (2005).



Figure 2: Dorsal (left) and ventral (right) coloration of Columbia Spotted Frog

### *Habitat*

The Columbia Spotted Frog can be found in a variety of vegetation types, but is restricted to mountainous areas or moist riparian zones in arid western landscapes (Patla and Keinath 2005). Columbia Spotted Frogs have been reported up to elevations of 2,947m in Montana (Maxell et al. 2003). In Yellowstone National Park, the species was mostly commonly found in seasonally flooded palustrine wetlands though semi-permanent and saturated areas were also used (Patla and Keinath 2005). The Columbia Spotted Frog is typically associated with willows or aquatic vegetation, which provide thermal cover and protection from predators (Patla and Keinath 2005). In the Bighorn Mountains, the Columbia Spotted Frog has been found along lake margins, in kettle ponds, and in willow-dominated riparian corridors.

### *Distribution*

The bulk of the Columbia Spotted Frog's range occurs to the west of Wyoming (Figure 3a), from southeast Alaska south through British Columbia and Alberta, western Montana and Wyoming, northern and central Idaho, northeastern Oregon, and eastern Washington (Reaser and Pilliod 2005). Within Wyoming, the species can be observed from the northwest corner of the state east to the Bighorn Mountains, and south into Star Valley (Baxter and Stone 1985; Figure 3b).

The Bighorn Mountains of Wyoming support a glacial relict Columbia Spotted Frog population that is geographically isolated from other core populations by the arid Bighorn Basin (Dunlap 1977). The Bighorn population is of particular interest because it is genetically distinct from other Columbia Spotted Frog populations within the continuous core range (Bos and Sites 2001). Within the Bighorn Mountains, the Columbia Spotted Frog has been documented only within the Bighorn National Forest. Knowledge of the distribution of the Columbia Spotted Frog

in the Bighorn Mountains has continued to increase with survey efforts since the species was first reported in the 1970's.

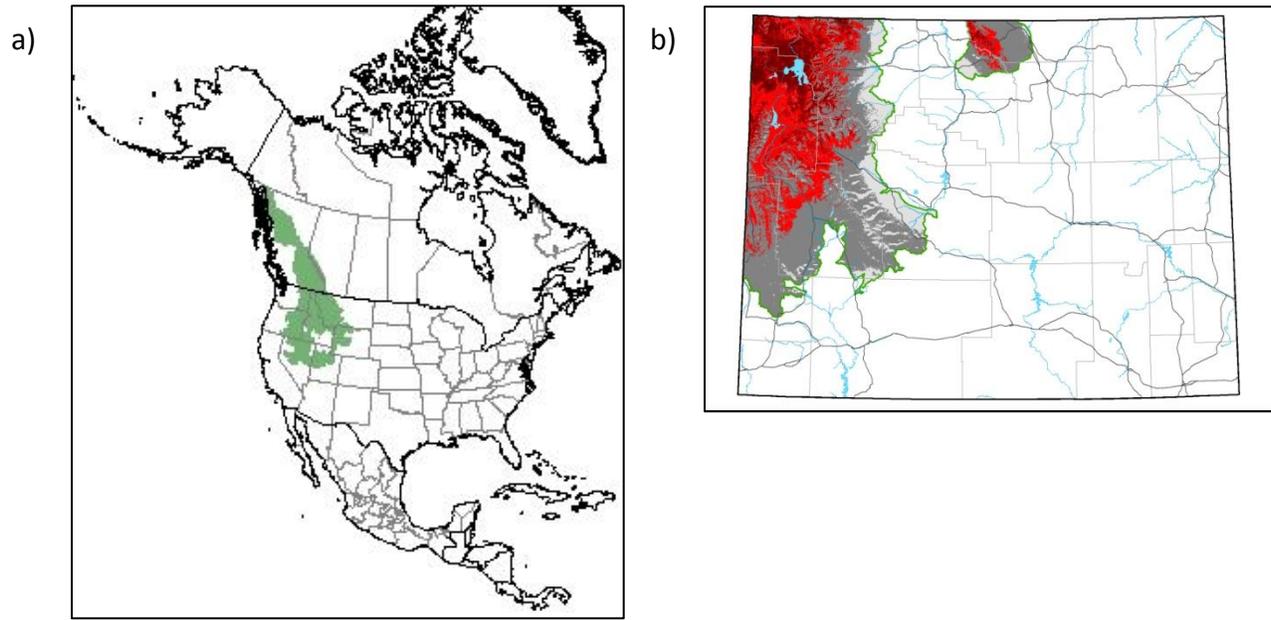


Figure 3. Map of a) the rangewide distribution of the Columbia Spotted Frog in North America (IUCN 2010), and b) predicted distribution map of Columbia Spotted Frogs in Wyoming (Keinath et al. 2010).

#### Pre-1990

Dunlap (1977) first described the Bighorn population of the Columbia Spotted Frog from Sibley Lake, east of Burgess Junction, in Sheridan County (Figure 4) Dunlap (1977) reported an abundant breeding population at Sibley Lake, however, surveys in adjacent habitat failed to detect additional populations.

#### 1990-2005

The USFS began recording sightings of sensitive amphibian species in 1992, largely due to efforts by Bighorn National Forest biologist Harold Golden. From 1992-2004, the USFS identified multiple sites containing Columbia Spotted Frogs (Figure 5), many of which were confirmed or suspected breeding sites (Craig 2004, WYNDD 2012). Surveys extended the distribution over 7km south along the South Tongue River and several of its tributaries. Golden

also extended the distribution over 8km west along both Big and Little Willow Creeks west of Burgess Junction, and approximately 2km northwest to the headwaters of Johnson Creek.

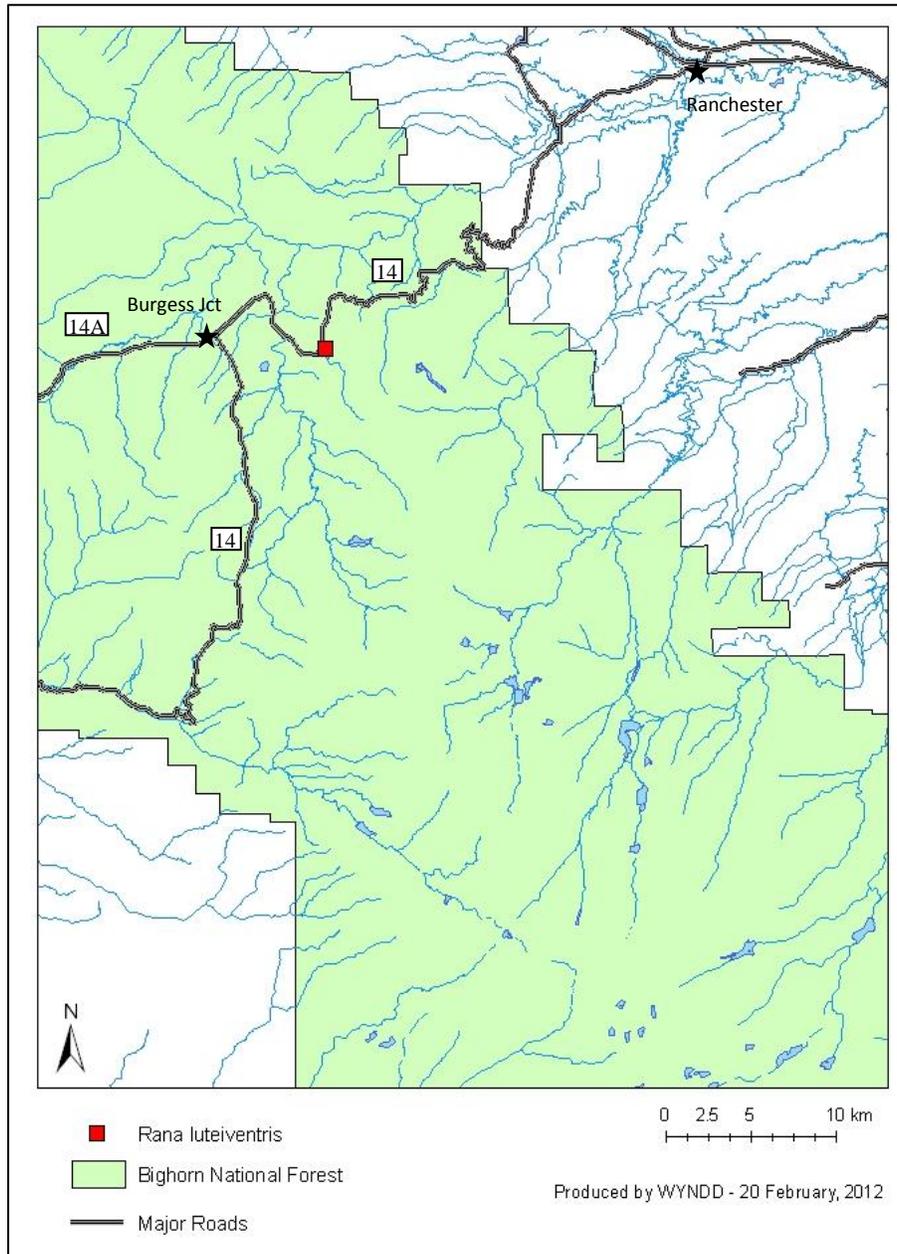


Figure 4. Known distribution of the Columbia Spotted Frog in the Bighorn Mountains prior to 1990.

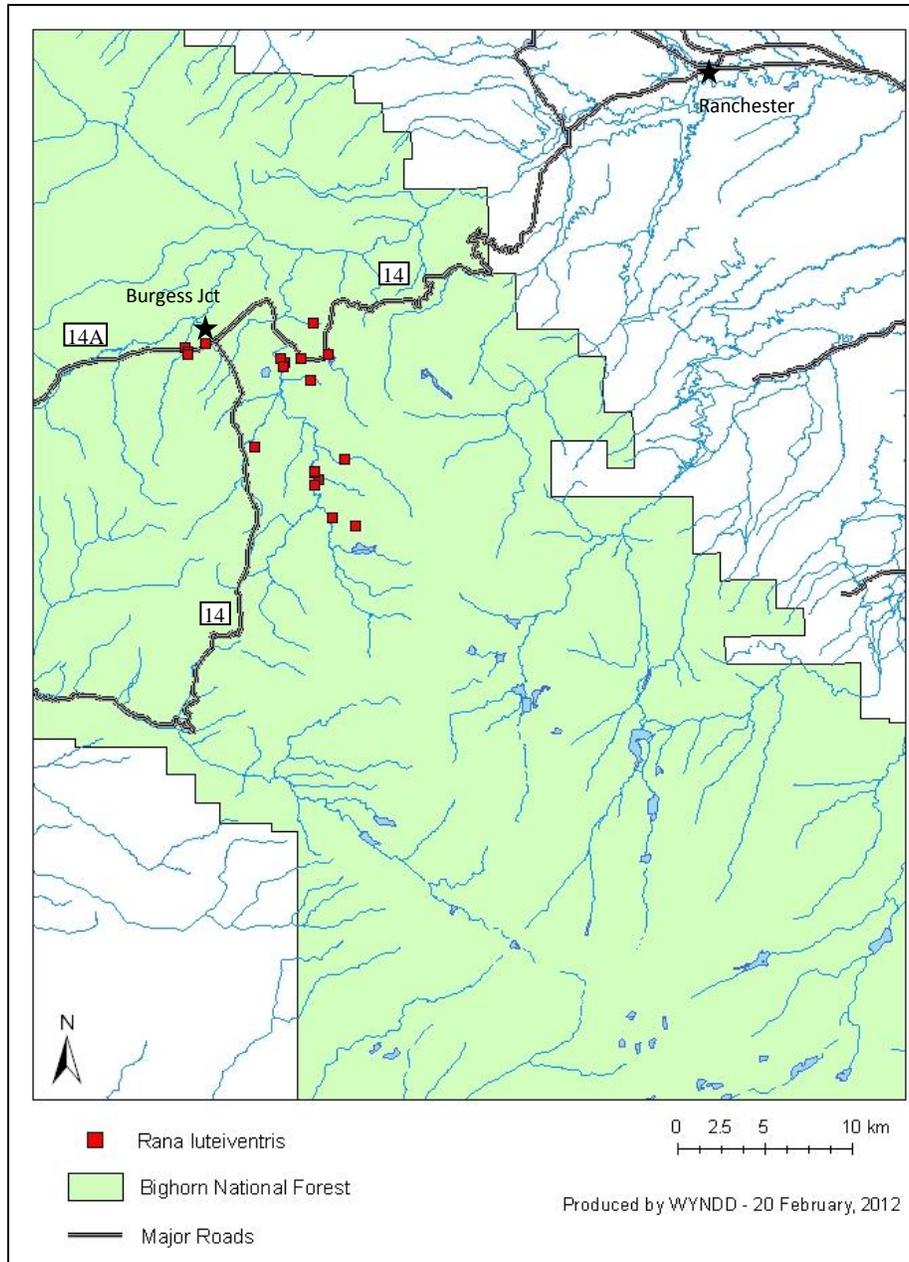


Figure 5. Distribution of the Columbia Spotted Frog in the Bighorn Mountains in 2005 following increased survey and reporting efforts in the 1990's and early 2000's.

### 2006-2011

Surveys conducted by WGFD herpetologists in 2009-2011 further extended the distribution of the Columbia Spotted Frog in the Bighorn Mountains. The species was documented over 30km southeast of Sibley Lake just south of Park Reservoir in the Little Goose Creek drainage in

2009, and 19km southeast of Sibley Lake at Sawmill Lakes in the Big Goose Creek drainage in 2010. WGFD crews also extended the western extent of the distribution by approximately 1km, documenting Columbia Spotted Frogs further up Big Willow Creek than previous observations by the USFS. Surveys of sensitive fen plants conducted by WYNDD botanist Bonnie Heidel and contract biologist/botanist Jim Zier corroborated the southern extension by also recording Columbia Spotted Frogs in the Big Goose Creek drainage at Sawmill Lakes in 2009 and in a pothole east of Dome Lake Reservoir in 2010 (Heidel and Zier 2010, personal communication). The Columbia Spotted Frog is now known to occur in the South Tongue River, Big Goose Creek, and Little Goose Creek drainages in the Bighorn National Forest (Figure 6).

### *Population Trend*

The Columbia Spotted Frog has experienced population declines throughout its range (Reaser and Pilliod 2005). The species is currently considered a USFWS Species of Concern, and was petitioned for federal listing in 1989 (54 FR 42529). Federal listing of Columbia Spotted Frogs was found to be warranted for some populations, but precluded (58 FR 27260-27263), and a distinct population segment in the Great Basin is designated as a candidate for future federal listing (74 FR 57804-57878). It is not known if Columbia Spotted Frog populations are in decline in Wyoming. Populations within the Greater Yellowstone Ecosystem appear robust and the species is commonly observed. However, one monitored population of spotted frog in Yellowstone National Park declined 85% in recent years (Koch and Peterson 1995). This decline was attributed to habitat fragmentation resulting from increased road infrastructure.

Population trends for the Columbia Spotted Frog in the Bighorn National Forest are currently unknown. The Columbia Spotted Frog within the Bighorn National Forest has been described by the Forest Service as “stable (at a minimally viable level)” (Patla and Keinath 2005). Targeted amphibian surveys conducted in 2009-2011 by WGFD revealed more breeding sites and a greater abundance of spotted frogs in the Bighorn Mountains than previously documented. WGFD crews documented at least 9 breeding locations for this species, with dozens of adults, juveniles, and egg masses detected at Sibley Lake. This represents a marked increase in observations from previous reports. The reason for this increase is unknown. One possible explanation might be survey timing. Surveys were conducted by WGFD immediately following ice-off of Sibley Lake, when breeding first occurred. If historic surveys were conducted later in the year, adults may have migrated away from breeding habitat. As the season progresses, egg masses may also be harder to observe due to natural degradation of the mass.

