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Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the Northern Leopard Frog in the Western United States as Threatened; Proposed Rule

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R2–ES–2009–0030; 92210–1111–FY08–B2]

Endangered and Threatened Wildlife and Plants; 12–Month Finding on a Petition To List the Northern Leopard Frog in the Western United States as Threatened

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service, announce a 12-month finding on a petition to list the northern leopard frog (*Lithobates* (=*Rana*) *pipiens*) under the Endangered Species Act of 1973, as amended (Act). After review of the best scientific and commercial information, we find that listing the northern leopard frog is not warranted at this time. However, we ask the public to submit to us any new information that becomes available concerning threats to the northern leopard frog or its habitat at any time.

DATES: The finding announced in this document was made on October 5, 2011.

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov* at Docket Number FWS–R2–ES–2009–0030. Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, Arizona Ecological Services Office, 2321 West Royal Palm Road, Suite 103, Phoenix, AZ 85021. Please submit any new information, materials, comments, or questions concerning this finding to the above street address.

FOR FURTHER INFORMATION CONTACT: Steven L. Spangle, Field Supervisor, Arizona Ecological Services Office (see **ADDRESSES**); by telephone at (602) 242–0210; or by facsimile at (602) 242–2513. If you use a telecommunications device for the deaf (TDD), please call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Act (16 U.S.C. 1531 *et seq.*), requires that, for any petition to revise the Federal Lists of Endangered and Threatened Wildlife and Plants that contains substantial scientific or commercial information that listing the species may be warranted, we make a finding within 12 months of the date of receipt of the petition. In our finding, we are required to determine if the petitioned action is: (a) Not warranted, (b) warranted, or (c) warranted, but the immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are endangered or threatened, and expeditious progress is being made to add or remove qualified species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding, that is, requiring a subsequent finding to be made within 12 months. We must publish these 12-month findings in the **Federal Register**.

Previous Federal Actions

On June 5, 2006, we received a petition from the Center for Native Ecosystems, Biodiversity Conservation Alliance, Defenders of Black Hills, Forest Guardians, Center for Biological Diversity, The Ark Initiative, Native Ecosystems Council, Rocky Mountain Clean Air Action, and Mr. Jeremy Nichols requesting that the northern leopard frog (*Lithobates* (=*Rana*) *pipiens*) occurring in the western United States (Arizona, California, Colorado, Idaho, Iowa, Minnesota, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming) be listed as a threatened distinct population segment (DPS) under the Act. The petition contained detailed information on the natural history, biology, current status, and distribution of the western population of the northern leopard frog. It also contained information on what the petitioners reported as potential threats to the western population of the northern leopard frog such as habitat loss and degradation, predation and competition by nonnative species, disease, water pollution, climate change, and other factors. We acknowledged the receipt of the petition in a letter to the petitioners dated August 7, 2006. That letter explained that we would not be able to address their petition at that time. The reason for this delay was that responding to court orders and settlement agreements for other listing actions required nearly all of our listing funding.

In reviewing the petition, there were two issues for which the Service requested clarification from the petitioners. We were petitioned to list the population west of the Mississippi River and the Great Lakes region in the United States and south of the international boundary between the United States and Canada. However, although Wisconsin is located west of the Great Lakes region, the petition map did not show Wisconsin as a part of the petition, and the status of the species is not mentioned in that State. Therefore, we requested that the petitioners clarify whether they intended to include or exclude Wisconsin from the petitioned DPS. We also sought clarification as to whether the petitioners were requesting that we review only the western U.S. population of the northern leopard frog as a DPS or if they were also requesting us to consider listing the entire species or a significant portion of the range of the species. The petitioners responded to our clarification request in a letter dated February 8, 2008, requesting we review whether Wisconsin should be included in the western U.S. population of the northern leopard frog. In addition, the petitioners clarified that, if we find that listing the western U.S. population of northern leopard frogs as a DPS is not warranted, we review whether listing the entire species is warranted because of threats in a significant portion of its range.

On July 1, 2009, we published our 90-day finding (74 FR 31389) that the petition presented substantial scientific information indicating that listing the western population of the northern leopard frog may be warranted, and we initiated a status review to determine if listing the species as a DPS or throughout all or a significant portion of its range is warranted. Our July 1, 2009, 90-day finding opened a 60-day period to send us information for our status review. On October 28, 2009, we reopened this information solicitation period for our status review for an additional 30 days, ending November 27, 2009 (74 FR 55525). This notice constitutes our 12-month finding on the February 8, 2008, petition to list the northern leopard frog.

Species Information

Below we provide information relevant to understanding the analysis of information pertaining to the five factors. See Rorabaugh (2005) for a more complete description of the distribution and life history of the northern leopard frog.

Taxonomy

The northern leopard frog is in the family Ranidae (Lannoo 2005, p. 371), the true frogs, and is one of about 28 species within the genus *Lithobates* (formerly *Rana* (Frost *et al.* 2006, p. 10;

Frost *et al.* 2008, pp. 7–8)) that occur in North America (Lannoo 2005, p. 371). For more than a century, nomenclatural and taxonomic confusion has surrounded members of the *Lithobates* (=*Rana*) complex (Moore 1944, p. 349; Pace 1974, pp. 11–16; Merrell 1977, pp. 1–2; Hillis *et al.* 1983, p. 132 among others), and there is a wealth of literature from the late 1800s to present day that has attempted to accurately describe the different species and geographic variation within the complex. Until recently, all North American ranid frogs (frogs in the family Ranidae) were included within the single genus *Rana*. However, Frost *et al.* (2006, p. 10) placed most of these species into the genus *Lithobates.* This change is recognized by the Committee on Standard English and Scientific Names, which is the official names list of the American Society of Ichthyologists and Herpetologists, the Herpetologists' League, and the Society for the Study of Amphibians and Reptiles (Frost *et al.* 2008, pp. 7–8). Accordingly, the Service also recognizes and accepts Frost *et al.'*s (2008) *Lithobates* classification.

Physical Description

The northern leopard frog is a slim, smooth-skinned green, brown, or sometimes yellow-green frog with webbed hind feet. The frog is covered with large, oval dark spots, each of which is surrounded by a lighter halo or border (Stebbins 2003, pp. 234–235). The snout (nose) is pointed and the tympanum (eardrum) is round and approximately equal in diameter to the eye (Baxter and Stone 1980, p. 41). Northern leopard frogs have a white stripe on the upper jaw and the dorsolateral folds (paired, glandular ridges that run along each side of the back from behind the eyes to the rear) are light cream to yellow and are continuous (not broken posteriorly). The belly is white to cream-colored, and the posterior thigh has a light background color with dark spots. There are two different color morphs (variants) of the northern leopard frog that most often occur in western Minnesota, eastern North Dakota, and South Dakota (Rorabaugh 2005, p. 570; McKinnel1 *et al.* 2005, p. 7). These color morphs do occur in other locations (for example, see Ammon 2002, p. 11), but they are most prevalent in Minnesota, North Dakota, and South Dakota, as described above. The burnsi morph lacks dorsal spots and the kandiyohi morph has mottled pigment patches (speckles) between the dorsal spots. Adult body lengths (snout-vent) range from 2 to 4.5 inches (in) (5 to 11 centimeters (cm)) (Stebbins 2003, p. 234). Females average slightly larger than males (Leonard *et al.* 1993, p. 138; Werner *et al.* 2004, p. 97). Subadult, or recently metamorphosed frogs (see Biology section below), range in length from 1 to 2 in (2 to 5 cm) (Merrell 1977, pp. 10–11). During the breeding season, males have enlarged or swollen thumbs (innermost digit) on forefeet, and vocal sacs are not apparent except when the frog is calling (Baxter and Stone 1980, p. 41; Hammerson 1999, p. 145). The typical breeding call is a prolonged ''snore'' followed by a series of stuttering croaks or chuckles that tend to accelerate towards the end (Hammerson 1999, p. 145). These vocalizations may be interspersed with chuckling sounds (Stebbins 2003, p. 235).

Northern leopard frogs deposit their egg masses underwater in clusters, which they attach to vegetation. Eggs are laid in a single orange- to grapefruit-sized globular clump, and may be laid individually or communally in groups (Nussbaum *et al.* 1983, p. 182). Each egg mass may contain 645 to 7,648 individual eggs (Rorabaugh 2005, p. 572). The eggs hatch into tadpoles. Tadpoles (the larval stage in the lifecycle of the frog) are dark green to brown above with metallic flecking, and a cream to white translucent underside (Werner *et al.* 2004, p. 97). Tadpoles metamorphose into young frogs. For a detailed description of northern leopard frog tadpoles, see Scott and Jennings (1985, pp. 4–16).

Distribution

The northern leopard frog historically ranged from Newfoundland and southern Quebec, south through the northeast portions of the United States to West Virginia, west across the Canadian provinces and northern and central portions of the United States to British Columbia, Oregon, Washington, and northern California, and south to Arizona, New Mexico, and extreme western Texas (Rorabaugh 2005, p. 570).

Current range maps tend to show an extensive and connected distribution for the northern leopard frog; however, its actual distribution is sparse and fragmented in Washington, Oregon, Idaho, California, Nevada, Arizona, New Mexico, Utah, Colorado, western Montana, and western Wyoming in the western United States (Rorabaugh 2005, pp. 570–571), throughout New England (New Hampshire Fish and Game Department 2005, pp. A208–A209), and in British Columbia, Northern Territories, Alberta, Saskatchewan, and parts of Manitoba in Canada (Committee on the Status of Endangered Wildlife in Canada 2009, p. iii).

Habitat

The northern leopard frog is an amphibian (a cold-blooded vertebrate that spends some time on land, but must breed and develop into an adult in water) and as such is ectothermic (incapable of generating their own body heat) (Wells 2007, p. 2). They have highly permeable skin, which allows for rapid passage of water and gases so that they can use their external environment to regulate body temperature and moisture loss (Wells 2007, pp. 2–3). As part of its complex life history, the northern leopard frog requires a mosaic of habitats, which includes aquatic overwintering and breeding habitats, and upland post-breeding habitats, as well as habitat linkages, to meet the requirements of all of its life stages (Pope *et al.* 2000, p. 2505; Smith 2003, pp. 6–15; Rorabaugh 2005, pp. 571–575). Although aquatic breeding habitat is required for long-term population survival, upland foraging, dispersal, and overwintering habitats are critical if individual leopard frogs are to survive to reproductive maturity. For example, researchers noted an area near Chicago that had low northern leopard frog abundance, but extensive potential aquatic breeding habitat. It was not until habitat surrounding the ponds was restored from scrub forest to grasslands that leopard frog numbers increased dramatically (K.S. Mierzwa, pers. comm. in Pope *et al.* 2000, p. 2506). These complex habitat requirements make northern leopard frogs particularly vulnerable to the impacts of habitat loss and fragmentation. Reduction or removal of these habitats or loss of connectivity between habitat components could reduce the capacity of the landscape to support the species (Pope *et al.* 2000, p. 2505; Green 2005, p. 31).

Northern leopard frogs breed in a variety of aquatic habitats that include slow-moving or still water along streams and rivers, wetlands, permanent or temporary pools, beaver ponds, and human-constructed habitats such as earthen stock tanks and borrow pits (Rorabaugh 2005, p. 572). Successful breeding areas typically do not contain predaceous fish or other predators (Merrell 1968, p. 275; Hine *et al.* 1981, p. 12; Orr *et al.* 1998, p. 92; Smith 2003, pp. 19–21). Emergent vegetation, such as sedges and rushes, are important features of breeding and tadpole habitats (Gilbert *et al.* 1994, p. 468; Smith 2003, pp. 8–9), and tadpoles are most often found in backwaters and still pools (Rorabaugh 2005, p. 572).

Sub-adult northern leopard frogs typically move from breeding areas to

feeding sites along the borders of larger, more permanent bodies of water, as smaller frogs are closely tied to water (Merrell 1970, p. 49). Recently metamorphosed frogs will move up and down drainages and across land in an effort to disperse from breeding areas (Seburn *et al.* 1997, p. 69) and may disperse more than 0.5 mile (mi) (800 meters (m)) from their place of metamorphosis (Dole 1971, p. 223). Dole (1971, p. 226) found that dispersal in Michigan occurred on warm, rainy nights and that frogs dispersed overland; however, warm rains are not common in all parts of the species' range and other dispersal routes may be important as well. Streams are an important corridor for dispersing juvenile frogs (Seburn *et al.* 1997, pp. 68–69), and vegetated drainage ditches may also facilitate connectivity between seasonal habitats (Pope *et al.* 2000, p. 2505). In some areas of the western United States, subadults may remain in the breeding habitat within which they metamorphosed (Smith 2003, p. 10).

In addition to the breeding habitats, adult northern leopard frogs require stream, pond, lake, or river habitats for overwintering and upland habitats adjacent to these areas for summer feeding. In summer, adults and juveniles commonly feed in open or semi-open wet meadows and fields with shorter vegetation, usually near the margins of water bodies, and seek escape cover underwater. Post-breeding summer habitats do not include barren ground, open sandy areas, heavily wooded areas, cultivated fields, heavily grazed pastures, or mowed lawns (Rorabaugh 2005, p. 573). Buffer zones around wetland breeding sites should be maintained for movement to surrounding upland foraging habitat. Rittenhouse and Semlitsch (2007, p. 154) collected data from 13 published radio telemetry and tagging studies looking at frog and salamander use of terrestrial habitat surrounding wetlands. They found that, on average, a buffer width of 1,877 ft (572 m) around the breeding site is needed to encompass the non-breeding habitat used by 90 percent of the frogs in a given population (Rittenhouse and Semlitsch 2007, pp. 155–157).

During winter, northern leopard frogs are thought to hibernate underwater in ponds, in lakes, or on the bottom of deeper streams or waters that do not freeze to the bottom and that are well-oxygenated (Nussbaum 1983, p. 181; Stewart *et al.* 2004, p. 72). Northern leopard frogs are intolerant of freezing and of waters that have severely reduced or complete loss of dissolved oxygen. If these conditions occur during hibernation, death of northern leopard frogs is likely (Rorabaugh 2005, p. 574).

Based upon their research in Wisconsin, Hine *et al.* (1981) described the ideal ''breeding pond'' as having the following features:

(1) The pond or wetland site should be located within approximately 1.0 mile (mi) (1.6 kilometers (km)) of suitable overwintering habitat (larger bodies of water) so that adults can find the breeding habitat when they emerge in the spring and juvenile frogs are able to find overwintering sites in the fall.

(2) In the spring, the water depth should be approximately 5 ft (1.5 m) or more so that there is balance of open water and vegetation cover.

(3) Emergent vegetation (such as sedge, bulrush, and cattail) should occur along at least two-thirds of the pond or wetland to provide escape cover and places to attach egg masses.

(4) The slope should be gradual to promote habitat for emergent vegetation.

(5) Natural terrestrial habitats should be maintained peripheral to wetlands summer habitat for adults post-breeding, for juvenile growth, and for dispersal or movement corridors.

(6) Water should be relatively permanent throughout the year, but should dry every decade or so in order to eliminate any predaceous fish that become established.

Water quality and temperature are important determinants of northern leopard frog habitat. Because northern leopard frogs have permeable skin, which may transfer external contaminants to its internal organs, good (*i.e.,* non-polluted) water quality is important at breeding locations. Chemical contamination of habitats can result in malformations, population declines, decreased growth rates, reduced activity, and other impacts to northern leopard frogs (Diana and Beasley 1998, pp. 267–276). Temperature plays an important role in both the springtime migratory and breeding behaviors of northern leopard frogs (Merrell 1970, pp. 50–51; Merrell 1977, pp. 5–6, 9). When ambient air temperature is greater than or equal to 50 degrees Fahrenheit (°F) (10 degrees Celsius (°C)), northern leopard frogs move from their overwintering sites to their breeding sites (Merrell 1970, p. 50). The calling sites and areas where egg masses are deposited are not random and appear to be chosen based upon temperature as these activities tend to be located in the warmest portions of breeding ponds (Merrell 1977, p. 6).

Biology

As soon as males leave overwintering sites, they travel to breeding ponds and call in shallow water (Smith 2003, p. 13). Breeding typically occurs during a short period in the spring beginning in early April (Pace 1974, p. 92; Corn and Livo 1989, p. 4); at higher elevations and more northern latitudes, the onset of breeding is late April to early May (Corn and Livo 1989, p. 5; Gilbert *et al.* 1994, p. 467). Most northern leopard frogs are sexually mature at age 2, although the age of sexual maturity may vary from age 1 to age 3 in any given population depending upon environmental conditions (Leclair and Castanet 1987, p. 368; Gilbert *et al.* 1994, pp. 468–469). Male frogs attract females by calling from specific locations within a breeding pond when temperatures are close to 68 °F (20 °C) or more, with several males typically calling together to form a chorus (Merrell 1977, p. 7). Eggs are typically laid within breeding habitats, 2 to 3 days following the onset of chorusing (Corn and Livo 1989, p. 5). Eggs are laid in non-acidic, shallow (4 to 26 in (10 to 65 cm)), still water that is exposed to sunlight, and are usually attached to emergent vegetation just below the water surface (Merrell 1977, p. 6; Gilbert *et al.* 1994, pp. 467–468; Pope *et al.* 2000, p. 2505). Egg masses may include several hundred to several thousand eggs (Corn and Livo 1989, pp. 6–7) and are deposited in a tight, oval mass (Rorabaugh 2005, p. 572). Time to hatching is correlated with temperature and ranges from 2 days at 81 °F (27 °C) to 17 days at approximately 53 °F (12 °C) (Nussbaum *et al.* 1983, p. 182).

Tadpoles are the ephemeral, feeding, non-reproductive, completely aquatic larvae in the life cycle of the frog (McDiarmid and Altig 1999, p. 2). The length of time required for metamorphosis (the development of the aquatic tadpole to a frog) is variable, and depending upon temperature, may take 3 to 6 months from time of egg-laying (Merrell 1977, p. 10; Hinshaw 1999, p. 105). Northern leopard frog tadpoles are predominantly generalist herbivores (plant eaters), typically eating attached and free-floating algae (Hoff *et al.*1999, p. 215); however they may feed on dead animals (Hendricks 1973, p. 100). Adult and subadult frogs are generalist insectivores (insect eaters) that feed on a variety of terrestrial invertebrates such as insect adults, larvae, spiders, and leeches (Merrell 1977, p. 15; Collier *et al.* 1998, p. 41; Smith 2003, p. 12; Rorabaugh 2005, p. 575). In addition, adult northern leopard frogs have also been known to prey upon small

northern leopard frogs, birds, and snakes (Merrell 1977, p. 15).

Status

Northern leopard frogs, like many amphibian populations, are dynamic, and their individual numbers may naturally fluctuate in size within populations. However, across the range of the northern leopard frog, information suggests that there is an ongoing loss of populations throughout the species' range. The loss of populations across the landscape is what results in species' declines (Green 2005, p. 29). Population declines of northern leopard frogs are well-documented in the western United States and western Canada, but are also documented rangewide (through the Midwestern and Eastern United States), as described below.

The most recent complete summary of distributional and abundance patterns of the northern leopard frog is from Rorabaugh (2005, pp. 570–571), which documents a substantial contraction of the species' range, especially in the western two-thirds of the United States, where widespread extirpations have occurred. Other authors have also compiled summary data indicating population declines (*e.g.,* Smith and Keinath 2007, p. 14). Since the 1960s, the northern leopard frog has experienced significant declines and losses throughout its range (Gibbs *et al.* 1971, p. 1028), particularly in the western United States and western Canada, and tends to become less abundant the farther west one proceeds (Corn and Fogelman 1984, p. 150; Hayes and Jennings 1986, p. 491; Clarkson and Rorabaugh 1989, p. 534; Corn *et al.* 1989, pp. 26–29; Koch and Peterson 1995, pp. 84–87; Corn *et al.* 1997, pp. 37–38; Weller and Green 1997, p. 323; Casper 1998, p. 199; Hammerson 1999, pp. 146–147; Leonard *et al.* 1999, p. 51; Dixon 2000, p. 77; Smith 2003, pp. 4–6; Jennings and Fuller 2004, pp. 125–127; Werner *et al.* 2004, pp. 97–98; Committee on the Status of Endangered Wildlife in Canada 2009, p. v; Germaine and Hays 2009, p. 537; Johnson *et al.* 2011, p. 557).

Based upon this and other information, the northern leopard frog appears to be declining, is considered rare, or is locally extirpated from many historical locations in Arizona, California, Colorado, Idaho, Iowa, Minnesota, Missouri, Montana, Nebraska, Nevada, New Mexico, Oregon, Texas, Utah, Washington, Wisconsin, and Wyoming (Hayes and Jennings 1986, p. 491; Stebbins and Cohen 1995, p. 220; Johnson and Batie 1996; Bowers *et al.* 1998, p. 372; Casper 1998, p. 199; Lannoo 1998, p. xvi; Mossman *et al.* 1998, p. 198; Smith 2003, pp. 4–6; Smith and Keinath 2004, pp. 57–60; McCleod 2005, pp. 292–294; Rorabaugh 2005, p. 571; Johnson *et al.* 2011, p. 561). The species is nearly extirpated from almost 100 percent of its historical range in Texas, California, Oregon, and Washington (Stebbins and Cohen 1995, p. 220; McAllister *et al.* 1999, p. 15; Stebbins 2003, p. 235; Germaine and Hays 2009, p. 537).

Table 1 lists current NatureServe ranks for States and provinces in which the northern leopard frog is known to occur. NatureServe conservation status assessment procedures have different criteria, evidence requirements, purposes, and taxonomic coverage than the Federal Lists of Endangered and Threatened Wildlife and Plants, and therefore, these rankings may not coincide with legal listing processes (NatureServe 2008, p. 1). However, for a species as widespread as the northern leopard frog, the NatureServe rankings aid in summarizing the relative risks facing the northern leopard frog throughout its range and are provided here for this reason.

NatureServe lists Maryland and New Jersey as States where the northern leopard frog occurs. However, the Maryland Department of Natural Resources lists the northern leopard frog as an introduced species that occurs in one county (Maryland Department of Natural Resources 2011, p. 2), and the frog does not occur in New Jersey (Gessner and Stiles 2001, pp. 1–9; New Jersey Division of Fish and Wildlife 2006, pp. 1–2).

TABLE 1—NATURESERVE AND STATE, PROVINCE, AND TERRITORY RANKS FOR NORTHERN LEOPARD FROGS IN STATES AND PROVINCES IT IS KNOWN TO OCCUR

[NatureServe 2011, p. 1]

State, province, territory or sovereign nation	Natural heritage program rank*	State, province, territory rank
Arizona	S2 (Imperiled)	Species of Greatest Conservation Need.
California	S2 (Imperiled)	Species of Greatest Conservation Need.
Colorado	S3 (Vulnerable)	Species of Greatest Conservation Need, Species of Special Concern.
Connecticut	S2 (Imperiled)	Special Concern Species.
Idaho	S3 (Vulnerable)	Species of Greatest Conservation Need.
Illinois	S5 (Secure)	Non-game Indicator Species.
Indiana	S2 (Imperiled)	Species of Greatest Conservation Need.
Iowa	S5 (Secure)	No ranking or status.
Kentucky	S3 (Vulnerable)	Species of Greatest Conservation Need.
Maine	S3 (Vulnerable)	Species of Greatest Conservation Need (Priority 3).
Maryland	S4 (Apparently Secure), introduced spp	No ranking or status (considered an introduced species).
Massachusetts	S3/S4 (Vulnerable/Apparently Secure)	Species of Special Concern, Species of Greatest Conservation Need.
Michigan	S5 (Secure)	Species of Greatest Conservation Need.
Minnesota	S4 (Apparently Secure)	No ranking or status.
Missouri	S2 (Imperiled)	Species of Conservation Concern.
Montana	S1/S3 (Critically Imperiled/Vulnerable)	Species of Concern, Species of Greatest Conservation Need.
Navajo Nation (NE Arizona, NW New Mexico, SE Utah).	S2 (Imperiled)	Endangered.
Nebraska	S5 (Secure)	At-Risk Species (Tier II).
Nevada	S2/S3 (Imperiled/Vulnerable)	Species of Conservation Priority.
New Hampshire	S3 (Vulnerable)	Species of Concern.
New Jersey	SNR (Unranked), species not present	Species not present.

TABLE 1—NATURESERVE AND STATE, PROVINCE, AND TERRITORY RANKS FOR NORTHERN LEOPARD FROGS IN STATES AND PROVINCES IT IS KNOWN TO OCCUR—Continued

[NatureServe 2011, p. 1]

State, province, territory or sovereign nation	Natural heritage program rank*	State, province, territory rank
New Mexico	S1 (Critically Imperiled)	Species of Greatest Conservation Need.
New York	S5 (Secure)	No ranking or status.
North Dakota	SNR (Unranked)	No ranking or status.
Ohio	SNR (Unranked)	No ranking or status.
Oregon	S1/S2 (Critically Imperiled/Imperiled)	Sensitive Critical, List 2 Species (threatened with extinction or presumed extinct).
Pennsylvania	S2/S3 (Imperiled/Vulnerable)	Priority Conservation Species (Tier 5).
Rhode Island	S2 (Imperiled)	Species of Greatest Conservation Need.
South Dakota	S5 (Secure)	No ranking or status.
Texas	S1 (Critically Imperiled)	No ranking or status (likely extirpated).
Utah	S3/S4 (Vulnerable/Apparently Secure)	Species of Concern (Tier III).
Vermont	S4 (Vulnerable)	No ranking or status.
Washington	S1 (Critically Imperiled)	Endangered.
West Virginia	S2 (Imperiled)	Species in Greatest Need of Conservation.
Wisconsin	S4 (Vulnerable)	No ranking or status.
Wyoming	S3 (Vulnerable)	Species of Greatest Conservation Need.
Alberta	S2/S3 (Imperiled/Vulnerable)	Threatened.
British Columbia	S1 (Critically Imperiled)	Endangered.
Labrador and Newfoundland	S3/S4 (Vulnerable/Apparently Secure)	No ranking or status.
Manitoba	S4 (Vulnerable)	No ranking or status.
New Brunswick	S5 (Secure)	No ranking or status.
Northwest Territories	SNR (Unranked)	No ranking or status.
Nova Scotia	S5 (Secure)	No ranking or status.
Ontario	S5 (Secure)	Not at risk.
Prince Edward Island	S4/S5 (Apparently Secure/Secure)	No ranking or status.
Quebec	S5 (Secure)	No ranking or status.
Saskatchewan	S3 (Vulnerable)	Interim Species at Risk.

