CANDIDATE ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Bufo canorus*

COMMON NAME: Yosemite toad

LEAD REGION: 1

INFORMATION CURRENT AS OF: December 10, 2002

STATUS/ACTION:
___ New candidate
_X_ Continuing candidate
___ Non-petitioned
_X_ Petitioned - Date petition received: April 3, 2000
_X 90-day positive - FR date: October 12, 2000
_X 12-month warranted but precluded - FR date: December 10, 2002
___ Is the petition requesting a reclassification of a listed species?
___ Listing priority change
Former LP: ___
New LP: ___
Latest Date species became a Candidate: December 10, 2002
___ Candidate removal: Former LP: ___
___ A - Taxon more abundant or widespread than previously believed or not subject to a degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
___ F - Range is no longer a U.S. territory.
___ I - Insufficient information on biological vulnerability and threats to support listing.
___ M - Taxon mistakenly included in past notice of review.
___ N - Taxon may not meet the Act's definition of "species."
___ X - Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Amphibian, Bufonidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: California

CURRENT STATES/ COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: California

LEAD REGION CONTACT: Diane Elam (CNO), 916-414-6464; Scott McCarthy (RO), 503-231-6237

LEAD FIELD OFFICE CONTACT: Sacramento FWO, Jacob Martin 916-414-6600

BIOLOGICAL INFORMATION:

Species Description

Yosemite toads (*Bufo canorus*) are moderately sized, with a snout-urostyle length (measured from the tip of the snout to the posterior edge of the urostyle, a bony structure at the posterior end of the spinal column) of 30-71 millimeters (mm) [1.2-2.8 inches (in)] with rounded to slightly oval paratoid glands (a pair of glands, one on each side of the head, that produce toxins) (Karlstrom 1962). The paratoid glands are less than the width of a gland apart (Stebbins 1985). A thin mid-dorsal (on the middle of the back) stripe is present in juveniles of both sexes. The stripe disappears or is reduced with age, and more quickly in males (Jennings and Hayes 1994). The iris of the eye is dark brown with gold iridophores (reflective pigment cells) (Jennings and Hayes 1994). Males are smaller than females, with less conspicuous warts (Stebbins 1951). Differences in coloration between males and females are more pronounced in the Yosemite toad than in any other North American frog or toad (Stebbins 1951). Females have black spots or blotches edged with white or cream that are set against a gray, tan or brown background color (Jennings and Hayes 1994). Males have a nearly uniform dorsal coloration of yellow-green to olive drab to darker greenish brown (Jennings and Hayes 1994). Karlstrom (1962) suggested that differences in coloration between the sexes evolved because they provide the Yosemite toad with protective coloration. The uniform coloration of the adult male matches and blends with the silt and grasses that they frequent during the breeding season, whereas the young and females with disruptive coloration tend to use a wider range of habitats with broken backgrounds; thus coloration may help conceal individual toads from predators.

Taxonomy

The Yosemite toad was originally described by Camp (1916), and given the common name Yosemite Park toad. Subsequent detections of this species indicated that its range extends beyond the boundaries of Yosemite National Park and Grinnel and Storer (1924) referred to this species as the Yosemite toad.

Similarities in appearance between the Yosemite toad and the western toad (*B. boreas*) were noted by Camp (1916). Based on general appearance and structure and on distribution, it appears that these two species are closely related (Myers 1942; Stebbins 1951; Mullally 1956; Savage 1958). The close relationship between *B. boreas* and *B. canorus* is also supported by studies of bone structure (Tihen 1962 a,b) and by the survivorship of hybrid toads produced by artificially crossing the two species (Blair 1959, 1963, 1964).

Camp (1916), using characteristics of the skull, concluded that *B. boreas*, *B. canorus*, and *B. nestor* (extinct) are more closely related to each other than to other North American toads, and these species comprise the most primitive group of *Bufo* in North America. Blair (1972) grouped *B. boreas*, *B. canorus*, black toads (*B. exsul*), and Amargosa toads (*B. nelsoni*), together taxonomically as the Aboreas group.

Feder (1977) found *B. canorus* to be genetically distinctive based on samples from a limited geographic range. However, Yosemite toads are thought to hybridize with western toads in the northern part of their range (Karlstrom 1962; Morton and Sokolski 1978). Shaffer et al. (2000) performed genetic analysis of a segment of mitochondrial DNA from 372 Yosemite toads from Yosemite and Kings Canyon National Parks. Their data showed significant genetic differences in Yosemite toads between the two parks. They also found significant genetic variability within Yosemite National Park between drainages and within both Parks between breeding sites. Their data also indicated that black toads are a subgroup within Yosemite toads rather than a separate species. Stephens (2001) examined mitochondrial DNA from eight Yosemite toads [selected from the samples examined by Shaffer et al. (2000) to represent the range of variability found in that study] and 173 western toads. Stephens' data indicate that *Bufo* in the Sierra Nevada occur in northern and southern evolutionary groups, each of which include both Yosemite and western toads (i.e., toads of both species are more closely related to each other within a group than they are to members of their own species in the other group). Further genetic analysis of Yosemite toads sampled from throughout their range, and from other toad species surrounding their range, is needed to fully understand the evolutionary history and appropriate taxonomic status of the Yosemite toad (Stephens 2001).

Habitat

Yosemite toads use meadow habitats surrounded by lodgepole (*Pinus contorta*) or whitebark (*P. albicaula*) pines (Camp 1916). They are most likely to be found in areas with thick meadow vegetation or patches of low willows (*Salix* spp.) (Mullally 1953). They are most often seen near water, but only occasionally in water (Mullally and Cunningham 1956), and use rodent burrows for over-wintering and probably for temporary refuge during the summer (Jennings and Hayes 1994). They also use spaces under surface objects, including logs and rocks, for temporary refuge (Stebbins 1951; Karlstrom 1962). Breeding habitat includes the edges of wet meadows and slow flowing streams (Jennings and Hayes 1994). Tadpoles have also been observed in shallow ponds and shallow areas of lakes (Mullally 1953). Moist upland areas such as seeps and springheads are important summer non-breeding habitats for adult toads (David Martin, University of California, Santa Barbara, pers. comm., 2002).

Historic and Current Range and Status

The historic range of Yosemite toads in the Sierra Nevada occurs from the Blue Lakes region north of Ebbetts Pass (Alpine County) to 5 kilometers (km) [3.1 miles (mi)] south of Kaiser Pass in the Evolution Lake/Darwin Canyon area (Fresno County) (Jennings and Hayes 1994). The historic elevational range of Yosemite toads is 1,460 to 3,630 m (4,790 to 11,910 ft) (Stebbins 1985).

The historic and current acreage of Yosemite toad habitat (wet meadows, shallow breeding waters, and moist uplands) within the historic range of Yosemite toads is unknown, although these habitats have been degraded and may be decreasing in area as a result of conifer encroachment and livestock grazing (see Factor A below). The vast majority of land within the range of the Yosemite toad is federally managed, with 919,011 hectares (ha) [2,270,918 acre (ac)] (99 percent of the range) on USFS, NPS, and Bureau of Land Management lands. Much of this land is within designated wilderness. The remaining land within the species' range is a mix of State, local government, and private lands.

The following known site discussion is based on the California Wildlife Habitat Relations range map, obtained as a geographic information system data from CDFG for the species, although this map includes large areas of unsuitable habitat. However, this map is the best available range map for the species, although the species has been detected in a few locations outside its boundaries, primarily at the southern end of the range. The site-specific information is based on localized studies that do not represent a comprehensive range-wide assessment of the species' status.

(1) Yosemite toads are known from three sites in the southeast corner of the El Dorado National Forest where it borders with the Toiyabe and Stanislaus National Forests. Two of these three sites have been confirmed as occupied since 1990.

(2) Yosemite toads are known from 25 locations along the west side of the Toiyabe National Forest, 15 of which have been confirmed as occupied since 1990.