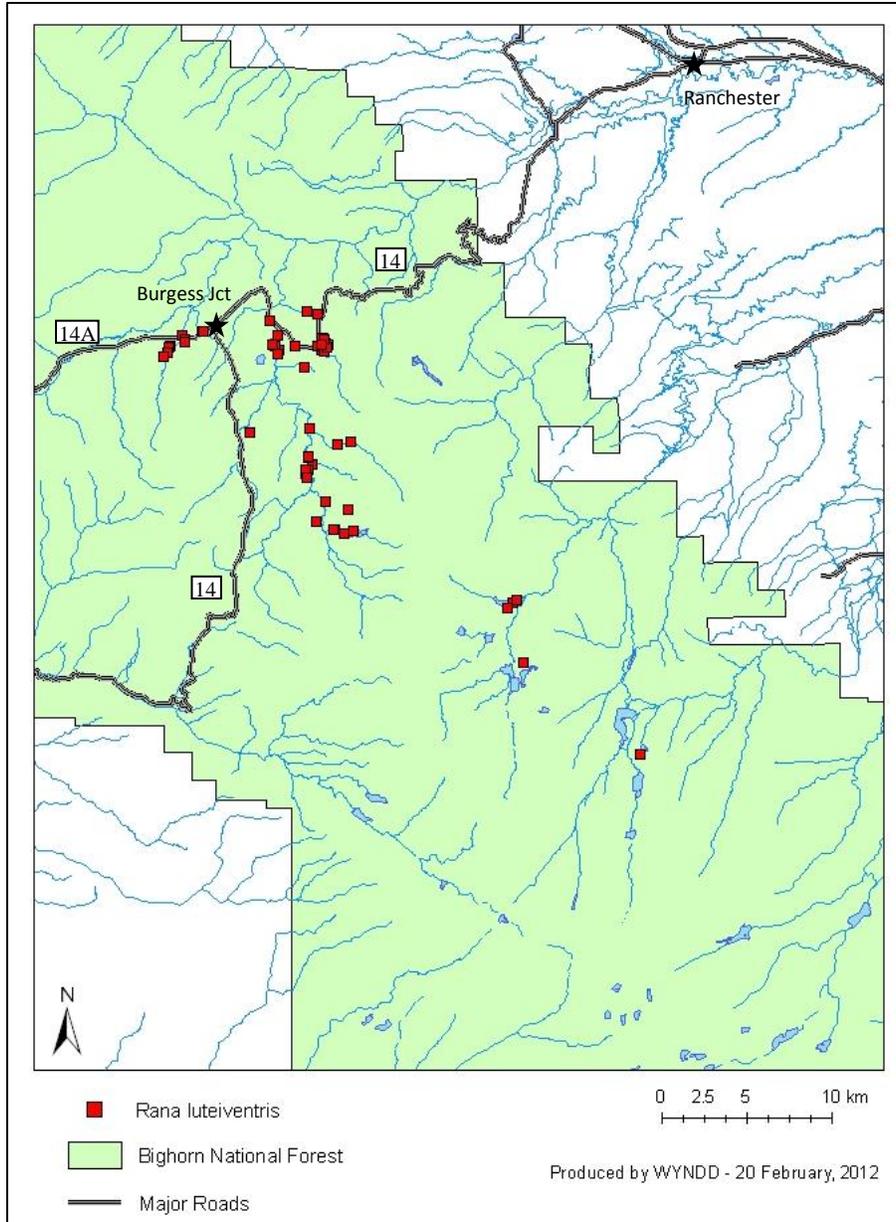


Figure 6. Distribution of the Columbia Spotted Frog in the Bighorn Mountains as of 2011 resulting from targeted amphibian surveys by WGFD and increased reporting efforts by others from 2006-2011.

*Breeding Sites and Important Population Centers*

Sibley Lake, where the Columbia Spotted Frog was first documented by Dunlap (1977), remains the most important known breeding site for the species. A large number of egg masses have been found in recent years by WGFD along several sections of the shoreline. Over 52 egg masses were found by WGFD in the northern bay and 25 egg masses were documented

in the easternmost bay since 2009. Several egg masses also have been detected on the south end of Sibley Lake where Prune Creek enters the lake (Figure 7).

Several locations on the South Tongue River and its tributaries also are important breeding sites. Golden found 23 egg masses in 2002 on Prune Creek half way between Sibley Lake and the South Tongue River. He also documented 17 egg masses on Schutts Flat along the South Tongue River in 2001. Records of eggs and/or tadpoles on Schutts Flat date back to the early 1990's, and indicate that this location has been an active breeding site for well over a decade (WYNDD 2012). Breeding sites also have recently been identified farther up the South Tongue River in willow-dominated riparian areas, especially above Bonanza Creek.

Additional breeding sites have been documented in beaver ponds along Big Willow Creek and Little Willow Creek, west of Burgess Junction. WGFD crews also documented a juvenile Columbia Spotted Frog at Sawmill Lakes in the Big Goose Creek drainage in 2011, suggesting that breeding occurred at that site or in the immediate vicinity (Figure 7). This is the first record of breeding outside of the South Tongue River drainage for this species.

### *Potential Threats*

There are many factors that have been attributed to Columbia Spotted Frog decline throughout their continental range. These include habitat alteration and fragmentation, human recreation, chemical pollutants, invasive exotics, predation by introduced species, disease, and increased UV-B radiation (Reaser and Pilliod 2005; Pilliod and Peterson 2001; Lefcort et al. 1998; Patla and Keinath 2005). Disease is of particular concern. Ranavirus and amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) have been documented in Columbia Spotted Frogs in western Wyoming (Patla and Keinath 2005). As of yet, these diseases have not been documented in the Bighorns. Chytrid testing of epidermal swabs from 26 Columbia Spotted Frogs sampled in the Bighorn Mountains from 2009 to 2010 found no evidence of the fungus. Both chytrid fungus and ranavirus are potentially lethal diseases that can result in large-scale die-offs. If mass mortality should occur in the Bighorn Mountains, populations may not be able to recover. In a similar situation, chytrid fungus attributed declines have occurred in the Boreal Toad in the Southern Rocky Mountains (Carey et al. 2006; Muths et al. 2003). Only three known breeding population of Boreal Toad remain within Wyoming's Medicine Bow National Forest (Estes-Zumpf, unpublished data).

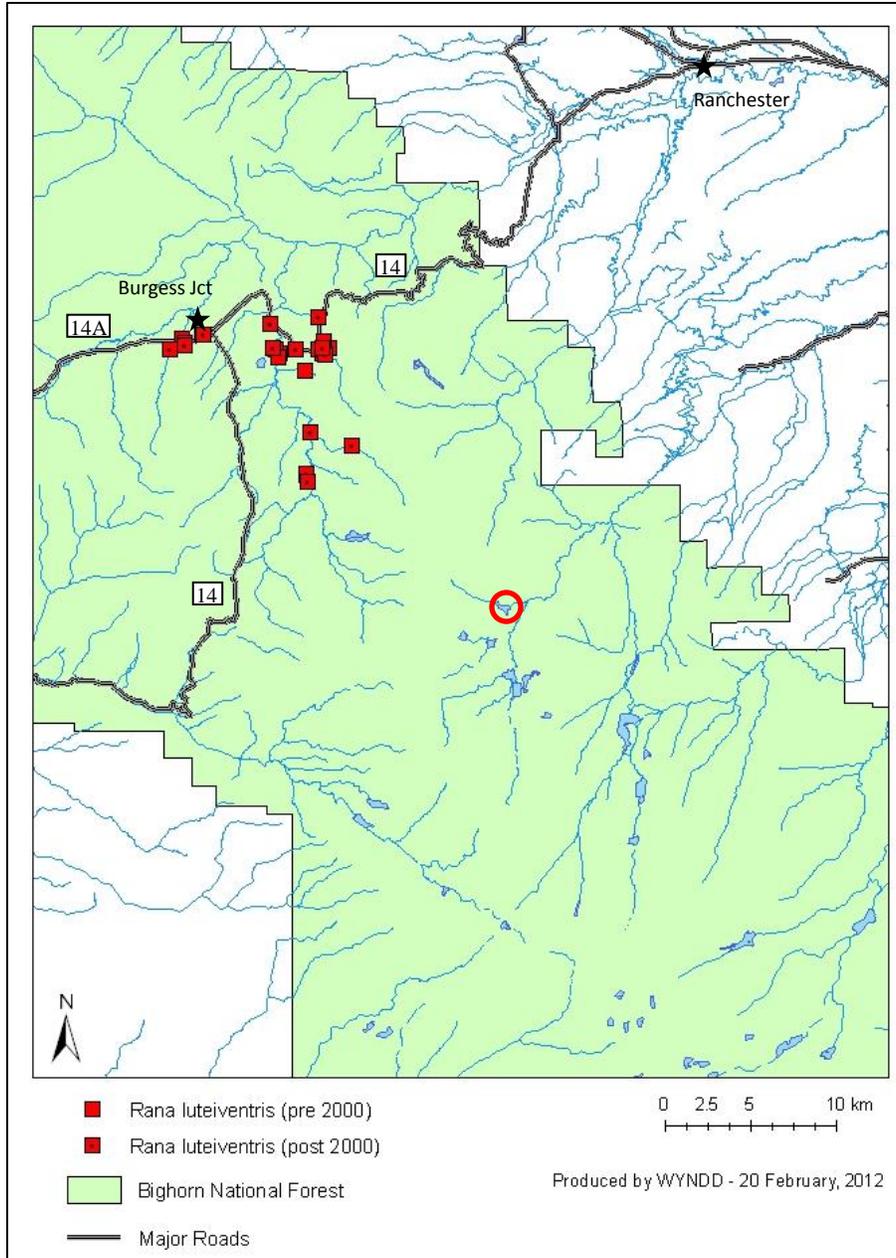


Figure 7. Documented breeding locations for the Columbia Spotted Frog in the Bighorn Mountains. Areas were considered breeding sites if egg masses, tadpoles, or metamorphs were observed. A juvenile Columbia Spotted Frog was also detected at Sawmill Lakes in 2011 (red circle), suggesting that breeding occurred somewhere in the immediate vicinity.

## **Wood Frog**

### *Taxonomy and Management Status*

Although the isolated populations of the Wood Frog in the Rocky Mountains were once thought to be a separate species (*Rana maslini*) from Wood Frogs in the rest of North America (*Rana sylvaticus*), the species designation was found to not be warranted in 1976 (Redmer and Trauth 2005). The Wood Frog's genus was changed from *Rana* to *Lithobates* in 2006 (Frost et al. 2006).

The Bighorn population of the Wood Frog primarily occurs on lands administered by the Bighorn National Forest and is considered a sensitive species by the USFS (USDA Forest Service 2005a). The species is ranked as NSS2 by WGFD, indicating that Wood Frogs are considered vulnerable due to restricted or declining population size or distribution, and that limiting factors are severe and continue to increase in severity (WGFD 2010). The species also is a Species of Greatest Conservation Need (SGCN) in Wyoming (WGFD 2010). The Wood Frog is given a Natural Heritage Program global heritage rank of G5 (secure) due to its widespread distribution in North America (NatureServe Explorer 2011). Because populations in Wyoming are small and disjunct from the rest of the species' range, the Wood Frog has an S1 (critically imperiled) state heritage rank in Wyoming because its rarity or other factors make it especially vulnerable to extirpation from the state (Keinath et al. 2003).

### *Description*

The Wood Frog is a medium-sized frog that reaches an average adult size of 5 cm snout-vent length (Baxter and Stone 1985). The coloration of this species in the Bighorn Mountains varies slightly from the Medicine Bow population in south-central Wyoming. The dorsum is tan to brown in color and lacks the mid-dorsal white stripe typically found in populations in the Medicine Bow Mountains. A few irregular dark spots or lines may occur on the dorsum. A dark "mask" and white line along the upper lip is always present (Figure 8). The ventral coloration is typically cream to white. For a detailed description of the different life-stages, natural history, and ecology of the Wood Frog, see Muths et al. (2005).



Figure 8: Bighorn Wood Frog Coloration

### *Habitat*

The Wood Frog uses a variety of habitats, including tundra, wet meadows, bogs, and coniferous and deciduous forests (Redmer and Trauth 2005). In Wyoming, sites occupied by the Wood Frog include sedge wetlands, grassy wet meadows, willow bogs, and forest ponds, especially those with partial to open canopy cover (Muths et al. 2005). Similar to Columbia Spotted Frogs, the moisture content of the air and substrate influence Wood Frog distribution more than habitat type (Bellis 1962, Roberts and Lewin 1979, Muths et al. 2005). In the Bighorn Mountains, Wood Frogs often also occur in small kettle ponds and fens. Although all three amphibian species will use fens, the Wood Frog may use fen habitat more often than either the Columbia Spotted Frog or the Northern Leopard Frog. Wood Frogs breed in small permanent, semi-permanent, or ephemeral ponds with sunny shores and emergent vegetation. After breeding, frogs move into sedge-meadows, bogs, and interior forests (Muths et al. 2005). During winter, the Wood Frog hibernates near breeding sites remaining close to the surface under vegetation, rocks, or logs (Muths et al. 2005).

### *Distribution*

The bulk of the Wood Frog's range occurs to the north and east of Wyoming (Figure 9a). This species can be found from Alaska to Labrador and south to the Appalachian Mountains (Stebbins 2003). Isolated populations occur in Colorado and Wyoming. Within Wyoming, the Wood Frog occurs in two disjunct populations. One population is located primarily in the Medicine Bow National Forest, while the other occurs in the Bighorn National Forest (Figure 9b). Both populations are thought to result from rapid post glacial dispersal (Muths et al. 2005).

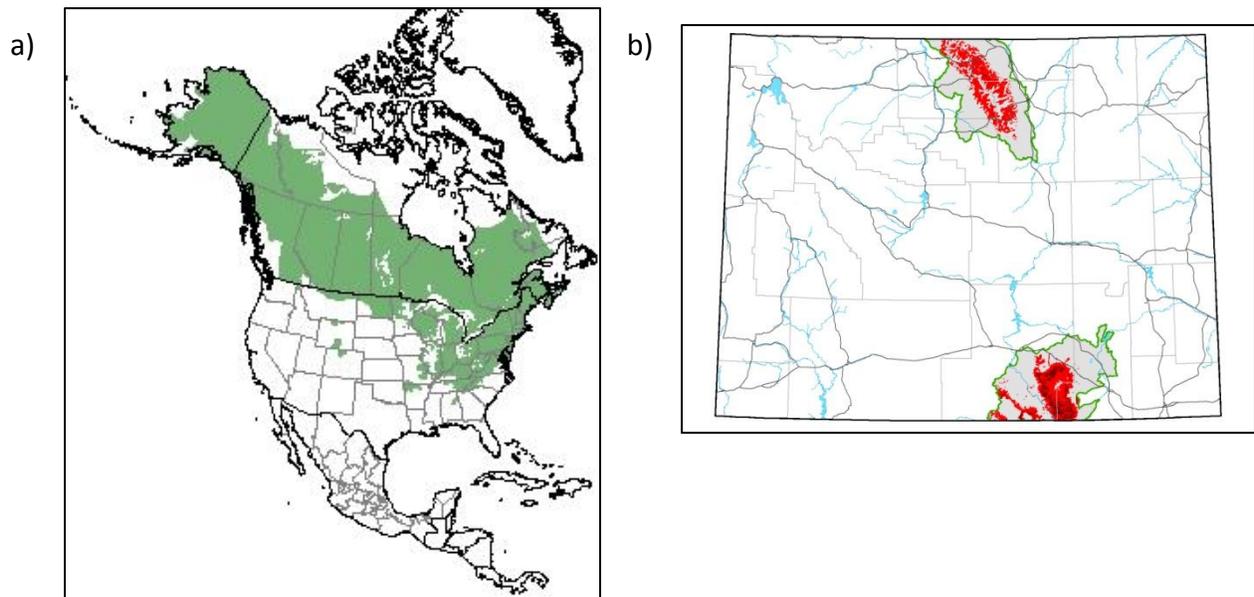


Figure 9. Map of a) the range-wide distribution of the Wood Frog in North America (IUCN 2010), and b) predicted distribution map of Wood Frogs in Wyoming (Keinath et al. 2010).

Pre-1990

Dunlap (1977) first documented Wood Frogs within the Bighorn Mountains in 1974 in the Big Goose Creek drainage from an unnamed lake along Red Grade Road and from a small pond just southwest of the southernmost of the Sawmill Lakes (Figure 10). The two initial localities were roughly 1.6km apart and the Sawmill Lake site contained Wood Frog tadpoles. In the late 1970's, Rocket Mueller contributed Wood Frog specimens from the Dome Lakes area approximately 2.5km from the original locality on Red Grade Road (WYNDD 2012).