* S1 = Critically Imperiled: At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
S2 = Imperiled: At high risk of extinction due to restricted range, few populations (often 20 or fewer), steep declines, or other factors.
S3 = Vulnerable: At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors. Such species are often rare or found locally in a restricted range.
S4 = Apparently Secure: Uncommon but not rare; some cause for long-term concern due to declines or other factors. Such species are likely to be quite rare in parts of their range, especially at the periphery.
S5 = Secure: Common; widespread and abundant. Such species are potentially rare in parts of their range, especially at the periphery.
SNR = Unranked. State or Province conservation status not yet assessed.

The International Union for the Conservation of Nature's ''Red List Categories and Criteria'' were developed for classifying species at high risk of global extinction (IUCN 2003, p. 1), and as such have different criteria, evidence requirements, purposes, and taxonomic coverage than the Federal Lists of Endangered and Threatened Wildlife and Plants. However, just as with the NatureServe data, because we are reviewing the entire range of the northern leopard frog, the International Union for the Conservation of Nature assessment is useful in summarizing the current status of the northern leopard frog throughout its range.

The International Union for the Conservation of Nature currently lists the northern leopard frog as a species of 'least concern' in view of its wide distribution, tolerance to degree of habitat modification, and presumed large population (Hammerson *et al.* 2004, p. 2). The International Union for the Conservation of Nature states that the population trend is decreasing (Hammerson *et al.* 2004, p. 3), but the authors believe that the northern leopard frog is not declining fast enough to qualify for listing in a more threatened category (Hammerson *et al.* 2004, p. 2). The International Union for the Conservation of Nature reviewed Hammerson *et al.* (2004, pp. 1–6) in 2011, and no updates were made to the 2004 review. Since 2004, Rorabaugh (2005, pp. 570–577) completed a status review for the northern leopard frog in the United States (Rorabaugh 2005, pp. 570–577), and the Committee on the Status of Endangered Wildlife in Canada published the Assessment and Update Status Report for the Northern Leopard Frog in Canada (Committee on the Status of Endangered Wildlife in Canada 2009, pp. 1–76). The Rorabaugh (2005, pp. 570–577) status review found that for a variety of reasons the northern leopard frog is declining throughout its range, but particularly in the western United States. The Committee on the Status of Endangered Wildlife in Canada (2009, pp. iii) assessment notes that there are continued declines for the northern leopard frog throughout the western provinces and evidence of declines in eastern Canada. The current International Union for the Conservation of Nature review does not cite either of these documents or provide any current threats assessment. The International Union for the Conservation of Nature analysis for the northern leopard frog also includes leopard frogs in Panama, which likely belong to the *Lithobates* complex, but do not belong to the same species as the northern leopard frog. Therefore, we do not consider the International Union for the Conservation of Nature review for the northern leopard frog a current assessment of the species' status in North America.

Western States

Until the late 1970s, northern leopard frogs were widespread and abundant in much of northern Arizona (Apache, Coconino, Greenlee, Mohave, Navajo, and Yavapai Counties) in springs, streams, rivers, stock tanks, and lakes throughout northern Arizona (Arizona Game and Fish Department 2009, p. 1).

Currently, there is one northern leopard frog population located near Seligman, Arizona; a metapopulation (several breeding locations in close proximity to one another) located south of Flagstaff, Arizona; and three refugial sites developed by the State and Service (and other partners) to assist in stocking northern leopard frogs to other locations in Arizona, north of the Colorado River. All of these locations are located in Coconino County. Outside of these locations, fairly rigorous visual encounter surveys conducted within the species' historical range, including Grand Canyon National Park and the Kaibab National Forest, have not located northern leopard frogs (Kaibab National Forest 2007, p. 1; Kaibab National Forest 2008, p. 1; Drost *et al.* 2008, p. 7). The species is listed as a Species of Greatest Conservation Need in the Arizona State Wildlife Action Plan (Arizona Game and Fish Department 2006, Appendix M, p. 153) and has a NatureServe rank of S2 (Imperiled) (NatureServe 2011, p. 1). In Arizona, there is no open season for northern leopard frog, and collecting is illegal except as authorized by State permit, effective January 1, 1993 (Commission Order 41). The northern leopard frog has also significantly declined on the Navajo Nation (which is situated in southeastern Utah, northeastern Arizona, and northwestern New Mexico) in the last century. Most remote desert populations of northern leopard frogs were lost between the 1920s and 1970s, and mountain populations were lost in the late 1980s. The Navajo Nation has listed the northern leopard frog as a ''Group 2—Endangered Species'' on the Navajo Endangered Species List, which means its prospects of survival or recruitment on the Navajo Nation are in jeopardy (Navajo Nation Department of Fish and Wildlife 2009, p. 3).

The northern leopard frog is a State of California species of special concern and is listed as a Species of Special Concern (native populations only) (California Department of Fish and Game, Natural Diversity Database, 2009) and as a Species of Greatest Conservation Need in California Department of Fish and Game's State Wildlife Action Plan (California Department of Fish and Game 2007); however, the northern leopard frog is not listed under the California Endangered Species Act. The northern leopard frog may be taken under the authority of a sport fishing license, subject to restrictions (California Code of Regulations, Title 14, Section 5.05). The frog is ranked S2 (Imperiled) by NatureServe (NatureServe 2011, p. 1). Northern leopard frogs are likely native to the region east of the Sierra Nevada-Cascade crest in the following areas of California: upper Pit River basin (Shasta, Lassen, and Modoc counties), Surprise Valley (Modoc County), lower Klamath Lake basin (Siskiyou County), Lake Tahoe region (El Dorado County), Carson River drainage (Alpine County) and Owens River Valley (Mono and Inyo counties) (Jennings and Fuller 2004, p. 122). The northern leopard frog was introduced to at least 15 other sites in California, but most of these introductions have not resulted in naturalized populations that continue to exist today (Jennings and Hayes 1994, p. 80; Jennings and Fuller 2004, p. 119). There is a small, introduced population in Merced County, near the Merced National Wildlife Refuge (NWR) that persisted as recently as 2007 (Jennings and Fuller 2004, pp. 119, 127; Woolington 2009, pers. comm.). Since the 1970s, northern leopard frogs have disappeared from most (approximately 95 percent) of their historic range in California, (Jennings and Fuller 2004, p. 119; Rorabaugh 2005, p. 571) and may be completely extirpated from these areas of the State as we are not aware of any recent confirmed sightings. Jennings and Hayes (1994, p. 82) knew of only two extant, native northern leopard frog populations as of the 1990s: one adult was observed at Tule Lake National NWR (Siskiyou County) in 1990, and 8 to 10 juveniles were found near Pine Creek in Round Valley near Bishop (Inyo County) in 1994. Northern leopard frogs are no longer found on Tule Lake NWR (Adams 2011, pers. comm.), and no northern leopard frogs have been observed during amphibian surveys conducted on the Klamath Falls NWR Complex, including Tule Lake NWR (Austin 2009, pers. comm.). Recent surveys conducted by the California Department of Fish and Game did not locate any northern leopard frogs in the Owens River Area (Becker 2011, pers. comm.). In addition, surveys found that sites previously considered to be northern leopard frog habitat now contain nonnative aquatic species, and the habitat has been extensively modified such that there are likely few areas of suitable habitat left in the Owens Valley (Becker 2011, pers. comm.). Northern leopard frogs have not been found in the Lake Tahoe basin for over 20 years, and the species is presumed to be extirpated from the area (Jennings and Fuller 2004, p. 125). Jennings and Fuller (2004, p. 126) also report that a formerly isolated native northern leopard frog population on Hat Creek, Shasta County, is now apparently extirpated as well. Modoc NWR in northeastern California reported no known occurrences of northern leopard frogs on the refuge in recent times, and no northern leopard frogs were reported during numerous hours of amphibian survey time in 2004, 2005, and 2010 (Bachman 2011, pers. comm.).

The northern leopard frog was historically quite common throughout Colorado, but over the last 30 to 40 years, populations have declined and even been locally extirpated from portions of eastern and north-central Colorado, including Rocky Mountain and Mesa Verde National Parks (Corn and Fogleman 1984, p. 148; Corn *et al.* 1989, p. 15; Stebbins and Cohen 1995, p. 220; Corn *et al.* 1997, pp. 37–38; Hammerson 1999, pp. 146–147; Mesa Verde National Park 2009, p. 1; Johnson *et al.* 2011, p. 561). The Colorado Division of Wildlife has designated the northern leopard frog a Species of Greatest Conservation Need as well as a Species of Special Concern due to low population status and a declining population trend (Colorado Division of Wildlife 2006, pp. 2, 28, 305). These are not statutory categories; however, the northern leopard frog is classified as ''nongame'' wildlife and their harassment, taking, or possession is prohibited without a permit (Colorado Division of Wildlife 2009, p. 3). NatureServe ranks the northern leopard frog as S3 (Vulnerable) in Colorado (NatureServe 2011, p. 1). Intensive surveys conducted from 2007 through 2009 in the Front Range of Colorado indicate that northern leopard frogs there have become rare and documented losses are widespread (Johnson and McKenzie 2009, p. 9; Keeley 2009, pp. 5–6; Johnson *et al.* 2011, p. 562). Historically, northern leopard frogs were found at high densities in this region (Johnson *et al.* 2011, p. 562). Along the Western Slope (the area west of the continental divide in Colorado), data suggest that northern leopard frog populations remain viable, especially in the northern region (Johnson and McKenzie 2009, p. 10). This supports information from Arapaho and Browns Park NWRs, both located in northwestern Colorado, that continue to support northern leopard frogs (Johnson 2009, pers. comm.; Smart 2009, pers. comm.). Northern leopard frogs were the most common amphibian in southwest Colorado until the late 1960s, but now they are rare (San Miguel 2009, pers. comm.). Despite conducting amphibian surveys for 15 years with an emphasis on locating northern leopard frogs, none have been detected within Mesa Verde National Park, Colorado. Historically,

this species was found abundantly along the Mancos River in the park and adjacent lands (San Miguel 2009, pers. comm.). However, the overall status of the northern leopard frog in western Colorado is not currently known (Johnson *et al.* 2011, p. 563).

The Idaho Department of Fish and Game designated the northern leopard frog a Type 2 Species of Greatest Conservation Need (Idaho Department of Fish and Game 2005, Appendix B p. 6). A Type 2 species of greatest conservation need is defined as a rangewide or globally imperiled species that is experiencing significant declines throughout its range with a high likelihood of being listed in the foreseeable future due to its rarity (Idaho Department of Fish and Game 2005, Appendix B, p. 4). Reduced distribution and a declining population trend are noted in the Idaho Comprehensive Wildlife Conservation Strategy as reasons for the designation (Idaho Department of Fish and Game 2005, Species Account, p. 1). The northern leopard frog is also a protected nongame species, which means take or possession of the species is prohibited without a permit (Idaho Administrative Code 13.01.06–300.02). NatureServe ranks the northern leopard frog in Idaho as S3 (Vulnerable) (NatureServe 2011, p. 1). Both the Targhee National Forest and Kootenai NWR have records of northern leopard frogs from the 1970s (Service 1972, p. 11; Stebbins and Cohen 1995, p. 220). However, surveys in 1992 at 98 sites on the Targhee National Forest did not locate northern leopard frogs (Stebbins and Cohen 1995, p. 220), and Kootenai NWR has no records of frogs for the last 30 years (Rose 2009, pers. comm.). Deer Flat NWR amphibian surveys have only detected American bullfrogs (*Lithobates catesbeiana*). Northern leopard frogs are known to be present on Bear Lake, Grays Lake, and Minidoka NWRs, and presumed to be present on Camas NWR and Oxford Slough Wetland Protection Area (WPA) (Fisher and Mitchell 2009, p. 1).

Localized declines of northern leopard frogs are documented in Iowa (Lannoo *et al.* 1994, pp. 317–318; Hemesath 1998, p. 216). Lannoo *et al.* 1994 (p. 311) states, ''From descriptions of the turn-of-the-century commercial ''frogging'' industry in Dickinson County (Iowa), we estimate that the number of leopard frogs has declined by at least two, and probably three orders of magnitude.'' However, the northern leopard frog is ranked as Secure (S5) in Iowa by NatureServe (2011, p. 1) and is not considered a Species of Greatest Conservation Need (Iowa Department of Natural Resources 2006, p. 42). Currently, there is a continuous open season for northern leopard frogs in inland and boundary waters in Iowa, and up to 48 frogs can be collected per day (Iowa Department of Natural Resources 2011, p. 1). In 1991, the Iowa Department of Natural Resources initiated an annual anuran (frog and toad) survey. The survey is conducted by volunteers, and until 2007, volunteers were not required to distinguish between species of leopard frogs on the report forms (Iowa Department of Natural Resources 2009, p. 1). Survey data from 2007 and 2008 (when the species were separated) and older data from counties where it was thought only the northern leopard frog occurred were reviewed by the State. The analyses of this information suggest a possible downward trend in northern leopard frog presence, but the trend was not statistically significant (Iowa Department of Natural Resources 2009, p. 1).

Northern leopard frog populations began declining in Minnesota in the late 1960s or early 1970s (Rittschof 1975, p. 103; Minnesota Department of Natural Resources 2011a, pp. 1–2). The declines of northern leopard frog populations from the past are thought to have been substantial, but information is not detailed enough to know if the population is now stable or if it is still declining in Minnesota (Moriarty 1998, p. 168). However, because the species is still considered to be fairly common, it is not considered a Species of Greatest Conservation Need in Minnesota's Comprehensive Wildlife Strategy (Minnesota Department of Natural Resources 2006, Appendix B p. 9). The Minnesota Department of Natural Resources' northern leopard frog fact page does indicate that the northern leopard frog is still declining (Minnesota Department of Natural Resources 2011a, p. 2). The species is ranked S4 (Apparently Secure) by NatureServe (NatureServe 2011, p. 1). In Minnesota, from May 16 to March 31, licensed anglers and children under age 16 may take, use, buy, and sell an unlimited number of northern leopard frogs up to 6 inches long for bait (Minnesota Department of Natural Resources 2011b, p. 70). A Minnesota Department of Natural Resources commercial license is required to take northern leopard frogs for purposes other than bait.

Missouri is located on the periphery of the range for northern leopard frogs and the frog is currently only known to occur in two counties (Atchison and Mercer) that border Iowa (Missouri Department of Conservation 2009, p. 1). The northern leopard frog is listed as a Species of Conservation Concern by the Missouri Department of Conservation and NatureServe ranks it as Imperiled (S2) (Missouri Department of Conservation 2009, p. 1; NatureServe 2011, p. 1). This ranking is based upon the low number of known occurrences in Missouri and not based upon declining population trends (Missouri Department of Conservation 2009, p. 1). The Missouri Department of Conservation noted that it is likely that more populations are present in northern Missouri, but further surveys need to be completed to affirm this assumption (Missouri Department of Conservation 2009, p. 1). In Missouri, northern leopard frogs have regulatory protection from commercial take and non-resident collection. Missouri residents are allowed to possess up to five northern leopard frogs for education use (Wildlife Code Missouri 3CSR10–9.110); however, these five individuals cannot be sold, traded, shipped over State lines, or taken from public lands (Missouri Department of Conservation 2009, p. 2). Northern leopard frogs also cannot be used as live bait in Missouri (Wildlife Code Missouri 3CSR10–6.605).

Montana Fish, Wildlife, and Parks classified the northern leopard frog as a Species of Concern in Montana and it is considered a Species of Greatest Conservation Need in their Wildlife Conservation Strategy (Montana Fish, Wildlife, and Parks 2009, p. 1). Northern leopard frogs are protected from commercial collection in Montana (Montana Code Annotated 2009 87–5–116). Historically, northern leopard frogs occurred across the eastern plains of Montana and in the mountain valleys on both sides of the Continental Divide (Montana Fish, Wildlife, and Parks 2009, p. 1). However, since the 1990s, most previously known northern leopard frog populations on the west side of the Continental Divide in Montana are considered extirpated, and there has been a clear range contraction of northern leopard frogs (Werner 2003, p. 26; Montana Fish, Wildlife, and Parks 2009, p. 1). Currently, only two populations exist in western Montana. Surveys in the mid-1990s of historically occupied sites in central Montana, east of the Continental Divide, found only 19 percent of the sites to be occupied by northern leopard frogs (Montana Fish, Wildlife, and Parks 2009, p. 1). NatureServe provides a split rank for the State that reflects the difference in status between western (S1 Critically Imperiled) and eastern (S3 Vulnerable) Montana (NatureServe 2011, p. 1). Habitat restoration and survey efforts are being planned Statewide to provide

a current assessment of northern leopard frog distribution (Montana Fish, Wildlife, and Parks, 2009, p. 2).

The northern leopard frog occurs commonly in the State of Nebraska (McLeod 2005, p. 292) and has a NatureServe rank of S5 (Secure) (NatureServe 2011, p. 1). However, surveys conducted in 1997 and 1998 indicated a significant decline in northern leopard frog occurrences at the State level (McLeod 2005, p. 292). It is difficult to ascertain if this information represents a real decline or is representative of normal stochastic events, but data indicated significant differences from location data collected in the 1970s (McLeod 2005, p. 292). The Nebraska Game and Parks Commission identified the northern leopard frog as a Tier II At-Risk Species during development of the Nebraska Natural Legacy Project (2005, p. 319). Tier II species are typically those that are not at-risk from a global or national perspective, but are rare or imperiled within Nebraska. As of 2011, northern leopard frogs can no longer be commercially harvested or sold for bait in Nebraska; however, anglers can still collect them as bait for personal use (Nebraska Game and Parks Commission 2011, p. 5).

In Nevada, northern leopard frogs are currently ranked S2/S3 (Imperiled/Vulnerable) by NatureServe (NatureServe 2011, p. 1) and are on the Nevada Natural Heritage Program's Animal and Plant Watch List, which means they could be declining in Nevada or across much of their range, or may be less common than currently thought and could become at-risk in the future. The northern leopard frog is identified as a Species of Conservation Priority in the Nevada Wildlife Action Plan (Wildlife Action Plan Team 2006, p. 61). In addition, the northern leopard frog is a protected amphibian by Nevada statute (NAC 503.075) and cannot be collected for commercial, recreational, or educational purposes without a permit (Nevada Department of Wildlife 2009, p. 5). The Nevada Department of Wildlife notes that there is little historical or current information available to accurately assess the distribution and status of the northern leopard frog in Nevada (Nevada Department of Wildlife 2009, p. 1). However, recent surveys suggest that northern leopard frogs may no longer be abundant in Nevada and that there have been numerous local extirpations, for example, along the Truckee and Carson rivers in western Nevada and in springs of southern and eastern Nevada (Panik and Barrett 1993, p. 203; Hitchcock 2001, pp. 9, 109–110). While historical records and anecdotal evidence indicated that northern leopard frogs were once widely distributed in the State, the current species distribution is much smaller than the historical distribution (Hitchcock 2001, pp. 9, 38, 48). In addition, suitable northern leopard frog habitat is patchily distributed in the State due to the aridity and isolated nature of many wetland systems, which results in a discontinuous and limited distribution (Nevada Department of Wildlife 2009, p. 1). Recent Nevada Department of Wildlife records document northern leopard frog populations in Ruby Valley (including Ruby Lakes NWR) and Lower Mary's River in Elko and White Pine Counties; Spring Valley and Lake Valley in White Pine County; Lake Valley and Pahranagat Valley (including Pahranagat NWR) in Lincoln County; Carson River near Carson City; the lower Truckee River and Truckee meadows in Washoe County; and a small number of additional sites in western and northeastern Nevada (Hitchcock 2001, pp. 96–102; Service 2009, pp. 1–2; Nevada Department of Wildlife 2009, p. 2). Efforts to restore northern leopard frog habitat and re-establish the species have occurred along the lower Truckee River in western Nevada and on Pahranagat NWR (Horton 2010, pers. comm.; Rogers 2010, p. 7).

Historically, the northern leopard frog was documented from a large area in the northern and western part of New Mexico and along the entire length of the Rio Grande River valley, except southern Elephant Butte and northern Caballo Reservoirs (New Mexico Department of Game and Fish 2009, p. 1). Declines in northern leopard frogs have been reported from the Lower Rio Grande (below Caballo Reservoir), in the Jemez Mountains, and in the Chuska Mountains (Christman 2009, p. 5; New Mexico Department of Game and Fish 2009, p. 2). The species is believed to be extirpated from the Rio Grande Valley, south of Albuquerque (New Mexico Department of Game and Fish 2009, p. 3). Recent survey efforts indicate that northern leopard frogs are persisting in northern New Mexico, but most occupied sites contained small numbers of frogs with very few robust populations (Christman 2009, p. 13). The northern leopard frog is not listed as endangered or threatened in New Mexico under the Wildlife Conservation Act, but was designated a Species of Greatest Conservation Need by the New Mexico Department of Game and Fish, and NatureServe ranks it as S1 (Critically Imperiled) in New Mexico (New Mexico Department of Game and Fish 2006, p. 540; NatureServe 2011, p. 1). The northern leopard frog is protected from commercial take (Section 17–1–14 NMSA); however, take by New Mexico State residents for pets or other uses are uncontrolled (New Mexico Department of Game and Fish 2009, p. 2).

Historically, the northern leopard frog ranged Statewide in North Dakota and is still quite common today (North Dakota Game and Fish Department 2009, p. 1). Northern leopard frogs are widely distributed throughout the State and locally abundant in some locations (Newman 2009, p. 1; Scherr 2009, pers. comm.) but surveys conducted by Bowers *et al.* (1998, p. 372) found that the range of the northern leopard frog was less extensive in the prairie potholes region of North Dakota than previously described. Because of its distribution and local abundance, the northern leopard frog has no special status in the State, and there are no conservation programs that specifically target the northern leopard frog (North Dakota Game and Fish Department 2009, p. 1). Commercial frog licenses are available for unlimited collection of northern leopard frogs (North Dakota Administrative Code 30–03–04). NatureServe does not have a current ranking for North Dakota as it is currently under review (NatureServe 2011, p. 1).

The Oregon Department of Fish and Wildlife ranks the northern leopard frog as a ''Sensitive Critical'' species, meaning that it is imperiled with extirpation from a specific geographic area of the State due to small population sizes, habitat loss or degradation, or immediate threats (Oregon Biodiversity Information Center 2010, p. 7, 13). The sensitive species list is primarily a non-regulatory tool designed to provide a voluntary, proactive approach to conservation (Oregon Department of Fish and Wildlife 2008, p. 1). The Oregon Biodiversity Information Center lists the northern leopard frog as a ''List 2 Species'' meaning that it is threatened with extirpation or presumed to be extirpated from the State of Oregon (Oregon Biodiversity Information Center 2010, pp. 4, 13) and it is ranked S1/S2 (Critically Imperiled/Imperiled) by NatureServe (NatureServe 2011, p. 1). The Oregon Biodiversity Information Center (2010, p. 13), lists the following counties as containing historical locations for the northern leopard frog: Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, Crook, Grant, Baker, Malheur, Klamath, and Jackson Counties. Rorabaugh (2005, p. 571) reported that northern leopard frogs are extirpated from most historical

localities in Oregon. The six records we have from the Oregon Natural Heritage Information Center are observations from 1975, 1980, 1990, 1995, 1996, and 2003. We have found no records, current or historical, to indicate the presence of northern leopard frogs on either the Hart Mountain National Antelope Refuge (southern Oregon) or Sheldon NWR (northern Nevada) (Harper Collins 2009, pers. comm.). Frog surveys were conducted at Sheldon NWR in summer 2009, but they detected only nonnative American bullfrogs.

The status of the northern leopard frog in South Dakota is thought to be stable and NatureServe lists the frog as secure (S5) (South Dakota Department of Game, Fish, and Parks 2009, p. 1; NatureServe 2011, p. 1). The northern leopard has no specific protection in South Dakota and can be collected for commercial and non-commercial bait (South Dakota Laws and Regulations for Commercial Bait Dealers 2009, p. 1; South Dakota Department of Game, Fish, and Parks 2011, p. 23). The species' range includes almost the entire State based upon historical and current distribution maps (Fischer *et al.* 1999, p. 12; Naugle *et al.* 2005, p. 285). Smith *et al.* (2005, p. 9) found northern leopard frogs to be common in the Black Hills, and a Statewide herpetology (amphibian and reptile) survey report indicates that the distribution of the northern leopard frog in the State is stable (Backlund 2004, p. 8). However, there is no historical or recent abundance data to compare current survey data that would indicate population trend (Backlund 2004, p. 9). Information received from Lacreek and Waubay NWRs and the Huron Wetland Management District indicate northern leopard frogs are prevalent (Flannders-Wanner 2009, pers. comm.; Hubers 2009, pers. comm.; Koerner 2009, pers. comm.). Anuran auditory surveys (1997–1998) found northern leopard frogs to be one of the most widespread and wetland-abundant species in eastern South Dakota (Naugle *et al.* 2005, p. 290).

The northern leopard frog's historic range in Texas was in the Rio Grande Valley, El Paso County (a relatively small portion of the State). However, extensive efforts to locate the frog have been unsuccessful (Dixon 2000, pp. 42, 77). The northern leopard frog is ranked S1 (Critically Imperiled) by NatureServe (NatureServe 2011, p. 1), but is not listed as a species of conservation concern in the Texas Comprehensive Wildlife Conservation Strategy (Texas Parks and Wildlife Department 2005, pp. 748–751). The Texas Parks and Wildlife Department webpage (Texas Parks and Wildlife Department 2011a, p. 11) lists the species as occurring in Texas, but the most current field guide for amphibians and reptiles of Texas indicates the species is likely extirpated (Dixon 2000, p. 77). The Texas Parks and Wildlife Department requires that anyone who captures a wild animal, including frogs, be licensed or permitted (Texas Parks and Wildlife Department 2011b, p. 1).