(3) Yosemite toads are known from 28 sites on the Stanislaus National Forest, 22 of which have been confirmed as occupied since 1990. These sites occur primarily in two groups, one on the northern edge of the forest, where it borders with the El Dorado and Toiyabe National Forests, and the other in a band extending west across the Stanislaus National Forest, from its southeast border with Yosemite National Park and the Toiyabe National Forest.

(4) Yosemite toads are known from 49 sites along the west side of Inyo National Forest, 35 of which have been confirmed as occupied since 1990.

(5) Yosemite toads are known from 91 locations throughout Sierra National Forest, of which 84 have been confirmed as occupied since 1990.

(6) Yosemite toads are known from 78 sites scattered throughout Yosemite National Park, 57 of which have been confirmed occupied since 1990.

(7) Yosemite toads are known from 18 sites throughout the northern half of Kings Canyon National Park, 14 of which have been confirmed as occupied since 1990.

It is impossible to fully determine the extent to which Yosemite toads have declined, because baseline data on the number and size of historic populations are few. The following studies, which reassess the current status of historically documented populations, give the most insight into the species' decline.

Jennings and Hayes (1994) reviewed the current status of Yosemite toads using museum records of historic and recent sightings, published data, and unpublished data and field notes from biologists working with the species. They mapped 55 historically documented general localities throughout the range of the species where the toad had been present (based on 144 specific sites), and found that Yosemite toads are now absent from 29 of those localities, a decline of over 50 percent.

In 1990, David Martin surveyed 75 sites throughout the range of the Yosemite toad for which there are historic records of the species' presence, and found that 47 percent of those sites showed no evidence of any life stage of the species (Stebbins and Cohen 1997), a decline of about 63 percent.

Grinnell and Storer (1924) surveyed for vertebrates at 40 sites along a 143-km (89-mi) west-to-east transect across the Sierra Nevada, through Yosemite National Park, in 1915 and 1919.

Drost and Fellers (1996) conducted more thorough surveys, specifically for amphibians, at 38 of those sites in 1992. They found that Yosemite toads were absent from 6 of 13 sites in which they had been found in the original survey. At sites where Drost and Fellers (1996) found Yosemite toads, the toads occurred in low numbers (only 15 total adult and juvenile toads at all sites), with documented declines in relative abundance in three of the Grinnel and Storer (1924) sites, as based on their generalized abundance categories such as rare, common, and abundant. Therefore, the species has declined or disappeared completely from at least 9 of 13 (69 percent) of the Grinnel and Storer (1924) sites.

The only long-term study on the size of a population of Yosemite toads indicates that the population has declined dramatically. Kagarise Sherman and Morton (1993) studied Yosemite toads at Tioga Pass Meadow (Mono County, California) intensively from 1971 to 1982, and made less systematic observations from 1983 to 1991. To estimate the adult population size, they captured and marked toads entering breeding pools. From 1974 to 1978, an average of 258 males entered the breeding pools. In 1979, the number of male toads began to decline, and by 1982, the number of males had dropped to 28. During the same time period, the number of females varied between 45 and 100, but there was no obvious trend in number observed. In periodic surveys between 1983 and 1991, it appeared that both males and females continued to decline, and breeding activity became sporadic. In 1990, the researchers were only able to locate one female, two males, and four to six egg masses. In 1991, they found only one male and two egg masses. The researchers also surveyed non-breeding habitat in the same area and found similar population declines. To date, the population at Tioga Pass Meadow has not recovered (Roland Knapp, Sierra Nevada Aquatic Research Laboratory, pers. comm., 2002).

Kagarise Sherman and Morton (1993) also conducted occasional surveys of six other populations in the eastern Sierra Nevada. Five of these populations showed serious, apparently long-term, declines between 1978 and 1981, while the sixth population held relatively steady until the final survey in 1990, at which time it dropped precipitously. In 1991, E.L. Karlstrom revisited the site at which he had studied a breeding population of Yosemite toads from 1954 to 1958, just south of Tioga Pass Meadow within Yosemite National Park (Tuolumne County, California), and found no evidence of toads or signs of breeding (Kagarise Sherman and Morton 1993).

THREATS:

A. The present or threatened destruction, modification, or curtailment of its habitat or range.

Grazing

Mule deer (*Odocoileus hemionus*) and bighorn sheep (*Ovis canadensis*) have always occurred within the habitats used by the Yosemite toad (Ingles 1965). However, grazing by dense groups of large herbivores such as cattle and horses is not a natural situation in those habitats, and these habitats are vulnerable to degradation. Because Yosemite toad breeding habitat is shallow, that habitat is very vulnerable to changes in hydrology caused by grazing (D. Martin, pers. comm., 2002; R. Knapp, pers. comm., 2002).

Direct and indirect mortality of Yosemite toads have occurred as a result of livestock grazing. Cattle have been observed to trample Yosemite toad eggs and disturb eggs such that they fall into hoof-prints or other deeper water and die. Metamorph Yosemite toads have been observed to fall into cattle hoof-prints or to be defecated on by cattle, become trapped, and die, and adult Yosemite toads have been observed trampled to death in cattle hoof-prints (D. Martin, pers. comm., 2002). Preliminary research data indicate that Yosemite toad tadpoles in grazed areas take longer to metamorphose and produce smaller metamorphs than those in areas being rested from grazing, presumably due to high bacteria and nutrient levels, causing low water quality in the grazed areas (D. Martin, pers. comm., 2002).

Grazing removes vegetative cover, and before/after surveys have shown reductions in the number of Yosemite toads using an area after the herbaceous cover was grazed (D. Martin, pers. comm., 2002). Grazing can also cause erosion by disturbing the ground, removing vegetation, and destroying peat layers in meadows, which lowers the groundwater table and summer flows (Armour et al. 1994; D. Martin, pers. comm., 2002). Consequently, this may increase the stranding and mortality of tadpoles, or make these areas completely unsuitable for Yosemite toads (D. Martin, pers. comm., 2002). Grazing can also degrade or destroy moist upland areas used as non-breeding habitat by Yosemite toads (D. Martin, pers. comm., 2002), especially when nearby meadow and riparian areas have been fenced to exclude livestock. Livestock may also collapse rodent burrows used by Yosemite toads as cover and hibernation sites, or disturb toads and disrupt their behavior.

The impacts of grazing on habitat can be inferred by observing the recovery of vegetation, ground stability, and water flow that occurs when riparian areas are fenced to exclude livestock (Kattelmann and Embury 1996). An example of this, from a drainage occupied by Yosemite toads, is provided by a study of fish habitat on Silver King and Coyote Valley Creeks (tributaries of the Carson River, Alpine County, California). In this study, stream reaches were fenced to exclude cattle and, over time, bank stability increased and stream channels became deeper and narrower than the unfenced reaches. This indicated that streambank sloughing had been reduced, and vegetation was stabilizing soils and reducing erosion (Overton et al. 1994; Kattelmann and Embury 1996).

Livestock grazing in the Sierra Nevada has been so widespread for so long that, in most places, no ungrazed areas are available to illustrate the natural condition of the habitat (Kattelmann and Embury 1996). Due to the long, and historically unregulated history (Menke et al. 1996) of livestock and packstock grazing in the Sierra Nevada, and the lack of historic Yosemite toad population size estimates, it is difficult to make a quantitative link between grazing and reductions in Yosemite toad populations. However, because of the documented negative effects of livestock on Yosemite toad habitat, and documented direct mortality of the species caused by livestock, the decline of some populations of Yosemite toad has been attributed to the effects of livestock grazing (Jennings and Hayes 1994; Jennings 1996).

Roads and Timber Harvest

Any activity that severely alters the terrestrial environment, such as road construction and timber harvest, is likely to result in the reduction and occasional extirpation of amphibian populations in the Sierra Nevada (Jennings 1996). By creating gaps in the natural vegetation, roads and harvested areas may act as dispersal barriers and contribute to the fragmentation of Yosemite toad habitat and populations. Habitat fragmentation has been shown to have a negative effect on amphibian species richness (Lehtinen et al. 1999). Timber harvest removes vegetation and causes ground disturbance and soil compaction, which makes that ground more susceptible to erosion (Helms and Tappeiner 1996). Much of the erosion caused by timber harvests is from logging roads (Helms and Tappeiner 1996). This erosion could damage Yosemite toad breeding habitat by lowering the water table, and drying out riparian habitats used by the species.