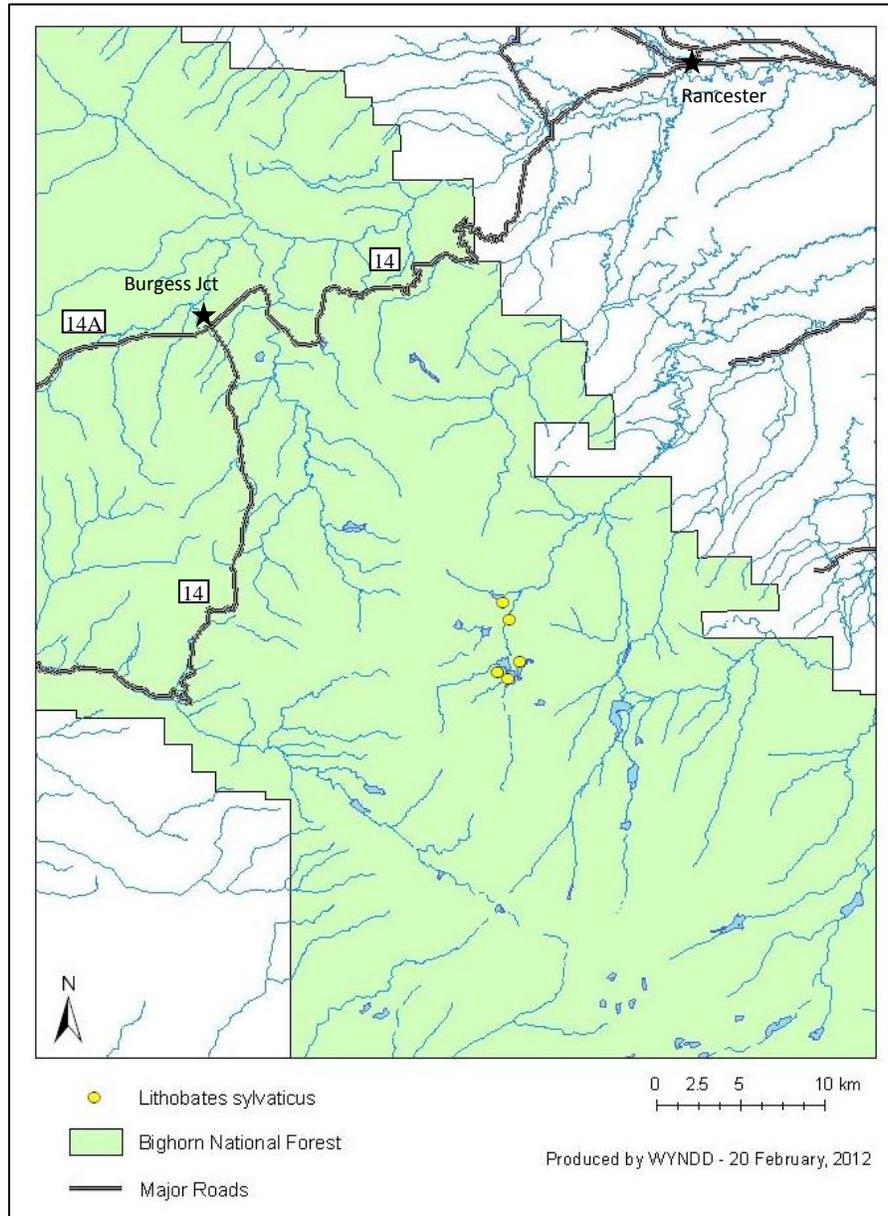


Figure 10. Known distribution of the Wood Frog in the Bighorn Mountains prior to 1990.

## 1990-2005

Few records of Wood Frogs exist until the 1990's. In 1991, unconfirmed observations of Wood Frogs were reported over 7km southeast of the Red Grade Road site along the East Fork of Big Goose Creek near the Big Goose Campground, and approximately 3.5km south-southeast along Antler Creek just west of Park Reservoir. Surveys by Golden (USFS) and other experts later confirmed Wood Frogs near both locations and extended the distribution southeast to Heidley Park and Last Chance Reservoir, over 10km from the Red Grade Road site (Figure 11). Surveys by Garber (1994) and Golden extended the distribution over 15km northwest into the South Tongue River drainage. Golden and others documented additional Wood Frog sites in wet meadows, potholes, and other wetlands in the East Fork South Tongue River drainage. Garber (1994) also documented Wood Frogs on the west slope of the Bighorn Mountains over 15km west in the Shell Creek Drainage near Moraine Creek (Figure 11).

## 2006-2011

Recent surveys by WGFDD and others have increased the number of known Wood Frog sites and breeding sites within the distribution. Furthermore, surveys by Truman State University professor, Chad Montgomery, extended the distribution up the East Fork Big Goose Creek drainage as far south as Duncan Lake (Figure 12), approximately 13km south-southeast from the Red Grade Road site. Montgomery also found Wood Frogs in a series of potholes above Cross Creek between Bighorn and Cross Creek Reservoirs (WYNDD 2012). Wyoming Department of Environmental Quality employee, Jason Martineau, documented a Wood Frog above Adelaide Lake on the west slope of the Bighorns at an elevation of about 2800m in the Shell Creek drainage (Figure 12).

In 2007, Golden documented 6 juvenile Wood Frogs in a kettle pond in the Middle Fork Crazy Woman Creek drainage just south of Highway 16 in the southern half of the Bighorn National Forest (WYNDD 2012; Figure 12). Golden's observation is the first reported Wood Frog population in the southern half of the Bighorn National Forest, and constitutes a 60km extension of the distribution from the original site along Red Grade Road. This southern site should be further investigated, and the surrounding habitats be surveyed for Wood Frog presence. If Wood Frogs are present, this area should also be monitored to determine status of the population. Southern Bighorn Wood Frog populations currently should be considered isolated from known northern Bighorn populations by an elevation boundary (Garber 1994).

Bighorn populations of the Wood Frog are now known from the upper portions (>2200m) of the South Tongue River, Big Goose Creek, Little Goose Creek drainages on the east slope and from the upper Shell Creek drainage on the west slope of the Bighorn Mountains. Golden's recent observation of Wood Frogs in the southern Bighorn National Forest also places the species in the Middle Fork Crazy Woman Creek drainage.

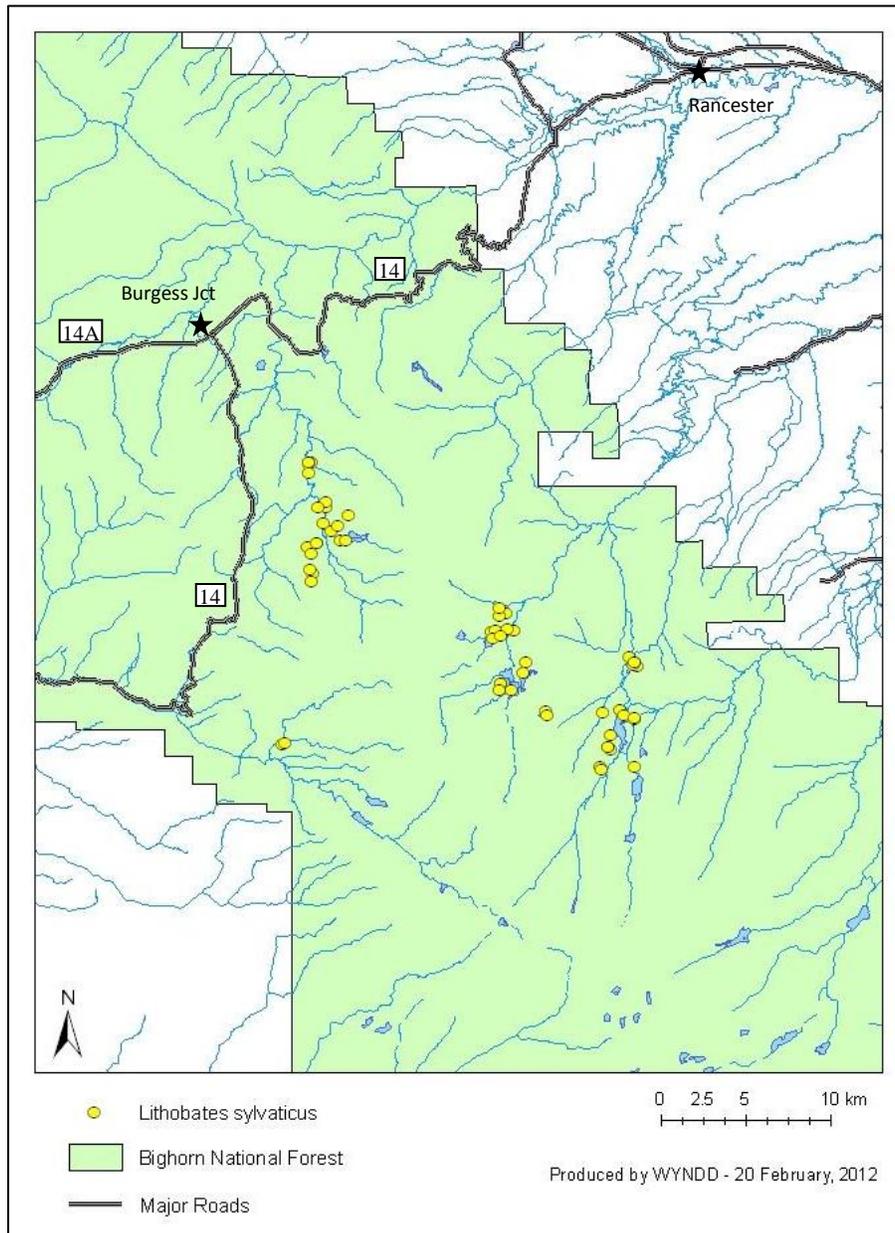


Figure 11. Distribution of the Wood Frog in the Bighorn Mountains in 2005 following increased survey and reporting efforts in the 1990's and early 2000's.

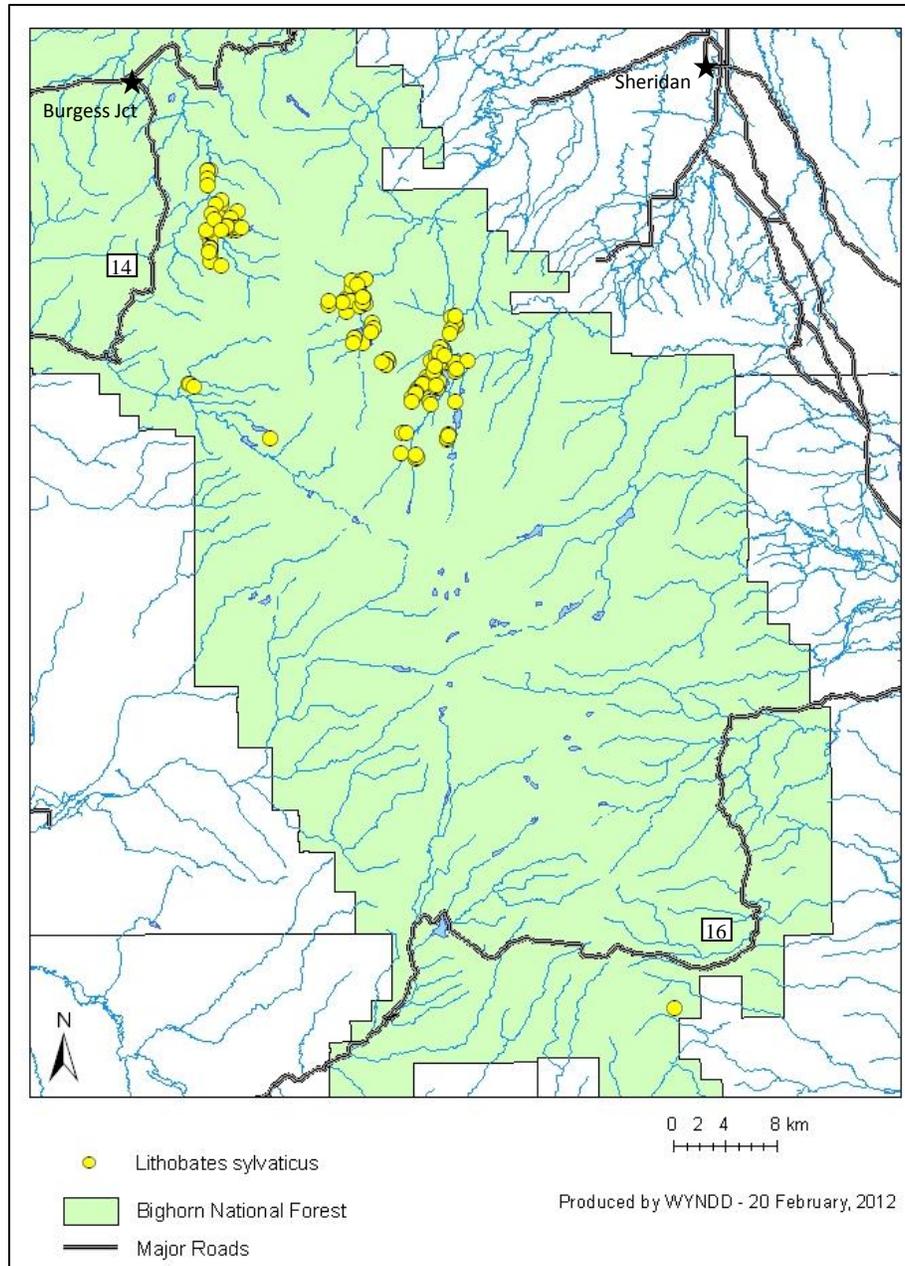


Figure 12. Distribution of the Wood Frog in the Bighorn Mountains as of 2011 resulting from targeted amphibian surveys by WGFD and increased reporting efforts by others from 2006-2011.

### *Population Trend*

Throughout their range, Wood Frogs are thought to be fairly abundant with stable populations (Redmer and Trauth 2005). However, systematic monitoring of this species

throughout much of its range generally is lacking, preventing rigorous assessment of population trends. Monitoring of Wood Frogs and other montane amphibians recently began in the Medicine Bow and Routt National Forests in southern Wyoming and northern Colorado, however, sufficient data do not yet exist to assess trends in this region (Estes-Zumpf, unpublished data).

Wood Frogs are thought to be locally abundant surrounding breeding habitat in the Bighorn National Forest (Garber 1994), and Wood Frogs were the most commonly encountered amphibian (836 observations) during WGFD amphibian surveys in the Bighorn Mountains from 2009-2011. Surveys in the past 6 years indicate that Wood Frogs still occur at most sites where they were documented in the past.

### *Breeding Sites and Important Population Centers*

The most important breeding site located thus far for the Wood Frog in the Bighorn Mountains is in the vicinity of Park Reservoir in the Little Goose Creek drainage (Figure 13). Zier considered the kettle ponds and wet meadows on the northeast shore of Park Reservoir “an important amphibian site” with “countless tadpoles of both wood and leopard frogs” (Zier 2006, personal communication). Zier also documented large numbers (>150) of adult, juvenile, and tadpole Wood Frogs in the string of kettle ponds running southwest along the western shore of Park Reservoir (Figure 13). Thus, the Park Reservoir area constitutes the largest known breeding population of Wood Frogs in the Bighorn National Forest to date.

Dunlap first documented Wood Frog tadpoles just south of the southernmost Sawmill Lake. The WGFD and others have documented likely evidence of breeding in the Sawmill Lakes and Twin Lakes more recently, indicating that this site continues to function as a breeding site for Wood Frogs in the Bighorn Mountains (Figure 14). Previously, only Wood Frogs were known to occupy this site, so identification was assumed. However, Northern Leopard Frogs and Columbia Spotted Frogs have now been observed in the same drainage, making identification of egg masses and tadpoles suspect unless identified by knowledgeable observers. In general, however, abundance of adults, juveniles, and tadpoles in the Sawmill/Twin Lakes area appears low relative to the Park Reservoir area. Records from the 1990’s and from more recent WGFD surveys consistently report only a small number of tadpoles, egg masses, and metamorphs at these sites. Kettle ponds along the northwest shore of Twin Lakes tend to have slightly higher numbers of tadpoles and metamorphs.

Additional documented breeding sites for the Wood Frog in the Bighorn Mountains include the southern end of Duncan Lake and nearby kettle ponds in the Big Goose Creek drainage. In the South Tongue River drainage, records of breeding exist from the 1990’s and 2000’s for the southwest end of Graves Creek and at several sites along the East Fork of the South Tongue River. Because Golden recorded adult and juvenile Wood Frogs, not metamorphs, at the southern Bighorn National Forest site we can only conclude that breeding occurred in the vicinity of the southern site. The exact breeding site for the southern population is currently unknown, though Golden commented that “enough juveniles were found to convince me that eggs had been deposited in this pond” (Golden 2007, personal communication).

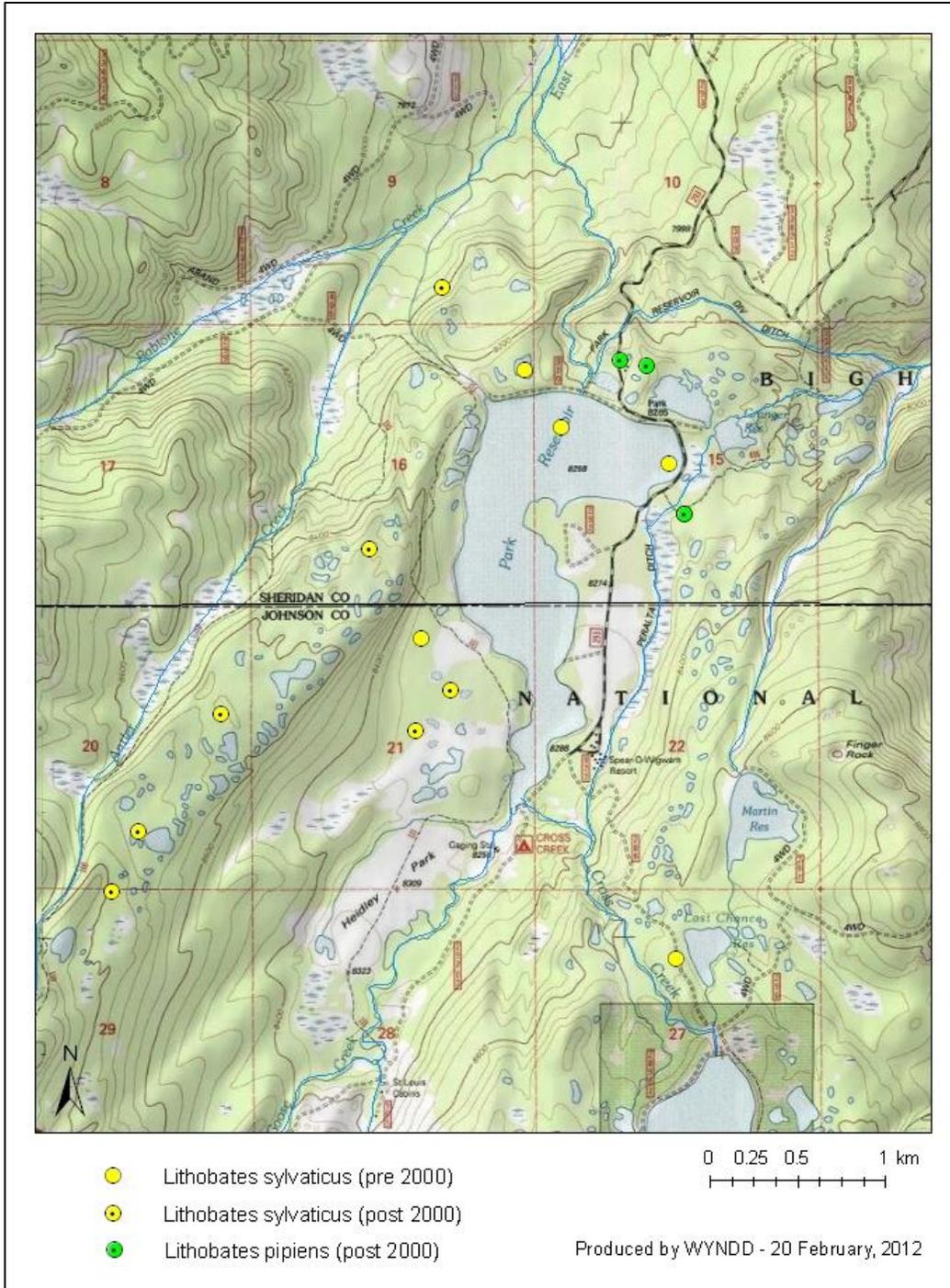


Figure 13: Map of important Wood Frog and Northern Leopard Frog breeding areas around Park Reservoir in the Little Goose Creek Drainage.