The Utah Division of Wildlife Resources considers northern leopard frog populations in Utah to be secure (Utah Division of Wildlife Resources 2009, p. 1). NatureServe ranks the northern leopard frog as S3/S4 (Vulnerable/Apparently Secure) (NatureServe 2011, p. 1). In Utah, the northern leopard frog is classified as ''controlled'' for collection, importation, and possession, and may only be collected with a certificate of registration (Administrative Rule R657–53: Amphibian and Reptile Collection, Importation, Transportation, and Possession). Historically the northern leopard frog is considered to be a wide-ranging species in Utah and is verified to have occurred in all but Davis and Wayne Counties (Utah Division of Wildlife Resources 2009, p. 2). Utah's Wildlife Action Plan lists the northern leopard frog as a Tier III Species of Concern (Sutter *et al.* 2005, p. 5–6). Tier III species are of conservation concern because they are linked to at-risk habitats, they have suffered significant population declines, or there is little information regarding the species. The northern leopard frog was listed as a species of concern due to lack of information, water development, and disease. In 2006, the Utah Division of Wildlife Resources began compiling survey information and conducting surveys to determine the current distribution of northern leopard frogs in Utah. Recent surveys have documented northern leopard frogs at 97 new sites (not historical sites), for a total of 683 known sites in Utah (Utah Division of Wildlife Resources 2009, p. 2). Of these sites, 75 percent (512) are extant, and 25 percent (171) are considered historical, as the observations occurred prior to 1989 (Utah Division of Wildlife Resources 2009, p. 2). We do not have information regarding how many of these sites are breeding sites versus other observations (such as dispersing frogs).

The northern leopard frog was listed in 2000 as an endangered species under the Endangered, Threatened, and Sensitive Species Classification (Washington Administrative Code, Title 232, Chapter 12, Section 014) in Washington State after surveys of 17 known historic locations confirmed occupancy at only two sites (Leonard *et al.* 1999, p. 52; Germaine and Hays 2009, p. 537). ''Endangered'' in this context means any wildlife species native to the State of Washington that is threatened with extinction throughout all or a significant portion of its range within the State. The northern leopard frog is ranked S1 (Critically Imperiled) in Washington State by NatureServe (NatureServe 2011, p. 1). Historically, the northern leopard frog occurred in six major watersheds in eastern Washington (Germaine and Hays 2009, p. 537). However, extensive surveys conducted at Gloyd Seeps and Potholes Reservoir in 2002–2005 indicate that the Gloyd Seeps population is likely no longer a functional breeding population and the Potholes Reservoir population is in sharp decline (Germaine and Hays 2009, p. 542). Although inclement weather prevented Washington Department of Fish and Wildlife from completing surveys in 2009, no observations of northern leopard frogs were made during what limited field time was available (Washington Department of Fish and Wildlife 2009, p. 32).

The northern leopard frog is not currently listed in Wisconsin, but over the past several decades, declines have been documented (Hine *et al.* 1981, pp. 2–3; Mossman *et al.* 1998, pp. 191–192, 198; Wisconsin Department of Natural Resources 2009, p. 1). In 1981, the Wisconsin Frog and Toad Survey began to monitor several species, including the northern leopard frog. The occurrence of a species is determined by whether or not the species is heard calling, and the abundance is ranked by the relative number of individuals heard calling at a site (Kitchell and Hay 2007, p. 1). Survey results from 1984 to 2007 indicate an overall decrease in the estimated population trend for northern leopard frogs (Kitchell and Hay 2007, p. 7). NatureServe ranks the northern leopard frog as S4 (Secure) (NatureServe 2011, p. 1). In Wisconsin, northern leopard frogs may be collected and possessed in unlimited numbers if the collector or possessor has a valid Class A Captive Wild Animal Farm License or a Commercial Bait License (Wisconsin Department of Natural Resources 2011, p. 13).

The northern leopard frog is considered to be widely distributed in Wyoming (Wyoming Game and Fish Department 2009, p. 1). The Wyoming Game and Fish Department identified the species as a Species of Greatest Conservation Need due to potential habitat degradation and loss, disease, absence of data, and contaminants (Wyoming Game and Fish Department

2005, p. 13). NatureServe ranks it as S3 (Vulnerable) (NatureServe 2011, p. 1). Population declines have been documented from the Laramie Plains, Targhee National Forest, and Grand Teton National Park (Baxter and Stone 1980, p. 44; Lewis *et al.* 1985, p. 167; Koch and Peterson 1995, p. 85). No population trend data are available for northern leopard frogs in Wyoming. Anecdotal reports and local survey information indicate that the frog may be common throughout eastern and southwestern Wyoming (Wyoming Game and Fish Department 2009, p. 1); however, others reports indicate that the present abundance of northern leopard frogs in Wyoming is unknown and the population trend is declining (Smith and Keinath 2007, p. 14). The Wyoming Game and Fish Department manages commercial, scientific, and education activities through their collection permitting system (Wyoming Game and Fish Department 2009, p. 3).

Eastern States

The northern leopard frog still occurs throughout the eastern States it is historically known from (Connecticut, Illinois, Indiana, Kentucky, Maine, Massachusetts, Michigan, New Hampshire, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and West Virginia) (Rorabaugh 2005, pp. 571–572). However, the frog currently has a very disjunct distribution throughout the northeast (New Hampshire Fish and Game Department 2005, pp. A208–A209); some populations are thought to be both locally and regionally declining (Smith and Keinath 2007, p. 14; Spriggs 2009, p. 29), and, in some cases, local extirpations have occurred (Rorabaugh 2005, p. 571; Spriggs 2009, p. 26). For example, habitat loss from urban development has resulted in local extirpations in Connecticut, Massachusetts, and Rhode Island (Klemens 2000, p. 41; Rorabaugh 2005, p. 571). Northern leopard frog declines also occurred in the Midwest in Michigan, Minnesota, and northeastern Illinois in the late 1960s or early 1970s (Rittschof, 1975, p. 103; Moriarty 1998, p. 168; Mierzwa 1998, p. 117), and although some populations have recovered, others have not (Mierzwa 1998, p. 117; Moriarty 1998, p. 168).

In 1999, the Northeast Endangered Species and Wildlife Diversity Technical Committee published a list of regional species of conservation concern, which included the northern leopard frog. The northern leopard frog was added to the list based upon declining populations or high risk of disappearing from the Northeast, lack of data with suspicion of risk of disappearing from the region, and special circumstances (such as vulnerability to collecting pressures) (Therres 1999, p. 97).

Northeast Partners in Amphibian and Reptile Conservation, using information from State wildlife action plans and other sources, developed the Northeast Amphibian and Reptile Species of Regional Responsibility and Conservation Concern (Northeast Partners in Amphibian and Reptile Conservation 2010, pp. 2–3). Based upon their analysis, the Northeast Partners in Amphibian and Reptile Conservation ranked the northern leopard frog as a species of High Concern and Regional Responsibility that should be considered a target for habitat and landscape-based conservation initiatives (such as land protection), may be an appropriate indicator for long-term monitoring to detect changes in distribution due to climate change, and should be among the highest priority species for Northeast Partners in Amphibian and Reptile Conservation to target conservation efforts (*e.g.,* create a regional species working group) (Northeast Partners in Amphibian and Reptile Conservation 2010, pp. 3–5). The ranking is based upon the number of northeastern States that comprise a species' U.S. distribution and the number of States that listed the species in their Wildlife Action Plans. Based upon their analysis, the northeastern States make up less than 50 percent of the northern leopard frog's U.S. distribution (occurs in 9 of 14 northeastern States), and it is listed as a Species of Greatest Conservation Concern in 6 of the 9 States it inhabits (Northeast Partners in Amphibian and Reptile Conservation 2010, p. 5).

In Connecticut, the northern leopard frog is locally common along sections of the Connecticut River and its tributaries (the Farmington, Scantic, and Coginchaug Rivers) (Klemens 2000, p. 40). Historical records of northern leopard frog distribution indicate that the frog was once widespread; current information indicates that the northern leopard frog no longer is found in some of these areas (Klemens 2000, p. 41). The northern leopard frog is considered a ''Special Concern'' species under Connecticut's State Endangered Species Act (Connecticut Department of Environmental Protection 2005, Appendix 1–b p. 18), and the NatureServe rank is S2 (Imperiled) (NatureServe 2011, p. 1). There is no open season for taking northern leopard frogs in Connecticut (Title 26 Fisheries and Game, Department of Environmental Protection Sec. 26–66–13).

Northern leopard frogs experienced a die-off in the 1960s or early 1970s in northeastern Illinois, but have since recovered in localized areas where extensive wetland habitat still occurs (Mierzwa 1998, p. 117). The northern leopard frog is less common in areas where significant wetland loss has occurred (Mierzwa 1998, p. 117). Statewide, the northern leopard frog is considered to be abundant with a stable and secure population trend in Illinois (S5 (Secure) ranking from NatureServe) (Smith and Keinath 2007, p. 14; NatureServe 2011, p. 1). However, most amphibian sampling efforts in Illinois have been largely opportunistic, and data are likely insufficient to accurately determine changes in distribution and abundance of species such as the northern leopard frog (Illinois Department of Natural Resources 2005, p. 102). The Illinois Comprehensive Wildlife Conservation Plan and Strategy identified the northern leopard frog as a non-game indicator species for improving wetland habitat (Illinois Department of Natural Resources 2005, p. 172). It is unlawful to take, possess, buy, sell, offer to buy or sell or barter any reptile, amphibian, or their eggs or parts taken from the wild in Illinois for commercial purposes unless otherwise authorized by statute (17 Illinois Adm. Code Section 880–10). If a person possesses a valid fishing license, they may take up to eight northern leopard frogs per day (17 Illinois Adm. Code Section 880–20, 880–30).

The northern leopard frog's range in Indiana includes northern and eastern Indiana. Minton (1998, pp. 217–220) noted significant declines in the northern leopard frogs populations based on observations he made from 1948 to 1993 throughout Indiana. The species is listed as a Species of Greatest Conservation Need in the Indiana Comprehensive Wildlife Strategy, listed as a Species of Special Concern by the Indiana Department of Natural Resources, and is ranked as Imperiled (S2) by NatureServe (Indiana Department of Natural Resources 2006, p. 30; NatureServe 2011, p. 1). In Indiana, an individual with a valid hunting or fishing license may collect up to four northern leopard frogs for non-commercial purposes (Indiana Department of Natural Resources 2011, p. 11).

The northern leopard frog is known historically from 22 counties in northern Kentucky (Kentucky Department of Fish and Wildlife Resources 2010, Amphibian Species Accounts, Northern leopard frog).

However, the species is considered to be decreasing in Kentucky, and populations have declined throughout the frog's historical State range. Kentucky Department of Fish and Wildlife Resources' recent survey records (1984–2004) show northern leopard frogs persisting in 10 counties, and no longer present in 12 counties (Kentucky Department of Fish and Wildlife Resources 2010, Amphibian Species Accounts, Northern leopard frog). The species is considered to be a Species of Greatest Conservation Need and ranked by NatureServe as Vulnerable (S3) (Kentucky Department of Fish and Wildlife Resources 2010, Appendix 1–1 p. 6; NatureServe 2011, p. 1). The northern leopard frog may be collected for personal bait use in Kentucky (301 Kentucky Administrative Regulations 1:130).

The northern leopard frog is a Species of Special Concern in Maine (Maine Department of Inland Fisheries and Wildlife 2005, p. 28) and is listed as a Priority 3 Species of Greatest Conservation Need in the Comprehensive Wildlife Conservation Strategy (Maine Department of Inland Fisheries and Wildlife 2005, p. 90). The Maine Department of Inland Fisheries and Wildlife chose this ranking due to the low to moderate potential for the northern leopard frog to become extirpated in the State, but concerns remain regarding restricted distribution, status, or extreme habitat specialization. Currently, the present abundance and population trend for the northern leopard frog in Maine are unknown (Smith and Keinath 2007, p. 14), and NatureServe ranks the species as S3 (Vulnerable) (NatureServe 2011, p. 1). A wildlife or fish possession permit is required from the Commissioner to take, possess, or hold in captivity northern leopard frogs (Maine Department of Inland Fisheries and Wildlife 2009, p. 1).

The northern leopard frog occurs Statewide in Massachusetts, except in Barnstable, Dukes, and Nantucket Counties (Massachusetts Division of Fisheries and Wildlife 2006, p. 406). Due to the widespread release of captive northern leopard frogs, their historical distribution and native status in Massachusetts is uncertain (Cardoza and Mirick (2002) in Massachusetts Division of Fisheries and Wildlife 2006, p. 406). As part of the Massachusetts Audubon Herp Atlas Project (1992 through 1998), the northern leopard frog was reported to be well-distributed and confirmed from approximately 13 percent of the quadrants (Massachusetts Division of Fisheries and Wildlife 2006, p. 406). Though the northern leopard frog is not listed in Massachusetts (Massachusetts Division of Fisheries and Wildlife 2006, p. 107), because its status in the State is unclear, it is a species of regional conservation concern, a Species of Special Concern, and a Species of Greatest Conservation Need in the Massachusetts Comprehensive Wildlife Conservation Strategy (Massachusetts Division of Fisheries and Wildlife 2006, pp. 137, 274, 292, 343, 348). There is a closed season on the hunting, fishing, taking and possession of northern leopard frogs in Massachusetts (Massachusetts Division of Fisheries and Wildlife 2002, p. 1). NatureServe ranks the northern leopard frog in Massachusetts as S3/S4 (Vulnerable/Apparently Secure) (NatureServe 2011, p. 1).

The Michigan Department of Natural Resources describes the northern leopard frog's distribution in Michigan as unknown, but considered patchy, and notes that it appears to be declining based upon the lack of reports compared to historical records from the current Frog and Toad Surveys (Eagle *et al.* 2005, Species of Greatest Conservation Need, p. 152; Smith and Keinath 2007, p. 14). The northern leopard frog is a Species of Greatest Conservation Need in Michigan's Wildlife Action Plan (Eagle *et al.* 2005, p. 20 in Aquatic Threats by Species of Greatest Conservation Need), but is ranked by NatureServe as S5 (Secure) (NatureServe 2011, p. 1). In Michigan, an all-species fishing license is required to take northern leopard frogs for personal bait use (Michigan Department of Natural Resources 2011, p. 9).

The northern leopard frog is a Species of Concern in New Hampshire and ranked as S3 (Vulnerable) by NatureServe (2011, p. 1). Possession of northern leopard frogs in New Hampshire is prohibited without a permit (New Hampshire Fish and Game Department 2011, p. 1). Distribution records from 1992 to 2004 were verified for Coos, Merrimack, Rockingham, and Sullivan Counties; reports from a number of other towns have not been verified with a voucher photograph or specimen (New Hampshire Fish and Game Department 2005, p. A–209). Throughout the area that the ranges of northern leopard frogs and pickerel frogs (*Lithobates palustrus*) overlap, it is important to verify distribution records via a photograph or a specimen as northern leopard frogs are commonly confused with pickerel frogs. New Hampshire is the only State we found that appears to require this information for distribution records. Based upon this information, it is likely that the current distribution of northern leopard frogs in New Hampshire is unknown.

The northern leopard frog is not identified as species of greatest conservation need or a species of concern in the Comprehensive Wildlife Conservation Strategy for New York (New York Department of Environmental Conservation 2005, p. 73), and NatureServe (2011, p. 1) ranks the northern leopard frog as S5 (Secure). Persons holding a freshwater fishing license or combined hunting and fishing license (including those entitled to fish without a license) may take northern leopard frogs for personal bait use (except in New York City, Suffolk County, and Nassau County), and frogs may be imported, bought, and sold at any time (New York Department of Environmental Conservation 2010, pp. 10–11, 16). The northern leopard frog distribution map for New York shows it having a very wide distribution throughout the State (New York Department of Environmental Conservation 2011, p. 1), but local herpetologists have reported declines throughout New York (O'Donnell 2011, pers. comm.). It is likely that the current abundance and population trends for northern leopard frogs in New York are unknown (Smith and Keinath 2007, p. 14).

The northern leopard frog is broadly distributed throughout Ohio and is considered to be secure by the Ohio Department of Natural Resources, Division of Wildlife (2005, pp. 125, 138, 143) and other sources (Smith and Keinath 2007, p. 14). Currently, NatureServe does not have a ranking for Ohio (NatureServe 2011, p. 1). In Ohio, a permit is required to possess northern leopard frogs (Ohio Revised Code 1531.02). Walker (1946, p. 88) described the northern leopard frog as being one of the most abundant frogs in Ohio. It is still considered to be locally abundant, but it does appear to be declining where wetlands have been drained. The range appears to be contracting in the southeastern counties where extensive field efforts have yielded few recent records (Ohio Frog and Toad Calling Survey 2011, p. 1).

The current distribution, abundance, and population trend for northern leopard frogs in Pennsylvania is unknown (Smith and Keinath 2007, p. 14; Gipe 2011, pers. comm.). The Comprehensive Wildlife Conservation Strategy states that there has been a reduction in the northern leopard frog's range, and although it was previously common in Pennsylvania and the northeast, it is suspected that it has significantly declined in recent years (Pennsylvania Game Commission and

Pennsylvania Fish and Boat Commission 2005, p. 10–41). The northern leopard frog is considered a Priority Conservation Tier 5 Species, and the need for a long-term monitoring program is identified (Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission 2005, p. 10–41). This conservation priority tier represents species that are fairly secure in Pennsylvania, but for which the Pennsylvania Biological Survey recommends some level of management attention. NatureServe (2011, p. 1) ranks the northern leopard frog in Pennsylvania as S2/S3 (Imperiled/Vulnerable). The collection of one northern leopard frog per day from Pennsylvania waters requires a fishing license, but a license is not required to take a frog from land (Pennsylvania Fish and Boat Commission 2011, pp. 1–2).

The northern leopard frog is a Species of Greatest Conservation Need and ranked by NatureServe as S2 (Imperiled) in Rhode Island (Rhode Island Department of Environmental Management, Division of Fish and Wildlife 2005, p. 24; NatureServe 2011, p. 1). Rhode Island currently has one small population of northern leopard frogs on an island; several other populations have been extirpated in recent years (O'Donnell 2011, pers. comm.). The removal from the wild, for any purposes, of northern leopard frogs is prohibited in Rhode Island, except by special permit (Rhode Island Department of Environmental Management, Division of Fish and Wildlife 2011, p. 38).

The Vermont Fish and Wildlife Department considers the northern leopard frog to be secure in Vermont (Kart *et al.* 2005, p. 1 Secure Species Summary; NatureServe 2011, p. 1). The species is distributed along the western edge of Vermont and then scattered populations are documented throughout the rest of the State (Kart *et al.* 2005, Distribution Map). Collection of northern leopard frogs for scientific research, education purposes, or for the purpose of using them as the subjects of art or photography is authorized through issuance of a scientific collection permit; other collections or take are authorized by Commissioner Letter with a valid hunting license (Vermont Fish and Wildlife Regulations Title 10, Chapter 1, Section 25).

The West Virginia Natural Heritage Program and NatureServe list a State rank of S2 (Imperiled) for the northern leopard frog (West Virginia Natural Heritage Program 2007, p. 11; NatureServe 2011, p. 1). The species is also listed as a Species in Greatest Need of Conservation (West Virginia Division of Natural Resources 2005, pp. 4F–Habitats-20, 5F–49, 5F–56). Statewide surveys were conducted between March 2008 and April 2009 to determine the status and distribution of northern leopard frogs in West Virginia (Spriggs 2009, p. 17). Surveys of 70 sites found only four occupied sites and only one of the sites constituted a breeding population (only single adult or juvenile frogs were located at the three other locations) (Spriggs 2009, pp. 38–39). In 2010, surveyors searched for northern leopard frogs at the known breeding population at Greenbottom Wildlife Management Area, West Virginia (including one day with four experienced surveyors), and found only one dead northern leopard frog (O'Donnell 2011, pers. comm.). Based upon Statewide survey data collected, Spriggs (2009, p. 29) recommended that the northern leopard frog NatureServe rank be changed to S1 (Critically Imperiled).

Canada

Historically, the northern leopard frog ranged across Canada from British Columbia to Nova Scotia. Canada represents approximately half of the current range of the northern leopard frog based on an estimation of land area in the United States and Canada. Within Canada, the northern leopard frog's range includes small to large portions of the area within the Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland. The distribution of northern leopard frogs in western Canada is more closely tied to major river drainages than is the species' distribution in eastern Canada (Seburn and Seburn 1998, p. 9).

The northern leopard frog is uncommon in the Northwest Territories and is historically known from nine sites (Fournier 1997, p. 104). These historical locations encompass a small area between the northern borders of Alberta and Saskatchewan and the southern border of Great Slave Lake (Weller and Green 1997, p. 323). Since 1980, a few frogs have been reported from three sites (Seburn and Seburn 1998, p. 6). The northern leopard frog is considered rare within this restricted range, and a lack of data precludes any determination of a population trend (Fournier 1997, p. 104). The northern leopard frog is not ranked in the Northwest Territories by NatureServe (NatureServe 2011, p. 1).

In British Columbia, the northern leopard frog historically occurred in the Kootenay and Columbia River valleys and in the Rocky Mountains east of Fernie (Seburn and Seburn 1998, p. 6). Currently, there is one native northern leopard frog population remaining at the Creston Valley Wildlife Management Area (estimated population less than 60 adults), plus one introduced population that has likely been extirpated (Committee on the Status of Endangered Wildlife in Canada 2009, pp. 42–43). The British Columbia (or Rocky Mountain) population is listed as Endangered under the Species at Risk Act (Statues of Canada 2002, c.29), which provides protection similar to that of the Endangered Species Act in the United States. The northern leopard frog is also on the provincial Red List and is listed as Endangered under British Columbia's Wildlife Act (Revised Statutes of British Columbia 1996, c. 488). The northern leopard frog is ranked as critically imperiled (S1) (NatureServe 2011, p. 1) in British Columbia.

Historically, northern leopard frogs were widely distributed and locally abundant in central and southern Alberta, and in the extreme northeastern region of the province (Alberta Northern Leopard Frog Recovery Team 2005, p. 3). Beginning in 1979, the northern leopard frog disappeared suddenly from much of its range in Alberta (Roberts 1992, p. 14; Seburn and Seburn 1998, p. 10). All previously known populations in central Alberta are no longer present, and to the south, populations have disappeared or are restricted to small, fragmented habitats with limited opportunity for dispersal (Roberts 1992, p. 14). In 1990–1991 and 2000–2001, province-wide surveys were conducted to determine the distribution of northern leopard frogs in Alberta. In the first survey, 24 sites were found to be occupied; the more recent survey found that of 269 historical sites surveyed, only 54 supported northern leopard frogs (Alberta Northern Leopard Frog Recovery Team 2005, p. 4). Currently, the northern leopard frog is thought to occur in about 20 percent of historically occupied areas in Alberta (Wilson *et al.* 2008, p. 864), and the NatureServe ranking is S2/S3 (imperiled/vulnerable) (NatureServe 2011, p. 1). The species is listed as Threatened under Alberta's Wildlife Act (Revised Statutes of Alberta 2000, Chapter W–10), and a recovery plan was prepared in 2005 (Alberta Northern Leopard Frog Recovery Team 2005).

Historically, northern leopard frogs were considered to be widespread and abundant in Saskatchewan (Seburn 1992, p. 18). However, the northern leopard frog experienced significant declines in the 1970s and is now absent

throughout most of its historical range (Didiuk 1997, p. 112; Weller and Green 1997, p. 323). Currently, the number of northern leopard frog populations in Saskatchewan is unknown, and there is no data to evaluate the population trends (Didiuk 1997, p. 112). Anecdotal information indicates that populations may be recovering (Seburn 1992, pp. 17–18), but declines and die-offs have also been reported and the overall population status is unknown (Committee on the Status of Endangered Wildlife in Canada 2009, p. 29). The current range of the northern leopard frog within Saskatchewan is thought to be discontinuous, and the majority of occurrences are in the very southern portion of the province (Saskatchewan Conservation Data Center 2006, p. 1). The northern leopard frog is currently on Saskatchewan's Interim Species at Risk List (Wildlife Act 1998, Chapter W–13.12), and is protected in provincial and national parks (Committee on the Status of Endangered Wildlife in Canada 2009, p. vi). The NatureServe rank for the northern leopard frog in Saskatchewan is S3 (Vulnerable) (NatureServe 2011, p. 1).

In Manitoba, northern leopard frogs suffered a significant die-off from 1975–1976, and within a year were absent from previously known population cores (Koonz 1992, p. 19; Committee on the Status of Endangered Wildlife in Canada 2009, p. 29). Since this time, populations have increased in some areas and remained extremely low in others (Koonz 1992, p. 20). Northern leopard frogs are not monitored in Manitoba and the current number and distribution of extant populations is not known (Committee on the Status of Endangered Wildlife in Canada 2009, p. 29). The current NatureServe rank for the northern leopard frog in Manitoba is S4 (secure) (NatureServe 2011, p. 1).

The northern leopard frog is thought to be common, widespread, and secure throughout southern and central Ontario, with sparse distribution in the north (Weller and Green 1997, p. 323; NatureServe 2011, p. 1). The species is currently listed as ''Not at Risk'' under the Ontario Endangered Species Act of 2007 (Statutes of Ontario 2007, Chapter 6) and under the Canadian Species at Risk Act (Ontario Nature 2011, p. 2). However, as with many parts of Canada, northern leopard frog populations have declined precipitously, particularly in northern and southwestern Ontario (Hecnar 1997, p. 9; Seburn and Seburn 1998, p. 10; Committee on the Status of Endangered Wildlife in Canada 2009, p. 29; Desroches *et al.* 2010, pp. 308–309). Although the widespread declines of the 1970s did not occur in Ontario as they did in the provinces to the west, relatively recent mass mortality events resulting from ranavirus have been documented in Ontario (Greer *et al.* 2005, p. 11; Committee on the Status of Endangered Wildlife in Canada 2009, p. 29). A 4-year study in the eastern and central regions of the province found declines of 23 percent (1992–1993) and 5 percent (1993–1994) in abundance of northern leopard frogs (Hecnar 1997, pp. 9, 11; Committee on the Status of Endangered Wildlife in Canada 2009, p. 29). Regional declines of northern leopard frogs have also been documented in southern Ontario, including the southern Great Lakes Region (Committee on the Status of Endangered Wildlife in Canada 2009, pp. 29–30). Hecnar (1997, p. 11) notes, ''Anecdotal reports suggest that *R. pipiens* is the most abundant frog in the Essex Plain. During this study (1992–1993), *R. pipiens* declined in occurrence across all regions of southwestern Ontario.''