By creating gaps in the natural vegetation, roads and harvested areas may act as dispersal barriers. Prior to the formation of National Parks and National Forests, timber harvest was widespread and unregulated, but primarily took place at low elevations on the west slope of the Sierra Nevada, below the elevational range of the Yosemite toad (University of California (UC) 1996). Between 1900 and 1950, the majority of timber harvest took place on old growth forests on private land (UC 1996). The majority of roads in National Forests of the Sierra Nevada were built between 1950 and 1990 to allow access to the forests for timber harvest (USDA 2001h). Between 1950 and the early 1990s, the USFS allowed major increases in timber harvest on National Forests and at higher elevations, and the majority of impacts on Yosemite toads probably took place during this period.

Roads may cause the potential for direct mortality of amphibians through roadkill (deMaynadier and Hunter 2000), and the possible introduction of contaminants such as petroleum products, herbicides, and pesticides. The levels of timber harvest and road construction have declined substantially since implementation of the California Spotted Owl Sierran Province Interim Guidelines in 1993, and some existing roads have been, or are scheduled for, decomissioning (USDA 2001h). Therefore, the risks posed by new roads and timber harvests have declined, but those already existing still pose risks to the species and its habitat through erosion, roadkill, and contaminant introduction.

Vegetation and Fire Management Activities

Vegetation management includes the removal of small trees and brush to reduce fuels, and to reduce competition, which allows faster growth of desired tree species (Helms and Tappeiner 1996). These activities may disturb the ground and increase erosion, which could cause damage to Yosemite toad habitat through siltation and lowering of groundwater levels. Brush removal sometimes includes the use of herbicides, which may run off into Yosemite toad habitat, causing lethal or sublethal effects on individuals (see Factor D and E below).

Long-term fire suppression has influenced changes in forest structure and dynamics in the Sierra Nevada. In general, the fire return interval is now much longer than it was historically, and live and dead fuels are more abundant and continuous (USDA 2001c). Fire is thought to be important in maintaining open aquatic and riparian habitats for amphibians in some systems (Russel et al. 1999).

Fire suppression, and changes in fire frequency and hydrology, has probably contributed to the decline of Yosemite toads through habitat loss caused by conifer encroachment on meadows (Chang 1996; NPS 2002). Under natural conditions, conifers are excluded from meadows by fire and soils too saturated for their survival. But as conifers begin to encroach on a meadow, if they are not occasionally set back by fire, they transpire water out of the meadow, reducing the saturation of the soils, and facilitating further conifer encroachment. Therefore, some vegetation treatment may be needed to maintain or restore Yosemite toad habitat.

Increases in fuel abundance have created the potential for catastrophic fires, which could cause direct mortality of Yosemite toads; however, data on the direct effects of fire on Yosemite toads are lacking. Fires and mechanical fire suppression activities (such as cutting fire lines) could cause erosion and siltation that could negatively impact Yosemite toad habitat. However, amphibians in general are thought to retreat to moist or subterranean refuges and thereby suffer low mortality during natural fires (Russel et al. 1999).

Fire retardant chemicals contain nitrogen compounds or surfactants (soaps). Laboratory tests of these chemicals have shown that after surfactants and ammonia are released when they are added to water, they cause mortality in fish and aquatic invertebrates (Hamilton et al. 1996), and likely have similar effects on amphibians. Therefore, if fire retardant chemicals were dropped in or near Yosemite toad habitat, they could have negative effects on individual toads. The majority of vegetation and fire management activities take place at lower elevations, but they do pose a threat to the species when they take place within the species' elevational range.

Recreation

Recreational activities take place throughout the Sierra Nevada and can have significant negative impacts on wildlife and their habitats (USDA 2001a). Recreation is the fastest growing use of National Forests (USDA 2001f). Heavy foot traffic in riparian areas tramples vegetation, compacts soils, and can physically damage streambanks. Trails (foot, horse, bicycle, or off-highway motor vehicle) compact soil in riparian habitat, which increases erosion, replaces vegetation, and can lower the water table (Kondolph et al. 1996). Trampling or the collapsing of rodent burrows by recreationists, pets, and vehicles could lead to direct mortality of all life stages of the Yosemite toad. Recreational activity may also disturb toads and disrupt their behavior (Karlstrom 1962).

Dams and Water Diversion

Several artificial lakes are located in or above Yosemite toad habitat, most notably Edison, Florence, Huntington, Courtright, and Wishon Reservoirs. By altering the timing and magnitude of water flows, these reservoirs have caused changes in hydrology, which may have negatively altered Yosemite toad habitat. Changes in water flows have caused increased water levels upstream of the reservoirs, which may have reduced the suitability of shallow water habitats necessary for egg-laying, or allowed the invasion of predatory fish into those habitats. Water flow changes may have contributed to the mortality of eggs and tadpoles either by stranding during low water or innundation during high water. The reservoirs themselves probably cover what was once Yosemite toad habitat. Most native Sierra Nevada amphibians cannot live in or move through reservoirs (Jennings 1996). Therefore, reservoirs represent both a loss of habitat and a barrier to dispersal and gene flow. These factors have probably contributed to the decline of Yosemite toads and continue to pose a risk to the species.

B. Overutilization for commercial, recreational, scientific, or educational purposes.

There is no known commercial market for Yosemite toads. There is also no documented recreational or educational use for Yosemite toads, although it is likely that they have been handled by curious members of the public and collected as pets.

Scientific research may cause some stress to Yosemite toads through disturbance and disruption from behavior, handling, and injuries associated with marking individuals. Scientific research has resulted in the death of a few individuals through accidental trampling (Green and Kagarise Sherman 2001), irradiation [Karlstrom (1957) collected data on Yosemite toad movements by implanting them with radioactive tags], and collection for museum specimens (Jennings and Hayes 1994). Given the current reduced size and number of populations (Jennings and Hayes 1994), further collection could pose a serious threat to Yosemite toad populations.

C. Disease or predation.

Prior to the stocking of high Sierra Nevada lakes with salmonid fishes, which began over a century ago, fish were entirely absent from most of this region (Bradford 1989). Introduced fish, such as rainbow and golden trout (*Oncorhynchus mykiss* ssp.), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*), have been shown to have a negative impact, primarily through predation on native populations of Sierra Nevada amphibians, including the mountain yellow-legged frog (Bradford 1989; Knapp and Matthews 2000) and Pacific chorus frog (Matthews et al. 2001).

Data on the effects of introduced fish on Yosemite toads are less clear, although re-surveys of historic Yosemite toad sites have shown that the species had disappeared from several lakes where they formally bred and which are now occupied by fish (Stebbins and Cohen 1997; D. Martin, pers. comm., 2002). Drost and Fellers (1994) state that Yosemite toads are less vulnerable to fish predation than frogs because they breed primarily in ephemeral waters that do not support fish. The palatability of Yosemite toad tadpoles to fish predators is unknown (Jennings and Hayes 1994), but is often assumed to be low based on the unpalatability of western toads (Drost and Fellers 1994; Kiesecker et al. 1996), to which Yosemite toads are closely related. Brook trout have been observed to prey on Yosemite toad tadpoles and to "pick at" Yosemite toad eggs, which later became infected with fungus (D. Martin, pers. comm., 2002). Brook trout have been observed to swim near, but, ignore Yosemite toad tadpoles, which gives evidence towards tadpoles being unpalatable, at least in some situations. If Yosemite toad tadpoles are unpalatable to trout, some tadpoles may still be taken by trout that have not yet learned to avoid them (R. Knapp, pers. comm., 2002). The palatability of metamorph Yosemite toads to trout is also unknown, but metamorph western toads have been observed in golden trout stomach contents (R. Knapp, pers. comm., 2002).