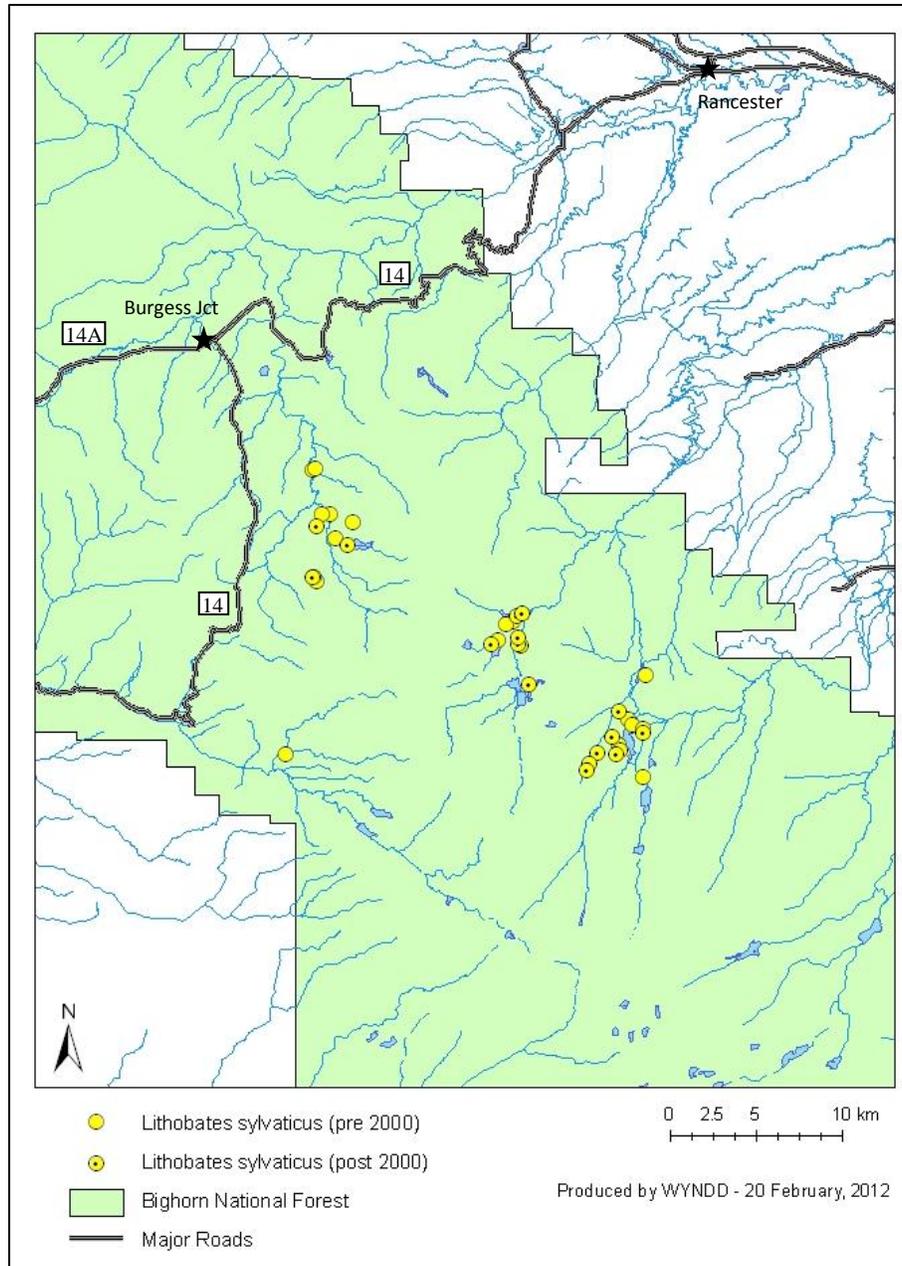


Figure 14. Documented breeding locations for the Wood Frog in the Bighorn Mountains. Areas were considered breeding sites if egg masses, tadpoles, or metamorphs were observed.

### *Potential Threats*

Disease could affect localized populations of this species. Chytrid fungus has been documented in Wood Frogs in the Medicine Bow Mountains in southern Wyoming (Estes-Zumpf, unpublished data) and northern Colorado (Muths et al. 2005). However, it is unknown

how chytrid infection influences individual survival rates in this species. Chytrid fungus also has been documented in other anurans in the Powder River Basin just east of the Bighorn Mountains (Estes-Zumpf et al. 2011). Epidermal swabs of 80 Wood Frogs from the Bighorns were tested for chytrid in 2009 and 2010 and no evidence of the fungus was detected. Other parasites may affect Wood Frogs, but more detailed research is required. Iridovirus associated die-offs have been documented in Wood Frog populations in Alaska, Massachusetts, North Carolina, Rhode Island, and Tennessee (Green and Muths 2005, Muths et al. 2005). Additional threats to Wood Frogs include habitat fragmentation and degradation. Clearcuts, highways, and increased road density have been found to restrict movement and gene flow of Wood Frogs (Crosby et al. 2009, Popescu and Hunter 2011).

## **Northern Leopard Frog**

### *Taxonomy and Management Status*

As with many other ranid frogs, the genus of Northern Leopard Frog was changed from *Rana* to *Lithobates* in 2006 (Frost et al. 2006). Leopard frogs are currently divided into five species, of which the most closely related to *L. pipiens* is *L. blairi* (Plains Leopard Frog), with which a zone of hybridization likely exists from south-central South Dakota to northeastern Nebraska (Dunlap and Kruse 1976). Populations of *L. pipiens* in the Bighorn Mountains do not appear genetically or morphologically distinct from others.

The Northern Leopard Frog is listed as a sensitive species by the Northern and Rocky Mountain regions of the USFS (USDA Forest Service 1994, 1999, 2003, 2005b), and by the Bureau of Land Management state offices in Wyoming (Bureau of Land Management 2001) and Colorado (Bureau of Land Management 2000). In Wyoming, the species is listed as an SGCN, though it is ranked as NSSU (status unknown), indicating that there is insufficient information on Wyoming populations to assign a status category, and designated as a Tier III species, indicating that it is a low management priority (WGFD 2010). The global natural heritage rank of Northern Leopard Frog is G5, or secure, though programs in Colorado and Wyoming consider it vulnerable (S3), which illustrates a common though untested, perception that the species is relatively secure across its range in the Great Plains and rarer in the Rocky Mountains. The Northern Leopard Frog is considered a species of special concern in Colorado and Idaho, and Montana considers it endangered on the western side of the Continental Divide (heritage rank S1) and of special concern to the east (heritage rank S4).

### *Description*

The Northern Leopard Frog is a medium-sized frog ranging from 5.1 to 11.0cm snout-vent length, with males being somewhat smaller than females. The dorsum ranges from brown to green in color and has two or three irregular rows of dark spots. Spots are typically encircled by a light border, making spots very distinct against the background color of the dorsum. The species also has pronounced dorsolateral ridges running along either side of the dorsum. Males

have swollen thumbs on their forefeet, paired vocal pouches visible during vocalization. Northern Leopard Frog tadpoles have a dark dorsum, often with a white belly. The dorsum and tail fins have gold and black flecking. The vent is located on the lower right side of the midline of the body near the tail fin. Under good conditions, Northern Leopard Frog tadpoles can reach snout-vent lengths of 10.0cm and the tail length is generally less than 1.5 times that of the body. Young Northern Leopard Frogs can have few or no spots. The call of the Northern Leopard Frog is a low, rattling snore followed by a series of chuckles, occurring primarily, but not exclusively, at night.



Figure 15. Variation in Northern Leopard Frog coloration

### *Habitat*

The Northern Leopard Frog has a complex life history that requires a broad range of habitats. Breeding, overwintering, and upland foraging habitat are different and must be present in close proximity in order to maintain healthy populations (Smith and Keinath 2007). Breeding typically occurs in semi-permanent to seasonal ponds with shallow, slow-moving or still waters and emergent vegetation. However, breeding can occur in shallow, quiet areas of permanent ponds and streams, beaver ponds, and even stock ponds in the western United States (Smith and Keinath 2007). After breeding, Northern Leopard Frogs move to grassy areas, wet meadows, and fens for foraging. The little that is known about overwintering habitat for this species suggest that they prefer the bottoms of lakes and ponds that are deep enough to not freeze solid (Rorabaugh 2005, Smith and Keinath 2007). In the Bighorn Mountains, Northern Leopard Frogs are often found in kettle ponds, wet meadows, and fens.

### *Distribution*

The Northern Leopard Frog ranges across large portions of the United States and Canada (Figure 16a) and is found in many lower elevation wetlands and riparian areas in Wyoming (Figure 16b). Although once believed to be common at higher elevations in mountain ranges in Wyoming, many of these higher elevation populations have disappeared for unknown reasons.

The Bighorn Mountains and southern portions of the Laramie Range have some of the few remaining higher elevation populations of this species in Wyoming.

### Pre-1990

Although records exist for Northern Leopard Frogs in the basins east and west of the Bighorn Mountains, the only documented occurrences of the Northern Leopard Frog in the Bighorn Mountains prior to 1990 are specimens collected in 1940 by George Baxter in Tensleep Canyon at the very south west corner of the Bighorn National Forest (Figure 17).

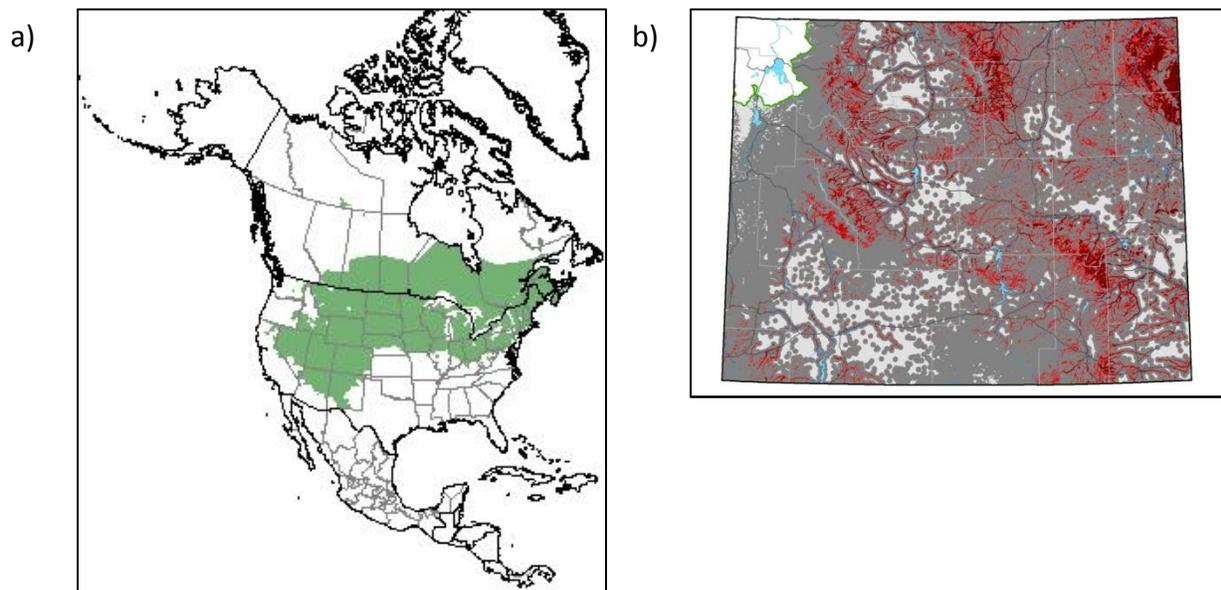


Figure 16. Map of a) the rangewide distribution of the Northern Leopard Frog in North America (IUCN 2010), and b) predicted distribution map of Northern Leopard Frogs in Wyoming (Keinath et al. 2010).

### 1990-2005

Northern Leopard Frogs were documented at Sherd Lake in the upper Clear Creek drainage and in a number of kettle ponds between French Creek and South Rock Creek just north of

Buffalo Park in the 1990's by USFS employees. Surveys by the USFS in 2002 documented a number of Northern Leopard Frog sites throughout the South Fork Ponds above 2500m elevation in the Clear Creek drainage (Figure 18). Garber (1994) extended the distribution north all the way to the Big Goose Creek drainage near Twin Lakes. Golden also extended the distribution north to the Big Goose Creek drainage, documenting Northern Leopard Frogs around Park Reservoir in the 1990's.

### 2006-2011

The distribution of Northern Leopard Frogs did not increase significantly during recent surveys. However, several new sites were documented within the known distribution and new breeding locations were documented. Northern Leopard Frogs are now known to occur in the Tensleep Creek, Rock Creek, Upper Clear Creek, and Big Goose Creek drainages in the Bighorn National Forest. Knowledge of the species' distribution within this range is limited, and the species is known from only a few locations within each drainage (Figure 19).

### *Population Trend*

Studies have documented range contractions, particularly in the western United States where there have been widespread local extinctions (Rorabaugh 2005), including many in states surrounding Wyoming (e.g., Cousineau and Rogers 1991, Maxell 2000, Koch and Peterson 1995). Declines may be more prevalent west of the continental divide and at higher elevations, but have regularly been documented throughout the Rocky Mountains (Smith and Keinath 2007). This led to a 2006 petition to list the Northern Leopard Frog as threatened under the United States Endangered Species Act for the western portion of its range (CFNE et al. 2006). Upon review of all available data, the Fish and Wildlife Service concluded that the Northern Leopard Frog "appears to be absent or declining throughout a large portion of its historical and current range in the western United States" and although "more secure in the eastern portion of its range, there are indications that local, and possibly regional, declines may also be occurring in the eastern United States" (USFWS 2011). However, the Service ruled that listing was not warranted because the western populations of the Northern Leopard Frogs did not meet their definition of a distinct population segment (USFWS 2011). Population trends for this species in the Bighorn Mountains are unknown.