The northern leopard frog is widely distributed throughout the southern region of Quebec, with sparse populations in the central region of the province (Weller and Green 1997, p. 323). Weller and Green (1997, p. 323) note that there is no evidence of historic or recent declines in Quebec, but Gilbert *et al.* (1994, p. 468) found lower densities of northern leopard frog egg masses than reported in Wisconsin and anecdotal declines of northern leopard frogs in the Richelieu River system of Quebec. Bonin (1992, p. 24) states that trends in northern leopard frog populations in Quebec are not known based upon data collected for the Amphibian and Reptile Atlas. In addition, Desroches *et al.* (2010, pp. 308–309) found that the northern leopard frog was uncommon on the Quebec side of James Bay.

In New Brunswick, the northern leopard frog is distributed throughout the province and populations are thought to be secure (S5 NatureServe rank) (McAlpine 1997, p. 123; Weller and Green 1997, p. 323; NatureServe 2011, p. 1). The northern leopard frog occurs throughout mainland Nova Scotia and Cape Breton Island and is considered to be secure (S5 NatureServe rank) with no evidence of declines (Weller and Green 1997, p. 323; NatureServe 2011, p. 1). On Prince Edward Island, the northern leopard frog status is apparently secure (S4) or secure (S5) (NatureServe 2011, p. 1).

In Newfoundland, the northern leopard frog was introduced to the western side of the island on several occasions, but is no longer present (Buckle 1971, p. 74; Maunder 1997, p. 94). The species is at the edge of its range in Labrador, but occurs in a few, discrete locations that are apparently secure (Committee on the Status of Endangered Wildlife in Canada 2009, p. 30; NatureServe 2011, p. 1).

Summary

In summary, 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 western Canada (Rorabaugh 2005, pp. 570–571). The species generally tends to be more abundant and more secure in the eastern portion of its range, but there are indications that local, and possibly regional, declines may also be occurring in the eastern United States (such as in Connecticut, Indiana, Kentucky, Maine, Massachusetts, Michigan, New Hampshire, Rhode Island, and West Virginia) as well. Historically, regional declines in the western United States and Canada occurred in the 1960s through 1970s, and since this time the northern leopard frog has either not recovered in many of these areas (such as in Alberta, Arizona, British Columbia, Colorado, Idaho, western Montana, Nevada, New Mexico, Oregon, Texas, Washington, and western Wyoming) or the status of that recovery is unknown due to a lack of information regarding changes in the number of sites occupied across the species' range over time (such as in Manitoba, Minnesota, Saskatchewan, and Utah). Occupancy trend data are also lacking throughout much of the western and eastern portions of the northern leopard frog's range where the northern leopard frog's status appears to be stable or where it is unknown (such as in Iowa, Illinois, Nebraska, New York, North Dakota, Ontario, Pennsylvania, South Dakota, and Wisconsin), and as such, the overall range status is likely unknown. However, despite the lack of occupancy trend data, information indicates that in the eastern United States and eastern Canada, the northern leopard frog is still widespread and relatively common.

Distinct Vertebrate Population Segment

We consider a species for listing under the Act if available information indicates such an action might be warranted. ''Species'' is defined by the Act as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife that interbreeds when mature (16 U.S.C. 1532(16)). We, along with the National Marine Fisheries Service (now the National Oceanic and Atmospheric Administration—Fisheries), developed

the Policy Regarding the Recognition of Distinct Vertebrate Population Segments (61 FR 4722; February 7, 1996), to help us in determining what constitutes a DPS. The policy identifies three elements that are to be considered regarding the status of a possible DPS. These elements include: (1) The discreteness of the population segment in relation to the remainder of the species to which it belongs; (2) the significance of the population segment to the species to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing (*i.e.,* is the population segment, when treated as if it were a species, is endangered or threatened?) (61 FR 4722; February 7, 1996). The first two elements are used to determine if a population segment constitutes a valid DPS. If it does, then the third element is used to consider whether such DPS warrants listing. In this section, we will consider the first two criteria (discreteness and significance) to determine if the western northern leopard frog is a valid DPS (*i.e.,* a valid listable entity). Our policy further recognizes it may be appropriate to assign different classifications (*i.e.,* threatened or endangered) to different DPSes of the same vertebrate taxon (61 FR 4722; February 7, 1996).

Discreteness

Under the DPS policy, a population segment of a vertebrate species may be considered discrete if it satisfies either one of the following two conditions:

(1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity (separation based on genetic or morphological characters) may provide evidence of this separation.

(2) It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

Marked Separation

In our evaluation of discreteness under the DPS policy, we primarily used the results of two recent genetic studies (Hoffman and Blouin 2004a, pp. 145–159; O'Donnell *et al.* 2011, pp. 1–11) to evaluate whether any populations of the northern leopard frog should be considered markedly separate. We based our determination on these two studies because they provided comprehensive data on the genetic variation across the range of the species. The petition to list a ''western DPS'' of the northern leopard frog was mainly based on the genetic information and conclusions from the study by Hoffman and Blouin (2004a). There has since been an additional genetic study conducted on the species by O'Donnell *et al.* (2011) that we also used in this 12-month finding. We found no other relevant information regarding the other factors to consider in evaluating population discreteness, such as physical, physiological, ecological, or behavioral factors, or morphological characters. We therefore focused our analysis on these two genetic studies in determining whether the best available information supports that there are discrete populations of the northern leopard frog that would be considered markedly separate under our DPS policy.

Hoffman and Blouin (2004a) reported two different lineages (lines of descent from a common ancestor) of mitochondrial DNA (mtDNA) haplotypes in northern leopard frogs. Analyzing mtDNA data is one way to measure the genetic variation within a species. When mtDNA lineages are geographically localized and separated by geographic barriers, this information can be used to identify evolutionarily separate units when it is used in combination with patterns displayed by other genetic markers (Avise 2004, p. 301). A haplotype refers to a set of closely linked genetic markers present on one chromosome that tend to be inherited together. The more similar these genetic markers, or haplotypes, are in a given sample of frogs, the more closely related those frogs are likely to be (with the opposite also being the case). This study (Hoffman and Blouin 2004a, p. 152) showed haplotypes of mtDNA genetic markers grouping into a ''western'' lineage, occurring mostly west of the Mississippi River and Great Lakes region in the United States and Canada, and an ''eastern'' lineage, occurring to the east of this area.

The initial study by Hoffman and Blouin (2004a, pp. 146, 150) found that on a broad scale the eastern and western haploypes have diverged for approximately 2 million years, indicating that the western and eastern lineages have likely been separate to some degree for a long time period, with secondary contact following Pleistocene glaciation events that occurred in North America (Hoffman and Blouin 2004a, p. 152). The overall differences were measured at approximately 4 percent sequence divergence, and this amount of mtDNA divergence is considered to be relatively high and is comparable to the differences found between some other recognized ranid frog species (Jaeger *et al.* 2001, p. 344; Hoffman and Blouin 2004a, p. 152). Hoffman and Blouin (2004a, p. 152) note that mtDNA divergence alone is not enough evidence to split eastern and western lineages into separate species and that more taxonomic work (such as research regarding nuclear genetic markers, morphology, and behavior) is needed before such a taxonomic revision would be justified. The results of this study indicated important genetic differences broadly between northern leopard frogs in the eastern and western portions of North America. However, additional data were needed to determine if the ''western'' lineage represented a separate population of the species.

Although a preliminary administrative report, the recent O'Donnell *et al.* (2011) study report by the U.S. Geological Survey was peer-reviewed and presents the findings of a robust analysis of the genetic variation of the northern leopard frog across its range in North America. The study replicated the earlier mtDNA analysis but had larger sample sizes (20–24 individuals per sample compared with 12 individuals per sample at most sample localities) and had more sample locations in the area of contact between the eastern and western lineages. In addition, it also included nuclear gene sequencing as well. Nuclear genetic sequences provided an additional way to measure genetic variation in populations of the northern leopard frog. Because of its maternal (mother to daughter) pattern of inheritance, mtDNA is inherited only as a single genetic unit and has some limits in value for evaluating recent and localized relationships within a species. However, DNA sequences from multiple nuclear genes provided more information from additional genetic makers. This is an important distinction because identification of geographic subdivisions, like judging population distinction in the case of this analysis of the northern leopard frog, depends on the related geographic patterns of different genetic markers (Avise 2004, p. 303).

The study by O'Donnell *et al.* (2011) was specifically designed to look at the genetic relationships of the species and to supplement the results of Hoffman and Blouin (2004) by increasing the number of samples in the area of probable overlap of the two lineages in the upper Midwest of the United States. The analysis for one mtDNA gene produced similar results to that of the earlier study—with strong divergence between east and west lineages and a narrow area of overlap (O'Donnell *et al.*

2011, pp. 2–3). However, the study also analyzed DNA from four nuclear genes. These nuclear genetic data still indicated deeply divergent eastern and western lineages of the northern leopard frog. However, and most importantly for our DPS analysis, the results of the nuclear data showed a broad zone of introgression between the two areas (in other words, a mixing of haplotypes) (O'Donnell *et al.* 2011, p. 10). We considered this large zone of introgression as the primary reason that a potential western population of the northern leopard frog is not considered markedly separate from other populations of the species.

So to determine whether these two lineages should be considered markedly separate populations and be considered discreet under our DPS policy, we looked at the relative amount of overlap in the distribution of northern leopard frogs that contain haplotypes from the eastern and western lineages. Hoffman and Blouin (2004a, pp. 147, 152, 155) found that the distributions of eastern and western haplotypes meet roughly at the Mississippi River and Great Lakes region, initially indicating that these geographic features may serve as physical barriers separating the eastern and western lineages. However, the additional nuclear genetic data from O'Donnell *et al.* (2011, p. 10) discussed above indicate the eastern and western lineages are not separated along these geographic features. Hoffman and Blouin (2004a, pp. 147, 152) also found some areas of co-occurrence of haplotypes of both lineages in Ontario, Canada, and indicated that this is likely the result of more recent (during the current interglacial period in North America) secondary contact between eastern and western lineages that were formerly separated. In addition, O'Donnell *et al.* (2011) reveal that the haplotype mixing evident in the nuclear analyses is more likely associated with introgression and that more research is needed to clearly explain the pattern of haplotype mixing. The full extent of current contact (and presumably gene flow from interbreeding) between northern leopard frogs with eastern and western haplotypes could not be evaluated in detail as a part of earlier study because there were only a few sample sites from the likely areas of contact in Wisconsin, Michigan, and western Ontario and limitations due to small sample sizes. Further, there are multiple factors that may be responsible for the co-occurrence of frogs with eastern and western haplotypes, for example, it is possible that the mixing of haplotypes between the east and west in the overlap zone may be attributable in part to the anthropogenic movement of individuals associated with the trade in northern leopard frogs that has taken place in this area since at least the 1950s (Gibbs *et al.* 1971, p. 1027; Collins and Wilbur 1979, p. 17).

Hoffman and Blouin (2004a, pp. 150–151) also found one individual frog (from a sample of 10) from Arizona with an eastern haplotype. They suggested this haplotype is likely not from a native frog, but from a released pet or laboratory animal. It is reasonable to believe it was a released eastern frog, or a descendant of one, because there is commercial trade in leopard frogs and tadpoles transported to pet stores, laboratories, and schools throughout the United States and Canada for recreational and scientific uses (Fisher and Garner 2007, p. 3). Their supposition is also supported by specific genetic research regarding this Arizona population of northern leopard frogs, which found haplotypes of mtDNA consistent with frogs from extreme eastern North America (from New York, New England, and adjacent areas of Quebec and Ontario) widespread in the Stoneman Lake area of northern Arizona (Theimer *et al.* 2011, p. 32).

The relatively small sample sizes (about 12 individuals were used for most sample localities) were a disadvantage of the Hoffman and Blouin (2004a, Appendix pp. 1–8) study in evaluating genetic variation across a narrow part of the range. While these sample sizes were useful for looking at broad patterns of geographic variation (which was the object of the study), they were less useful in answering our question of separation, because of their limited power for detecting haplotypes that may occur at low frequencies and there were few sample sites in the area of suspected overlap. The small differences in the amount of genetic variation at specific locations are important because even haplotypes at low frequencies can help us understand the relationships between the eastern and western lineages of northern leopard frogs and inform our determination of whether the western lineage is a markedly separate population. The O'Donnell *et al.* (2011, pp. 2–9) study utilized larger sample sizes and provides a level of detail more appropriate and helpful to evaluate similarities and differences in western and eastern lineages.

The results of O'Donnell *et al.* (2011, pp. 2–9) indicated that neither the Mississippi River nor the Great Lakes are acting as a physical barrier between western and eastern lineages of northern leopard frogs. The existence of western haplotypes in northern leopard frog populations located east of the Mississippi River and of eastern haplotypes in northern leopard frog populations located both north and south of the Great Lakes does not support a marked separation between eastern and western northern leopard frogs. Although the nuclear genetic sequences continue to show east-west trends in different haplotypes (supporting the mtDNA data of east-west differences), these nuclear data also indicate that western haplotypes (from frogs in the west) occur in frogs much farther to the east than the mtDNA data indicated. Western haplotypes of some of the nuclear genes were found extending east of the Mississippi River to the eastern end of the Great Lakes in New York (O'Donnell *et al.* 2011, pp. 6–8), and eastern haplotypes of some of the nuclear genes were found as far west as Nebraska (O'Donnell *et al.* 2011, p. 9). This area of overlap of haplotypes spans roughly 1,900 km (1,200 mi) from east to west across North America.

This broad co-occurrence of haplotypes of nuclear genes, as well as the more gradual geographic trends in haplotype distributions (O'Donnell *et al.* 2011, pp. 4–9), indicates there is not a marked separation between eastern and western lineages of the northern leopard frogs. The overlap in genetic markers across the midwestern United States leads us to conclude that there is no physical barrier or other processes keeping northern leopard frogs in the western part of the range discrete from the frogs in the eastern part of the range. Ongoing genetic analyses (such as microsatellite allele frequency analyses) will likely provide additional information regarding geographic patterns of genetic variation in northern leopard frogs (O'Donnell *et al.* 2011, p. 10), but these data are not currently available. Therefore, based upon the genetic information presented above (Hoffman and Blouin 2004a, pp. 145–159; O'Donnell *et al.* 2011, pp. 1–10), there does not appear to be marked separation between possible eastern and western populations of northern leopard frogs. We do recognize that this lack of a marked separation between the eastern and western populations may be a result of a variety of factors, including the anthropogenic movement of individuals for the trade in northern leopard frogs, but at this time, we do not have data supporting this claim. Because the potential eastern and western populations are not markedly separate, they are not considered discrete under

the DPS policy. Based upon the best available information, we conclude that the potential western U.S. population of northern leopard frog is not genetically discrete, in other words not markedly separate, from other northern leopard frogs.

International Border

In order to determine that the populations of northern leopard frog in the western United States are a DPS, we must have found that the western United States populations were discrete from populations in the eastern United States and that the western United States populations were discrete from population in Canada. The DPS policy allows us to use international borders to delineate the boundaries of a DPS if there are differences in control of exploitation, conservation status, or regulatory mechanisms between the countries. However, because we do not have a discrete east-west boundary of the potential DPS, we did not conduct further analysis regarding the northern boundary of the potential DPS between Canada and the United States.

Evaluation of Discreteness

The information discussed in the preceding section provides information on the geographic patterns that we evaluated to determine that the genetic information does not indicate that northern leopard frogs from the western United States are markedly separate from other populations of the northern leopard frog.

We note that our application of the DPS policy does not require absolute reproductive isolation as a prerequisite to recognizing the discreteness of a population segment. The presence of a small degree of sharing of genetic markers would not necessarily preclude us from concluding that there is discontinuity between populations and that they were markedly separated. However, in this case of the northern leopard frog, we do not have the information to make such an evaluation of whether or not the two populations are actually reproductively isolated. Although the genetic patterns indicate discontinuity in eastern and western mtDNA and nuclear haplotypes, the available genetic data do indicate there is more than a small degree of sharing of genetic markers. Rather than a small degree of shared markers, we found a broad extent of introgression that has western haplotypes of some nuclear genes occurring in samples of northern leopard frogs as far as New York. Therefore, because of the large area of overlap in haplotypes indicating no apparent barrier between the two lineages, we conclude at this time based on the best available scientific data that there is not marked separation between the western and eastern U.S. populations. This does not mean that the western and eastern populations of northern leopard frogs, as has been suspected for many years, are not unique and do not have significant conservation value. It simply means that, per our policy, the best available data at this time do not support a marked separation between the two populations, based on genetics and other information available to us.

In conclusion, based on our review of the best available information and pursuant to our DPS policy, we find that the western U.S. populations of northern leopard frog are not discrete from other populations of northern leopard frogs.

Significance

Under our DPS Policy, once we have determined that a population segment is not discrete, we do not need to consider whether that population segment is significant.

Conclusion

On the basis of the best available information, we determined that the western U.S. population of the northern leopard frog is not discrete in relation to the other populations of northern leopard frog. Therefore, we find that the western U.S. populations of northern leopard frog do not represent a valid DPS.

Having determined that the western U.S. populations of northern leopard frog are not a valid DPS, we proceed below with an analysis of threats for the northern leopard frog throughout its range.

Summary of Information Pertaining to Five Factors

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR part 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered or threatened based on any of the following five factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

(E) Other natural or manmade factors affecting its continued existence.

In making this finding, information pertaining to the northern leopard frog in relation to the five factors provided in section 4(a)(1) of the Act is discussed below.

In considering what factors might constitute threats to a species we must look beyond the exposure of the species to a particular factor to evaluate whether the species may respond to that factor in a way that causes actual impacts to the species. If there is exposure to a factor and the species responds negatively, the factor may be a threat and, during the status review, we attempt to determine how significant a threat it is. The threat is significant if it drives, or contributes to, the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined in the Act. However, the identification of factors that could impact a species negatively may not be sufficient to compel a finding that the species warrants listing. The information must include evidence sufficient to suggest that these factors are operative threats that act on the species to the point that the species may meet the definition of endangered or threatened under the Act.

Due to the wide geographic range of the northern leopard frog, and the diversity of habitat types which it occupies throughout its range, there are a wide variety and relatively large number of factors that have the potential to impact the species. However, these factors may result in impacts at the individual, population, or species scale, and may have a variety of effects from minor habitat degradation to complete habitat loss and mortality. As such, it is important to consider the magnitude and extent of impacts when assessing the factors affecting a species, and we attempt to provide this context throughout our discussions below.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

A number of hypotheses, including habitat loss, have been proposed for global amphibian declines (Blaustein *et al.* 1994, p. 61; Collins and Storfer 2003, pp. 90–94; Stuart *et al.* 2004, p. 1783; Green 2005, p. 28). In our review of the best scientific and commercial data available, impacts that are potentially affecting northern leopard frogs and their habitats throughout their range include habitat destruction, habitat fragmentation, and habitat degradation resulting from development, modification, and loss of wetland habitat. Because the northern leopard

frog, an amphibian, depends upon breeding ponds, upland foraging areas, overwintering aquatic habitats, and connectivity between these habitats across the landscape, it is very susceptible to the destruction (defined as complete loss of all or part of the frog's necessary habitat), fragmentation (isolation of all or part of the frog's necessary habitat without its alteration or destruction), and degradation (the deleterious alteration of all or part of the frog's necessary habitat) of its habitat (Green 2005, p. 28).

The destruction and degradation of northern leopard frog habitat has been widespread and has affected, and continues to affect, the species to some extent throughout its range (Maxell 2000, p. 15; Hitchcock 2001, pp. 64–66; Rorabaugh 2005, p. 576; Clarkson and Rorabaugh 1989, p. 535; Smith 2003, pp. 26–31). Habitat destruction and degradation is reported to be the primary threat to all ranid and lithobatid frogs in the United States (Bradford 2005, p. 923) and a principal cause of decline of northern leopard frogs in the western United States and Canada (Smith 2003, p. 4; Alberta Northern Leopard Frog Recovery Team 2005, p. 6; Rorabaugh 2005, p. 571; Committee on the Status of Endangered Wildlife in Canada 2009, p. 32). Factors with the potential to impact northern leopard frog habitat include wetland loss, agricultural development, livestock grazing, urban development, oil and gas development, forest management, roads, groundwater withdrawal, and air pollution. Below we present information about these factors and discuss the magnitude and extent of the impacts from these factors on the northern leopard frog.

Wetland Loss

As a species with aquatic and semi-aquatic life-history phases, freshwater wetland habitat is an extremely important component of northern leopard frog habitat. In order to discuss the different actions that result in destruction or modification of northern leopard frog habitat, it is important to understand what is known about the current overall status of wetlands throughout the range of the northern leopard frog.

It has been estimated that 53 percent of the Nation's former wetland area was lost from the 1780s to the 1980s (Dahl 1990, p. 5). In terms of States where the northern leopard frog occurs, Minnesota (42 percent loss), Maine (20 percent loss), Michigan (50 percent loss), and Wisconsin (46 percent loss) have the most remaining wetland area compared to historical times (Dahl 1990, p. 5). New Hampshire (9 percent loss) was the only State in the range of the northern leopard frog that lost less than 20 percent of its original wetland acreage (Dahl 1990, p. 5). California (91 percent loss), Connecticut (74 percent loss), Illinois (85 percent loss), Indiana (87 percent loss), Iowa (89 percent loss), Kentucky (81 percent loss), Missouri (87 percent loss), and Ohio (90 percent loss) lost over 70 percent of their original wetland acreage (Dahl 1990, pp. 5–6). The remaining States within the range of the northern leopard frog had estimated wetland losses ranging from 20 percent to 60 percent (Dahl 1990, p. 6).

Dahl (1990, p. 10) noted that wetland area in the lower 48 States had declined to the point that ''environmental, and even socio-economic benefits (ground water supply, water quality, shoreline erosion, floodwater storage, trapping of sediments, and climatic change) are now seriously threatened.'' The destruction and degradation of wetland and riparian habitat is thought to represent the most widespread impact to northern leopard frog populations in Arizona (Arizona Game and Fish Department 2009, p. 1), Colorado (Colorado Division of Wildlife 2009, p. 2), Idaho (Idaho Department of Fish and Game 2005), Montana (Montana Fish Wildlife and Parks 2009, p. 2), Nevada (Nevada Department of Wildlife 2009, p. 4), New Mexico (New Mexico Department of Game and Fish 2009, p. 3), North Dakota (North Dakota Game and Fish Department 2009, p. 2), Utah (Utah Department of Wildlife Resources 2009, pp. 2–3), Wisconsin (Wisconsin Department of Natural Resources 2009, p. 1), Connecticut (Klemens 2000, p. 1), Indiana (Indiana Department of Natural Resources 2006, p. 113), Kentucky (Kentucky Department of Fish and Wildlife Resources 2010, p. 27), Maine (Maine Department of Natural Resources 2005, p. 90), Massachusetts (Massachusetts Department of Fish and Wildlife 2006, pp. 276, 292, 328), Michigan (Eagle *et al.* 2005, Threats p. 20), New Hampshire (New Hampshire Fish and Game Department, p. A–210), New York (New York Department of Environmental Conservation 2005, pp. 57–58), and Rhode Island (Rhode Island Department of Environmental Management, Division of Fish and Wildlife 2005, p. 22).

While the total wetland losses in the United States are significant, the information regarding status and trend of wetlands only looks at total losses and gains of wetland area; there is no comprehensive data assessing trends in the quality or function of lost wetlands (Dahl 2006, p. 74). Therefore, we do not know how much of the lost wetland habitat would have naturally functioned as northern leopard frog habitat. In short, while the extent of wetland losses is broad and widespread throughout the range of the species, we are unable to assess the magnitude or severity of impact of these losses at the species scale. There have most likely been losses of northern leopard frog habitat concurrent with these wetland losses, but large areas of wetland remain intact in many States, particularly in the eastern portion of its range in the United States. Further, the data above address total change in wetland area without reference to the causes of the losses; thus it is difficult to relate past losses to future losses in this context. Ongoing impacts to northern leopard frog habitats will be discussed more specifically in the following sections.

Since the late 1980s, creation of new wetland area has occurred, although the rate of replacement area is much slower than the historical loss rate (Dahl 1990, p. 5). Data collected from 1998 to 2004 indicate that for the first time since uniform monitoring began, wetland creation actions resulted in a larger net gain of wetlands than net loss of wetlands during this time period (Dahl 2006, p. 15). However, the location and types of wetlands that represent this gain in wetland acres has not necessarily resulted in the creation of northern leopard frog habitat. In terms of location, a majority of the wetland areas gained were created in the southeast, particularly in Florida, which is outside the range of the northern leopard frog (Dahl 2006, p. 62). Further, review of created ponds from 1986 to 1997 indicates that only 2 percent of these ponds were reclassified as vegetated wetlands; most created ponds are designed and maintained to function as open water basins—deep waters with little vegetated shoreline and steep slopes—that are not conducive to northern leopard frog breeding, foraging, or dispersal (Hine *et al.* 1981, p. 12; Leja 1998, p. 351; Semlitsch 2000, p. 624). All of the created ponds that Dahl (2006, pp. 76–78) noted were manmade farm ponds, freshwater fishing ponds, detention ponds, and aquaculture ponds. Deepwater lakes and reservoirs also increased in area over this time period (typically associated with urban development) (Dahl 2006, p. 78). Many of these ponds or open water bodies are not an equivalent replacement for vegetated wetlands (Dahl 2006, p. 76), and although they count towards the total of wetland area in the conterminous United States, they do not necessarily indicate a gain in northern

leopard frog habitat, particularly if water quality, vegetation, and native species are not objectives for the created wetland.

In Canada, wetland loss has also occurred throughout the range of the northern leopard frog. Wetland habitat quality is considered to be a limiting factor for the one remaining northern leopard frog population in British Columbia (Committee on the Status of Endangered Species in Canada 2009, p. 16). It is estimated that approximately 60 percent of basins and 80 percent of wetland margins in the 1980s in southern Alberta were degraded and that local extirpations of northern leopard frogs likely occurred as a result (Alberta Northern Leopard Frog Recovery Team 2005, p. 6). By 1990, approximately 20 percent of prairie wetlands that likely functioned as northern leopard frog habitat in Manitoba were lost (Committee on the Status of Endangered Species in Canada 2009, p. 17). Similar patterns of significant wetland loss have occurred in southern Ontario and southern Quebec. Historically, 69 percent of southwestern Ontario consisted of wetlands; however, it is estimated that as much as 90 percent of southwestern Ontario wetlands no longer exist (Committee on the Status of Endangered Species in Canada 2009, p. 17). Again, similar to the situation in the United States, we do not have information assessing how much of this lost habitat may have functioned as northern leopard frog habitat or if any mitigation (such as created wetlands) has resulted in replacement habitat. While it is likely there have been losses of northern leopard frog habitat concurrent with these wetland losses, large areas of wetland remain intact, particularly in the eastern portion of Canada.