At a site where Yosemite toads normally breed in small meadow ponds, they have been observed to successfully switch breeding activities to stream habitat containing fish during years of low water (Phil Strand, Sierra National Forest, pers. comm., 2002). Thus, drought conditions can increase the toads' exposure to predatory fish. Also, although the number of lake breeding sites used by Yosemite toads is small relative to the number of ephemeral sites, lake sites may be especially important because they are more likely to be useable during years with low water (R. Knapp, pers. comm., 2002).

The effects of introduced fish on Yosemite toads needs further study, especially palatability experiments to determine the level of predation. Because Yosemite toads primarily breed in ephemeral waters, fish are probably less of an impact on them than on amphibians that breed primarily in perennial lakes and streams. However, the observed predation of Yosemite toad tadpoles by trout (Martin 1992; D. Martin, pers. comm., 2002) indicate that introduced fish do pose a risk to the species in some situations, which may be accentuated during drought years. Therefore, introduced fish have probably contributed to the decline of the species. As Yosemite toad populations become smaller and more fragmented, the impacts of predation may be significant.

Various diseases have been confirmed in dead Yosemite toads (Green and Kagarise Sherman 2001). Those diseases, in concert with other factors, are likely to have contributed to the decline of Yosemite toads and continue to be a risk to the species. Mass die-offs of amphibians have been attributed to: chytrid fungal infections of metamorphs and adults (Carey et al. 1999); *Saprolegnia* fungal infections of eggs (Blaustein et al. 1994); iridovirus infection of larvae, metamorphs, or adults; and bacterial infections (Carey et al. 1999). Humans, pets, livestock, packstock, vehicles, and wild animals may all act as disease vectors. Although it has not been observed in the Sierra Nevada, introduced fish may also serve as disease vectors to amphibians. Infection of both fish and amphibians by the same pathogen has been documented with viral (Mao et al. 1999) and fungal (Blaustein et al. 1994) pathogens.

Tissue samples from dead or dying adults and from healthy tadpoles were collected during a die-off of adult Yosemite toads at Tioga Pass Meadow and Saddlebag Lake and analyzed for disease (Green and Kagarise Sherman 2001). Several infections were found in the adults, including: chytridiomycosis (chytrid fungal infection), bacillary bacterial septicemia (red-leg disease), *Dermosporidium* (a fungal infection), myxozoan infection (parasitic cnidarians (relatives of jellyfish)), *Rhabdias* spp. (a parasitic roundworm) infection, and several species of trematode (parasitic flatworm) infection. However, no single infectious disease was found in more than 25 percent of individuals, and some dead toads showed no infection that would explain their death. No evidence of infection was found in tadpoles. The authors concluded that the die-off was caused by suppression of the immune system caused by an undiagnosed viral infection or chemical contamination that made the toads susceptible to the diagnosed infections. This seems likely considering the evidence suggesting environmental contaminants as a factor contributing to the decline of Yosemite toads (see Factor E).

Carey (1993) developed a model to explain the disappearance of boreal toads (*Bufo boreas boreas*) in the Rocky Mountains. In that model, she hypothesized that the toads were stressed by some unknown environmental factor. This stress caused a physiological response that suppressed the immune system, which was further hindered by cold temperatures typical of the toads' high-elevation environment. The toads then died of infection by pathogens normally found in their environment. This model may fit Yosemite toad die-offs, given the close relationship between the two toads and their occupation of similar habitats.

Saprolegnia ferax is a species of water mold that commonly infects fish. This mold has been documented to cause massive lethal infection of eggs of western toads in Oregon (Blaustein et al. 1994). However, it is unclear whether the infection was caused by the introduction of the fungal pathogen via fish stocking, or if the fungus was already present and the eggs' ability to resist infection was inhibited by some unknown environmental factor. Subsequent laboratory experiments (Kiesecker et al. 2001) showed that the fungus could be passed from hatchery fish to western toads. Fungal growth on Yosemite toad eggs was observed by Kagarise Sherman (1980), but the fungal species was not determined, and it was unclear whether the fungus killed the eggs or grew on them after they died of some other cause.

D. The inadequacy of existing regulatory mechanisms.

The Yosemite toad occurs on Federal, State, and private lands. Existing regulatory mechanisms do not fully protect this species or its habitat on these lands. Federal, State, and local laws have been insufficient to prevent past and ongoing losses of the limited habitat of the Yosemite toad.

Under section 404 of the Clean Water Act (CWA), the U.S. Army Corps of Engineers (Corps) regulates the discharge of fill material into waters of the United States, including wetlands. However, 99 percent of the Yosemite toad's range is on Federal land, so few projects that include fill of wetlands are likely in these areas. Therefore, section 404 of the CWA is not likely to be relevant to the Yosemite toad in most cases.

Yosemite toads may not be taken or possessed within a National Park without a special permit from the NPS. In addition, cattle grazing, stocking of invasive fish, and most timber harvest are prohibited within National Park boundaries (NPS 2001). However, Yosemite toads have continued to decline within the National Parks in which the species occurs. This may be, in part, due to the Parks allowing such activities as packstock grazing and recreation in Yosemite toad habitat, as well as chemical contamination of the species and its habitat from sources outside the Parks.

The Wilderness Act of 1964 calls for designated wilderness land "to be protected and managed so as to preserve its natural conditions." Timber harvest and the use of motor vehicles are generally prohibited within wilderness areas, but cattle grazing and invasive fish stocking are permitted within National Forest wilderness lands and pose a threat to the species and its habitat. The species has declined sharply (Jennings and Hayes 1994) regardless of wilderness designation in large portions of its range.

The Yosemite toad is considered a sensitive species by the USFS. Each National Forest was required to complete a Land and Resource Management Plan (LRMP) by the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended by the National Forest Management Act of 1976 (NFMA). Those acts require that the LRMPs provide for multiple use and sustained yield of the products and services obtained from the National Forests, including wildlife. The Sierra Nevada Forest Plan Amendment (Amendment) (USDA 2001d) amends the LRMPs of National Forests within the Sierra Nevada to address issues pertaining to: old forest ecosystems and associated species; aquatic, riparian, and meadow ecosystems and associated species; fire and fuels; noxious weeds; and lower westside hardwood ecosystems. The Amendment calls for the preparation of a conservation assessment, activity-related standards and guidelines, and conservation measures by the USFS to protect Yosemite toads and their habitat occurring in National Forests within the Sierra Nevada.

Under the Amendment to the LRMPs of National Forests within the Sierra Nevada, (USDA 2001f), the USFS is to provide the following conservation measures for Yosemite toads under: (A) Exclude livestock (including pack and saddle stock) from standing water and saturated soils in wet meadows and associated streams and springs occupied by Yosemite toads, or identified as “essential habitat” in the conservation assessment for the Yosemite toad during the breeding and rearing season (as determined locally). If physical exclusion of livestock, such as fencing, is impractical, then exclude grazing from the entire meadow until the meadow has been dry for 2 weeks. Wet meadows are defined as relatively open meadows with low to moderate amounts of woody vegetation that have standing water and saturated soils after the first of June; if these conditions do not persist in the meadow for more than 2 weeks, allow grazing only in those portions of the meadow where dry conditions exist; (B) Monitor a sample of occupied Yosemite toad sites to assess: (1) habitat conditions, and (2) Yosemite toad occupancy and population dynamics. Based on the monitoring data, modify or suspend grazing if Yosemite toad conservation is not being accomplished. These grazing restrictions may be modified through formal adaptive management studies, developed in cooperation with the USFS’s Pacific Southwest Research Station, designed to assess the effects of grazing intensity and frequency on Yosemite toad habitat conditions and site occupancy; and (C) Conduct surveys of unoccupied suitable habitat for the Yosemite toad within this species’ historic range to determine presence of Yosemite toads. Complete surveys of these areas within 3 years of January 2001. If surveys are not completed within the 3-year period, consider unsurveyed meadows as occupied habitat and apply restrictions for excluding livestock described in (A).