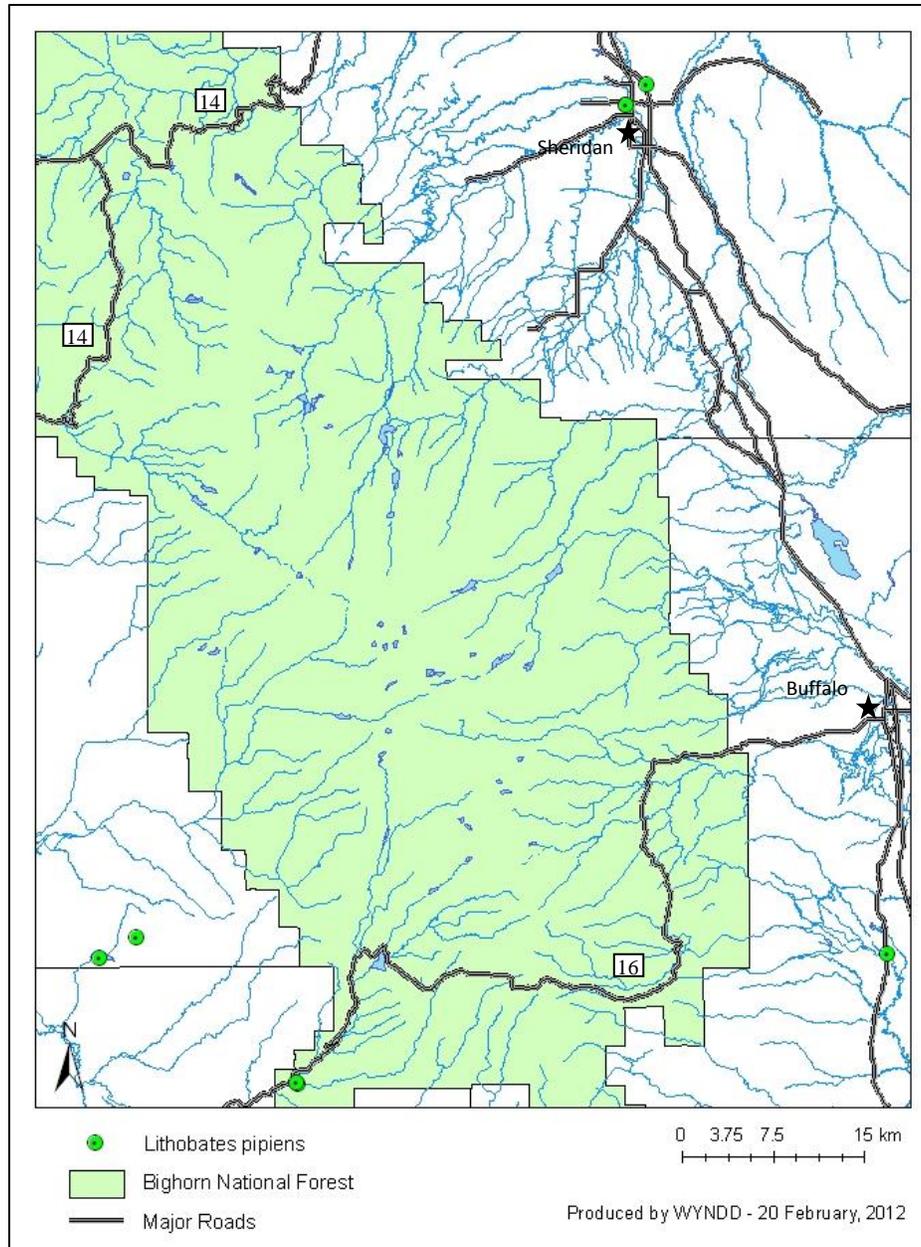


Figure 17. Known distribution of the Northern Leopard Frog in the Bighorn Mountains prior to 1990.

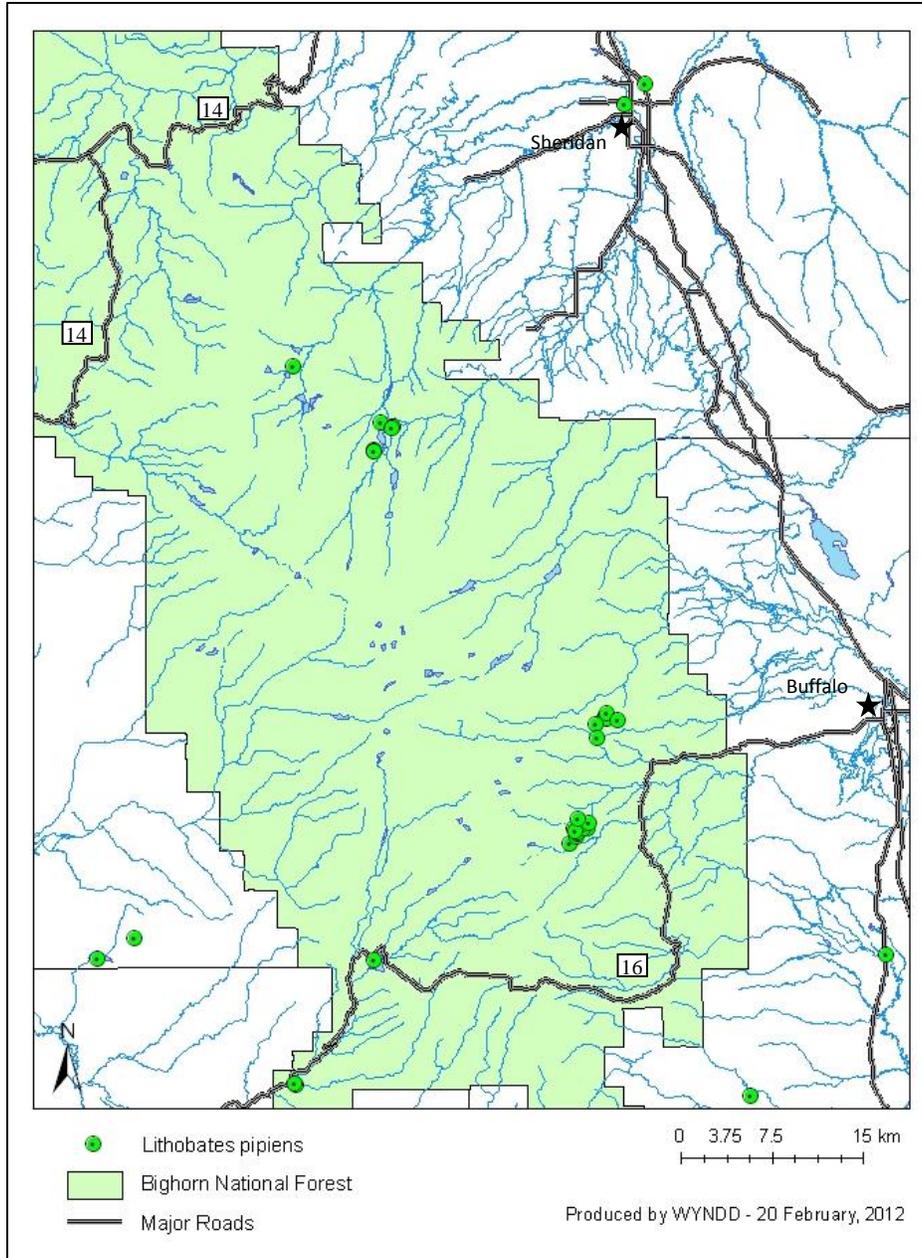


Figure 18. Distribution of the Northern Leopard Frog in the Bighorn Mountains in 2005 following increased survey and reporting efforts in the 1990's and early 2000's.

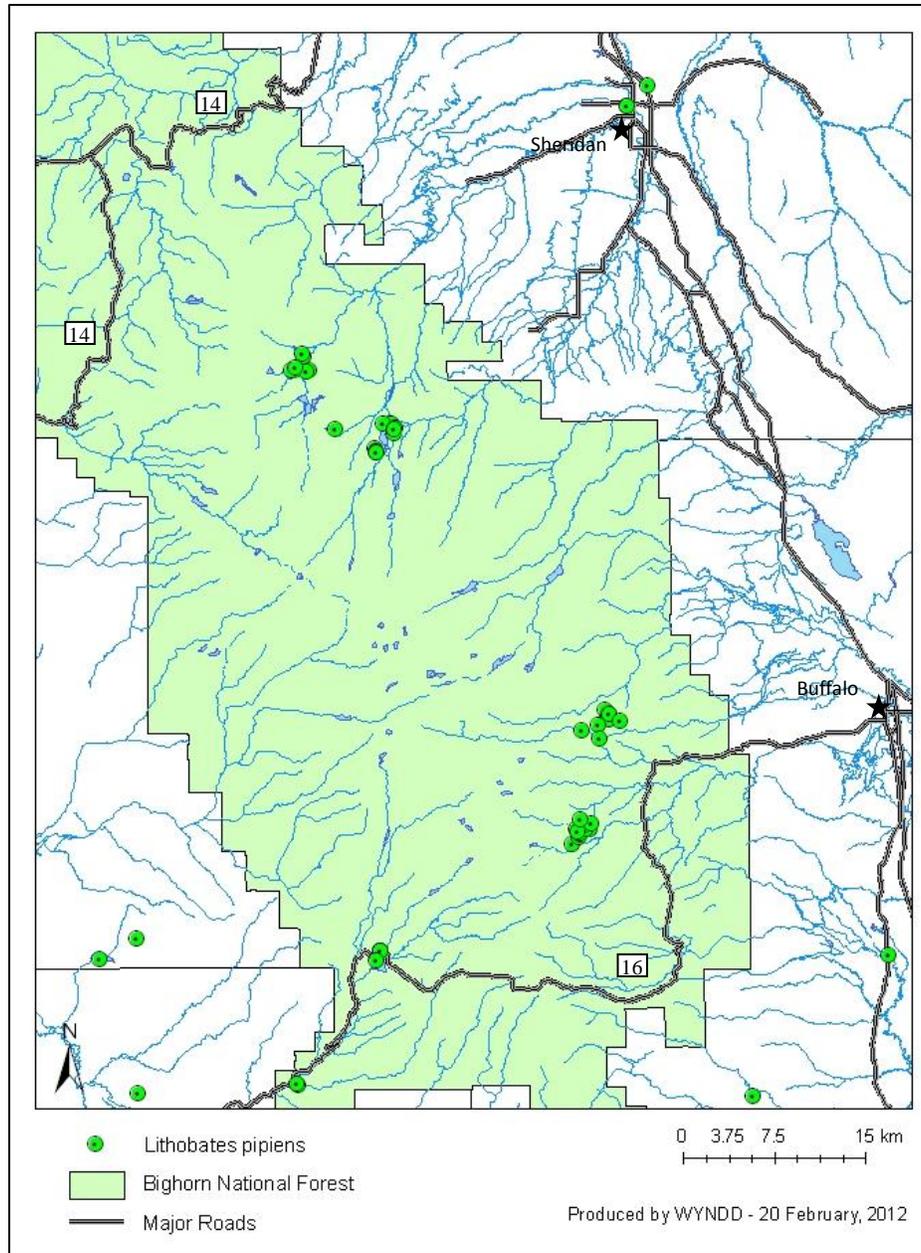


Figure 19. Distribution of the Northern Leopard Frog in the Bighorn Mountains as of 2011 resulting from targeted amphibian surveys by WGFD and increased reporting efforts by others from 2006-2011.

### *Breeding Sites and Important Population Centers*

Breeding by the Northern Leopard Frog has been confirmed within the past 12 years (since 2000) at the South Fork Ponds in the upper Clear Creek drainage, as well as in ponds along the north shore of Park Reservoir, ponds just east of Weston Reservoir, and in a small pond between Lake Fontinalis and Lake Dunchi in the Big Goose Creek drainage (Figure 20). Breeding also is suspected due to presence of juveniles at the kettle ponds between French and South Rock Creeks. Of the known breeding locations, the South Fork Ponds and the ponds along the north shore of Park Reservoir have the highest densities of Northern Leopard Frog tadpoles and/or egg masses (Figure 13). In 2002, USFS employees documented many juveniles and several hundred tadpoles at two sites just east of Sherd Lake in the South Fork Ponds.

### *Potential Threats*

No single factor has been identified as the cause of declines in Northern Leopard Frog populations across the western United States, however, a number of threats have been identified. Bullfrogs are not native to the western United States and are invading western ponds and streams. Predation by invasive Bullfrogs has been implicated in the decline of several western Northern Leopard Frog populations (Rorabaugh 2005). Exposure to ambient ultraviolet light can not only result in immunosuppression, but can be lethal to Northern Leopard Frog tadpoles if insufficient cover is present (Ankley et al. 2000, Rorabaugh 2005). Chytrid fungus is believed to be a contributing factor in many Northern Leopard Frog declines including mass mortalities in the Colorado Rocky Mountains (Cary et al. 1999, Rorabaugh 2005). Although chytrid fungus has been detected in Northern Leopard Frogs just east of the Bighorn Mountains in the Powder River Basin (Estes-Zumpf et al. 2011), chytrid testing of 11 samples taken from Northern Leopard Frogs in the Bighorns in 2009 and 2010 found no evidence of the fungus. Lastly, Northern Leopard Frogs need a mix of breeding, wintering, and foraging habitats, making this species especially susceptible to loss, degradation, and fragmentation of habitat (Rorabaugh 2005).

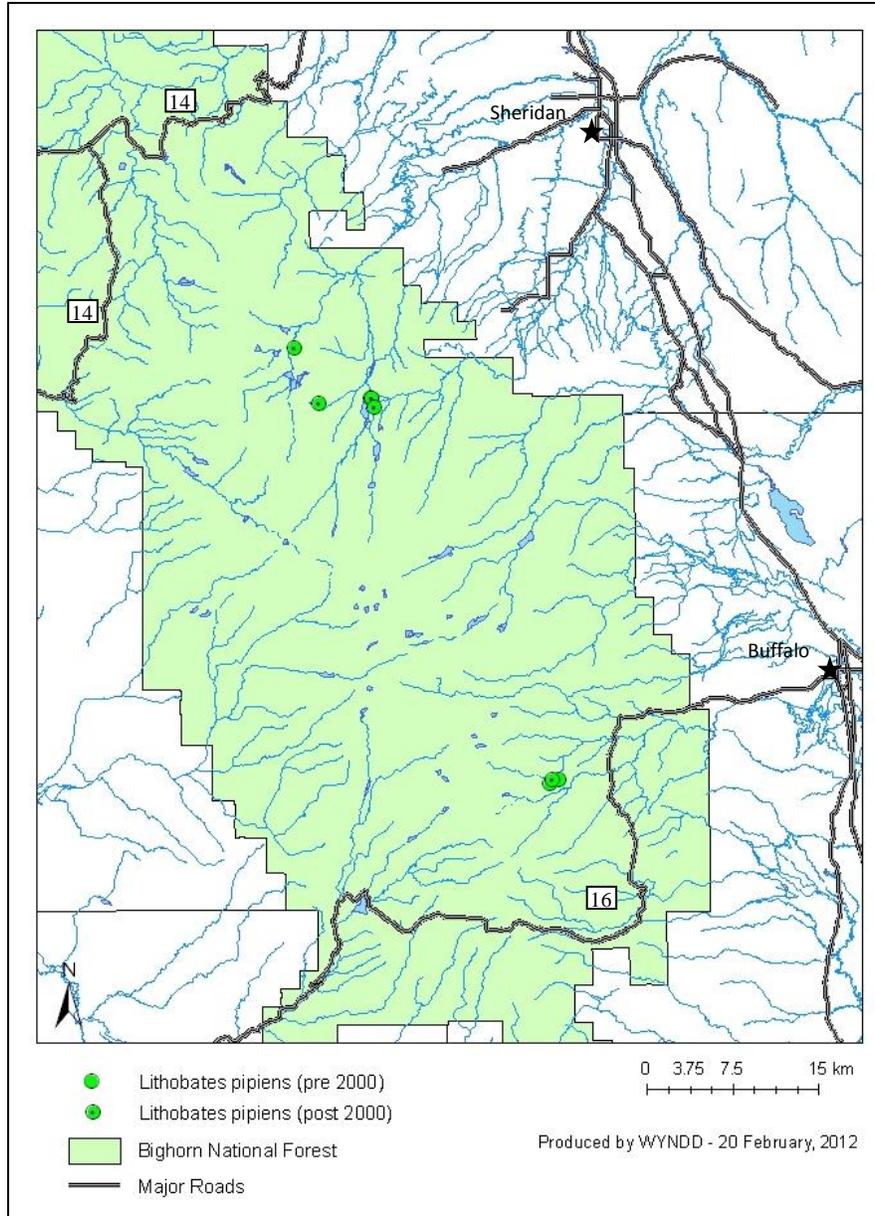


Figure 20. Documented breeding locations for the Northern Leopard Frog in the Bighorn Mountains. Areas were considered breeding sites if egg masses, tadpoles, or metamorphs were observed.

## SPECIES OVERLAP

The Bighorn Mountains are the only location in Wyoming and one of only a few sites in most of the western United States where the Columbia Spotted Frog, Wood Frog, and Northern Leopard Frog co-occur. Within the Bighorn Mountains, all three species currently are only known to occur together at a few sites in the Big Goose Creek and Little Goose Creek drainages. In general, the Columbia Spotted Frog appears to be the most common amphibian in the north-central portion of the Bighorn Mountains, the Wood Frog the most common amphibian in the central portion, and the Northern Leopard Frog the most common amphibian in the southern portion of the Bighorn Mountains (Figure 21).

The distribution of the Wood Frog appears to have the largest overlap with other Bighorn amphibian species, overlapping the distribution of the Northern Leopard Frog to the south and the Columbia Spotted Frog to the north (Figure 21). The Columbia Spotted Frog appears to have the smallest distribution of the 3 amphibian species in the Bighorn Mountains, and the least amount of overlap. The Columbia Spotted Frog is the only amphibian documented in the northern portion of the species' distribution. Wood Frogs have only been documented in the South Tongue River as far north as just downstream of Bonanza Creek.