Across the range of the species, it is clear that significant total wetland area has been lost since colonial times. It is logically certain that some of these areas represented historic habitat for northern leopard frogs; however, it is not possible to assess the extent of loss of actual northern leopard frog habitats based on a generalized review of loss of wetlands. Further, while wetland losses have occurred, large areas of wetland remain, particularly in the eastern portion of the United States and Canada.

Agricultural Development

Agricultural development has occurred across the range of the northern leopard frog, but particularly in the Midwestern States of the United States (Leja 1998, p. 349). The U.S. Department of Agriculture, Natural Resource Conservation Service (USDA NRCS) has a broad land cover and use map that shows by State the amount of land in cropland, pastureland, rangeland, forest land, developed land, Federal lands, and other lands. Data from this map shows that greater than 80 percent of the total land area (outside Federal lands) in Iowa, Nebraska, North Dakota, and South Dakota is used for agricultural purposes, such as cropland, pastureland, and rangeland (USDA NRCS 2001). In addition, many other western and Midwestern States also have significant amounts of land identified as agricultural within the range of the northern leopard frog (USDA NRCS 2001). While agricultural development continues to be a large land-use practice in South Dakota (57 percent cropland), North Dakota (35 percent cropland), and Ohio (45 percent cropland) (USDA NRCS 2001), the northern leopard frog appears to be relatively stable in these States (Hossack *et al.* 2005, p. 428; Rorabaugh 2005, p. 571), despite this level of usage.

Agricultural development may fragment, destroy, or degrade northern leopard frog habitat directly due to conversion of native habitats to cropland and de-watering of adjacent habitats, or indirectly through the introduction of contaminants and invasive species into habitats (Wang *et al.* 1997, p. 10; Leonard *et al.* 1999, p. 58; Leja 1998, pp. 345–353; Knutson *et al.* 2004, p. 675; Rorabaugh 2005, p. 576). Most of the historic wetland loss discussed above is thought to be due to conversion to agriculture (Leja 1998, p. 349). Agricultural development can result in modification of river valley habitat, including draining of wetlands, channelization and damming of rivers, and development of irrigation systems (Wang *et al.* 1997, p. 11; Findlay and Houlahan 1997, p. 1001), all of which may modify breeding, overwintering, and dispersal habitat for northern leopard frogs (Scott and Jennings 1985, p. 19; Lannoo *et al.* 1994, pp. 317–318; Leja 1998, pp. 345–353; Knutson *et al.* 2000, p. 139; Ammon 2002, p. 2; Idaho Department of Fish and Game 2005, Northern leopard frog species account; Colorado Division of Wildlife 2009, p. 1; Rogers 2010, p. 8). For example, in Idaho, Camas NWR is losing wetlands to groundwater depletion by nearby agriculture, and Grays Lake NWR and Minidoka NWR cannot control water levels because of senior water rights assigned to other agencies, and their use for agriculture (Fisher and Mitchell 2009, pers. comm.). In Canada, the past conversion of large areas of grassland to agriculture has also likely resulted in the loss of northern leopard frog habitat, particularly foraging and overwintering habitats near breeding sites (Didiuk 1997, p. 113; Hecnar 1997, p. 13). In southern Alberta, drainage of wetlands for agricultural use in the 1980s was extensive and is thought to have contributed to local extirpations of northern leopard frogs (Alberta Northern Leopard Frog Recovery Team 2005, p. 6). The land being used for agriculture in the prairies has lately increased by 62 million acres (25 million hectares), and there is pressure to alter remaining wetland areas (Committee on the Status of Endangered Wildlife in Canada 2009, p. 32).

Geographically isolated (or depressional) wetlands surrounded by upland watersheds (such as the prairie potholes region) make up a large proportion of the wetland resource in arid and semi-arid regions of the northern leopard frog's range (Skagen *et al.* 2008, p. 594). However, although the ''wet'' (surface water) portion of the wetland is vitally important for northern leopard frog breeding, the upland terrestrial habitat adjacent to the wetland is also a critical component of their habitat needs (Semlitsch 2000, p. 620; Pope *et al.* 2000, p. 2506; Gibbons 2003, p. 630; Semlitsch and Bodie 2003, p. 1223). Although agricultural development may result in the maintenance or creation of actual ''wet'' wetland habitat (Leja 1998, p. 350), crops and pastures—areas that provide poor or no habitat for northern leopard frog—typically occur on the immediate edge of the water (Guerry and Hunter 2002, p. 752; Committee on the Status of Endangered Species in Canada 2009, p. 32). Research indicates that land use practices around the wetland may be as important as the size of the wetland itself (Findlay and Houlahan 1997, p. 1007). Amphibian species richness increases with wetland area, and herpetofauna abundance, including the northern leopard frog, show a strong positive correlation with the proportion of forest cover on lands within 1.2 mi (2 km) of wetlands (Findlay and Houlahan 1997, pp. 1006–1007). Northern leopard frogs breeding in active agricultural lands may end up crossing roads and tilled agricultural fields which would increase the likelihood of mortality, and northern leopard frogs that breed in active agricultural lands require larger home ranges than do frogs that breed in intact wetlands and grasslands (Pember *et al.* 2002, p. 4.9)

Habitat fragmentation caused by agriculture has also likely limited northern leopard frog dispersal, as frogs may have difficulty moving through active croplands (Didiuk 1997, p. 113;

Saskatchewan Conservation Data Centre 2006, p. 2). Agricultural development also tends to result in disturbed ground, which can impact the distance and the quality of habitat between habitat patches (Didiuk 1997, p. 113; Pember *et al.* 2002, p. 4.9; Alberta Northern Leopard Frog Recovery Team 2005, p. 6; Mazerolle and Desrochers 2005, p. 455; Committee on the Status of Endangered Wildlife in Canada 2009, p. 32). Barren land, agricultural lands, and recently cut forests increase the resistance of the landscape to northern leopard frog movement (Mazerolle and Desrochers 2005, p. 462). Vegetation on undisturbed sites likely reduces evaporative water loss in dispersing or moving frogs through protection from the wind and sun (reduced dehydration), while surfaces with no vegetative cover likely endanger individual frogs and constitute barriers to frog movement (Mazerolle and Desrochers 2005, p. 462). In addition, agriculturally induced habitat fragmentation can increase the role of genetic drift, which may hamper adaptive responses to local environments (Johansson *et al.* 2007, p. 2699). Research regarding the European common frog (*Rana temporia*) found that populations in fragmented agricultural habitats were smaller and had lower genetic diversity compared to populations in a more continuous landscape. More genetic diversity leads to healthier populations. Breeding pond isolation, resulting from fragmented landscapes, has also been shown to negatively affect population persistence and recolonization of ranid and lithobatid frogs to suitable habitats (Witte *et al.* 2008, p. 381).

Agriculture is also the primary source of water pollution throughout the western range of the northern leopard frog and occurs primarily through sedimentation, nutrient pollution, pesticide pollution, and mineral pollution (Ribaudo 2000, pp. 5–11). On many NWRs, pesticide and herbicide use are regulated by Service Pesticide Use Plans, but these plans may not adequately account for toxicity to northern leopard frogs, and thus pesticide and herbicide use may result in impacts to individuals or populations of the species (Dickerson and Ramirez 1993, pp. 1–2; Fisher and Mitchell 2009, pers. comm.). Overwintering northern leopard frogs in permanent waters are likely to be in close contact with sediments on the pond bottom that may contain agricultural chemicals resulting from run-off (Didiuk 2007, p. 113). This close contact with chemicals may make the northern leopard frog more susceptible to potential adverse chemical effects in these areas.

Leopard frogs that inhabit agricultural wetlands and landscapes are also vulnerable to pesticide exposure (King *et al.* 2008, p. 13) (see Pesticides under *Factor E* for further discussion). In addition, ''hotspots'' of amphibian malformations, including northern leopard frog malformations, tend to occur in altered wetlands (Lannoo 2008, p. 200) (see Malformations under *Factor E* for further discussion).

As described above, agricultural development has been shown to result in adverse effects to northern leopard frogs in some portions of its range. The above review of the best available information indicates that large areas of historical habitat have likely been lost due to agricultural development and that current habitats may continue to be subject to ongoing impacts of agricultural development. The most significant impacts associated with agricultural development are likely the loss of historical habitats due to conversion to agricultural lands. Ongoing impacts to areas currently associated with agriculture likely negatively impact local populations through reduced breeding success and individual survival. However, even States with a significant land base in agriculture (such as South Dakota, North Dakota, and Ohio) appear to be maintaining stable populations of northern leopard frogs. Therefore, though research indicates that agricultural development can have a negative impact on local populations of northern leopard frogs, the best available information does not indicate the ongoing impacts are significant at the species level. Based upon the best available information, agricultural development does not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Livestock Grazing

Approximately 70 percent of the land surface in the western United States (including Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, California, Idaho, Oregon, and Washington) is or has been grazed by livestock (Fleischner 1994, p. 630; Krausman *et al.* 2009, p. 15). Historical and ongoing livestock grazing are specifically identified as being responsible for the loss and degradation of northern leopard frog habitats, and for negatively affecting northern leopard frog populations at sites in Arizona (Clarkson and Rorabaugh 1989, p. 535; Sredl 1998, pp. 573–574), California (California Department of Fish and Game 2007), Idaho (Idaho Department of Fish and Game 2005, Appendix F), Montana (Maxell 2000, p. 15), Nevada (Hitchcock 2001, p. 66), North Dakota (Euliss, Jr. and Mushet 2004, p. 82), South Dakota (Smith 2003, p. 27), and Wyoming (BLM 2009, p. 3). For example, most of the habitat in the Pit River-Modoc Plateau area and the Owens Valley of California, where the northern leopard frog occurred historically, has been severely altered and fragmented largely because of livestock grazing practices. The essential habitats bordering riparian zones are either no longer present or so fragmented that the habitat can no longer support northern leopard frog populations (Jennings and Hayes 1994, p. 82). Although management may be changing in some areas, many wetland habitats are likely still recovering from historical grazing impacts (Krausman *et al.* 2009, p. 16). This is particularly true because the western United States has a relatively arid climate, which can result in longer habitat recovery intervals, and perennial waters tend to be rarer and more disjunct from other waters than in the eastern United States.

Livestock select riparian habitats for water, shade, and cooler temperatures. They tend to spend a disproportionate amount of their time in riparian zones, and they can adversely affect these systems in a number of important ways (Fleischner 1994, pp. 633–635; Belsky *et al.* 1999, pp. 420–424; Jones 2000, pp. 159–161). Because of this disproportionate use of mesic and riparian habitats by livestock, northern leopard frog populations are vulnerable to the effects of poorly managed livestock grazing (Maxell 2000, pp. 15–16; Smith 2003, p. 30). Specifically, trampling by livestock may result in the death of individual frogs (Bartlet 1998, p. 96; Maxell 2000, p. 15; Smith 2003, p. 30), and the compaction of soils around aquatic habitats, thereby decreasing infiltration of water into the soil, increasing soil erosion, and contributing to stream channel down cutting (Kauffman and Kreuger 1984, pp. 432–434; Belsky *et al.* 1999, pp. 419–431). These impacts could hinder or prevent movements of northern leopard frogs by reducing and eliminating riparian vegetation that provides cover.

Impacts to water quality through increased sedimentation (Belsky *et al.* 1999, pp. 420–424; Alberta Northern Leopard Frog Recovery Team 2005, p. 7) may reduce the depth of breeding ponds or overwintering habitats, increase water temperatures, and create favorable environments for diseases and parasites

known to contribute to mortality in northern leopard frogs (Maxell 2000, pp. 15–16; Johnson and Lunde 2005, pp. 133–136; Ouellet *et al.* 2005, p. 1435). Increased watershed erosion caused by livestock grazing can accelerate sedimentation of deep pools used by frogs (Gunderson 1968, p. 510). The indirect effects of grazing on northern leopard frog habitat may also include increases in sedimentation generated by grazing. Sediment can alter primary productivity and fill interstitial spaces in drainage materials with fine particulates that impede water flow, reduce oxygen levels, and restrict waste removal (Chapman 1988, pp. 5–10).

Disturbance from livestock wading and defecating in northern leopard frog habitat has been found to have negative effects on the reproductive success of northern leopard frogs and to result in negative impacts to habitat (Knutson *et al.* 2004, p. 677). The significant input of urine and manure and the turbidity caused by livestock disturbance was found to lead to poor water quality (such as increased nitrates) and low oxygen concentrations, which can result in reduced development and survival of egg masses and tadpoles (Marco *et al.* 1999, p. 2837; Rouse *et al.* 1999, pp. 800–802; Ortiz *et al.* 2004, pp. 235–236; Alberta Northern Leopard Frog Recovery Team 2005, p. 7; Earl and Whiteman 2009, p. 1336). In addition, Knutson *et al.* (2004 p. 675) found that the grazed ponds had little or no aquatic or emergent vegetation, and that this was a result of livestock wading in the pond.

In contrast, there is information from some portions of the range of the species that indicates leopard frog species can persist, and even benefit from, well-managed livestock grazing (Hitchcock 2001, p. 62; Service 2007, pp. 32–34; Alberta Northern Leopard Frog Recovery Plan 2005, p. 7; Arizona Game and Fish Department 2009, pp. 2–3; New Mexico Department of Fish and Game 2009, p. 3). Limited grazing around riparian areas can create open foraging areas for leopard frogs, and livestock management can result in the creation of stock tanks (ponds or impoundments that function as waterholes) that can provide breeding and dispersal habitat for northern leopard frogs, particularly in arid western landscapes (Sredl *et al.* 1997, pp. 46, 49; Theimer *et al.* 2011, p. 11).

Historically, livestock grazing has likely resulted in degraded habitats and local declines and extirpations of northern leopard frogs in some portions of their range. However, the information reviewed above suggests that livestock grazing has only resulted in substantive impacts in the western portions of the United States and Canada, with very little to no information suggesting how livestock grazing has or is adversely impacting northern leopard frog populations in the eastern United States or eastern Canada. Further, declines and extirpations associated with livestock grazing are likely historical impacts in most areas, with ongoing impacts manifesting primarily through effects associated with degraded habitats. Finally, there is no evidence that livestock grazing use is spreading to areas that are not already subject to those uses. Therefore, the best available scientific information indicates that livestock grazing does not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Urban Development

Urbanization refers to the development of areas for human uses. Areas subject to urbanization tend to be correlated to areas with increased human population growth. This development is resulting in impacts to northern leopard frog habitat across its range (Hitchcock 2001, pp. 64–66; Smith and Keinath 2007, p. 29; Connecticut Department of Environmental Protection 2005, pp. 2–16–2–18; Maine Department of Inland Fisheries and Wildlife 2005, Chapter 5 p. 109; New Hampshire Fish and Game Department 2005, p. A210–212; Wisconsin Department of Natural Resources 2009, p. 1). The 2010 Census reported that the human population in the United States has increased almost 10 percent since 2000. The only State within the range of the northern leopard frog that did not have an increase in population is Michigan (Mackun and Wilson 2011, pp. 1–2). Nevada, Arizona, Utah, Texas, and Idaho were the fastest growing States, and New Hampshire and South Dakota were the fastest growing States in the northeast and Midwest, respectively. Pennsylvania ranks fifth in the nation in the amount of open space it loses to development every day and it has lost over half of its wetlands to development (Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission 2005, pp. 10–34). In Canada, Ontario and Quebec are the largest provinces in terms of numbers of people; larger numbers of people typically contribute more to increases in urban development and modification of northern leopard frog habitats. Projected human population growth is also expected to result in increased needs for water (surface diversions and groundwater pumping) to support this growth (Deacon *et al.* 2007, p. 688). This could decrease water availability for northern leopard frogs and thereby impact the amount and extent of habitat for northern leopard frogs. Reexamination of historic northern leopard frogs sites in northeastern Ohio (Orr *et al.* 1998, p. 92) found that two sites had been destroyed by development and three had been eliminated by high-intensity agriculture. A study in Iowa and Wisconsin found a negative association with urban land use and relative abundance of northern leopard frogs (Knutson *et al.* 1999, p. 1441; Knutson *et al.* 2000, p. 140). From 1998 to 2004, 140,400 ac (56,800 ha) or 61 percent of wetland losses in the United States occurred due to urban and rural development (Dahl 2006, p. 47). These wetland losses are considered to be irreversible as they are the result of permanent construction (such as houses and roads) that alters wetland hydrology (Dahl 2006, pp. 47, 63). Urban development often results in conversion of natural habitats to homes, roads, and industrial uses, which can result in direct mortality from traffic (Mazerolle 2004, p. 47; Bouchard *et al.* 2009, p. 23), chemical contamination of wetlands (Fahrig *et al.* 1995, p. 177), and modification of existing wetland habitats to benefit sport fish rather than native amphibians (Knutson *et al.* 1999, p. 1444).

Based upon the above information, urban development has likely resulted in the historical and continued loss of northern leopard frogs and their habitat throughout their range. While the magnitude of these impacts is conceivably high in localized areas, urbanization is not ubiquitous throughout the range of the northern leopard frog. General information about human population growth and associated urbanization cannot be extrapolated to support high magnitude threats throughout all portions of the range of the northern leopard frog. Further, despite urbanization trends, the northern leopard frog is apparently still considered to be widespread and common in the eastern United States and eastern Canada. Therefore, the best available scientific information indicates that urbanization does not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Oil and Gas Development

Natural gas drilling is currently occurring in at least 25 States that have populations of northern leopard frogs. In 2007, there were 449,000 natural gas

wells in 32 States, which was a 30 percent increase from 2000; it is estimated that 32,000 new natural gas wells per year could be drilled by 2012 (Lustgarten 2008, p. 2). Examples of the increase in magnitude of drilling in the United States can be observed by the increase in approved permits in Wyoming and Pennsylvania. The first natural gas well in Sublette County, Wyoming, was drilled in 1939, and by 2008, 700 gas wells were producing natural gas on the Pinedale Anticline (a major gas field in Sublette County). In 2008, the Bureau of Land Management approved 4,400 more natural gas wells in Sublette County (Lustgarten 2008, p. 3). In Susquehanna County, Pennsylvania, there was a 27-fold increase in natural gas well permits from 2007 to 2009. Natural gas mining is also occurring in Canada, the world's third-largest producer and exporter of natural gas (Natural Resources Canada 2011, p. 1). However, we have minimal specific information assessing the overlap of occupied northern leopard frog habitats with planned oil and gas development operations for most of the range of the species.

The Powder River Basin in Wyoming and Montana and the San Juan Basin in Colorado and New Mexico, areas within the range of the northern leopard frog, currently have the highest coalbed methane (a natural gas) productions in the United States (Environmental Protection Agency 2004, p. 1–1). Possible impacts to northern leopard frogs associated with coalbed methane development may include discharge of contaminated water into breeding ponds, loss of spring flows related to groundwater withdrawals, discharge of extremely cold water into breeding habitats, discharge of water containing nonnative predatory fish in these same areas, and road-related mortality associated with increased use of roads or new roads to support the coalbed methane development (Allan 2002, pp. 5–8; Gore 2002, pp. 1–14; Noss and Wuethner 2002, pp. 1–20). Mining and oil and gas development may also lead to contamination of habitats (Spengler 2002, pp. 7–26; Smith 2003, pp. 26, 31). Domestic and stock tank waters have dried or become contaminated with gas in Wyoming's Powder Basin (Powder River Basin Resource Council 2009, p. 1). Although some States that have populations of the northern leopard frog are implementing wetland and riparian protections in connection with oil and gas drilling (Colorado Division of Wildlife 2009, p. 5), it is unclear if all States are implementing such measures and whether or not these measures have resulted in decreased impacts to northern leopard frogs.

Another area where there is information about oil and gas development activities in northern leopard frog habitats is the Marcellus Shale. The Marcellus Shale is a black shale formation extending underground from Ohio and West Virginia northeast into Pennsylvania and southern New York that contains natural gas reserves. Although there are areas where the Marcellus Shale is exposed at the surface, it is as deep as 7,000 ft (2,134 m) or more below the ground surface along the Pennsylvania border. Natural gas drilling operations have proliferated in Pennsylvania over the past years, and at least 1,415 new wells were drilled in 2010 (Goldberg 2011, p. 2). The drilling is expected to expand into Ohio and West Virginia. New York is currently conducting a comprehensive review of the potential environmental impacts associated with natural gas development and Ohio's State government approved drilling in Ohio's State parks on June 15, 2011.

Hydraulic fracturing is a method used to extract natural gas from the earth. Environmental concerns with hydraulic fracturing include water use and management, and the composition of the fluids used (Environmental Protection Agency 2011, p. 1). Hydraulic fracturing consists of pumping chemicals (such as benzene) and high volumes of water and sand down the well under high pressure to create fractures in the gas-bearing rock (New York Department of Environmental Conservation 2011, p. 1). The propping material holds the fractures open allowing more gas to flow into the well. The hydraulic fracturing of the Marcellus Shale will require large volumes of water to fracture the rocks and produce natural gas. In 2008, oil and gas wells disgorged approximately 9 million gallons of wastewater a day in Pennsylvania, and water use is expected to increase to at least 19 million gallons per day (Sapien 2009, p. 2).

The wastewater is a product of the hydraulic fracturing which pumps about 1 million gallons of water mixed with sand and chemicals into each well to withdraw the natural gas. When it comes back out, the water contains toxins and dissolved solids. Wastewater contains enough dissolved solids that the water can be five times as salty as sea water. Recent research found methane contamination of drinking water in Pennsylvania and New York from natural gas extraction on the Marcellus Shale (Osborn *et al.* 2011, p. 2). In addition, water contamination has been documented near drilling areas in Sublette County, Wyoming, and Santa Fe, New Mexico; chemical spills of hydraulic fracturing chemicals have occurred in Colorado (Lustgarten 2008, pp. 2–9).

The rate, timing, and location of water withdrawals could result in negative impacts to streams, downstream riverine and riparian resources, wetlands, and aquifer supplies where hydraulic fracturing to mine natural gas occurs (New York Department of Environmental Conservation 2009, p. 6–4). The draft environmental impact statement for natural gas drilling in New York states, ''Water for hydraulic fracturing may be obtained by withdrawing it from surface water bodies away from the well site or through wells drilled into groundwater aquifers'' (New York Department of Environmental Conservation 2009, p. 6–4). The existence and sustainability of wetland habitats directly depend on the presence of water at or near the surface of the soil. The functioning of a wetland is driven by the inflow and outflow of surface water and groundwater. As a result, withdrawal of surface water or groundwater for high volume hydraulic fracturing could impact wetland resources and northern leopard frog habitat. These potential impacts depend on the amount of water within the wetland, the amount of water withdrawn from the catchment area of the wetland, and the dynamics of water flowing into and out of the wetland. Even small changes in the hydrology of the wetland can have significant impacts on the wetland plant community and on the wildlife, such as the northern leopard frog, that depend on the wetland. As discussed in the Biology section, wintering northern leopard frogs are intolerant of freezing, and withdrawals that reduce water depths in overwintering habitat could lead to high levels of winter kill if water levels are reduced so much that these areas freeze.

In summary, some northern leopard frog populations could be impacted by oil and gas development activities through changes to water quantity or quality (due to chemical pollution or increased salinity) and through insufficient water flow to maintain wetland and stream habitat. Natural gas drilling and hydraulic fracturing may occur across the range of the northern leopard frog; however, the impacts are expected to be localized population and habitat losses rather than regional or species-level effects. Pennsylvania, Ohio, West Virginia, Kentucky, Wyoming, Colorado, Montana, and New Mexico all have oil and gas development occurring within their

boundaries; however, we have little to no information about oil and gas development activities in northern leopard frog habitats throughout the rest of the range of the species, notably the Midwestern United States and Canada. Therefore, the best available scientific information indicates that oil and gas development does not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Roads

Roads have been shown to pose barriers to northern leopard frog dispersal, to contribute to nonpoint source pollution, and to result in direct mortality of northern leopard frogs (Smith 2003, pp. 27, 38; Maxell 2000, p. 25; Fahrig *et al.* 1995, pp. 177–182). The movements of adult northern leopard frogs to breeding habitats during spring rains and the extensive dispersal of juveniles from breeding ponds in late summer make this species vulnerable to highway traffic (Orr *et al.* 1998, p. 93; Langen *et al.* 2009, p. 111), and there are many reports of large amounts of leopard frog road mortality (see references in Carr and Fahrig 2001, p. 1075; Glista *et al.* 2008, pp. 81–82; Langen *et al.* 2009, p. 111). Road building is often tied to other activities such as urban, agricultural, and oil and gas development, so roads may impact leopard frogs directly and indirectly.

Bouchard *et al.* (2009, pp. 5–6) found that the northern leopard frog's inability to avoid roads and their slow movement make them particularly vulnerable to road mortality and that roads could thus result in negative effects to local population abundance. Other studies did not find any decreasing trends in abundance for amphibian roadside populations (Mazerolle 2004, p. 51). Traffic density within 0.9 mi (1.5 km) of occupied northern leopard frog habitat may have negatively affected local frog abundance, but it was unclear if results were due to the observed road mortality, pollution (*e.g.,* vehicle emissions, road runoff), or increased urbanization (Carr and Fahrig 2001, p. 1074). Other studies have also documented smaller amphibian populations in the vicinity of major roads and within landscapes with high road densities than populations where roads are distant and few (Langen *et al.* 2009, p. 104). ''Hotspots'' for northern leopard frog road mortality tend to occur along causeways (road segments with water on either side) with wetland sites within 328 ft (100 m) of the road (Langen *et al.* 2009, p. 110).

In summary, although research indicates that roadside populations of northern leopard frogs may be adversely impacted by roads and evidence shows that individual frogs are certainly impacted through road mortality, the information assessed indicates these impacts are localized and result in effects to local frog abundance, not population level impacts. While roads occur throughout the range of the northern leopard frog, the best available information does not suggest that roads constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that they will in the future.