Conservation measures also include direction to avoid application of pesticides within 152 m (500 ft) of known Yosemite toad sites, and the removal of invasive fish from some areas of mountain yellow-legged frog habitat, which could benefit Yosemite toads if they are also using those areas (USDA 2001d). The conservation measures also set limits for grazing utilization of grasses and shrubs, livestock use and road construction in willow flycatcher (*Empidonax trailii*) habitat (which includes areas that may also be inhabited by Yosemite toads), packstock use of Yosemite toad habitat during the breeding and rearing season, and disturbance of streambanks and lakeshores. The conservation measures also recommend removing livestock gathering and handling facilities from riparian and meadow areas and providing off-stream watering devices for livestock. The Amendment also includes requirements for monitoring to review how well the objectives established by the Amendment have been met, and how closely management standards and guidelines have been applied (USDA 2001e).

The USFS has been implementing these conservation measures since 2001, but they have not yet been fully implemented. The Amendment is currently being reviewed, and it remains unknown if these measures will be changed or if any additional protection of theYosemite toad will be included. Therefore, the Amendment has not yet provided sufficient protection for the Yosemite toad and its habitat, and it is not known if it will in the future. Also, the effect of the LRMPs in place on National Forests within the Sierra Nevada is unknown. Yosemite toads have continued to decline (Jennings and Hayes 1994).

The State of California considers the Yosemite toad a species of special concern, but it is not State-listed as threatened or endangered under the California Endangered Species Act. California Sport Fishing Regulations include the Yosemite toad as a protected species that may not be taken or possessed at any time except under special permit from the CDFG. This gives the Yosemite toad some legal protection from collecting, but does not protect it from other causes of mortality or alterations to its habitat.

The California Environmental Quality Act (CEQA) requires review of any project that is undertaken, funded, or permitted by a State or local governmental agency. If a project with potential impacts on Yosemite toad were reviewed, CDFG personnel could determine that, although not listed, the toad is a de facto endangered, threatened, or rare species under section 15380 of CEQA. Once significant effects are identified, the lead agency has the option of requiring mitigation for effects through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA Sec. 21002). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of listed endangered species or their habitat. Protection of listed species through CEQA is, therefore, dependent upon the discretion of the agency involved.

The California Forest Practice rules set guidelines for the design of timber harvests on private land to reduce impacts on non-listed species. However, these rules have little application to the protection of Yosemite toad because approximately 99 percent of the species' range is on Federal land.

The California Department of Pesticide Regulation has authority to restrict the use of pesticides. Their Toxic Air Contaminant (TAC) Program includes assessment of the risks posed by airborne pesticides by collecting air samples near sites of pesticide application and in communities near those sites. If air samples indicate that reductions in exposure are needed, mitigation measures are developed to bring about those reductions (California Department of Pesticide Regulation 2001). However, the TAC program is intended primarily to protect human health, and air samples are not taken at far distant locations from application sites, like those inhabited by Yosemite toads.

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

Yosemite toads probably are exposed to a variety of pesticides and other chemicals throughout their range. Environmental contaminants could negatively affect the species by causing direct mortality; suppressing the immune system; disrupting breeding behavior, fertilization, growth or development of young; and disrupting the ability to avoid predation (Carey and Bryant 1995).

Hydrocarbon and other contamination from oil production and road runoff; the application of numerous chemicals for agricultural production; roadside maintenance; and rodent and vector control programs may all have negative effects on Yosemite toad populations. Also, the airborne transport of pesticides as a result of drift from agricultural applications, including chlorothalonil, malathion, diazinon, and chlorpyrifos, from the Central Valley of California to the Sierra Nevadas, has been documented (Aston and Seiber 1997; McConnell et al. 1998) in samples of air, rain, snow, lake water, and pine needles.

Cholinesterase is an enzyme that functions in the nervous system and is disrupted by organophosphorus pesticides, including malathion, chlorpyrifos, and diazinon (Sparling et al. 2001). Reduced cholinesterase activity and pesticide residues have been found in Pacific chorus frog larvae collected in the Sierra Nevada downwind of the Central Valley (Sparling et al. 2001). Cholinesterase activity was significantly lower in samples from the Sierra Nevada than from samples taken from coastal California, upwind of the Central Valley. No samples were taken above approximately 1,500 m (4,900 ft) elevation (Sparling et al. 2001), which barely overlaps the 1,460 to 3,630 m (4,790 to 11,910 ft) elevational range (Stebbins 1985) of Yosemite toads. However, significant amounts of pesticide residues have been documented as high as 1,920 m (6,300 ft) in Sequoia National Park, south of Yosemite and Kings Canyon National Parks (Aston and Seiber 1997; McConnell et al. 1998). In addition to interfering with nerve function, contaminants may act as estrogen mimics (Jennings 1996), or may otherwise disrupt endocrine function (Carey and Bryant 1995), and may have a negative effect on amphibian populations.

Dichlorodiphenyltrichloroethane (DDT) and its residues were found in frogs throughout the Sierra Nevada during the late 1960s (Corey et al. 1970), and those residues still appear in Pacific chorus frog larvae collected in the late 1990s (Sparling et al. 2001), over 25 years after DDT was banned for use in the United States.

Spatial analysis of populations of Yosemite toads shows a trend towards greater decline in populations downwind of areas of the Central Valley with more agriculture, where there is presumably more pesticide use; however this trend is not statistically significant (Carlos Davidson, California State University, Sacramento, in litt., 2002).

Snow core samples from the Sierra Nevada contain a variety of contaminants from industrial and automotive sources including: hydrogen ions (indicative of acidic precipitation), nitrogen and sulfur compounds (NH_4, NO_3, SO_2, and SO_4), and heavy metals (Pb, Fe, Mn, Cu, and Cd) (Laird et al.1986). The pattern of recent frog extinctions in the southern Sierra Nevada corresponds with the pattern of highest concentration of air pollutants from automotive exhaust, possibly due to increases in nitrification (or other changes), caused by those pollutants (Jennings 1996).

The effect of contaminants on amphibians needs further research (Hall and Henry 1992), and there are few, if any, studies on the direct effect of contaminants on Yosemite toads. However, we know of one study which shows that there are significant levels of contaminants that have been deposited in the Sierra Nevada, and the correlative evidence between areas of contamination in the Sierra Nevadas and areas of amphibian decline (Jennings 1996; Sparling et al. 2001; C. Davidson, in litt., 2002), and the significant evidence of an adverse physiologic effect of pesticides on Sierra Nevada amphibians in the field (Sparling et al. 2001), indicate that contaminants may be a severe risk to the Yosemite toad and may have contributed to the species' decline.

Rodent control programs probably have an adverse indirect effect on Yosemite toad populations. Control of rodents that create burrows, such as ground squirrels, could significantly reduce the number of burrows available for use by Yosemite toads that require them for hibernation. Because the burrow density required by Yosemite toads in an area is not known, the loss of burrows as a result of control programs cannot be quantified at this time. Active rodent colonies probably are needed to sustain Yosemite toads because inactive burrow systems become progressively unsuitable over time. Loredo et al. (1996) found that burrow systems collapsed within 18 months following abandonment by, or loss of, the ground squirrels. Rodent control programs must be analyzed and implemented carefully in Yosemite toad habitat so the persistence of the species is not threatened. Much of the species' range is occupied by livestock (primarily cattle). Most livestock owners seek to eliminate rodent burrows because of the threat of cows breaking their legs if they accidentally step into a burrow.

The last century has included some of the most variable climate reversals, at both the annual (extremes and high frequency of El Nino and La Nina events) and near decadal scales (periods of 5- to 8-year drought and wet periods) that has been documented (USDA 2001b). These events may have negative effects on Yosemite toads. Severe winters (El Nino) would force longer hibernation times, and could stress the toads by reducing the time available for them to feed and breed. Severe winters may also depress reproductive effort. Morton (1981) theorized that fluctuations in energy storage from year to year might explain why many female Yosemite toads do not breed on a yearly basis. Alternately, during mild winters (La Nina), precipitation is reduced. This reduction in precipitation could lead to stranding and death of Yosemite toad eggs and tadpoles, a major documented source of mortality (Zeiner et al. 1988; Kagarise Sherman and Morton 1993; Jennings and Hayes 1994), or to increased exposure to predatory fish.