Historically, the 3 amphibian species were not known to overlap in the Bighorn Mountains (Dunlap 1977, WYNDD 2012), but our current effort to compile data has revealed distribution overlaps. We expect that this does not represent increased sympatry over time, but rather that surveyors assumed eggs or tadpoles observed in a given area belonged to the only species previously known to occur in that area. Most of the records for the 3 amphibian species in the Bighorn Mountains were made by knowledgeable observers (biologists, natural resource personnel, herpetologists, etc.). Thus, records of adult and juvenile amphibians are likely accurate. However, egg and tadpole identification is particularly difficult, and since we do not know each observer's knowledge of egg and tadpole identification in the field we cannot confirm that all records of eggs and tadpoles were correctly identified to species. We provide a guide to assist surveyors in distinguishing between life stages of the 3 species in Appendix C; though differentiating between egg masses and tadpoles in the field can be difficult for those not experienced in doing so.

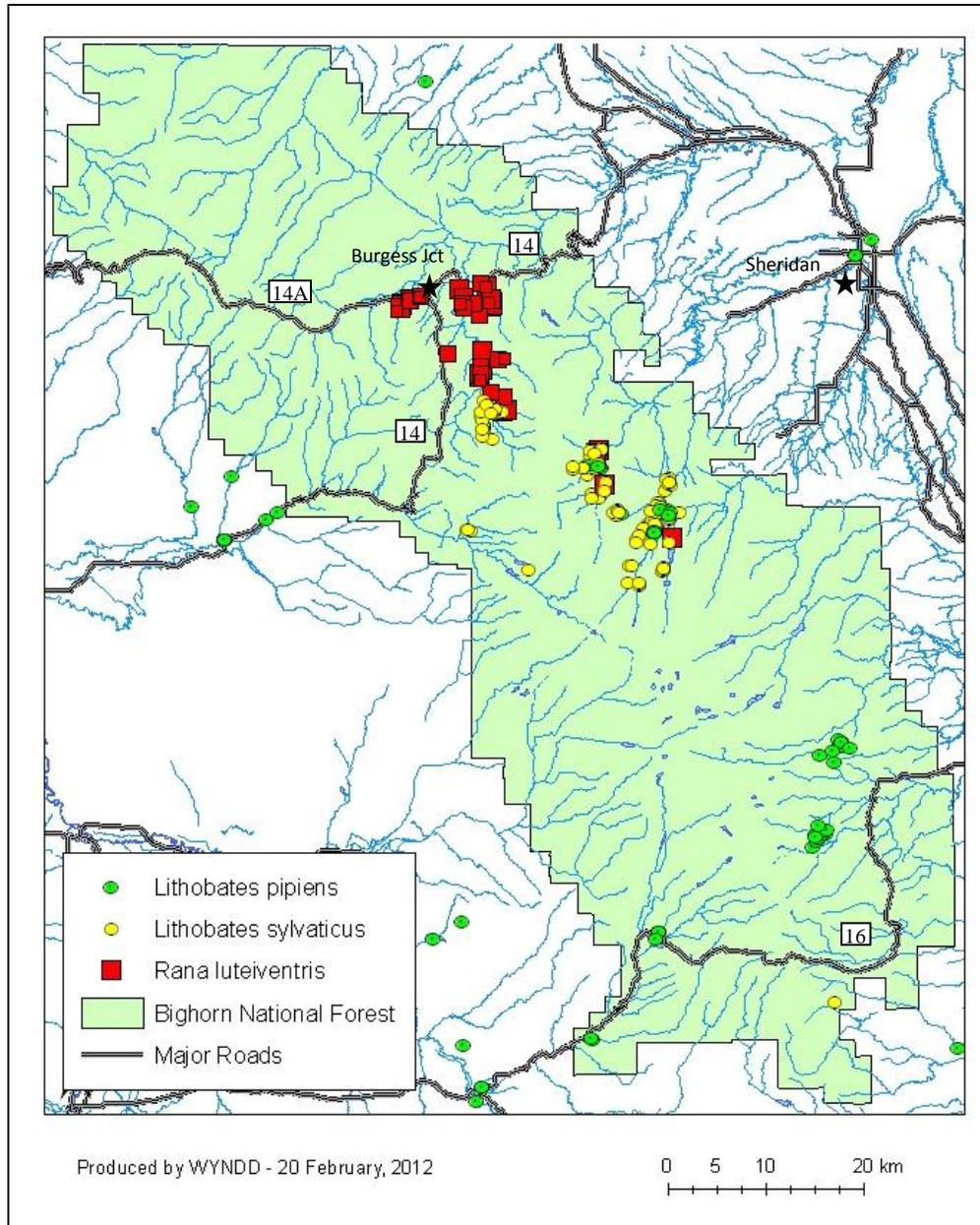


Figure 21. Documented locations of Columbia Spotted Frogs, Wood Frogs, and Northern Leopard Frogs as of 2011 showing distributions and degree of overlap of the three species.

## **FUTURE SURVEY EFFORTS**

Increased attention and survey effort by the Bighorn National Forest, WGFD, WYNDD, and other entities in the past two decades has greatly increased our knowledge of the distribution and status of amphibians in the Bighorn Mountains. New populations and breeding sites have been added in the past five years that have extended distributions considerably, yet only a small portion of the Bighorn National Forest has been searched thus far.

Surveys conducted for amphibians or other aquatic species by knowledgeable people who report that no amphibians were detected (negative data) in an area can help inform future survey efforts. Compiled negative data from recent WGFD amphibian surveys, university projects (Montgomery 2010, personal communication), and WYNDD inventories (Garber 1994; Zier 2009 & 2010, personal communication) identify areas that have been searched (Figure 22). We recommend targeting future surveys toward areas that have not heretofore been searched. The intervening habitat from Graves Creek to Sawmill Creek between amphibian populations in the South Tongue River and Big Goose Creek drainages should be further surveyed. Because two species occur in both drainages, information on habitat corridors over the potential elevation barrier between the drainages would provide valuable insight on connectivity between populations in this rugged mountain range.

Golden's documentation of a single Wood Frog site in the southern tip of the Bighorn National Forest warrants further surveys for the species in this area. Specifically upper portions of the Middle and North Fork Crazy Woman Creek drainages should be searched for Wood Frogs and other amphibian species. Golden also documented an unidentified toad and one of the only Boreal Chorus Frogs observed on the Bighorn National Forest in the areas specified above.

The largest information gaps occur throughout much of the Cloud Peak Wilderness, along the east slope of the mountains between Buffalo and Sheridan, and almost all of the Bighorn National Forest north of Highway 14 and Highway 14 Alternate. These areas have received little or no survey effort and records of amphibians in these areas could increase species' distributions, identify new breeding sites, and/or reveal important links between apparently isolated populations.

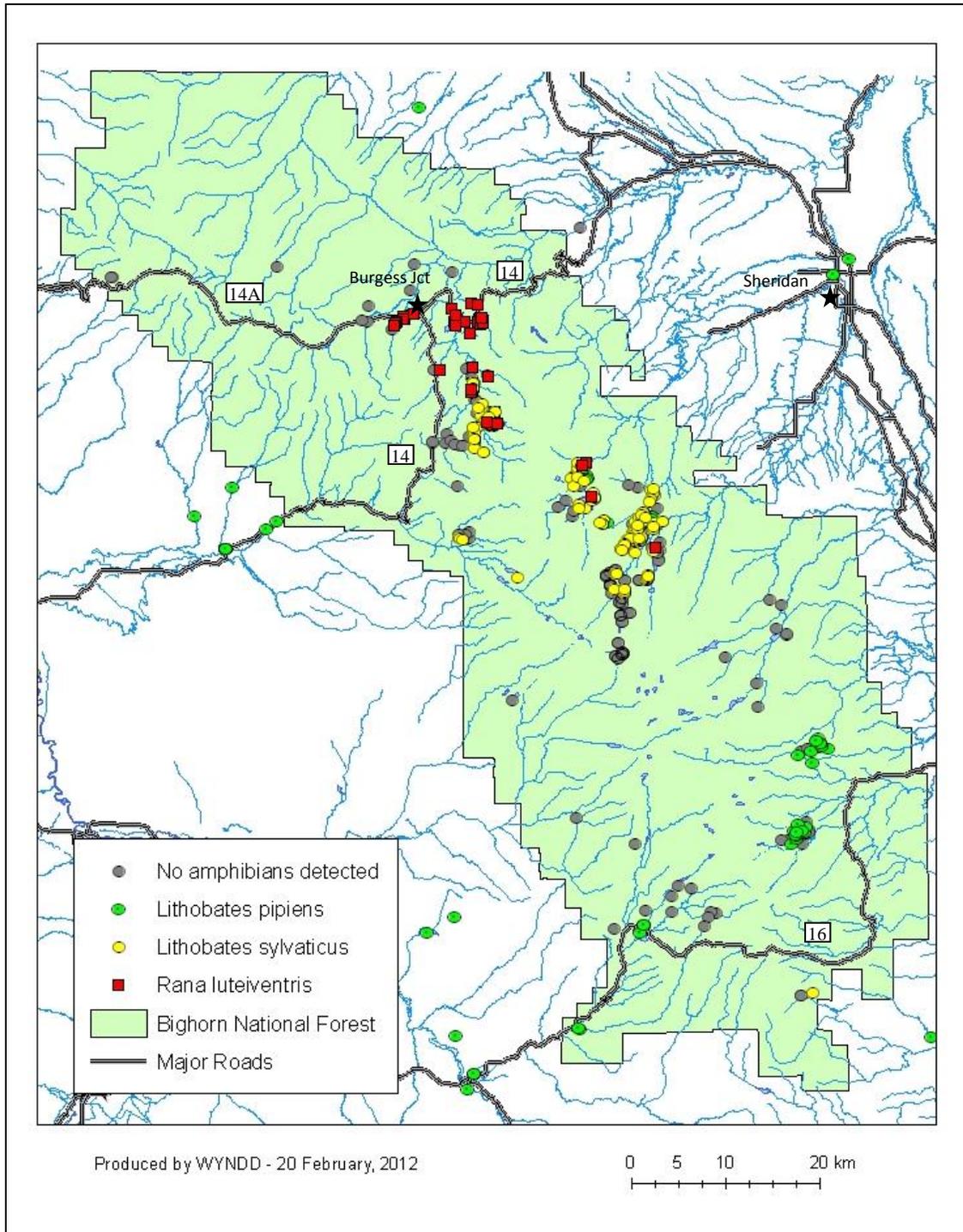


Figure 22. Locations of surveys by people knowledgeable about amphibians where amphibians were (colored symbols) and were not found (gray circles).

## EXISTING MANAGEMENT PLANS AND CONSERVATION STRATEGIES

Currently all three amphibian species are considered sensitive species by the USFS Rocky Mountain Region and emphasis species to be used as surrogates for addressing species viability in the Bighorn National Forest (USDA Forest Service 2005a). Although no formal amphibian monitoring programs are currently in place, the Bighorn National Forest lists both monitoring of aquatic habitat conditions for native riparian-dependant species and monitoring habitat use by amphibians in known locations as a high monitoring priority (USDA Forest Service 2005). A high priority rank indicates that monitoring of a particular natural resource is required by law or regulation. The USFS has been working with the WGFD to inventory amphibian species in the Bighorn National Forest and is exploring possible monitoring plans for amphibians (Walker 2011, personal communication).

Although no management standards appear to exist regarding amphibians or their habitat, the Bighorn National Forest has issued management guidelines for maintaining aquatic habitats on the forest for the benefit of biological diversity. These guidelines include maintaining or mitigating impacts to important habitat types (including bogs, fens, and springs), as well as maintaining and/or enhancing riparian and watershed function within 300 feet (92 meters) of perennial streams, wetlands, and lakes. However, research on Wood Frogs (Harper et al. 2008, Freindfelds et al. 2011) suggests that 100-meter buffers around breeding wetlands are insufficient to protect habitat required by this species. Furthermore, a meta-analysis of 19 species of frogs found that, on average, core terrestrial habitat extends 205 – 370 meters from breeding sites (Semlitsch and Bodie 2003). Thus, existing data suggest that land managers should consider increasing the recommended buffer distance to at least 300 meters around important amphibian breeding sites.

Because fens take thousands of years to form, are irreplaceable, cannot be reclaimed, and have excellent water-holding capabilities, the USFS Region 2 issued supplemental guidelines in 2011 for the management of fens on Forest Service Lands (USDA Forest Service 2011). These guidelines recommend that the Forest Service make every reasonable effort to avoid adversely impacting the function and ecological services provided by fens. The Forest Service also recommended establishing Special Areas to protect fens and their associated watersheds (USDA Forest Service 2011). Because fens are used by all three amphibian species, especially Wood Frogs, on the Bighorn National Forest, protection of fens should help to maintain amphibian habitat on the Forest.

## RECOMMENDATIONS

1. Because large portions of the Bighorn Mountains have not been surveyed for amphibians, we recommend additional surveys in areas beyond those already searched (Figure 22) to further delineate the distributions of amphibian in the Bighorn National Forest.

2. We recommend development and implementation of an amphibian monitoring program in the Bighorn Mountains. Due to the disjunct nature of Bighorn amphibian populations, any decline in numbers could ultimately lead to localized extirpation without the possibility of re-colonization from other populations. Depending on the desired scope of inference, monitoring could be done at random sites containing amphibian habitat across the Bighorn National Forest, or could be restricted to sites containing known populations. The former would allow inference to amphibian populations throughout the national forest. The latter would be smaller scale and require fewer resources but would limit inferences about population trends to monitored sites.
3. Geographically isolated populations may need increased conservation effort due to the increased probability of localized extinction and limited opportunities for re-colonization (Primack 1993). Currently many breeding populations of Bighorn amphibian seem to be separated by intervening unsuitable habitat. It is recommended that work be conducted that examines population connectivity and habitat use versus availability. We recommend that suitable habitat be connected when possible to ensure metapopulation stability throughout the Bighorn National Forest.
4. Garber (1994) provides an excellent overview of threats to frog populations that are pertinent to the Bighorn National Forest. We recommend that this document be reviewed when considering amphibian management or land development in the Bighorn Mountains.
5. Amphibian chytrid fungus is likely the most pressing threat to amphibians in the Bighorn Mountains since it has been documented in the basins surrounding the mountain range. We recommend that the Bighorn National Forest educate employees and the public about methods to reduce the spread of chytrid fungus, such as allowing equipment and clothing (especially boots) to dry completely between waterbodies and stream reaches. Formal decontamination protocols using bleach or fungicide solutions are available and can be obtained from WGFD or WYNDD. We also recommend that any monitoring effort include swabbing of individuals using protocols outlined in Livo (2004) to test for chytrid infection.
6. Sibley Lake and the area around Park Reservoir are important population centers and breeding sites for amphibians in the Bighorn Mountains. We recommend conserving/protecting amphibian breeding habitat around Sibley Lake and Park Reservoir to maintain local amphibian populations.
7. Amphibian breeding locations were found at or in close proximity to sites with fish populations. Documented egg masses often occurred in old oxbows, small ponds, and side channels with limited fish access. Egg masses were deposited in heavy vegetation within waters containing fish populations. Ovipositing in vegetation could be a tactic to enable tadpoles and egg masses to avoid predation from fish. Introduced trout have been found to have negative impacts on Columbia Spotted Frog populations (Pilliod and

Peterson 2001). Fishless off-channel waters and areas of thick emergent vegetation should be maintained to help ensure persistence of Bighorn Mountain amphibians.

8. Wood Frogs will move hundreds of meters between breeding and post-breeding habitats (Baldwin et al. 2006, Rittenhouse and Semlitsch 2007). Although adult Wood Frogs can cross clear cuts, they do not settle in them (Freidenfelds et al. 2011). Furthermore, Wood Frog juveniles have been found to avoid open canopy habitat and abrupt edges, preferring to move through mature forest rather than recent clear cuts (Popescu and Hunter 2011). Thus, forested buffers around breeding ponds need to be large enough (>300 meters) to allow movement between breeding sites and wintering sites, when possible. In addition, some level of connectivity between populations should be maintained by protecting forested corridors, wetlands, moist ravines, and seeps/springs between breeding sites.
9. We documented extensive overlap of distributions of amphibian species in the Bighorn Mountains. Species identification of egg and tadpole life stages can no longer be assumed based on location, as was previously thought. We recommend that surveyors use caution in identifying these life stages to species. Photographs of egg masses should be taken, when possible. Questionable tadpole specimens should be collected, placed in vials or whirlpacs containing ethanol and labeled with the date and location (UTM coordinates when possible), and sent to WGFD herpetologists or WYNDD zoologists for identification. We also invite dissemination of Appendix C (or a modification of this appendix) to UFSF employees and other surveyors to assist in distinguishing between the 3 species.

## **ACKNOWLEDGEMENTS**

This amphibian status and distribution update was a joint effort by WYNDD and WGFD with support from the Bureau of Land Management as part of a statewide amphibian coordination effort. WGFD Bighorn amphibian surveys were made possible by the Wyoming State Legislature through allocation of general funds. The dedication of our state to our natural heritage is greatly appreciated. Additional thanks go to the Sheridan Regional Fish Crew and everyone who helped with WGFD amphibian surveys, including Chris Moan, Margo Hennet, John Beem, Andrew Nikirk, Nick Quintana, Katie Leuenberger, and Katie Weber. We sincerely thank the Bighorn National Forest, especially Harold Golden, for sharing their amphibian data. We thank WYNDD botanical surveyors Jim Zier and Bonnie Heidel for keeping their eyes open for amphibians while surveying for sensitive fen plants in the Bighorn Mountains. Amanda Bowe, Katie Leuenberger, and Melanie Arnett assisted with pulling together and mapping data for this effort. Special thanks go to Charlotte Matthews, Paul Mavrakis, Bill Bradshaw, and others for reviewing earlier versions of this report.