Forest Management

The northern leopard frog is associated with forested as well as grassland or open areas (Blomquist and Hunter 2009, p. 150). Based upon broad land cover and use, forest management occurs in forested areas throughout the range of the northern leopard frog (USDA NRCS 2001). Timber harvest activities may impact northern leopard frog populations in several ways. Clearcuts (areas where all trees are removed) at breeding sites can result in enhanced tadpole development through increased water temperatures and food production (Semlitsch *et al.* 2009, p. 859). However, clearcuts can also result in negative effects to juvenile and adult northern leopard frog movement due to higher surface temperatures (from canopy removal), and loss of soil-litter moisture in upland habitats surrounding breeding ponds, which affects the species' ability to move through these areas into post-breeding habitat (Maxell 2000, pp. 12–14; Smith 2003, p. 29; Semlitsch *et al.* 2009, p. 860). Research on timber management and northern leopard frog seasonal habitat requirements found that northern leopard frogs in the late spring and summer used open, wet areas; frogs used unharvested forest for longer movements (Blomquist and Hunter 2009, p. 153). Forest management may affect local populations of northern leopard frogs by fragmenting habitats and reducing landscape connectivity.

Forest management has the potential to impact northern leopard frog breeding, dispersal, and foraging habitats in forested areas throughout its range. However, the information we reviewed does not indicate that forest management, clearcutting in particular, is occurring at a level or extent that would result in impacts at the species level. Therefore, the best available information indicates forest management is not a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Groundwater Withdrawal

Throughout the range of the northern leopard frog, particularly in the western United States and Canada, naturally geographically isolated (or depressional) wetlands completely surrounded by upland plant communities (such as the prairie pothole wetlands in the upper Midwestern United States and Canada) and human-caused isolated wetlands (such as natural wetlands that are no longer connected to streams due to roads or other development) are important habitats for the northern leopard frog. Many of these ''isolated'' wetlands appear to be disconnected from other water sources, but are hydrologically connected to other wetlands or waters through sub-surface or groundwater connections (Tiner 2003, p. 495). Because of this hydrologic connection, groundwater withdrawal can result in significant impacts to wetland habitats and may result in decreased surface water, decreased recharge, and reduced water levels in wetland and spring habitats (Alley *et al.* 1999, pp. 33–44; Alberta Northern Leopard Frog Recovery Plan 2005, p. 7; Wirt *et al.* 2005, pp. G1–11; Patten *et al.* 2008, p. 279). Specifically, groundwater withdrawal can result in loss of northern leopard frog breeding ponds and spring- and riparian-associated vegetation, and thus the loss or modification of northern leopard frog habitat (Alberta Northern Leopard Frog Recovery Plan 2005, p. 7; Patten *et al.* 2008, p. 286). In addition, decreased surface water levels may reduce the water level in overwintering habitats, which may result in the area freezing and an increased risk of mortality as wintering northern leopard frogs are intolerant of freezing (see Biology section).

Across the range of the northern leopard frog, these habitats occur in the prairie potholes region (see above), the playas and springs of the Southwest, the Sandhills wetlands in northern Nebraska, channeled scablands in eastern Washington, woodland vernal pools of the northeastern United States, and many other natural ponds throughout the United States (Tiner 2003, p. 497). Within these areas, there is regional and local information to indicate that current and proposed groundwater pumping may result in reduced habitat for northern leopard frogs, particularly in the arid West (Tiner 2003, p. 513; Deacon *et al.* 2007). Specifically, the BLM recently released the Draft Environmental Impact Statement for the Clark, Lincoln, and White Pine Counties Groundwater Development Project in Nevada (BLM

2011). Based upon the modeling analysis, the BLM predicts that northern leopard frog habitat (for all life stages) will be reduced in currently occupied areas of central-eastern Nevada as a result of the proposed action (BLM 2011, p. 3.7–45). This information indicates that isolated wetland habitats such as those in Spring Valley, Nevada, may be significantly impacted by these proposed groundwater withdrawals.

Groundwater depletion has been a concern in the Southwest and High Plains for many years due to the arid climate and a lack of water resources; however, increased demands on groundwater resources have overstressed aquifers in many areas of the United States (Bartolino and Cunningham 2003, p. 2). The Southwest United States has experienced rapid human population growth over the last two decades in conjunction with long-term drought. This situation has resulted in increased demand for water resulting in impacts to wetland and spring habitats from groundwater pumping (Levick *et al.* 2008, pp. 70–71). Brussard *et al.* (1998, pp. 505–542) found that pumping of groundwater from gold mines impacted spring communities in the north-central region of Nevada. Groundwater pumping by the City of Albuquerque, New Mexico, contributed to the loss of wetland habitat in the Rio Grande valley as well (Bogan 1998, pp. 562–563). In addition, groundwater modeling studies indicate that aquifers in eastern and southern Nevada that supply water to springs currently occupied by northern leopard frogs may decline in response to pumping in these areas to meet human water demands (Schaefer and Harrill 1995, p. 46). However, streams and wetlands in the Northeast, the High Plains, the Pacific Northwest, and other regions of the United States have also been impacted by groundwater pumping (Bartolino and Cunningham 2003, p. 2). Impacts have included lowered water tables, reduced surface flows, desiccation of springs, and decreased lengths of perennial streams as a result of groundwater pumping (Bartolino and Cunningham 2003, pp. 2–4). Currently, there are many ongoing discussions throughout the Southwest regarding water supplies and how groundwater pumping may be used to meet human water demands. While specific plans regarding how these future plans may impact northern leopard frogs are limited at this time in many areas, as described above, the recently proposed Clark, Lincoln, and White Pine Counties Groundwater Development Project (Bureau of Land Management 2011) is expected to reduce occupied northern leopard frog habitat in Spring Valley, Nevada.

As described above in the Oil and Gas Development section, an increase in natural gas mining (using hydraulic fracturing) may also result in increases in groundwater pumping throughout Pennsylvania, Ohio, West Virginia, Kentucky, Wyoming, Colorado, Montana, and New Mexico (see Oil and Gas Development above for further discussion).

In summary, groundwater pumping has likely contributed to localized and possibly regional declines of northern leopard frog habitat, particularly in isolated wetlands and arid areas. However, in assessing the impacts of groundwater pumping on current northern leopard frog populations, impacts are most usually described as potential effects to habitat availability. These impacts are further described as occurring at local and regional, rather than species-wide, scales. Impacts to isolated wetlands in particular are likely to be localized. Further, impacts to water resources in the arid West cannot be extrapolated to the eastern United States and eastern Canada due to differences in climate and geography. Finally, there is little to no information about groundwater withdrawals in Canada, and the northern leopard frog is apparently still considered to be widespread and relatively common in the eastern United States and eastern Canada. Therefore, the best available information indicates groundwater withdrawal is not a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Air Pollution

Acid precipitation may be affecting northern leopard frog habitat in the western United States, including the Rocky Mountain region of Colorado, New Mexico, and Wyoming. Acidic water is an environmental stressor for northern leopard frogs (Simon *et al.* 2002, p. 697), and leopard frog abundance may be reduced in areas where water acidification has occurred (Pope *et al.* 2000, p. 2505). In the last few decades, high-elevation aquatic habitats have become more acidic (Corn and Vertucci 1992, p. 363; Simon *et al.* 2002, p. 697), which may be a result of air pollution. The emissions of certain gases (principally sulfur dioxide and nitrogen oxides) into the air may lead to acid precipitation and the acidification of aquatic habitats. Acidification of aquatic habitats may result in decreased reproductive capabilities of adult northern leopard frogs, and mortality and developmental abnormalities in northern leopard frog tadpoles (Simon *et al.* 2002, p. 697). In addition, acid precipitation can result in the direct destruction of vegetation needed for habitat (Environmental Protection Agency 2000, pp. 48699–48701; Jezouit 2004, pp. 423–445). Nitrogen dioxide, which also contributes to the formation of acid rain (Baron *et al.* 2000, p. 352; Fenn *et al.* 2003, p. 404; Jezouit 2004, pp. 423–445; Environmental Protection Agency 2005, p. 59594), can increase the acidity of soils and aquatic ecosystems; may contribute to eutrophication (a process whereby increased nutrients lead to decreased dissolved oxygen); and may possibly change plant community composition (*e.g.,* enhanced growth of invasive species and shifts in phytoplankton productivity) (Baron *et al.* 2000, p. 358; Fenn *et al.* 2003, pp. 404–418). However, effects from air pollution (in the form of acid precipitation) are currently only a consideration in high-elevation habitats in the western United States. Additionally, at this time, the potential impacts are theoretical and have not been shown to result in population-level impacts to the species. Therefore, the best available information does not indicate that air pollution constitutes a significant threat to northern leopard frogs at the species level now, nor do we have indication that it will in the future.

Summary of Factor A

The northern leopard frog occupies a wide geographic range across the United States and Canada. Because it occurs across such a large area, the habitats it uses are subject to a number of impacts that represent potential threats at various scales. As discussed above, these factors generally have been historical in impact or are occurring now and into the future at scales below the species level, both individually and in combination. Further, while there have been declines noted in portions of the range of the species, the frog is apparently still considered to be widespread and relatively common in the eastern United States and eastern Canada. Therefore, the best available information indicates that the present or threatened destruction, modification, or curtailment of its habitat or range is not a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization of the northern leopard frog for commercial, recreational, scientific, or educational purposes is not reported to be a current threat to the species in most of its range (Woolington 2011, pers. comm.; Smith 2003, p. 21; Arizona Game and Fish Department 2009, p. 2); however, northern leopard frogs are harvested for bait and for use in biology laboratories in some portions of its range (Smith 2003, p. 21; Quinn 2009, pers. comm.; Minnesota Department of Natural Resources 2011a, p. 2). Northern leopard frogs are collected for commercial purposes in Nebraska, Minnesota, and Wisconsin, and historical collection in other States likely contributed to long-term population declines in some areas (Lannoo *et al.* 1994, p. 317; Moriarty 1998, p. 168; Smith 2003, p. 21). From 1995–1999, approximately 174,772 northern leopard frogs were collected in Nebraska to supply two biological supply houses (Smith 2003, p. 21). Northern leopard frogs in Minnesota have been heavily collected for fish bait and for the biological supply trade, and there is little regulation on the collection of frogs there (Moriarty 1998, p. 168). Other States that have identified overutilization as a potential effect to the northern leopard frog include Connecticut (Connecticut Department of Environmental Protection 2005, p. 4–4–4–5), Maine (Maine Department of Inland Fisheries and Wildlife 2005, p. 109), Massachusetts (Massachusetts Department of Fish and Wildlife 2006, p. 407), and Michigan (Eagle *et al.* 2005, Species of Greatest Conservation Need 152 of 242). However, other than naming collection as a potential concern or including conservation measures to guard against overutilization in their State wildlife action plans, we have no information regarding the magnitude of the potential threat of collection in these States.

As noted earlier in the Status section, northern leopard frog populations crashed in 1973 in Minnesota, which halted the commercial collections for uses other than bait from 1974 to 1987. Harvest records from the 1990s report collections of 1,000 to 2,000 pounds of frog per year, compared to reports in the early 1970s that were in the 100,000-pound-per-year range (Moriarty 1998, p. 168). According to North Dakota Game and Fish Department records, 31,683 leopard frogs were collected by wholesalers from 1996–2008. That is an average of 2,463 frogs per year. The North Dakota Game and Fish Department does not believe that this level of use has impacted the population (North Dakota Game and Fish Department 2009, p. 2). There are no restrictions in South Dakota regarding the collection of northern leopard frogs, and they are a legal bait species (limit of 24 per day) (South Dakota Department of Game, Fish, and Parks 2011, p. 23) and some South Dakota tribal members collect and sell northern leopard frogs to educational suppliers in Minnesota (Quinn 2009, pers. comm.). The northern leopard frog may also be legally used for bait or other personal uses (typically with a permit or license) in Iowa, Missouri, Nebraska, New Mexico, Illinois, Indiana, Kentucky, Michigan, New York, Pennsylvania, and Vermont (as identified in the Status section above).

In 1971, Gibbs *et al.* (p. 1027) described the frog trade and the decline of northern leopard frogs throughout most of their range. Due to the declines noted by Gibbs *et al.* (1971), many States began establishing laws to prevent uncontrolled collecting. Today, many State wildlife agencies, including those in the western United States, use commercial and collection regulations to control human actions that may harm wildlife populations, such as collection of amphibians (Adams *et al.* 1995, p. 394; see also discussion in Status section describing State collection laws and under Factor D describing regulatory mechanisms).

Though many States have established regulations regarding the collection of northern leopard frogs, wild-caught amphibians are still traded on the global market, and there is some concern as to whether the take of wild-caught individuals is biologically sustainable (Schlaepfer *et al.* 2005, p. 257). Recent research found that millions of individuals, millions of body parts and products, and more than 2,204,623 pounds (lbs) (1,000,000 kilograms (kg)) of amphibians and reptiles are shipped across U.S. borders each year for commercial purposes (Schlaepfer *et al.* 2005, p. 257). Greater than 2.5 million whole, wild-caught amphibians and reptiles were imported into the United States between 1998 and 2002, but these animals were not tracked by species (Schlaepfer *et al.* 2005, p. 257). Information tracked by the Service's Law Enforcement Management Information System indicates that 249,233 lbs (113,050 kg) of northern leopard frog were imported into the United States between 1998 and 2002, for food and research (Schlaepfer *et al.* 2005, p. 259). An additional 112,289 body parts and products and 1,177,970 lbs (534,318 kg) of *Lithobates* frogs (not identified to species), which likely consisted in part of wild-caught northern leopard frogs, were imported into the United States during this same timeframe. There were 361,858 *Lithobates* frogs imported or exported from the United States with no species specific identification (Schlaepfer *et al.* 2005, p. 261). We can conclude from this information that the U.S. trade in amphibians and reptiles, which is a fraction of the world trade in terms of wild-caught amphibians and reptiles (Schlaepfer *et al.* 2005, p. 263), is importing large numbers of northern leopard frogs from Canada. There are no data to indicate if this trade in wild-caught northern leopard frogs is sustainable, and it may partially explain why the frog continues to decline in Ontario and other portions of eastern Canada. Schloegel *et al.* (2009, p. 1424) found that an average of 5.1 million Ranid (= Lithobatid) frogs per year, including live animals and their parts, were imported into the United States between 2000 and 2005. However, based upon the reported origin of the frogs (China and Taiwan), it is likely that most of these imports were American bullfrogs. However, there is evidence that the commercial trade in amphibians, particularly in American bullfrogs, does result in the spread of disease (such as ranaviral disease and *Batrachochytrium dendrobatidis,* which can cause the amphibian disease, chytridiomycosis), and aids in the spread of invasive species (Fisher and Garner 2007, pp. 3–4; Picco and Collins 2008, p. 1588; Schloegel *et al.* 2009, pp. 1424–1425). In Arizona, northern leopard frogs do appear in the pet trade, either in local pet stores or through on-line suppliers (Arizona Game and Fish Department 2009, p. 3), and documented releases of eastern northern leopard frogs into existing populations have occurred (Hoffman and Blouin 2004a, pp. 150–151; Theimer *et al.* 2011, pp. 3, 30; O'Donnell *et al.* 2011, p. 3), which may have genetic implications for the ongoing conservation of the species.

Summary of Factor B

Despite historic population and regional declines, we do not have any evidence of impacts to northern leopard frogs at the species level from overutilization for commercial, recreational, scientific, or educational purposes, and we have no information that indicates this factor will become a threat to the species in the future. The significant declines and extirpations within the range of the species have occurred in areas other than those that

have traditionally been subject to the highest collection pressures. Further, the collections appear to be occurring in portions of the range that have apparently stable populations. Therefore, the best scientific and commercial information available indicates that overutilization for commercial, recreational, scientific, or educational purposes does not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Factor C. Disease or Predation

Disease

Fungal, viral, and bacterial diseases may cause mass mortality and contribute to population declines of northern leopard frogs (Rorabaugh 2005, pp. 575–577). Disease has caused mass mortality in ranid and lithobatid frogs in almost every western State in the United States (Bradley *et al.* 2002; Muths *et al.* 2003; Briggs *et al.* 2005). There are several fungal diseases that affect the northern leopard frog (Faeh *et al.* 1998, p. 263); of those, amphibian chytridiomycosis caused by the fungus *Batrachochytrium dendrobatidis* (Bd) has likely had a large impact on northern leopard frogs in the western United States (Johnson *et al.* 2011, p. 564). Mortality from chytridiomycosis is reported for several leopard frog species, including the northern leopard frog, in Arizona, British Columbia, California, and Colorado (Bradley *et al.* 2002, pp. 206–212; Muths *et al.* 2003, p. 361; Briggs *et al.* 2005, p. 3149; Committee on the Status of Endangered Wildlife in Canada 2009, p. 26; Johnson *et al.* 2011, p. 564). Information in Muths *et al.* (2003, p. 364) notes a northern leopard frog museum specimen from Colorado preserved in 1974 was examined histologically and tested positive for Bd, which means the presence of Bd in Colorado can be traced back to the 1970s and is a possible contributing factor to the extensive mortalities that occurred there (Carey *et al.* 1999, p. 461). This time period is also when extensive declines of northern leopard frogs occurred throughout the western United States and Canada, in places such as Wisconsin, Alberta, Saskatchewan, and Manitoba. Longcore *et al.* (2006, p. 440) found that Bd is widespread in the Northeast and the highest prevalence of Bd in a Maine species was the northern leopard frog. However, there was no observed decline in northern leopard frog populations despite the significantly high infection rate (Longcore *et al.* 2006, p. 441). It is possible that northern leopard frogs in the eastern United States have developed some resistance to Bd, or that thermoregulatory behavior (such as basking on a sunny day) may slow the growth of the fungus (Longcore *et al.* 2006, pp. 441–442). It is currently not known under what circumstances the northern leopard frog is susceptible to the lethal effects of chytridiomycosis, but it remains a concern as the fungus appears to be prevalent in the East and in the West (Ellis 2011, pers. comm.; Van Stralen 2011, pers. comm.), and mortality in wild frogs in British Columbia is thought to be the result of chytridiomycosis.

Recent studies indicate that factors such as habitat degradation, habitat fragmentation, and climate change may exacerbate the lethal effects of chytridiomycosis on amphibian populations (Carey *et al.* 1999, pp. 459–472; Ouellet *et al.* 2005, p. 1437). Habitat fragmentation may prevent populations from recovering after lethal outbreaks of chytridiomycosis (Ouellet *et al.* 2005, p. 1437), and other stressors such as water pollution may make northern leopard frogs more susceptible to chytridiomycosis (Carey *et al.* 1999, pp. 459–472; Kiesecker *et al.* 2004, p. 138).

Saprolegniasis, a water-borne fungal disease, may also affect populations of northern leopard frogs (Faeh *et al.* 1998, p. 263). However, this fungal disease is usually secondary to other stressors such as bacterial infections or trauma (Faeh *et al.* 1998, p. 263). Saprolegnia has been associated with embryonic die-offs of ranid frogs in Oregon, and is found in Columbia spotted frog (*Rana luteiventris*) eggs in Idaho and Montana (Patla and Keinath 2005, p. 43), but there is no other information provided to indicate that this disease is currently impacting northern leopard frogs.

Faeh *et al.* (1998, pp. 260–261) provided information regarding five viral diseases that have and could potentially affect the northern leopard frog. These include the iridoviruses, which include ranavirus, polyhedral cytoplasmic amphibian virus, tadpole edema virus, and frog erythrocytic virus. Ranavirus may be extremely lethal, and all life stages of frogs may acquire the disease, although tadpoles are the most susceptible to the disease (Daszak *et al.* 1999, p. 744). The loss of 80 to 90 percent of tadpoles in a population from ranavirus may result in an 80 percent loss of adult recruitment (survival of individuals to sexual maturity and joining the reproductive population), which may negatively affect population viability (Daszak *et al.* 1999, pp. 742–745). The introduction of bullfrogs and spread of tiger salamanders throughout the U.S. range of the northern leopard frog may increase the potential of ranavirus infection as both American bullfrogs and tiger salamanders are hosts for the ranavirus (Picco and Collins 2008, p. 1588; Schloegel *et al.* 2009, p. 1424). Relatively recent mass mortality events of northern leopard frog metamorphs resulting from ranavirus have been documented in Ontario (Greer *et al.* 2005, p. 11).

Septicemia or ''red leg'' involves one or a combination of hemolytic (destructive to blood cells) bacteria that enter the body via wounds or abrasions (Faeh *et al.* 1998, p. 261). Septicemia often results in death in individuals and often results in mass mortality. Septicemia may also have contributed to northern leopard frog declines in the Midwestern United States in the early 1970s (Koonz 1992, p. 20) and caused declines in Colorado between 1974 and 1982 (Carey 1993, pp. 356–358). However, ''red leg'' may be triggered by a variety of environmental factors, and it is unclear how it may be influencing northern leopard frog declines in the United States and Canada (McAllister *et al.* 1999, p. 19).

Significant mortality events of northern leopard frogs have been attributable to disease (Rorabaugh 2005, p. 575). However, with the exception of chytridiomycosis, impacts to northern leopard frogs associated with these diseases appear to be localized. Chytridiomycosis may be having significant effects to northern leopard frogs in the West, but does not appear to be significantly affecting frogs in other portions of its range as the frog is apparently still considered to be widespread and stable in the eastern United States and eastern Canada. Therefore, the best available information does not indicate that disease is a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Nonnative Species

The introduction of nonnative aquatic animals, particularly American bullfrogs and predatory fishes, has resulted in the loss and decline of northern leopard frogs throughout their range, but particularly in the western United States and Canada (Merrell 1968, p. 275; Hine *et al.* 1981, p. 12; Hammerson 1982, pp. 115–116; Hayes and Jennings 1986, p. 491; Hecnar and M'Closkey 1997, p. 126; Livo *et al.* 1998, p. 4; Orr *et al.* 1998, p. 92; Maxell 2000, p. 144; Hitchcock 2001, p. 63; Smith 2003, pp. 19–21; Alberta Northern Leopard Frog Recovery Team 2005, p. 8; Rorabaugh 2005, p. 574; Smith and Keinath 2007,

p. 24; Committee on the Status of Endangered Wildlife in Canada 2009, p. 35). Northern leopard frogs typically breed in waters without fish or aquatic predators (Merrell 1977, p. 16; Hine *et al.* 1981, p. 12). Nonnative animals (including crayfish, American bullfrogs, and fish) displace northern leopard frogs by degrading habitat (*e.g.,* destroying emergent vegetation, increasing turbidity, reducing algal or invertebrate populations) or through direct predation on eggs, tadpoles, and adult leopard frogs (Green 1997, p. 300).

American bullfrogs, which compete with and prey on northern leopard frogs, are thought to be a primary cause of the widespread decline of northern leopard frogs throughout the western United States (Bury and Luckenbach 1976, p. 10; Hammerson 1982, pp. 115–116; Kupferberg 1997, p. 1749; Livo *et al.* 1998, p. 4). The American bullfrog is native to the eastern and Midwestern United States and historically had a very wide native distribution that excluded much of the western United States. American bullfrogs currently are not present in most of eastern Montana, North Dakota, South Dakota, southern Idaho, central and western Wyoming, most of Utah, and a small portion of northern Arizona and White Pine County, Nevada (Casper and Hendricks 2005, p. 541). These areas where the American bullfrog has yet to invade coincide with some areas where the northern leopard frog still occurs and, in some cases, appears to be stable (such as Nebraska, North Dakota, South Dakota, and eastern Montana). American bullfrogs have also been introduced into British Columbia (Weller and Green 1997, p. 320).

As previously described, northern leopard frogs typically breed in fishless waters (Merrell 1968, p. 275) and likely have little natural defense against predation by introduced fish (Smith and Keinath 2007, p. 25). In Canada, research shows that introduced predaceous fish reduce the abundance and diversity of frog populations, including the northern leopard frog (Hecnar and M'Closkey 1997, pp. 126–127). Common carp (*Cyprinus carpio*) cause increased turbidity and the destruction of emergent vegetation, which can displace northern leopard frogs by modifying habitat, reducing invertebrates, and eliminating algae (McAllister *et al.* 1999, pp. 6–7). Information from Bradford (2005, pp. 922–923) indicates that lithobatid frogs in the western United States may be more adversely affected than lithobatid frogs in the eastern United States due to their greater exposure to exotic, introduced species. Because northern leopard frogs in the western United States evolved in permanent or semi-permanent waters without large aquatic predators (Merrell 1968, p. 275), they may be more vulnerable to predation by introduced sport fish, bullfrogs, and crayfish (Bradford 2005, p. 923). In addition, literature studying the habitat preferences of northern leopard frogs from Ohio and Wisconsin indicates that across the range of the northern leopard frog, successful breeding habitats tend to be free of predaceous fish due to periodic drying (Merrell 1977, p. 16; Hine *et al.* 1981, p. 12). This implies that when nonnative species are present, it is more likely that northern leopard frogs will not successfully reproduce.

Invasive plants may also impact northern leopard frog habitat in the western United States (Maxell 2000, pp. 21–22; Hitchcock 2001, pp. 5–6). Tamarisk and other nonnative aquatic and terrestrial plants alter riparian habitats by forming dense stands that exclude native amphibians (Maxell 2000, p. 21) and enhance the survival of other introduced species, such as American bullfrogs (Adams *et al.* 2003, pp. 343–351; Maxell 2000, p. 21; Hitchcock 2001, pp. 5–6, 62–66).

Effects to northern leopard frogs from nonnative species are likely significant in the western United States and Canada, but information we reviewed does not indicate nonnative species are having significant impacts on northern leopard frog populations in the eastern portion of their range. Further, northern leopard frogs are apparently considered to be widespread and relatively common in the eastern United States and eastern Canada. Therefore, the best available information indicates that impacts associated with nonnative species do not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Summary of Factor C

Disease and predation have undoubtedly contributed to the loss of northern leopard frog populations historically, particularly in the western United States, and will likely continue to impact northern leopard frogs in some portions of its range at local or regional scales. However, despite these impacts, the frog is apparently still considered to be widespread and relatively common in the eastern United States and eastern Canada. Therefore, the best available information indicates that impacts due to disease and predation do not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Factor D. The Inadequacy of Existing Regulatory Mechanisms

Under this factor, we examine whether existing regulatory mechanisms are inadequate to address the threats to the northern leopard frog discussed under Factors A, B, C, and E. The Service considers regulatory mechanisms to mean all regulatory and statutory mechanisms that are related to a comprehensive regime designed to maintain a conserved wildlife population. Section 4(b)(1)(A) of the Act requires the Service to take into account, ''those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species * * *.'' We consider these efforts when developing our threat analyses under all five factors, and in particular under Factor D. Therefore, under Factor D we consider not only laws and regulations, but other mechanisms that are part of a regulatory process, such as management plans, agreements, and conservation practices.