Changes in climate that occur faster than the ability of endangered species to adapt could cause local extinctions [U.S. Environmental Protection Agency (EPA) 1989]. Analysis of the Antarctic Vostok ice core has shown that over the past 160,000 years, temperatures have varied with the concentrations of greenhouse gasses such as carbon dioxide and methane (Harte 1996). Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30 percent, methane concentrations have more than doubled, and nitrous oxide (another greenhouse gas) levels have risen approximately 15 percent (EPA 1997). The burning of fossil fuels is the primary source of these increases (EPA 1997). Global mean surface temperatures have increased 0.3 to 0.7 Celsius (0.6-1.2 Fahrenheit) since the late 19th century (EPA 1997). Climate modeling indicates that the overall effects of global warming on California will include higher average temperatures in all seasons, higher total annual precipitation, and decreased spring and summer runoff due to decreases in snowpacks (EPA 1989, 1997). Decreases in spring and summer runoff could lead to the loss of breeding habitat for Yosemite toads and an increase in stranding mortality of eggs and tadpoles.

Changes in temperature may also affect virulence of pathogens to a different degree than the immune systems of amphibians (Carey et al. 1999), and may make Yosemite toads more susceptible to disease. An experimental increase in stream water temperature was shown to decrease density and biomass in invertebrates (Hogg and Williams 1996). Thus global warming might have a negative impact on the Yosemite toad prey base.

Drought has contributed to the decline of Yosemite toads (Jennings and Hayes 1994), and the effects of climate change may also have contributed to that decline. These effects pose an ongoing, range-wide risk to the species.

Acid precipitation has been hypothesized as a cause of amphibian declines in the Sierra Nevada, because waters there are extremely low in acid neutralizing capacity, and therefore susceptible to changes in water chemistry due to acidic deposition (Bradford et al. 1994). Precipitation acidity in the Sierra Nevada has been documented to have significantly increased at a collection station at approximately 2,100 m (6,900 ft) elevation near Lake Tahoe (Byron et al. 1991). In addition to raising the acidity of water, acidic deposition may also cause increases in dissolved aluminum, because aluminum is more soluble at higher acidity. These increases in dissolved aluminum may be toxic to amphibians (Bradford et al. 1992). In laboratory experiments (Bradford et al. 1992; Bradford and Gordon 1992), high acidity and high aluminum concentrations did not have significant effects on survival of Yosemite toad embryos or newly hatched tadpoles. However, at pH 5.0 (pH represents acidity on a negative scale, with 7 being neutral and lower numbers being more acidic) and at high aluminum concentrations, Yosemite toad embryos hatched earlier, and the tadpoles showed a reduction in body size. In a complementary field study of 235 randomly selected potential amphibian breeding sites (Bradford et al. 1994), no significant difference was found in pH between sites occupied and unoccupied by Yosemite toads. These data indicate that acid precipitation is an unlikely cause of decline in Yosemite toad populations (Bradford et al. 1994). Therefore, acid deposition is considered a low risk to the species at this time, but should still be considered in conservation efforts because of the possibility of sublethal effects (Bradford et al. 1992), of its interaction with other factors, and the potential for more severe acidic deposition in the future.

Ambient ultraviolet-b (UV-B) radiation [280 to 320 nanometers (11.0 to 12.6 microinches)] has increased at north temperate latitudes in the past two decades (Adams et al. 2001). Ambient levels of UV-B were demonstrated to cause significant decreases in survival of western toad eggs in field experiments (Blaustein 1994). In a laboratory experiment (Kats et al. 2000), metamorph western toads exposed to levels of UV-B below those found in ambient sunlight showed a lower alarm response to chemical cues of injured toads than metamorphs that were completely shielded from UV-B. This indicates that ambient levels of UV-B may cause sublethal effects on toad behavior that may increase their vulnerability to predation. In a field experiment (Kiesecker and Blaustein 1995), the synergistic effects of exposure to ambient levels of UV-B radiation, and exposure to a pathogenic fungus (*Saprolegnia*), were shown to cause significantly higher mortality of western toad embryos than either factor alone.

Sadinsky et al. (1997) observed a high percentage of embryo mortality in Yosemite toads at six breeding sites in Yosemite National Park, but in a preliminary field experiment this mortality did not appear to be related to UV-B. In spatial statistical analysis of extant and extinct populations, higher elevation was shown to have a positive effect on the likelihood that populations of Yosemite toads were extant. This is counter to what would be expected if UV-B were the primary cause of decline (C. Davidson, in litt., 2002), as sites at higher elevations would be expected to receive more solar radiation due to the thinner atmosphere. The increase in UV-B at high elevations in the Sierra Nevada has not been more than 5 percent in the past several decades (Jennings 1996). These data indicate that UV-B has probably not contributed significantly to the decline of Yosemite toads and is probably currently a low risk to the species. However, as with acid precipitation, UV-B should still be considered as a risk to the species because of the potential for sublethal effects, synergistic effects with other factors, and the potential for further increases in UV-B radiation in the future.

FOR RESUBMITTED PETITIONS:

a. Is listing still warranted? _Y_

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? _Y_

c. Is a proposal to list the species as threatened or endangered in preparation? _Y_

d. If the answer to c. above is no, provide an explanation of why the action is still precluded: Since publication of the 2002 CNOR, the publication of a proposed rule to list this species has been precluded by other higher priority listing actions, and based on work scheduled we expect that will remain the case for the remainder of Fiscal Year 2004. Almost the entire national listing budget has been consumed by work on various listing actions taken to comply with court orders and court-approved settlement agreements, emergency listing, and essential litigation-related, administrative, and program management functions. We will continue to monitor the status of the Yosemite toad as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures.

LAND:

The vast majority of land within the range of the Yosemite toad is federally managed, with 919,011 ha (2,270,918 ac) (99 percent of the range) on USFS, NPS, and Bureau of Land Management lands. Much of this land is within designated wilderness. The remaining land within the species' range is a mix of State, local government, and private lands.

PRELISTING: The USFS, in cooperation with the Service, NPS, CDFG, and university and private researcher scientists, is conducting a conservation assessment for the species as prescribed in the Sierra Nevada Forest Plan Amendment.

REFERENCES:

Adams, M.J., D.E. Schindler, and R.B. Bury. 2001. Association of amphibians with attenuation of ultraviolet-b radiation in montane ponds. Oecologia. 128:519-525.

Armour, C.A., D. Duff, and W. Elmore. 1994. The effects of livestock grazing on western riparian and stream ecosystems. Fisheries 19:9-12.

Aston, L.S. and J.N. Seiber. 1997. Fate of summertime organophosphate pesticide residues in the Sierra Nevada Mountains. Journal of Environmental Quality 26:1483-1492.

Blair, W.F. 1959. Genetic compatability and species groups in U.S. toads (*Bufo*). The Texas Journal of Science 11:427-453.

Blair, W.F. 1963. Evolutionary relationships of North American toads of the genus *Bufo*: A progress report. Evolution 17:1-16.

Blair, W.F. 1964. Evidence bearing on the relationships of the *Bufo boreas* group of toads.

The Texas Journal of Science 16:181-192.

Blair, W.F. 1972. Evolution in the genus *Bufo*. University of Texas Press. Austin. Pages 93-95.

Blaustein, A.R. 1994. Amphibians in a bad light. Natural History. Pages 32-39.

Blaustein, A.R., D.G. Hokit, and R.K. O'Hara. 1994. Pathenogenic fungus contributes to amphibian losses in the pacific northwest. Biological Conservation 67:251-254.

Bradford, D.F. 1989. Allotopic distribution of native frogs and introduced fishes in high Sierra Nevada lakes of California: implications of the negative effect of fish introductions. Copeia 1989(3):775-778.

Bradford, D.F., M.S. Gordon, D.F. Johnson, and R.D. Andrews. 1994. Acidic deposition as an unlikely cause for amphibian population declines in the Sierra Nevada, California. Biological Conservation 69:155-61.