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## **APPENDIX A: Wyoming Game and Fish Department Bighorn Mountain Amphibian Surveys, 2009-2010.**

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### **ABSTRACT**

The main goal of this project was to verify known populations of Columbia Spotted Frog (*Rana luteiventris*) and Wood Frog (*Lithobates sylvaticus*) in the northern portions of the Bighorn National Forest, Wyoming. The secondary goal of this project was to expand the known distribution of these species in habitats adjacent to known locations. Amphibian surveys were conducted between June 3<sup>rd</sup> and July 23<sup>rd</sup> during the summers of 2009 and 2010. Thirty three areas were surveyed for amphibians over the two year period. Frogs or their egg masses were observed at 22 of the 33 survey sites (66%). A total of 1,161 amphibian observations were made (Columbia Spotted Frog n=325, Wood Frog n=836). A total of 8,287 man minutes (approximately 138 man hours) were spent surveying for Columbia Spotted and Wood Frogs. Belly swabs were taken from up to the first five amphibians encountered at each survey location to test for the presence of *Batrachochytrium dendrobatidis* (Bd or chytrid fungus). No amphibian tested positive for Bd during the course of this project. The known distribution for the Columbia Spotted Frog was extended into an adjacent watershed (approximately seven miles between observations). The data collected for this project will provide a baseline for subsequent species monitoring.

### **JUSTIFICATION**

As a result of relatively small population sizes, geographic isolation, and limited distribution; Columbia Spotted Frogs and Wood Frogs are of concern to wildlife managers in the Bighorn National Forest. In response to this concern, the Wyoming Game and Fish Department's (WGFD) Aquatic Assessment Crew (AAC) began a project in 2009 to verify known populations of Columbia Spotted Frog and Wood Frog and to survey for additional breeding populations. During this project, the AAC also surveyed for chytrid fungus infections within known Bighorn amphibian populations. Information collected as part of this effort will provide baseline data for possible future monitoring programs.

### **METHODS**

The specific study area was defined by incorporating all 10-digit HUCs that received survey effort into a single unit. These include the Tongue River-Fool Creek (1009010101) and Big

Goose Creek (1009010102) watersheds (Figure A-1). All watersheds are located within Sheridan and Johnson Counties.

## Survey Methods

Survey locations were initially selected by referencing the Wyoming Natural Diversity Database, WGFD Observation System, WGFD herpetological databases, and local experts for historic Columbia Spotted Frog and Wood Frog observations. Due to time constraints, all historic observations were not able to be verified. Thirty three survey sites were selected based on access, availability of suitable habitat, and proximity to known frog observations (Figure A-2, Appendix B). We surveyed 29 sites in 2009 and 26 sites in 2010. Visual encounter surveys (VES) were conducted at least once at all selected survey sites. When possible, a survey was conducted at the same location in 2009 and 2010. Each survey consisted of at least two observers walking through suitable habitat while looking for adult/juvenile frogs, tadpoles, and egg masses (Crump and Scott 1994). Surveys were not time or area constrained. Each survey was concluded when all suitable habitat in the immediate area had been searched. The first five frogs observed at each survey location were sampled for chytrid fungus following Livo (2004). Frogs were counted and classified as adult/juvenile, larvae, or egg mass. Point locations were collected for each observation (UTM, NAD 27, Zone 13). We also collected data on air and water temperature, wind speed, and general weather conditions. After each survey, all equipment that contacted water or an amphibian was disinfected with a 10% bleach solution to prevent possible spread of chytrid fungus or other disease (Kirshtein et al. 2007). All surveys were conducted between June 3<sup>rd</sup> and July 23<sup>rd</sup>. Surveys began immediately after Sibley Lake was free of ice. Spotted Frogs were surveyed initially, while Wood Frogs were surveyed after Red Grade Road became passable to the Big Goose Creek watershed.

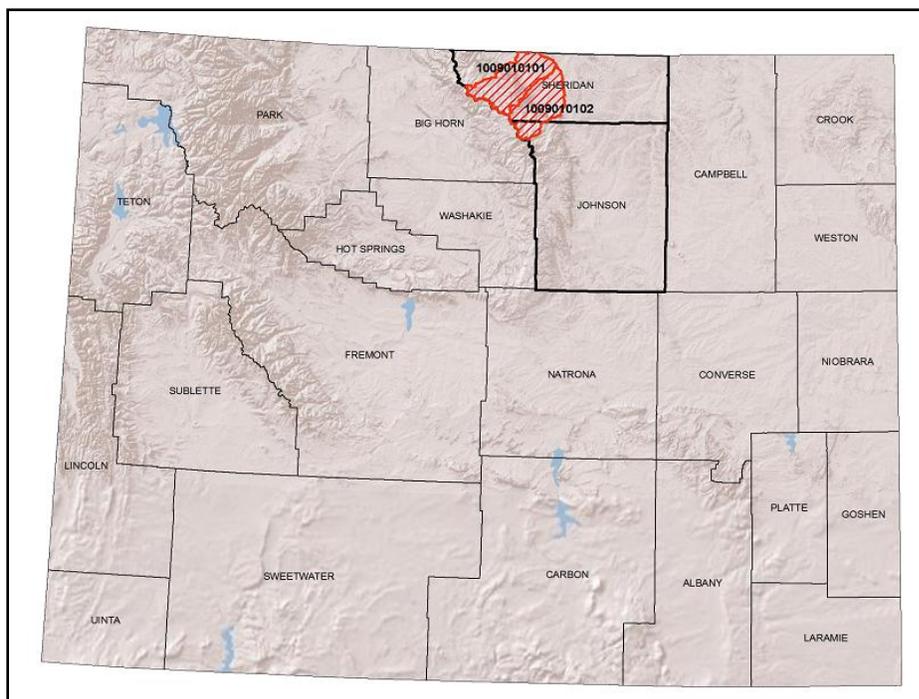


FIGURE A-1: Survey area including Tongue River-Fool Creek (1009010101) and Big Goose Creek watersheds (1009010102).

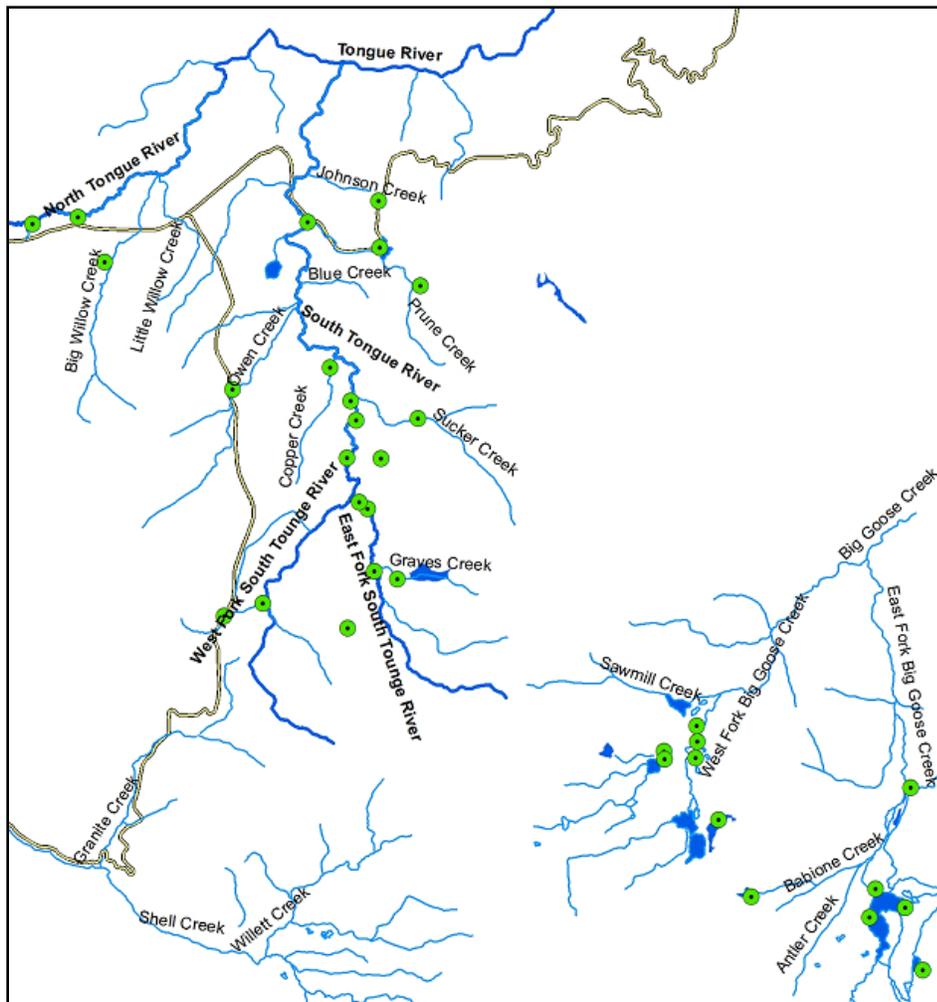


FIGURE A-2: Start locations for all 2009 and 2010 survey plots

## RESULTS

### Visual Encounter Surveys

Frogs or egg masses were observed at 22 of the 33 survey sites (66%). During the two year survey period, a total of 1,161 amphibian observations were made (Columbia Spotted Frog n=325, Wood Frog n=836). A total of 8,287 man minutes (approximately 138 man hours) were spent surveying for Columbia Spotted and Wood Frogs (Table A-1). In 2009, 4,631 man minutes were spent surveying for amphibians (approximately 77 man hours). In 2010, 4,095 man minutes were spent surveying for amphibians (approximately 68 man hours). Northern Leopard Frogs (adult/juvenile n= 75, larvae n= 800+) and a single Wandering Gartersnake

(*Thamnophis elegans vagrans*) were also observed while surveying. These additional observations all occurred within the Big Goose Creek watershed. A total of 44 belly swabs were collected for Bd detection. All tests came back negative. No Bd was detected in the Bighorn National Forest as part of this survey effort.

TABLE A-1: Survey sites and associated survey effort.

| Site Name                             | 2009 Survey Effort<br>(man minutes) | 2010 Survey Effort<br>(man minutes) |
|---------------------------------------|-------------------------------------|-------------------------------------|
| Big Willow Creek                      | 320                                 | 110                                 |
| Bonanza Creek                         | 0                                   | 234                                 |
| Bruce/Prospect Creek                  | 75                                  | 0                                   |
| Bull Creek                            | 0                                   | 127                                 |
| Copper Creek                          | 0                                   | 80                                  |
| Dome Lake Wetland                     | 72                                  | 0                                   |
| Dry Gulch                             | 159                                 | 0                                   |
| Duncan Lake                           | 308                                 | 280                                 |
| E Fork South Tongue                   | 100                                 | 0                                   |
| E. Big Goose Creek                    | 132                                 | 0                                   |
| E. Big Goose/Beaver Ditch             | 90                                  | 140                                 |
| Graves Creek                          | 280                                 | 579                                 |
| Johnson Creek                         | 0                                   | 122                                 |
| Martin Res.                           | 112                                 | 0                                   |
| Owen Creek                            | 115                                 | 0                                   |
| Park Reservoir- Eastside ponds        | 0                                   | 170                                 |
| Park Reservoir- Northside Ponds       | 0                                   | 120                                 |
| Park Reservoir- Westside Ponds        | 0                                   | 200                                 |
| Prospect Creek                        | 132                                 | 0                                   |
| Prune Creek                           | 0                                   | 234                                 |
| Sawmill Lakes                         | 0                                   | 240                                 |
| Sibley Lake                           | 948                                 | 246                                 |
| Snail Creek/Big Goose Creek           | 344                                 | 0                                   |
| South Tongue/ Prune Creek             | 220                                 | 96                                  |
| South Tongue/Bonanza Creek            | 345                                 | 124                                 |
| South Tongue/Graves Creek             | 308                                 | 96                                  |
| Sucker Creek                          | 85                                  | 201                                 |
| Tie Flume                             | 0                                   | 104                                 |
| Twin Lakes                            | 288                                 | 180                                 |
| Twin Lakes - Southern Ponds           | 0                                   | 140                                 |
| Unknown campground near Bonanza Creek | 0                                   | 52                                  |
| Upstream Dead Swede                   | 0                                   | 60                                  |
| Weston Res.                           | 198                                 | 160                                 |
| <b>Totals</b>                         | <b>4631</b>                         | <b>4095</b>                         |

## Columbia Spotted Frog

Over the course of the two year period, Columbia Spotted Frogs were observed at 10 of 33 sites (30%; Table A-2, Figure A-3). During 2009, this species was found at 4 of 29 surveyed sites (14%). A total of 142 observations were made during this time period. Observations consisted of adults / juveniles (n=100) and egg masses (n= 42). The average success rate for 2009 was 0.032 frogs or egg masses per minute (approximately 2 frogs or egg masses per hour). Columbia Spotted Frogs were observed at 10 of 26 surveyed sites (38%) during 2010. A total of 183 observations were made during this period. Observations consisted of adults / juveniles (n=40) and egg masses (n=143). The average success rate for 2010 was 0.095 frogs or egg masses per minute (approximately 5.7 frogs or egg masses per hour). Although success rates were higher in 2010, most observations were egg masses (Table A-2).

TABLE A-2: Survey sites where Columbia Spotted Frogs were observed.

| Site Name                  | 2009               |            |                          | 2010               |            |                          |
|----------------------------|--------------------|------------|--------------------------|--------------------|------------|--------------------------|
|                            | # Adult / Juvenile | # Egg Mass | Observation / man minute | # Adult / Juvenile | # Egg Mass | Observation / man minute |
| Big Willow Creek           | 3                  | 0          | 0.009                    | 0                  | 14         | 0.127                    |
| Graves Creek               | 0                  | 0          | 0.000                    | 8                  | 7          | 0.026                    |
| Johnson Creek              | 0                  | 0          |                          | 11                 | 6          | 0.139                    |
| Prune Creek                | 0                  | 0          |                          | 0                  | 1          | 0.004                    |
| Sawmill Lakes              | 0                  | 0          |                          | 6                  | 0          | 0.025                    |
| Sibley Lake                | 94                 | 28         | 0.129                    | 12                 | 94         | 0.431                    |
| South Tongue/ Prune Creek  | 1                  | 3          | 0.018                    | 0                  | 2          | 0.021                    |
| South Tongue/Bonanza Creek | 2                  | 11         | 0.038                    | 2                  | 15         | 0.137                    |
| Sucker Creek               | 0                  | 0          | 0.000                    | 1                  | 1          | 0.010                    |
| Tie Flume                  | 0                  | 0          |                          | 0                  | 3          | 0.029                    |
| <b>Totals</b>              | 100                | 42         |                          | 40                 | 143        |                          |

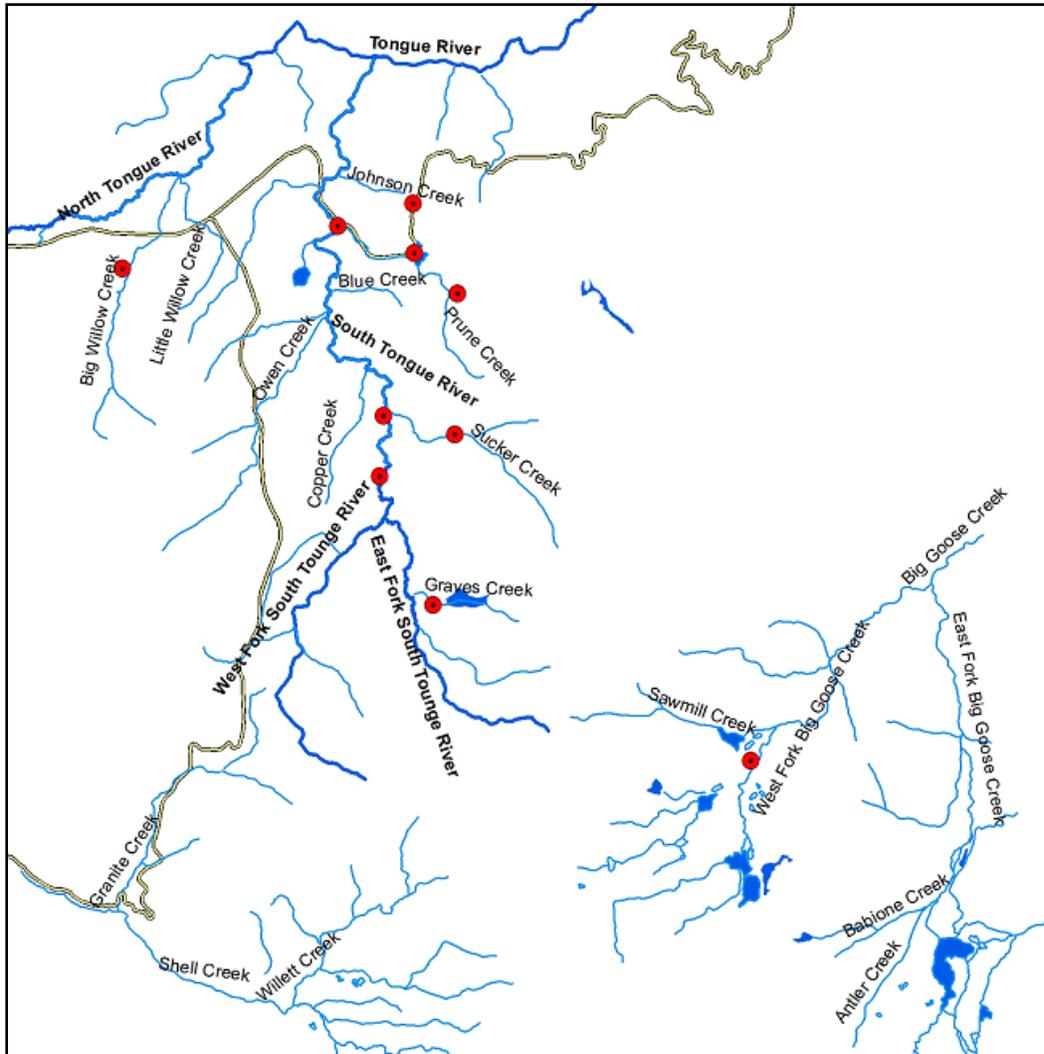


FIGURE A-3. Survey start locations where at least one Columbia Spotted Frog or egg mass was observed during 2009 or 2010.