Regulatory mechanisms, if they exist, may preclude the need for listing if such mechanisms are judged to adequately address the threat to the species such that listing is not warranted. Conversely, threats are not ameliorated when not addressed by existing applicable regulatory mechanisms, or when the existing mechanisms are not adequate (or not adequately implemented or enforced). Within its distribution in the United States, the northern leopard frog occurs on lands managed by a myriad of Federal and State agencies, Native American tribes, and private lands. In Canada, the northern leopard frog occurs on a similar variety of jurisdictions. In this section, we review actions taken by State and Federal entities that effectively reduce or remove threats to the northern leopard frog.

Federal Laws and Regulations

The northern leopard frog is not specifically covered by the provisions of any Federal law or regulation. However, there are Federal agencies that manage lands occupied by northern leopard frogs and laws that are applicable to the management and conservation of the species and its habitat.

All Federal agencies are required to adhere to the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq.*) for projects they fund, authorize, or carry out. The Council on Environmental Quality's regulations for implementing NEPA (40

CFR parts 1500–1518) state that environmental impact statements shall include a discussion on the environmental impacts of the various project alternatives (including the proposed action), any adverse environmental effects that cannot be avoided, and any irreversible or irretrievable commitments of resources involved (40 CFR part 1502). NEPA itself is a disclosure law that provides an opportunity for the public to submit comments on the particular project and propose other conservation measures that may directly benefit listed or sensitive fish and wildlife species; however, it does not require subsequent minimization or mitigation measures by the Federal agency involved. Although Federal agencies may include conservation measures for listed species as a result of the NEPA process, there is no requirement that impacts to the northern leopard frog from action analyzed under NEPA would be precluded. Any such measures are typically voluntary in nature and are not required by the statute. Additionally, activities on non-Federal lands are subject to NEPA if there is a Federal nexus, such as permitting by the U.S. Army Corps of Engineers or the Federal Energy Regulatory Commission.

The Environmental Protection Agency's mission is to protect human health and the environment. The agency implements this mission by setting standards for clean air, and regulating pesticide use, chemical use, and water pollution, among other actions. There are a number of laws that are central to this mission; however, the most important in terms of preventing impacts to northern leopard frogs are likely the Clean Air Act of 1970 (42 U.S.C. 7401 *et seq.*), the Clean Water Act of 1972 (33 U.S.C. 1251 *et seq.*), and the Safe Drinking Water Act of 1974 (42 U.S.C. 300f *et seq.*). However, as previously discussed, we have determined that the adverse effects to habitat for the northern leopard frog is not nor is likely to have a species-level impact.

The Clean Air Act is the Federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes the Environmental Protection Agency to establish National Ambient Air Quality Standards to protect public health and public welfare and to regulate emissions of hazardous air pollutants. The Environmental Protection Agency is required under the Clean Air Act to set National Ambient Air Quality Standards for six air pollutants (ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxides, and lead). Evidence indicates that the National Ambient Air Quality Standards for sulfur dioxide, which contributes to the formation of acid precipitation, may not be adequate to protect aquatic ecosystems from the impacts of acid precipitation and acidification impacts, and continued acid precipitation may cause vegetation damage under the current sulfur dioxide National Ambient Air Quality Standards. Under the current National Ambient Air Quality Standards, acid precipitation is likely to continue and may result in adverse habitat effects from nitrogen deposition (Baron *et al.* 2000, p. 365; Fenn *et al.* 2003, pp. 417–418).

The Clean Water Act establishes the basic structure for surface water quality protection in the United States. The Environmental Protection Agency employs a variety of regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. The Clean Water Act made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. The overall objective of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters so that they can support ''the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water.''

The Safe Drinking Water Act is the main Federal law that ensures the quality of Americans' drinking water. Under the Safe Drinking Water Act, the Environmental Protection Agency sets standards for drinking water quality and oversees the States, localities, and water suppliers who implement those standards. Section 1421 of the Safe Drinking Water Act tasks the Environmental Protection Agency with protecting underground sources of drinking water for all current and future drinking water supplies across the country.

The Service, Bureau of Land Management (BLM), National Park Service (NPS), and U.S. Forest Service (Forest Service) are the primary Federal agencies that manage lands that provide habitat for the northern leopard frog.

The northern leopard frog occurs on the Service's National Wildlife Refuges and Wetland Management Areas in States throughout the northern leopard frog's U.S. range. The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. Management on these National Wildlife Refuges largely results in the enhancement of northern leopard frog habitat (Hultberg 2009, pers. comm.; South Dakota Department of Game, Fish and Parks 2009, pp. 2–3).

The northern leopard frog occurs on BLM lands in Colorado, Idaho, Montana, New Mexico, Nevada, and Wyoming, and may also inhabit BLM lands in North Dakota and South Dakota. The frog has declined or is absent from BLM lands in Arizona (Clarkson and Rorabaugh 1989, p. 534), Idaho (Makela 1998, pp. 8–9), Montana (Maxell 2000, p. 144), Nevada (Hitchcock 2001, p. 9), Washington (McAllister *et al.* 1999, pp. 1–4), and Wyoming (Smith and Keinath 2004, p. 57), based upon current ranges. BLM lists the northern leopard frog as a sensitive species in Colorado, Nevada, Wyoming, and Montana; the species is not listed as sensitive on BLM lands elsewhere.

The Federal Land Policy and Management Act of 1976 (FLPMA) (43 U.S.C. 1701 *et seq.*) is the primary Federal law governing most land uses on BLM-administered lands. Section 102(a)(8) of FLPMA (43 U.S.C. 1701(a)(8)) specifically recognizes the public lands are to be managed to provide food and habitat for fish and wildlife.

BLM Manual section 6840 guides the management of sensitive species in a manner consistent with species and habitat management objectives in land use and implementation plans to promote their conservation and to minimize the likelihood and need for listing under the Act (BLM 2008, p. 05V). This manual also requires that resource management plans (RMPs) should address sensitive species, and that implementation ''should consider all site-specific methods and procedures needed to bring species and their habitats to the condition under which management under the Bureau sensitive species policies would no longer be necessary'' (BLM 2008, p. 2A1).

Where it has been designated as a sensitive species under BLM Manual 6840, northern leopard frog conservation must be addressed in the development and implementation of RMPs on BLM lands. RMPs are the basis for all actions and authorizations involving BLM-administered lands and resources. Resource management plans that include areas of northern leopard frog habitat were completed beginning in the 1980s. RMPs have been developed or amended to incorporate State or regionally developed rangeland

health standards and guidelines, which BLM developed beginning in 1995 (60 FR 9894, February 22, 1995). Standards describe the specific conditions needed for public land health, such as the presence of streambank vegetation; guidelines are the rangeland management techniques designed to achieve or maintain healthy public lands, as defined by the standards. Standards and guidelines must be consistent with the fundamentals of rangeland health, which include watersheds that are in, or are making significant progress toward, properly functioning physical condition, including their riparian-wetland and aquatic components, and water quality that complies with State water quality standards. Areas and activities are assessed to determine if the standards are being achieved, and if not, actions must be taken towards fulfilling the standards (43 CFR 4180.1).

The Service has no specific documentation of how implementation of the rangeland health standards have maintained or improved riparian or wetland conditions within northern leopard frog habitat on BLM-administered lands. The latest Public Land Statistics report available (2010) lists 23,618 acres (ac) (9,558 hectares (ha)) of wetlands either in properly functioning condition or functioning-at-risk with an upward trend, out of 49,764 total wetland ac (20,139 ha) on BLM lands in Colorado, Idaho, Montana, Nevada, New Mexico, North and South Dakota, and Wyoming. The same report lists 12,215 mi (19,658 km) of riparian areas either in properly functioning condition or functioning-at-risk with an upward trend, out of 19,759 total miles (31,799 km) on BLM lands in the same States.

The BLM has regulatory authority for oil and gas leasing on Federal lands and on private lands with a Federal mineral estate, as provided at subpart 3100 (Onshore Oil and Gas Leasing: General) of Title 43 of the CFR, and they are authorized to require stipulations as a condition of issuing a lease. The BLM has developed best management practices to reduce habitat fragmentation, loss, and degradation from energy development. However, use of these conditions is discretionary, and the Service does not have information as to how this authority has been applied.

The NPS manages portions of habitat throughout the range of the northern leopard frog. The NPS carries out its responsibilities in parks and programs under the authority of the National Park Service Organic Act of 1916 (16 U.S.C. 1 *et seq.*). As defined in the National Park Service Organic Act, the purpose of national parks is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

The Forest Service manages habitat for northern leopard frogs in the western United States on National Forests and National Grasslands in several States, including Arizona, Colorado, Idaho, Minnesota, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming. Management of National Forest System lands is guided principally by the National Forest Management Act (NFMA) (16 U.S.C. 1600 *et seq.*). The NFMA specifies that all National Forests must have a Land and Resource Management Plan (LRMP) (16 U.S.C. 1604) to guide and set standards for all natural resource management activities on each National Forest or National Grassland. The NFMA requires the Forest Service to incorporate standards and guidelines into LRMPs (16 U.S.C. 1604(c)). The Forest Service conducts NEPA analyses on its LRMPs, which include provisions to manage plant and animal communities for diversity, based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives. The Forest Service planning process is similar to that of the BLM.

As described in the Status section, populations of northern leopard frogs have declined across most of the western States on lands with populations under Forest Service jurisdiction. The northern leopard frog is designated a ''sensitive species'' in Forest Service Regions 1 (Northern Region—northern Idaho, Montana, North Dakota, and northwest South Dakota), 2 (Rocky Mountain Region—Colorado, Nebraska, most of South Dakota and Wyoming), 3 (Southwest Region—Arizona and New Mexico), 5 (Pacific Southwest Region—California), and 6 (Pacific Northwest—Oregon and Washington), but not in Regions 4 (Intermountain Region—southern Idaho, Nevada, Utah, and western Wyoming) and 9 (Eastern Region—includes all eastern States and Minnesota). Sensitive species status does not provide special protection but requires, ''an analysis of the significance of adverse effects on the population, its habitat, and on the viability of the species as a whole'' (Forest Service's Manual at 2672.1).

Tribal Laws

Of the hundreds of tribal nations located throughout the range of the northern leopard frog in the United States and Canada, we only received information regarding the northern leopard frog from the Navajo Nation (Arizona, New Mexico, and Utah), the Fort Peck Tribes (Montana), the Confederated Salish and Kootenai Tribes of the Flathead Nation (Montana), and the Sisseton-Wahpeton Oyate (South Dakota). The Navajo Nation provided us with specific information regarding tribal laws. We will continue to welcome any additional information regarding the northern leopard frog from tribal nations.

Navajo Endangered Species List Group 2 species are protected under Navajo Nation law. The Navajo Nation Code (17 Navajo Nation Code section 507) makes it ''unlawful for any person to take, possess, transport, export, process, sell or offer for sale or ship'' a Group 2 species. Under this Code, ''take'' means ''the hunting, capturing, killing in any manner or the attempt to hunt, capture or kill in any manner * * *.'' Habitat protection, per se, is not afforded under the Navajo Nation Code.

The Navajo Nation government, pursuant to 2 Navajo Nation Code section 164, reviews actions involving the use of natural resources for compliance with Navajo Nation law, including the Navajo Endangered Species Code. The Navajo Nation Fish and Wildlife Department, through the section 164 review process, advises the tribal Resources Committee and the Navajo Nation Council whether proposed natural resources projects are in compliance with the Navajo Endangered Species Code. The Resources Committee has the power to give final approval for any land exchanges, non-mineral leases, right-of-ways, permits, and other licenses and interests on Navajo land in accordance with applicable and Federal and Navajo Nation laws. The Resources Committee recommends all actions involving the approval of mineral agreements, land acquisitions, and energy development agreements to the Navajo Nation Council. Some protection for northern leopard frog habitat may be provided through this review.

State Laws and Regulations

Only 1 of the 33 States assessed in the Status section above has listed the northern leopard frog under a State wildlife conservation law. In 2000, the Washington Department of Fish and Wildlife listed the northern leopard frog as an endangered species under the Endangered, Threatened, and Sensitive Species Classification (Washington Administrative Code, Title 232, Chapter 12, Section 014). However, because northern leopard frogs are currently

known from only two sites (Germaine and Hays 2009, p. 537) in Washington State, this regulatory mechanism protects relatively few individuals.

Arizona, California, Colorado, Connecticut, Idaho, Indiana, Kentucky, Maine, Massachusetts, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, Oregon, Pennsylvania, Rhode Island, Utah, West Virginia, and Wyoming included the northern leopard frog specifically as a species of greatest conservation need or species of concern in their State wildlife action plans (designations vary by State as described in Status section above); however, this designation provides no regulatory protection to the species or its habitat. The northern leopard frog is not considered a species of concern in Illinois, Iowa, Minnesota, New York, North Dakota, Ohio, South Dakota, Texas, Vermont, and Wisconsin.

Several States have laws that provide some protection of northern leopard frogs in regards to collection, as discussed in the Status section above. These laws and regulations generally preclude or limit collection without a permit, but do not preclude impacts to habitat.

In summary, State wildlife conservation laws generally provide for an inconsistent network of protections for the northern leopard frog. While take is prohibited in some States, and the species is afforded some management consideration in project planning, the laws generally do not preclude impacts to habitat. However, 23 of the 33 States within the range of the northern leopard frog have indicated commitment through their State wildlife action plans to implementing conservation actions and habitat enhancement projects to benefit the northern leopard frog.

International Laws and Regulations

The northern leopard frog, Rocky Mountain population, is listed as endangered under the Federal Species at Risk Act (Statues of Canada 2002, c.29) in Canada. The Species at Risk Act, passed December 12, 2002, is a commitment by the Canadian government to prevent the extinction of wildlife and provide the necessary actions for the recovery of the species deemed endangered. Wildlife species listed under the Species at Risk Act are provided with legal protection to avoid extinction resulting from human activities (Government of Canada Species at Risk Public Registry 2011). The northern leopard frog is also Red Listed as endangered under the British Columbia Wildlife Act (Revised Statutes of British Columbia 1996, c. 488), which prohibits the killing or collecting of amphibians or keeping them in captivity without a permit. In British Columbia, the one remaining northern leopard frog population is located in the Creston Valley Wildlife Management Area (Committee on the Status of Endangered Wildlife in Canada 2009, p. 42). The Creston Valley Wildlife Management area is protected by the British Columbia government and by the Convention on Wetlands of International Importance (''Ramsar Convention,'' Ramsar, Iran 1971), where Creston Valley was designated a Wetland of International Importance on February 21, 1994. The Convention on Wetlands is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. In addition, other provincial legislation, including the Fish Protection Act (Bill 25–1997), the Creston Valley Wildlife Act (Revised Statutes of British Columbia 1996, c. 84), the Integrated Pest Management Act (Statues of British Columbia 2003, c. 58), and the Riparian Areas Regulation (Fish Protection Act, British Columbia Regulation 376/2004) provide habitat protection and enhancement to the remaining northern leopard frog population (Committee on the Status of Endangered Species in Canada 2009, p. vi).

The northern leopard frog was listed as threatened in Schedule 6 of Alberta's Wildlife Act (Revised Statutes of Alberta 2000, Chapter W–10), based on a decline in the number of populations, the fragmentation of occupied habitats, and limited population dispersal capabilities of the species (Alberta Northern Leopard Frog Recovery Team 2005, p. 1). As a result of the listing, the Alberta Northern Leopard Frog Recovery Plan was created and is currently being implemented (Alberta Northern Leopard Frog Recovery Team 2005). In Saskatchewan, the northern leopard frog is currently on the province's Interim Species at Risk List (Wildlife Act 1998, Chapter W–13.12) and is protected in provincial and national parks (Committee on the Status of Endangered Wildlife in Canada 2009, p. vi). The national status of the western boreal and prairie population (which includes Alberta, Saskatchewan, Manitoba, and the Northwest Territories) was evaluated in 1998 and 2002, and the northern leopard frog was designated a Species of Special Concern (Committee on the Status of Endangered Wildlife in Canada 2004, p. 20). As a result of the national designation, a management plan was required to be developed for the western boreal and prairie population. Although the northern leopard frog has no national or provincial status in Eastern Canada, the species is protected on Federal lands managed by Parks Canada (national parks and historic sites), Environment Canada (national wildlife areas), and the Department of Defense (Committee on the Status of Endangered Wildlife in Canada 2009, p. vi).

As noted in the **BACKGROUND** section above, the northern leopard frog population in western Canada is small and fragmented, but as one proceeds east, the number of northern leopard frog populations and their known status, based on the best available information, improves. Where the northern leopard frog has and likely continues to decline in western Canada, there is no information to indicate that the species is threatened by the inadequacy of existing regulatory mechanisms in Canada.

Summary of Factor D

While northern leopard frog conservation has been addressed in some State, Federal, and international plans, laws, regulations, and policies, none of these have applicability throughout the range of the northern leopard frog sufficient to provide effective population-level conservation. However, we have found in the analysis of the other four factors (A, B, C, and E) that there are no threats that currently rise to a level such that they significantly impact the northern leopard frog at the species level. Therefore, we conclude that the best scientific and commercial information available indicates that the inadequacy of existing regulatory mechanisms is not a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence

Pesticides

Even at low levels, pesticides can contribute to local declines or extirpation of northern leopard frog populations, particularly in areas that are in close proximity to heavy or frequent pesticide use because tadpole and larval stages are sensitive to even low-level pesticide contamination (Berrill *et al.* 1997, p. 244). The effects to northern leopard frogs from pesticides, including herbicides, piscicides (chemical substances poisonous to fish), and insecticides, vary, but information indicates that the species is negatively affected both

acutely and via sublethal symptoms by several pesticides and chemicals (rotenone, Roundup, atrazine, malathion, copper sulfate, and fenthion) that are commonly used in the United States (Stebbins and Cohen 1995, pp. 215–216; Fordham 1999, p. 125; Hayes *et al.* 2002, pp. 895–896; Beasley *et al.* 2005, p. 86; Patla 2005, p. 275; Relyea 2005, p. 353; Rorabaugh 2005, p. 576). Pesticide contamination of surface waters in the United States is extensive, and concentrations of pesticides are frequently greater than water-quality benchmarks for aquatic life and fish-eating wildlife (Gilliom *et al.* 2006, p. 8). Of the streams analyzed as part of the National Water Quality Assessment Program, 57 percent contained one or more pesticides that exceeded at least one aquatic life protection benchmark (Gilliom *et al.* 2006, p. 8), which may result in decreased habitat quality, malformations, and decreased fitness of northern leopard frogs (Rorabaugh 2005, p. 576).

While northern leopard frogs may be exposed to pesticides in a number of ways, they are most significantly exposed to pesticides when run-off from agricultural and urban areas reaches occupied habitats. Exposure to pesticide run-off can influence parasitic community structure and seasonal recruitment in northern leopard frogs (King *et al.* 2008, p. 20). Berrill *et al.* (1997, p. 243) found that tadpoles (including northern leopard frog tadpoles) are extremely sensitive (*i.e.,* they experience paralysis and death) to exposure of one pesticide at a time; pesticides in combination likely have more severe effects. Ouellet *et al.* (1997, p. 97) examined northern leopard frogs in agricultural and non-agricultural ponds in Quebec and found that frogs in the agricultural ponds had a variety of hind limb malformations. The authors identified agricultural pesticides as a potential causal agent. Pesticide exposure not only can cause malformations in frogs (Lannoo 2008, pp. 142–144), but contact with pesticides has been found to increase amphibians vulnerability to *Ribeiroia* (trematode) and other parasitic infections, which are also known to cause frog malformations (Kiesecker 2002, p. 9903; Lannoo 2008; Rohr *et al.* 2008, p. 1237). In addition, increased nitrates from fertilizers can also result in adverse effects to amphibian development and survival (Marco *et al.* 1999, p. 2837; Rouse *et al.* 1999, pp. 800–802). Therefore, although northern leopard frogs were not specifically tested for pesticides in the examples from Washington or Quebec, it is plausible that the habitat alteration and subsequent contamination of aquatic habitats with pesticides contributed to the decline of northern leopard frogs in these areas. Agrichemical pollution is also thought to be a factor in declining amphibian populations in Nebraska and Quebec (Beasley *et al.* 2005, p. 86; McCleod 2005, p. 293; King *et al.* 2008, p. 20).

Based upon the above information, exposure to pesticides has likely contributed to northern leopard frog population extirpations throughout their range. While the magnitude of these impacts is conceivably high in localized areas, pesticide use is not ubiquitous throughout the range of the northern leopard frog; thus pesticide use is likely not resulting in impacts at regional and species-level scales. Further, despite ongoing exposure to pesticides, the northern leopard frog is apparently still considered to be widespread and common in the eastern United States and eastern Canada. Therefore, the best available scientific information indicates that pesticide use does not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Malformations

Within the last 15 to 20 years, malformed northern leopard frogs have been reported with increasing frequency in the United States, particularly in Minnesota, North Dakota, South Dakota, and Vermont (Helgen *et al.* 1998, p. 288; Sessions 2003, p. 168; Johnson and Lunde 2005, p. 124; Rorabaugh 2005, p. 576). Malformations are also reported from Colorado, Indiana, Iowa, Michigan, Missouri, Montana, Ohio, Quebec, and Wisconsin (Converse *et al.* 2000, p. 163; Johnson and Lunde 2005, pp. 124–128; Rorabaugh 2005, p. 575; North American Center for Reporting Amphibian Malformations 2006). Noted malformations have included limb deformities, multiple or missing limbs, jaw deformities, stunted growth, multiple eyes, missing eyes, and various other growths (Helgen *et al.* 1998, pp. 288–297; Hoppe 2005, p. 104). Malformations are believed to be caused by a variety of natural and manmade factors, including trematode parasites, pesticides, ultraviolet-B radiation, predation attempts, and water contamination (Helgen *et al.* 1998, pp. 294–297; Blaustein and Johnson 2003, pp. 87–91; Sessions 2003, p. 168; Johnson and Lunde 2005, pp. 124–138;), but are generally linked to human-induced changes in aquatic habitats (Meteyer *et al.* 2000, pp. 151–171; Johnson and Lunde 2005, pp. 130–136; Lannoo 2008, pp. 105–110, 197). These malformations typically lead to mortality as behavior and physical mobility (such as swimming, hopping, and feeding) are compromised to the point of affecting individual fitness (Helgen *et al.* 1998, p. 289; Hoppe 2005, pp. 105–108). Northern leopard frogs tend to be one of the most common species found with malformations (Lannoo 2008, p. 207).

Malformations are a concern because they affect the ability of individual and local populations of northern leopard frogs to survive, and because they are a likely indicator of decreased water quality and of decreased overall habitat quality. However, as stated above, there are likely many causes of malformations in northern leopard frogs that have to do with local, site-specific conditions and are likely not the result of the same causal agent throughout the range of the northern leopard frog (Lannoo 2008, p. 200). Further, the diversity of habitat used by northern leopard frogs may provide some protection against the variety of agents that seem to result in malformation at the local scale. The rate of malformations in some local populations of northern leopard frogs may result in significant effects to these populations; however, the impact of malformations on the northern leopard frog at the species level is not known to be significant. Therefore, based on the best available information, we conclude that malformations are not a significant threat to northern leopard frogs at the species level now, nor do we have indication that it will in the future.

Climate Change

''Climate'' refers to an area's long-term average weather statistics (typically for at least 20- or 30-year periods), including the mean and variation of surface variables such as temperature, precipitation, and wind, whereas ''climate change'' refers to a change in the mean and/or variability of climate properties that persists for an extended period (typically decades or longer), whether due to natural processes or human activity (Intergovernmental Panel on Climate Change (IPCC) 2007a, p. 78). Although changes in climate occur continuously over geological time, changes are now occurring at an accelerated rate. For example, at continental, regional and ocean basin scales, recent observed changes in long-term trends include: A substantial increase in precipitation in eastern parts of North American and South America, northern Europe, and northern and central Asia, and an increase in intense tropical cyclone activity in the North Atlantic since about 1970 (IPCC 2007a,

p. 30); and an increase in annual average temperature of more than 2 °F (1.1 °C) across US since 1960 (Global Climate Change Impacts in the United States (GCCIUS) 2009, p. 27). Examples of observed changes in the physical environment include: An increase in global average sea level, and declines in mountain glaciers and average snow cover in both the northern and southern hemispheres (IPCC 2007a, p. 30); substantial and accelerating reductions in Arctic sea-ice (*e.g.,* Comiso *et al.* 2008, p. 1), and a variety of changes in ecosystem processes, the distribution of species, and the timing of seasonal events (*e.g.,* GCCIUS 2009, pp. 79–88).

The IPCC used Atmosphere-Ocean General Circulation Models and various greenhouse gas emissions scenarios to make projections of climate change globally and for broad regions through the 21st century (Meehl *et al.* 2007, p. 753; Randall *et al.* 2007, pp. 596–599), and reported these projections using a framework for characterizing certainty (Solomon *et al.* 2007, pp. 22–23). Examples include: (1) It is virtually certain there will be warmer and more frequent hot days and nights over most of the earth's land areas; (2) it is very likely there will be increased frequency of warm spells and heat waves over most land areas, and the frequency of heavy precipitation events will increase over most areas; and (3) it is likely that increases will occur in the incidence of extreme high sea level (excludes tsunamis), intense tropical cyclone activity, and the area affected by droughts (IPCC 2007b, p. 8, Table SPM.2). More recent analyses using a different global model and comparing other emissions scenarios resulted in similar projections of global temperature change across the different approaches (Prinn *et al.* 2011, pp. 527, 529).