Bradford, D.F, C. Swanson, and M.S. Gordon. 1992. Effects of low pH and aluminum on two declining species of amphibians in the Sierra Nevada, California. Journal of Herpetology 26:369-377.

Bradford, D.F. and M. Gordon. 1992. Aquatic amphibians in the Sierra Nevada; current status and potential effects of acidic deposition on populations. Draft final report to California Air Resources Board. Con. No. A932-139. 85 pp. + appendices

Brattstrom, B.H. 1962. Thermal control of aggregation behavior in tadpoles. Herpetologica 18:38-46.

Byron, E., R. Axler, and C. Goldman. 1991. Increased precipitation acidity in the Central Sierra Nevada. Atmospheric Environment 25A: 271-275.

California Department of Pesticide Regulation. 2001. Regulating pesticides: the California story, a guide to pesticide regulation in California.

Camp, C.L. 1916. Description of *Bufo canorus*, a new toad from Yosemite National Park. University of California Publications in Zoology 17:59-62.

Carey, C. 1993. Hypothesis concerning the causes of the disappearance of boreal toads from the mountain of Colorado. Conservation Biology 7: 355-361.

Carey, C. and C.J. Bryant. 1995. Possible interrelationships among environmental toxicants, amphibian development, and decline of amphibian populations. Environmental Health Perspectives. 103: Supplement 4:13-17.

Carey, C., N. Cohen, and L. Rollins-Smith. 1999. Amphibian declines and immunological perspective. Developmental and Comparative Immunology. 1999:1-14.

Chan, L.M. 2001. *Bufo canorus* (Yosemite toad) larval cannibalism. Herpetological Review 32:101.

Chang, C. 1996. Ecosystem responses to fire and variations in fire regimes. In: Sierra Nevada ecosystem project, final report to Congress. University of California, Davis. Pages 1071-1099.

Corey, L.C., P. Fjeld, and W. Serax. 1970. Distibution of DDT residues in the Sierra Nevada Mountains. Pesticides Monitoring Journal 4:205-211.

Cunningham, J.D. 1963. Additional observations on the ecology of the Yosemite toad, *Bufo canorus*. Herpetologica 22:1-7.

deMaynadier, P.G. and M.L. Hunter. 2000. Road effects on amphibian movements in a forested landscape. Natural Areas Journal 20:56-65.

Drost C. and G. Fellers, 1994. Decline of frog species in the Yosemite section of the Sierra Nevada, Technical Report No. NPA/WRUC/NRTR 94-02, Cooperative National Park Resources Studies Unit. 56 pp.

Drost C. and G. Fellers. 1996. Collapse of a regional frog fauna in the Yosemite area of the California Sierra Nevada, USA. Conservation Biology 10(2):414-425.

Environmental Protection Agency. 1989. The potential effects of global climate change on the United States. Report to Congress. USEPA Office of Policy, Planning, and Evaluation. 401 pp.

Environmental Protection Agency. 1997. Climate change and California. State climate change information sheets. USEPA Office of Policy, Planning, and Evaluation. 4 pp.

Green, D.E. and C. Kagarise Sherman. 2001. Diagnostic histological findings in Yosemite toads (*Bufo canorus*) from a die-off in the 1970s. Journal of Herpetology 35:92-103.

Grinnel, J. and T.I. Storer. 1924. Animal life in Yosemite. University of California Press, Berkeley. 16 pp.

Feder, J.H. 1977. Genetic variation and biochemical systematics in western *Bufo*. MA thesis, University of California, Berkeley. 72 pp.

Hall, R.J. and P.F.P. Henry. 1992. Assessing effects of pesticides on amphibians and reptiles: status and needs. Herpetological Journal 2:65-71.

Hamilton, S.J., S.F. McDonald, M.P. Gaikowski, and K.J. Buhl. 1996. Toxicity of fire retardent chemicals to aquatic organisms: progress report. International Wildland Fire Foam Symposium, Thunderbay, Ontario. 132-144pp. Northern Prairie Wildlife Research Center Home Page. Http://www.npwrc.usgs.gov/resource/othrdata/fireweb/toxicity/toxicity.htm (Version 02MAR98).

Harte, J. 1996. Feedbacks, thresholds and synergies in global change: population as a dynamic factor. Biodiversity and Conservation 5:1069-1083.

Helms, J.A. and J.C. Tappeiner. 1996. Silviculture in the Sierra. In: Sierra Nevada ecosystem project, final report to Congress. University of California, Davis. Pages 439-476.

Hogg, I.D., and D.D. Williams. 1996. Response of stream invertebrates to a global-warming thermal regime: an ecosystem level manipulation. Ecology 77:395-408.

Ingles, L.G. 1965. Mammals of the Pacific states. Stanford University Press, Stanford. Pages 412-472.

Jennings, M.R. 1996. Status of amphibians in: Sierra Nevada ecosystem project: final report to Congress. University of California, Davis. Pages 921-944.

Jennings, M.R. and M.P. Hayes. 1994. Amphibian and reptile species of special concern in California. California Department of Fish and Game. Rancho Cordova. Pages 50-53.

Karlstrom, E.L. 1957. The use of Co_{60} as a tag for recovering amphibians in the field. Ecology 38:187-195.

Karlstrom, E.L. 1962. The toad genus *Bufo* in the Sierra Nevada of California: ecological and systematic relationships. University of California Publications in Zoology 62:1-104.

Karlstrom, E.L. and R.L. Livezey. 1955. The eggs and larvae of the Yosemite toad *Bufo canorus* Camp. Pages 221-227.

Kagarise Sherman, C. 1980. A comparison of the natural history and mating system of two anurans: Yosemite toads (*Bufo canorus*) and black toads (*Bufo exsul*). PhD dissertation, University of Michigan. 394 pp.

Kagarise Sherman, C. and M.L. Morton. 1984. The toad that stays on its toes. Natural History 93:72-78.

Kagarise Sherman, C. and M.L. Morton. 1993. Population declines of Yosemite toads in the eastern Sierra Nevada of California. Journal of Herpetology 27:186-198.

Kats, L.B., J.M. Kiesecker, D.P. Chivers, and A.R. Blaustein. 2000. Effects of UV-B radiation on anti-predator behavior in three species of amphibians. Ethology 106:921-931.

Kattelmann, R. and M. Embury. 1996. Riparian Areas and Wetlands. In: Sierra Nevada ecosystem project, final report to congress. University of California, Davis. 66 pp.

Kiesecker, J.M. and A.R. Blaustein. 1995. Synergism between UV-B radiation and a pathogen magnifies embryo mortality in nature. Proceedings of the National Academy of Science 92:11049-11052.

Kiesecker, J.M., A.R. Blaustein, and C.L. Miller. 2001. Transfer of a pathogen from fish to amphibians. Conservation Biology 15:1064-1070.

Kiesecker, J.M., D.P. Chivers, and A.R. Blaustein. 1996. The use of chemical cues in predator recognition by western toad tadpoles. Animal Behavior 52:1237-1245.

Kondolph, G.M., R. Kattelmann, M. Embury, and D.C. Erman. 1996. Status of riparian habitat. In: Sierra Nevada ecosystem project, final report to Congress. University of California, Davis. Pages 1009-1030.

Knapp, R.A. and K.R. Matthews. 2000. Nonnative fish introductions and the decline of the mountain yellow-legged frog from within protected areas. Conservation Biology. 14:428-438.

Laird, L.B., H.E. Taylor, and V.C. Kennedy. 1986. Snow chemistry of the Cascade-Sierra Nevada Mountains. Environmental Science and Technology 20:275-290.

Lehtinen, R.M., S.M. Galatowitsch, and J.R. Tester. 1999. Consequences of habitat loss and fragmentation for wetland amphibian assemblages. Wetlands 19:1-12.

Loredo, I., D. Van Vuren, and M.L. Morrison. 1996. Habitat use and migration behavior of the California tiger salamander. Journal of Herpetology 30(2): 282-285.

Mao,J., D.E. Green, G. Fellers, and V.G. Chinchar. 1999. Molecular charachterization of iridoviruses isolated from sympatric amphibians and fish. Virus Research 63:45-52.