### Wood Frog

Over the course of the two year period, Wood Frogs were observed at 14 of 33 sites (42%; Table A-3, Figure A-4). During 2009, this species was found at 9 of 29 surveyed sites (31%). A total of 330 observations were made during this time period. Observations consisted of adults / juveniles (n=329) and egg masses (n= 1). The average success rate for 2009 was 0.227 frogs or egg masses per minute (approximately 14 frogs or egg masses per hour). Wood Frogs were observed at 10 of 26 surveyed sites (38%) during 2010. A total of 506 adult / juvenile observations were made during this period. Only 1 egg mass was observed for this

species in 2009 (Table 3). The average success rate for 2010 was 0.304 frogs or egg masses per minute (approximately 18 frogs or egg masses per hour).

TABLE A-3: Survey sites where Wood Frogs were observed.

| Site Name                       | 2009               |            |                          | 2010               |            |                          |
|---------------------------------|--------------------|------------|--------------------------|--------------------|------------|--------------------------|
|                                 | # Adult / Juvenile | # Egg Mass | Observation / man minute | # Adult / Juvenile | # Egg Mass | Observation / man minute |
| Dome Lake Wetland               | 59                 | 0          | 0.819                    | 0                  | 0          |                          |
| Duncan Lake                     | 6                  | 0          | 0.019                    | 18                 | 0          | 0.064                    |
| E. Big Goose Creek              | 50                 | 0          | 0.379                    | 0                  | 0          |                          |
| E. Big Goose/Beaver Ditch       | 3                  | 0          | 0.033                    | 17                 | 0          | 0.121                    |
| Graves Creek                    | 1                  | 0          | 0.004                    | 2                  | 0          | 0.003                    |
| Martin Res.                     | 17                 | 0          | 0.152                    | 0                  | 0          |                          |
| Snail Creek/Big Goose Creek     | 154                | 1          | 0.451                    | 0                  | 0          |                          |
| Park Reservoir- Eastside ponds  | 0                  | 0          |                          | 26                 | 0          | 0.153                    |
| Park Reservoir- Northside Ponds | 0                  | 0          |                          | 18                 | 0          | 0.150                    |
| Park Reservoir- Westside Ponds  | 0                  | 0          |                          | 70                 | 0          | 0.350                    |
| Sawmill Lakes                   | 0                  | 0          |                          | 46                 | 0          | 0.192                    |
| Twin Lakes                      | 7                  | 0          | 0.024                    | 78                 | 0          | 0.433                    |
| Twin Lakes - Southern Ponds     | 0                  | 0          |                          | 140                | 0          | 1.000                    |
| Weston Res.                     | 32                 | 0          | 0.162                    | 91                 | 0          | 0.569                    |
| <b>Totals</b>                   | 329                | 1          |                          | 506                | 0          |                          |

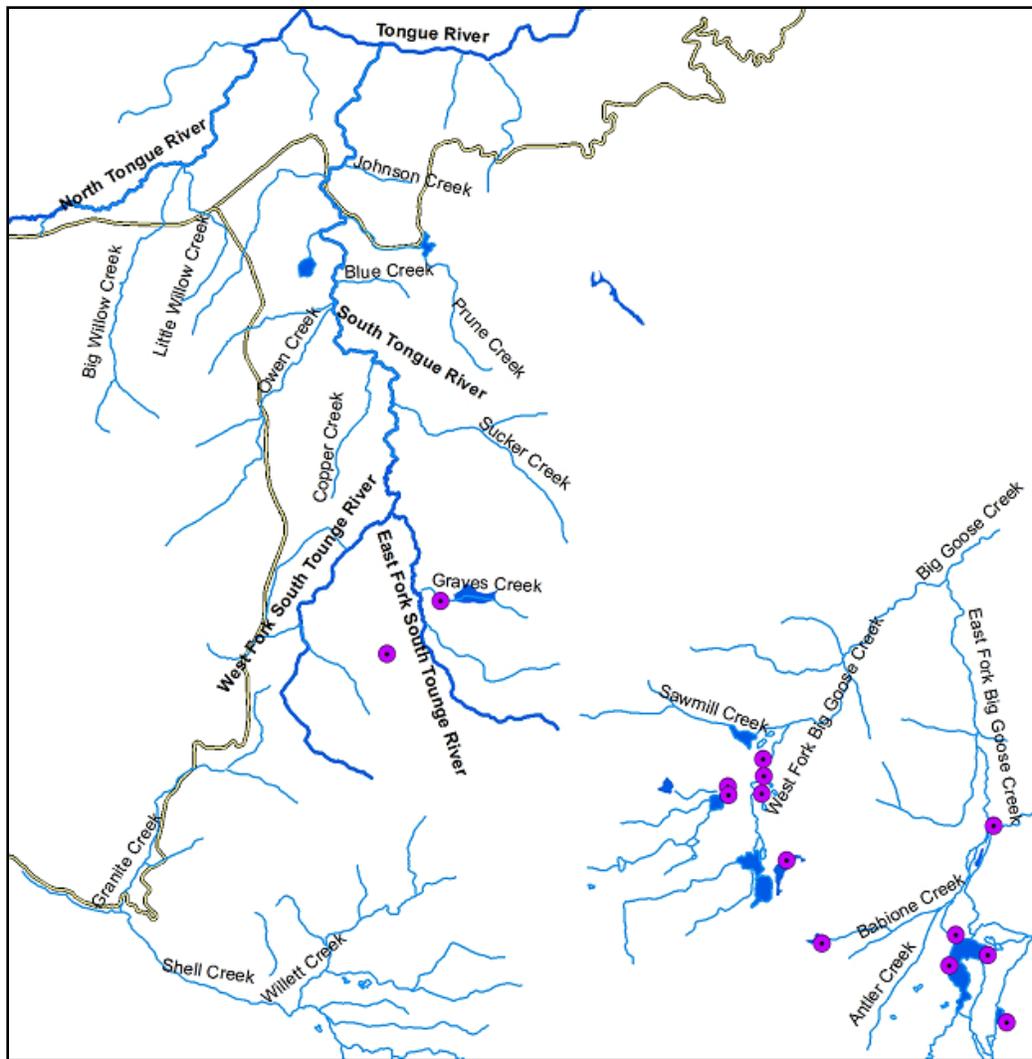


FIGURE A-4: Survey start locations where at least one Wood Frog or egg mass was observed during 2009 or 2010.

## APPENDIX B: WGFD Survey Site, 2009-2010

| Site Name                             | Start Easting | Start Northing |
|---------------------------------------|---------------|----------------|
| Big Willow Creek                      | 297762        | 4958703        |
| Bonanza Creek                         | 306306        | 4952413        |
| Bruce/Prospect Creek                  | 303206        | 4947303        |
| Bull Creek                            | 295111        | 4959498        |
| Copper Creek                          | 305454        | 4954165        |
| Dome Lake Wetland                     | 318392        | 4939595        |
| Dry Gulch                             | 295235        | 4961207        |
| Duncan Lake                           | 306010        | 4946268        |
| E Fork South Tongue                   | 306501        | 4950667        |
| E. Big Goose Creek                    | 317883        | 4942414        |
| E. Big Goose/Beaver Ditch             | 324731        | 4939628        |
| Graves Creek                          | 307470        | 4948253        |
| Johnson Creek                         | 306974        | 4960926        |
| Martin Res.                           | 325529        | 4934651        |
| Owen Creek                            | 302031        | 4954154        |
| Park Reservoir- Eastside ponds        | 324936        | 4937107        |
| Park Reservoir- Northside Ponds       | 324146        | 4937401        |
| Park Reservoir- Westside Ponds        | 323768        | 4937257        |
| Prospect Creek                        | 301606        | 4946323        |
| Prune Creek                           | 307233        | 4958752        |
| Sawmill Lakes                         | 318159        | 4943814        |
| Sibley Lake                           | 307103        | 4959183        |
| Snail Creek/Big Goose Creek           | 317008        | 4942113        |
| South Tongue/ Prune Creek             | 304652        | 4960038        |
| South Tongue/Bonanza Creek            | 305995        | 4951349        |
| South Tongue/Graves Creek             | 307091        | 4948209        |
| Sucker Creek                          | 308631        | 4953376        |
| Tie Flume                             | 306170        | 4954303        |
| Twin Lakes                            | 316283        | 4942029        |
| Twin Lakes - Southern Ponds           | 318034        | 4941897        |
| Unknown campground near Bonanza Creek | 306029        | 4953175        |
| Upstream Dead Swede                   | 306212        | 4950822        |
| Weston Res.                           | 319717        | 4937155        |

| <b>Site Name</b>                      | <b>Stop Easting</b> | <b>Stop Northing</b> |
|---------------------------------------|---------------------|----------------------|
| Big Willow Creek                      | 297752              | 4958688              |
| Bonanza Creek                         | 307133              | 4952027              |
| Bruce/Prospect Creek                  | 303129              | 4947097              |
| Bull Creek                            | 295319              | 4959992              |
| Copper Creek                          | 305409              | 4955111              |
| Dome Lake Wetland                     | 318604              | 4939771              |
| Dry Gulch                             | 296856              | 4960199              |
| Duncan Lake                           | 306010              | 4946268              |
| E Fork South Tongue                   | 306694              | 4950318              |
| E. Big Goose Creek                    | 317883              | 4942414              |
| E. Big Goose/Beaver Ditch             | 325109              | 4940842              |
| Graves Creek                          | 307683              | 4947938              |
| Johnson Creek                         | 307063              | 4960771              |
| Martin Res.                           | 325529              | 4934651              |
| Owen Creek                            | 302104              | 4954363              |
| Park Reservoir- Eastside ponds        | 324941              | 4936780              |
| Park Reservoir- Northside Ponds       | 323933              | 4937425              |
| Park Reservoir- Westside Ponds        | 323717              | 4936442              |
| Prospect Creek                        | 301810              | 4946670              |
| Prune Creek                           | 308472              | 4957878              |
| Sawmill Lakes                         | 317860              | 4942957              |
| Sibley Lake                           | 307103              | 4959183              |
| Snail Creek/Big Goose Creek           | 316749              | 4942093              |
| South Tongue/ Prune Creek             | 304652              | 4960038              |
| South Tongue/Bonanza Creek            | 305977              | 4952041              |
| South Tongue/Graves Creek             | 306918              | 4948192              |
| Sucker Creek                          | 308396              | 4953381              |
| Tie Flume                             | 306106              | 4953981              |
| Twin Lakes                            | 316759              | 4941808              |
| Twin Lakes - Southern Ponds           | 317812              | 4941861              |
| Unknown campground near Bonanza Creek | 306287              | 4953316              |
| Upstream Dead Swede                   | 306399              | 4950546              |
| Weston Res.                           | 319717              | 4937155              |

**APPENDIX C: A visual guide for identifying Columbia Spotted Frogs, Wood Frogs, and Northern Leopard Frogs in the field.**

**Adult Differentiation:**

*Columbia Spotted Frog*

|   |  |
|---|--|
|    | <p><b>Dorsal Characteristics</b></p> <ul style="list-style-type: none"> <li>• Adult snout to vent length approximately 2.8 inches for females and 2.4 inches for males.</li> <li>• Dorsal skin has warty texture.</li> <li>• Tympanum indistinct</li> <li>• Dorsolateral lines present, but may be indistinct in adults.</li> <li>• Irregular dark spotting along dorsum.</li> <li>• Spots lack light borders.</li> <li>• Spots may have light centers.</li> <li>• Mask and light upper jaw stripe present.</li> </ul> |
|  | <p><b>Ventral Characteristics</b></p> <ul style="list-style-type: none"> <li>• Red to orange coloration on lower abdomen, legs, and groin.</li> <li>• Throat and upper belly speckled with black.</li> </ul>   |

*Wood Frog*



**Dorsal Characteristics**

- Adult snout to vent length approximately 5 cm.
- Skin is smooth, but with a few raised lines along back. Lines often with dark borders.
- Dorsolateral lines present and distinct. Dorsolateral lines may be darker than dorsal coloration
- Tympanum equal in size to eye.
- Brown to tan in coloration.
- Sides often dark spotted.
- Mask and light upper jaw stripe present.



Photo by Dan Lewis

**Ventral Characteristics**

- Throat has dark mottled coloration
- Belly is white.

*Northern Leopard Frog*



**Dorsal Characteristics**

- Adult snout to vent length approximately 2.8 inches. However, snout to vent length can exceed 4 inches.
- Tympanum equal to eye in size, and distinct.
- Dorsolateral folds present and distinct. Folds are often lighter in color than dorsal background.
- Dorsal background coloration ranges from brown to light green.
- Large evenly spaced spots along back with light borders.



**Ventral Characteristics**

- Ventral coloration is white.
- May have some dark mottling on sides of throat.

*Chytrid infection:* Chytrid infection may cause the belly and groin of some amphibians to be reddish in coloration (Figure C-1). However, this is only an indication of chytrid infection, as other factors can cause discoloration. PCR analysis of epithelial swabs collected using approved methodology is the only way to confirm infection from amphibian chytrid fungus.



Figure C-1. Northern Leopard Frog exhibiting red coloration thought to occur from chytrid infection.

**Tadpole Differentiation:**

Species of tadpole are often difficult to differentiate in the field. It is recommended that identification of tadpoles be done under a dissecting scope until the identifier feels comfortable with species morphology. If identification remains in doubt, it is recommended that the observer contact the Wyoming Game and Fish Department herpetologist or the Wyoming Natural Diversity Database for assistance. Observers may also wish to revisit the observed locale until juvenile frogs become available. A tutorial and list of terms used in for tadpole identification may be found at <http://www.pwrc.usgs.gov/tadpole/>.

|                       | Labial Tooth Row Formula (LTRF) | Color   | Tail Morphology                                    | Comments   |
|-----------------------|---------------------------------|---|--|--|
| Columbia Spotted Frog | 2/3(1)                          | Dorsum brown to greenish with gold flecking that extends onto tail fin. | Basal tail height ÷ body length = approx. 0.2      | Similar to leopard frog, but with gap in 1 <sup>st</sup> posterior labial tooth row. |
| Wood Frog             | 3/4                             | Dorsum dark with clear tail fins, Belly often cream in color            | High dorsal fin originating at tail body junction. | Dorsal tail fin gives a more humped look to tadpole.                                 |
| Northern Leopard Frog | 2/3                             | Dorsum dark with spotting on tail fins                                  | Basal tail muscle height ÷ body length < 0.34      | Older tadpoles may have white stripe above mouth.                                    |

## Egg Differentiation:

|   |  |
|---|--|
|    | <p><b>Columbia Spotted Frog</b></p> <ul style="list-style-type: none"><li>• Laid in 2 to 5 inch clusters of 150-2000 eggs.</li><li>• Eggs are usually unattached, and located in vegetation near shoreline</li><li>• Eggs may be laid in large communal groups</li><li>• Eggs often found at surface of water</li><li>• Egg mass similar in appearance to Wood Frog</li></ul>                |
|   | <p><b>Wood Frog</b></p> <ul style="list-style-type: none"><li>• Laid in 2 to 5 inch clusters of 500 - 3000 eggs.</li><li>• Often attached to submerged structure.</li><li>• Egg mass often found near surface of water.</li><li>• Egg masses fairly "flimsy" with large amounts of clear jelly spacing out eggs.</li><li>• Egg mass similar in appearance to Columbia Spotted Frog</li></ul> |
|  | <p><b>Northern Leopard Frog</b></p> <ul style="list-style-type: none"><li>• Laid in 2 to 6 inch clusters of up to 65,000 eggs</li><li>• Eggs are black on one side and white on the other.</li><li>• Eggs are often attached to vegetation or resting on bottom substrate. Typically not found near surface of water.</li></ul>  |