All models (not just those involving climate change) have some uncertainty associated with projections due to assumptions used, data available, and features of the models; with regard to climate change this includes factors such as assumptions related to emissions scenarios, internal climate variability and differences among models. Despite this, however, under all global models and emissions scenarios, the overall projected trajectory of surface air temperature is one of increased warming compared to current conditions (Meehl *et al.* 2007, p. 762; Prinn *et al.* 2011, p. 527). Climate models, emissions scenarios, and associated assumptions, data, and analytical techniques will continue to be refined, as will interpretations of projections, as more information becomes available. For instance, some changes in conditions are occurring more rapidly than initially projected, such as melting of Arctic sea ice (Comiso *et al.* 2008, p. 1; Polyak *et al.* 2010, p. 1797), and since 2000 the observed emissions of greenhouse gases, which are a key influence on climate change, have been occurring at the mid- to higher levels of the various emissions scenarios developed in the late 1990's and used by the IPPC for making projections (*e.g.,* Raupach *et al.* 2007, Figure 1, p. 10289; Manning *et al.* 2010, Figure 1, p. 377; Pielke *et al.* 2008, entire). Also, the best scientific and commercial data available indicates that average global surface air temperature is increasing and several climate-related changes are occurring and will continue for many decades even if emissions are stabilized soon (*e.g.* Meehl *et al.* 2007, pp. 822–829; Church *et al.* 2010, pp. 411–412; Gillett *et al.* 2011, entire).

Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing ''climate change'' as a single threat in and of itself, we examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. For example, climate-related changes to habitats, predator-prey relationships, disease and disease vectors, or conditions that exceed the physiological tolerances of a species, occurring individually or in combination, may affect the status of a species. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007, p. 89; Glick *et al* 2011, pp. 19–22). As described above, in evaluating the status of a species, the Service uses the best scientific and commercial data available, and this includes consideration of direct and indirect effects of climate change. As is the case with all potential threats, if a species is currently affected or is expected to be affected by one or more climate-related impacts, this does not necessarily mean the species is a threatened or endangered species as defined under the Act. If a species is listed as threatened or endangered, this knowledge regarding its vulnerability to, and impacts from, climate-associated changes in environmental conditions can be used to help devise appropriate strategies for its recovery.

While projections from global climate model simulations are informative and in some cases are the only or the best scientific information available, various downscaling methods are being used to provide higher-resolution projections that are more relevant to the spatial scales used to assess impacts to a given species (see Glick *et al,* 2011, pp. 58–61). With regard to the area of analysis for the northern leopard frog, specific downscaled projections are not available for all the parts of its range, but we do have more generalized information. In North America, climate change is likely to constrain already over-allocated water resources, resulting in increased competition among agricultural, municipal, industrial, and ecological uses of water (Bates *et al.* 2008, p. 102). Of particular note are the expected changes in surface and groundwater hydrology. As the rate of warming accelerates, the timing, volume, quality, and spatial distribution of fresh water available to most areas in North America will change (Bates *et al.* 2008, p. 102; Johnson *et al.* 2010, p. 138). These changes will likely affect the quality and quantity of northern leopard frog habitat. Some areas, especially in the arid West, will likely see decreases in habitat, while other areas may experience stable or increasing available habitat. The freshwater wetland habitats the northern leopard frog depends upon for breeding and overwintering, particularly in the arid Southwest (Arizona, Colorado, New Mexico, Nevada, and Utah) and the prairie potholes region (Alberta, Iowa, Manitoba, Minnesota, Montana, North Dakota, Saskatchewan, and South Dakota) are expected to be particularly sensitive to climate change (Johnson *et al.* 2010, p. 128). Increases in drought and seasonal precipitation may have profound impacts to habitat; however, we are unable to reliably predict how changes in precipitation will affect current and future northern leopard frog habitat throughout the species' range.

Many experts expect that amphibians may be among the first vertebrates to exhibit broad-scale changes in response to global climate change (Reaser and Blaustein 2005, p. 61). The northern leopard frog is at the upper limit of its physiological tolerance to temperature and dryness throughout the arid and semi-arid habitats in the western United States (Hammerson 1999, pp. 146–147; Hitchcock 2001, pp. 18–19; Rorabaugh 2005, p. 577). As such, if the predictions for temperature increases are realized, these arid areas may no longer support the species. In addition, the northern leopard frog frequently depends upon small, ephemeral wetlands for breeding habitats (Merrell 1968, p. 275), and due to habitat fragmentation, the presence of nonnative aquatic species, and other

factors (such as agricultural and urban development, and roads), the leopard frog is bounded by dispersal barriers throughout its range (Rorabaugh 2005, p. 577). Species persistence is greater for species occupying larger patches of their historical range (Channell and Lomolino 2000, pp. 84–86). Because northern leopard frogs occupy relatively small patches of habitat compared to their historical distribution in some portions of their range, we may expect that climate change could result in further fragmentation of those populations in those portions of its range. In other words, the frogs may exist in smaller and smaller patches that are more remote from the core of their historical range.

As described above, changes in the quality and quantity of habitat are likely to occur throughout the range of the northern leopard frog. There are likely to be additional impacts to frogs in some portions of it range because of these changes. Climate change impacts in the arid and semi-arid areas could include earlier reproduction and more rapid development of larva due to more a more advanced spring, decreased mobility due to drier conditions, and shorter hibernation periods due to longer ice-free periods in the winter (Carey and Alexander 2003, pp. 111–121; Patla and Keinath 2005, pp. 44–46; Johnson *et al.* 2010, p. 133). Higher summer temperatures may result in high egg mortality (in response to freezing temperatures that may follow earlier breeding times) and in drying of breeding habitats prior to metamorphosis (in response to increased evaporation rate) (Smith 2003, p. 34). Climate change may also cause frogs to experience increased physiological stress and decreased immune system function, possibly leading to disease outbreaks (Carey and Alexander 2003, pp. 111–121; Pounds *et al.* 2006, pp. 161–167). Northern leopard frog populations at lower elevations are likely to show changes in phenology sooner than those at higher elevations (Corn 2003, pp. 622–625). Based upon the extended droughts in the Southwest and changes the Service has noted to northern leopard frog habitats in Arizona and New Mexico (Service 2007, pp. 38–41), it is likely that climate change may continue to reduce the amount of habitat available for northern leopard frogs, particularly in the western United States.

Climate change may result in significant impacts to some portions of the range of the northern leopard frog and may synergistically result in increased impacts from disease and other factors discussed above. The overall impacts of climate change will likely be very different across the range of the northern leopard frog, and it is difficult to predict how these effects will manifest themselves in terms of species-level impacts. There may be decreases in habitat in some areas, and increases in other portions of the range. As a result, it is possible that the species' range could expand, contract, or shift. However, we do not know enough about the capacity of this species to adapt to changing environmental conditions to make reliable predictions about future large-scale range contractions or shifts in response to climate change. In the arid West, it is likely that the predictions for greater variability in temperature and precipitation will result in further decreases in wetland habitats, which may exacerbate the negative interactions of native and nonnative species using wetted habitats. However, we expect that there may be portions of the species' range that may experience more favorable conditions, such as increased precipitation and temperature, that will positively affect habitat for the northern leopard frog. In conclusion, although we believe climate change will impact some northern leopard frog habitats in the future, the information we reviewed does not indicate that climate change will adversely impact northern leopard frogs at the species level. Therefore, based on the best available information, we conclude that climate change is not a significant threat individually or in combination to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Summary of Factor E

The northern leopard frog occupies a wide geographic range across the United States and Canada. As we have stated earlier, because it occurs across such a large area, the habitats it uses are subject to a number of impacts from pesticide use and climate change, and the species is subject to malformations that will impact local, and possibly even regional, populations. However, the wide diversity of wetland and upland habitats that are currently used by the northern leopard frog across its range may provide some protection in the future from changing climates and possibly from the variety of potential agents that cause malformations. Therefore, the best available information indicates that other natural and manmade factors do not constitute a significant threat to the northern leopard frog at the species level now, nor do we have indication that it will in the future.

Finding

As required by the Act, we considered the five factors in assessing whether the northern leopard frog is endangered or threatened throughout all of its range (*i.e.,* in danger of extinction now or in the foreseeable future). We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the northern leopard frog. We reviewed the petition, information available in our files, and other available published and unpublished information, and we consulted with other Federal, State, and tribal agencies.

There have been historical impacts to the northern leopard frog, in particular. The loss and degradation of wetland habitat, introduction of nonnative species, and disease, have resulted in local and regional extirpations of the species throughout its range, but particularly in the western United States and Canada, as described in the Background section above. Further, some of the threats discussed in this finding work in concert with one another to cumulatively create situations that potentially impact the northern leopard frog beyond the scope of each individual threat. It is likely that for such a widespread species as the northern leopard frog, causes of decline are dependent upon multiple factors or causes. This is particularly true since the northern leopard frog uses both terrestrial and aquatic habitats. For example, as discussed under *Factor A,* degradation of wetland habitats, resulting from agricultural use and the application of pesticides, results in increased immunosuppression and risk of parasitic infection in northern leopard frogs (Christin *et al.* 2003, pp. 1129–1130). These factors can also enhance the potential for malformations, which can result in decreased fitness, and subsequent declines of northern leopard frog populations. Malformations (discussed under *Factor E*) are likely the result of multiple causes. Lannoo (2008) describes the search for ''the'' cause of amphibian malformations, but eloquently determines in his comprehensive review that there is likely no one cause, but many factors that can result in malformations. Similarly, Thiemann and Wassersug (2000) found that the presence of predators and parasites also increased the susceptibility of *Rana* (=*Lithobates*) tadpoles to trematode infection by causing tadpoles to decrease their activity levels. They found that the combination of such stressors as increased predator loads (such as from

widespread predator introductions as discussed under *Factor C*), parasite infection, and pesticide pollution may synergistically result in increased impacts to tadpoles, which could be another factor in declining populations. However, even where these factors may work cumulatively to impact northern leopard frogs, the best available information does not indicate that current populations are being impacted significantly at scales above the population or regional levels.

In summary, in order to determine that the northern leopard frog warrants listing throughout its range, we must find that the best available information indicates it is *in danger of extinction* now or in the foreseeable future. The phrase ''in danger of extinction'' requires a showing that the species is actually likely in danger of extinction now, or likely to become so in the foreseeable future, not merely a showing that the species is facing threats. We must show that the threats are operative on the species such that the species meets the definition of threatened or endangered (*i.e.,* in danger of extinction now or in the foreseeable future). The northern leopard frog occupies a wide geographic range across the United States and Canada. Because it occurs across such a large area, it is subject to a number of impacts that represent potential threats at various scales. The number of threats the species has faced and continues to face may appear significant; however, as discussed above, the factors affecting the northern leopard frog have generally been historical in impact or are occurring now and into the future at scales below the species level as indicated by the presence of apparently stable populations in large areas of its range. Further, while there have been regional declines noted in the range of the species, particularly in the western portions of the United States and Canada, the frog is apparently still considered to be widespread and relatively common in the eastern United States and eastern Canada.

Based on our review of the best available scientific and commercial information pertaining to the five factors, we find that threats, alone or cumulatively, are not of sufficient magnitude at the species level to indicate that the northern leopard frog is in danger of extinction, or likely to become in danger of extinction within the foreseeable future, throughout all of its range.

Significant Portion of Its Range

The Act defines ''endangered species'' as any species which is ''in danger of extinction throughout all or a significant portion of its range,'' and ''threatened species'' as any species which is ''likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'' The definition of ''species'' is also relevant to this discussion. The Act defines the term ''species'' as follows: ''The term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.'' The phrase ''significant portion of its range'' is not defined by the statute, and we have never addressed in our regulations: (1) The consequences of a determination that a species is either endangered or likely to become so throughout a significant portion of its range, but not throughout all of its range; or (2) what qualifies a portion of a range as ''significant.''

Two recent district court decisions have addressed whether the ''significant portion of its range'' language allows the Service to list or protect less than all members of a defined ''species'': *Defenders of Wildlife* v. *Salazar,* 729 F. Supp. 2d 1207 (D. Mont. 2010), concerning the Service's delisting of the Northern Rocky Mountain gray wolf (74 FR 15123, Apr. 2, 2009); and *WildEarth Guardians* v. *Salazar,* 2010 U.S. Dist. LEXIS 105253 (D. Ariz. Sept. 30, 2010), concerning the Service's 2008 finding on a petition to list the Gunnison's prairie dog (73 FR 6660, February 5, 2008). The Service had asserted in both of these determinations that it had authority, in effect, to protect only some members of a ''species,'' as defined by the Act (*i.e.,* species, subspecies, or DPS), under the Act. Both courts ruled that the determinations were arbitrary and capricious on the grounds that this approach violated the plain and unambiguous language of the Act. The courts concluded that reading the ''significant portion of its range'' language to allow protecting only a portion of a species' range is inconsistent with the Act's definition of ''species.'' The courts concluded that once a determination is made that a species (*i.e.,* species, subspecies, or DPS) meets the definition of ''endangered species'' or ''threatened species,'' it must be placed on the list in its entirety and the Act's protections applied consistently to all members of that species (subject to modification of protections through special rules under sections 4(d) and 10(j) of the Act).

Consistent with that interpretation, and for the purposes of this finding, we interpret the phrase ''significant portion of its range'' in the Act's definitions of ''endangered species'' and ''threatened species'' to provide an independent basis for listing; thus there are two situations (or factual bases) under which a species would qualify for listing: a species may be endangered or threatened throughout all of its range; or a species may be endangered or threatened in only a significant portion of its range. If a species is in danger of extinction throughout a significant portion of its range, it, the species, is an ''endangered species.'' The same analysis applies to ''threatened species.'' Therefore, the consequence of finding that a species is endangered or threatened in only a significant portion of its range is that the entire species will be listed as endangered or threatened, respectively, and the Act's protections will be applied across the species' entire range.

We conclude, for the purposes of this finding, that interpreting the ''significant portion of its range'' phrase as providing an independent basis for listing is the best interpretation of the Act because it is consistent with the purposes and the plain meaning of the key definitions of the Act; it does not conflict with established past agency practice, as no consistent, long-term agency practice has been established; and it is consistent with the judicial opinions that have most closely examined this issue. Having concluded that the phrase ''significant portion of its range'' provides an independent basis for listing and protecting the entire species, we next turn to the meaning of ''significant'' to determine the threshold for when such an independent basis for listing exists.

Although there are potentially many ways to determine whether a portion of a species' range is ''significant,'' we conclude, for the purposes of this finding, that the significance of the portion of the range should be determined based on its biological contribution to the conservation of the species. For this reason, we describe the threshold for ''significant'' in terms of an increase in the risk of extinction for the species. We conclude that a biologically based definition of ''significant'' best conforms to the purposes of the Act, is consistent with judicial interpretations, and best ensures species' conservation. Thus, for the purposes of this finding, a portion of the range of a species is ''significant'' if its contribution to the viability of the species is so important that, without that portion, the species would be in danger of extinction.

We evaluate biological significance based on the principles of conservation biology using the concepts of

redundancy, resiliency, and representation. Resiliency describes the characteristics of a species that allow it to recover from periodic disturbance. Redundancy (having multiple populations distributed across the landscape) may be needed to provide a margin of safety for the species to withstand catastrophic events. Representation (the range of variation found in a species) ensures that the species' adaptive capabilities are conserved. Redundancy, resiliency, and representation are not independent of each other, and some characteristics of a species or area may contribute to all three. For example, distribution across a wide variety of habitats is an indicator of representation, but it may also indicate a broad geographic distribution contributing to redundancy (decreasing the chance that any one event affects the entire species), and the likelihood that some habitat types are less susceptible to certain threats, contributing to resiliency (the ability of the species to recover from disturbance). None of these concepts is intended to be mutually exclusive, and a portion of a species' range may be determined to be ''significant'' due to its contributions under any one of these concepts.

For the purposes of this finding, we determine if a portion's biological contribution is so important that the portion qualifies as ''significant'' by asking whether, without that portion, the representation, redundancy, or resiliency of the species would be so impaired that the species would have an increased vulnerability to threats to the point that the overall species would be in danger of extinction (*i.e.,* would be ''endangered''). Conversely, we would not consider the portion of the range at issue to be ''significant'' if there is sufficient resiliency, redundancy, and representation elsewhere in the species' range that the species would not be in danger of extinction throughout its range if the population in that portion of the range in question became extirpated (extinct locally).

We recognize that this definition of ''significant'' establishes a threshold that is relatively high. On the one hand, given that the consequences of finding a species to be endangered or threatened in a significant portion of its range would be listing the species throughout its entire range, it is important to use a threshold for ''significant'' that is robust. It would not be meaningful or appropriate to establish a very low threshold whereby a portion of the range can be considered ''significant'' even if only a negligible increase in extinction risk would result from its loss. Because nearly any portion of a species' range can be said to contribute some increment to a species' viability, use of such a low threshold would require us to impose restrictions and expend conservation resources disproportionately to conservation benefit: listing would be rangewide, even if only a portion of the range of minor conservation importance to the species is imperiled. On the other hand, it would be inappropriate to establish a threshold for ''significant'' that is too high. This would be the case if the standard were, for example, that a portion of the range can be considered ''significant'' only if threats in that portion result in the entire species' being currently endangered or threatened. Such a high bar would not give the ''significant portion of its range'' phrase independent meaning, as the Ninth Circuit held in *Defenders of Wildlife* v. *Norton,* 258 F.3d 1136 (9th Cir. 2001).

The definition of ''significant'' used in this finding carefully balances these concerns. By setting a relatively high threshold, we minimize the degree to which restrictions will be imposed or resources expended that do not contribute substantially to species conservation. But we have not set the threshold so high that the phrase ''in a significant portion of its range'' loses independent meaning. Specifically, we have not set the threshold as high as it was under the interpretation presented by the Service in the *Defenders* litigation. Under that interpretation, the portion of the range would have to be so important that current imperilment there would mean that the species would be currently imperiled everywhere. Under the definition of ''significant'' used in this finding, the portion of the range need not rise to such an exceptionally high level of biological significance. We recognize that if the species is imperiled in a portion that rises to that level of biological significance, then we should conclude that the species is in fact imperiled throughout all of its range, and that we would not need to rely on the ''significant portion of its range'' language for such a listing. Rather, under this interpretation we ask whether the species would be in danger of extinction everywhere without that portion, *i.e.,* if that portion were completely extirpated.

The range of a species can theoretically be divided into portions in an infinite number of ways. However, there is no purpose to analyzing portions of the range that have no reasonable potential to be significant or to analyzing portions of the range in which there is no reasonable potential for the species to be endangered or threatened. To identify only those portions that warrant further consideration, we determine whether there is substantial information indicating that: (1) The portions may be ''significant,'' and (2) the species may be in danger of extinction there or likely to become so within the foreseeable future. Depending on the biology of the species, its range, and the threats it faces, it might be more efficient for us to address the significance question first or the status question first. Thus, if we determine that a portion of the range is not ''significant,'' we do not need to determine whether the species is endangered or threatened there; if we determine that the species is not endangered or threatened in a portion of its range, we do not need to determine if that portion is ''significant.'' In practice, a key part of the portion status analysis is whether the threats are geographically concentrated in some way. If the threats to the species are essentially uniform throughout its range, no portion is likely to warrant further consideration. Moreover, if any concentration of threats applies only to portions of the species' range that clearly would not meet the biologically based definition of ''significant,'' such portions will not warrant further consideration.

After reviewing the potential threats throughout the range of the northern leopard frog, we determine that there is a portion of the range that could be considered to have concentrated threats. We defined this area, which we are calling the westernmost portion, as including the current range of the northern leopard frog within British Columbia and Alberta, Canada, and Washington, eastern Oregon (if any native populations remain), Idaho, California (if any native populations remain), Nevada, Utah, Arizona, New Mexico, Colorado, and the portions of Wyoming and Montana that are west of the Continental Divide. Below, we outline the elevated threats found within this westernmost portion of the northern leopard frog's range (see ''Summary of Information Pertaining to the Five Factors'' for complete discussion). We then assess whether this portion of the species' range may meet the biologically based definition of ''significant,'' that is, whether the contribution of this portion of the northern leopard frog's range to the viability of the species is so important that without this westernmost portion of the range, the species would be in danger of extinction.

This westernmost portion of the northern leopard frog's range has

experienced significant declines and continues to experience impacts, likely resulting from the influence of multiple contributing factors, but primarily resulting from the combination of habitat loss, the spread of American bullfrogs and predaceous fish into otherwise suitable breeding habitats, disease, and increased variability in temperature and precipitation (Rorabaugh 2005, pp. 575–577; Smith and Keinath 2007, pp. 29–31; Committee on the Status of Endangered Species in Canada 2009, pp. 31–35; Johnson *et al.* 2011, p. 557). As described above in *Species Information,* the northern leopard frog depends upon a landscape that includes breeding ponds, upland foraging areas, overwintering aquatic habitats, and connectivity among habitats and between populations (Pope *et al.* 2000, p. 2505; Smith 2003, pp. 6–15; Rorabaugh 2005, pp. 571–575). The destruction and degradation of wetland and riparian habitat is thought to represent the most widespread impact to northern leopard frog populations in Arizona (Arizona Game and Fish Department 2009, p. 1), Colorado (Colorado Division of Wildlife 2009, p. 2), Idaho (Idaho Department of Fish and Game 2005, Northern leopard frog species account), Montana (Montana Fish Wildlife and Parks 2009, p. 2), Nevada (Nevada Department of Wildlife 2009, p. 4), New Mexico (New Mexico Department of Game and Fish 2009, p. 3), and Alberta, Canada (Alberta Northern Leopard Frog Recovery Team 2005, p. 6). The loss of aquatic habitats has been compounded by the spread of the American bullfrog and nonnative fish in the West. These species predate on and compete with all life stages of northern leopard frogs and have further stressed northern leopard frog populations in this westernmost portion, likely contributing to population declines. Based upon the extended droughts in the Southwest and changes the Service has noted to northern leopard frog habitats in Arizona and New Mexico (Service 2007, pp. 38–41), it is likely that increased variability in temperature and precipitation will continue to reduce the amount of breeding and wintering habitat available for northern leopard frogs, particularly in the western United States.

After identifying elevated threats in the westernmost portion of the range of the northern leopard frog, we next consider whether this portion of the range should be considered a ''significant portion of its range'' based on the framework laid out above. In order for the westernmost portion of the range to be considered significant, we consider whether there is sufficient resiliency, redundancy, and representation in the remaining portion of the range (which includes the species in the rest of its range; hereafter referred to as the eastern portion of the range) such that the northern leopard frog would not be in danger of extinction if the westernmost portion of the range in question became extirpated (extinct locally). Our analysis, described below, finds that the westernmost portion of the range does not meet this definition of significant, because even without that portion of the range the species, rangewide, would not be in danger of extinction.

To determine whether or not the westernmost portion of the range is ''significant,'' we considered the species' resiliency, redundancy, and representation in the remainder (*i.e.,* the eastern portion) of its range. For resiliency, we evaluated whether the eastern portion of the range of the northern leopard frog, without the westernmost portion, would maintain the characteristics necessary to allow the species to recover from periodic disturbance. The eastern portion we refer to here includes Saskatchewan, eastern Montana, and eastern Wyoming, and continues east through Canada and the United States through the rest of the range of the northern leopard frog. This area encompasses a large proportion of the range of the species and contains a variety of wetland and upland habitats necessary to provide breeding and overwintering habitats, and habitat linkages. This area is also sufficiently large as to provide a margin of safety for the species to withstand disturbance events. We conclude that the eastern portion of the range of the northern leopard frog is sufficiently resilient that even without the westernmost portion of its range, the species would not be in danger of extinction.

As part of our evaluation of redundancy, we evaluated whether the eastern portion of the range of the northern leopard frog, without the westernmost portion, would have enough populations sufficiently distributed across the landscape to allow the species to withstand catastrophic events. Based upon what we know of the current population status in the eastern portion of the range, there are multiple areas (such as South Dakota, North Dakota, Ohio, Ontario, Vermont, New York, and Quebec) where the northern leopard frog is currently maintaining stable, widespread populations. These areas are sufficient in size and apparent distribution to serve as core areas from which northern leopard frogs can recolonize areas that could be subject to catastrophic future events (such as widespread flooding or drought). We conclude that the eastern portion of the range of the northern leopard frog is sufficiently redundant that even without the westernmost portion of its range, the species would not be in danger of extinction.

In our evaluation of representation, we considered whether the eastern portion of the range of the northern leopard frog, without the westernmost portion, contains enough variation to ensure that the species' adaptive capabilities are conserved (such that the genetic, morphological, physiological, behavioral, or ecological diversity of the species overall is maintained). Based upon our current knowledge of the northern leopard frog, we do not have evidence of morphological, physiological, or behavioral differences between individuals from the westernmost portion of the range and individuals in the eastern portion of the range. Although the westernmost portion of the range is located on the periphery of the species' overall range, the eastern portion contains large areas that represent an important genetic evolutionary history between eastern and western northern leopard frogs (Hoffman and Blouin 2004a, 2004b; Wilson *et al.* 2008). This important genetic information is represented within the defined eastern area and would not be lost if the westernmost portion of the range were extirpated. In addition, although not well studied, there are likely broad ecological differences between northern leopard frogs in the westernmost portion of the range compared to those in the eastern portion of the range that result from the geographical differences in habitat, climate, and species interactions. We recognize the ecological importance of conserving peripheral, as well as interior, populations of wide-ranging species. However, due to the diversity of areas the northern leopard frog occupies in the large eastern portion of its range, it is likely that sufficient ecological adaptation potential would be maintained to ensure ecological representation. We conclude that the eastern portion of the range of the northern leopard frog is sufficiently representative that even without the westernmost portion of its range, the species would not be in danger of extinction.

Based on our analysis, we find that the eastern portion of the range of the northern leopard frog contains sufficient redundancy, resiliency, and

representation that, even without the contribution of the westernmost portion of the species' range, the northern leopard frog would not be in danger of extinction. Therefore, we find that the westernmost portion of the northern leopard frog does not constitute a significant portion of the species' range.

In conclusion, based on a review of the best available information, we find the northern leopard frog is not in danger of extinction now or in the foreseeable future throughout all or a significant portion of its range and, therefore, does not warrant listing at this time.

We request that you submit any new information concerning the distribution and status of, or threats to, the northern leopard frog to our Arizona Ecological Services Office (see **ADDRESSES**) whenever it becomes available. New information will help us monitor the northern leopard frog and encourage its conservation. If an emergency situation develops for the northern leopard frog or any other species, we will act to provide immediate protection.

References Cited

A complete list of references cited is available on the Internet at *http://www.regulations.gov* and upon request from the Arizona Ecological Services Office (see **ADDRESSES** section).

Authors

The primary authors of this notice are the staff members of the Arizona Ecological Services Office.

Authority

The authority for this section is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: September 26, 2011.

Gregory E. Siekaniec,

Acting Director, Fish and Wildlife Service.

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