Martin, D.L. 1991. Captive husbandry as a technique to conserve a species of special concern, the Yosemite toad. Proceedings of the Northern California Herpetological Society=s conference on captive propagation and husbandry of reptiles and amphibians. 32 pp.

Martin, D.L. 1992. Sierra Nevada anuran survey: an investigation of amphibian population abundance in the national forests of the Sierra Nevada of California. Report to U.S. Forest Service. Canorus Ltd., Sacramento. 76 pp.

Matthews, K.R., K.L. Pope, H.K. Preisler, and R.K. Knapp. 2001. Effects of nonnative trout on Pacific treefrogs (*Hyla regilla*) in the Sierra Nevada. Copeia 2001:1130-1137.

McConnell, L.L., J.S. LeNoir, S. Datta and J.N. Seiber. 1998. Wet deposition of current-use pesticides in the Sierra Nevada mountain range, California, USA. Environmental Toxicology and Chemistry 10:1908-1916.

Menke, J.W, C. Davis, and P. Beesley. 1996. Rangeland assessment. In: Sierra Nevada ecosystem project, final report to Congress. University of California, Davis. 56 pp.

Morton, M.L. 1981. Seasonal changes in total body lipid and liver weight in the Yosemite toad. Copeia 1981:234-238.

Morton, M.L. and K.N. Sokolski. 1978. Sympatry in *Bufo boreas* and *Bufo canorus* and evidence of natural hybridization. Bulletin of the Southern California Academy of Science 77:52-55.

Mulder, B.S., B.B. Schultz, and P.W. Sherman. 1978. Predation on vertebrates by Clark's Nutcrackers. Condor 80:49-451.

Mullally, D.P. 1953. Observations on the ecology of the toad *Bufo canorus*. Copeia 1953:182-183.

Mullaly, D.P. 1956. The relationships of the Yosemite and western toads. Herpetologica. 12:133-135.

Mullaly, D.P. and J.D. Cunningham. 1956. Aspects of the thermal ecology of the Yosemite toad. Herpetologica. 12:57-67.

Myers, G.S. 1942. The black toad of Deep Springs Valley, Inyo County, California. Occasional Papers of the Museum of Zoology, University of Michigan 460:1-19.

National Park Service. 2001. Development zone tree hazard reduction, Grant Grove area, Kings Canyon National Park. Environmental Assessment. Project SEKI EMC 01-09. 62 pp.

National Park Service. 2002. Draft Yosemite Fire Management Plan. Environmental Impact Statement. Chapter 3. 1 pp.

Overton, C.K, G.L. Chandler, and J.A. Pisano. 1994. Northern/Intermountain regions' fish habitat inventory: grazed, rested, and ungrazed reference stream reaches, Silver King Creek, California. USDA Forest Service, General technical Report INT-GTR-311. 30 pp.

Russel, K.R., D.H. Van Lear, and D.C. Guynn. 1999. Prescribed fire effects on herpetofauna: review and management implications. Wildlife Society Bulletin 27:374-384.

Sadinsky, W.J., M.J. Soule, G.M. Fellers, and J.E. Cleaver. 1997. Research update on a study funded in part by a seed grant from the declining amphibian population task force. 8 pp.

Savage, J.M. 1958. A preliminary biosystematic analysis of toads of the *Bufo boreas* group in Nevada and California. Year Book of the American Philosophical Society 1959:251-254.

Shaffer, H.B., G.M. Fellers, A. Magee, and R. Voss. 2000. The genetics of amphibian declines: population substructure and molecular differentiation in the Yosemite toad, *Bufo canorus*, (Anura, Bufonidae) based on single strand conformation polymorphism analysis (SSCP) and mitochondrial DNA sequence data. Molecular Ecology 9:245-257.

Sparling, D.W, G.M. Fellers, and L.L. McConnell. 2001. Pesticides and amphibian population declines in California, USA. Environmental Toxicology and Chemistry 20:1591-1595.

State of California. 2001. Department of Finance, Interim County Population Projections.

Sacramento, California. 8 pp.

Stebbins, R.C. 1951. Amphibians of western North America. University of California Press, Berkeley. Pages 225-248.

Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin. Boston. Pages 71-72.

Stebbins, R.C. and N.W. Cohen. 1997. A natural history of amphibians. Princeton University Press, Princeton. Pages 66, 94-95, 213-215.

Stephens, M.R. 2001. Phylogeography of the *Bufo boreas* (Anura, Bufonidae) species complex and the biogeography of California. MS Thesis, Sonoma State University. 62 pp.

Tihen, J.A. 1962a. A review of new world fossil bufonids. The American Midland Naturalist 67:157-183.

Tihen, J.A. 1962b. Osteological observations on new world *Bufo*. The American Midland Naturalist 67:157-183.

University of California. 1996. People and resource use. In: Sierra Nevada ecosystem project, final report to Congress. University of California, Davis.

USDA. 2001a. Sierra Nevada Forest Plan Amendment, Final Environmental Impact Statement. Volume 2, Chapter 3, Part 3.4, pp. 221. USDA Forest Service.

USDA. 2001b. Sierra Nevada Forest Plan Amendment, Final Environmental Impact Statement. Volume 2, Chapter 3, Part 2, pp. 33. USDA Forest Service.

USDA. 2001c. Sierra Nevada Forest Plan Amendment, Final Environmental Impact Statement. Volume 2, Chapter 3, Part 2, pp. 35. USDA Forest Service.

USDA. 2001d. Sierra Nevada Forest Plan Amendment, Final Environmental Impact Statement. Volume 3, Chapter 3, Part 4.4, pp. 218-225. USDA Forest Service.

USDA. 2001e. Sierra Nevada Forest Plan Amendment, Final Environmental Impact Statement. Volume 4, Appendix E, pp. 1. USDA Forest Service.

USDA. 2001f. Sierra Nevada Forest Plan Amendment, Final Environmental Impact Statement. Record o f Decision. USDA Forest Service.

USDA. 2001g. Sierra Nevada Forest Plan Amendment, Final Environmental Impact Statement. Volume 2, Chapter 3, Part 5.6, pp. 474. USDA Forest Service.

USDA. 2001h. Sierra Nevada Forest Plan Amendment, Final Environmental Impact Statement. Volume 2, Chapter 3, Part 5.5, pp 445. USDA Forest Service.

Zeiner, D.C., W.F. Laudenslayer, and K.E. Meyer (eds.). 1988. California's wildlife. Volume

I. Amphibians and reptiles. California Statewide Wildlife Habitat Relations System, California Department of Fish and Game, Sacramento. 2 pp.

LISTING PRIORITY (* after number)

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11*
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: The magnitude of threats to the Yosemite toad was determined to be moderate. Yosemite toads face multiple ongoing threats that cause direct mortality and degradation of habitat, and the species has declined accordingly. All studies for which baseline data are available show that Yosemite toads have disappeared from over 45 percent of sites where they were historically documented and that remaining populations have declined. The only long-term study of a population of Yosemite toads shows that the population crashed in 1979 and has not recovered. Scientific studies have shown that factors such as livestock grazing can cause direct mortality of Yosemite toads and negatively affect their habitat. Airborne contaminants are also likely contributing to their decline. Some evidence indicates that non-native trout may also have negative impacts on the species. The magnitude of threats was determined to be moderate, rather than high, because almost all of the species' range occurs on Federal land, which protects the species from private development and facilitates management of the species by Federal agencies.

Imminence: The imminence of threats to the Yosemite toad was determined to be non-imminent. Threats are ongoing, but no major imminent change in threats is expected.

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes to the candidate list, including listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all additions of species to the candidate list, removal of candidates, and listing priority changes.

Approve: Steve Thompson ______________________ March 6, 2003 ___
Acting Regional Director, Fish and Wildlife Service Date

Concur: Steve Williams ________________ April 5, 2004 ________________________
Director, Fish and Wildlife Service Date

Do not concur:________________________________
Director, Fish and Wildlife Service Date

Director's Remarks: ____

____

____

Date of annual review: February 2003
Conducted by:__________________

Comments: ____

____

____