African Clawed Frog (*Xenopus laevis*)

Ecological Risk Screening Summary

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1 Native Range and Status in the United States

Native Range

From Somma (2016):

"*Xenopus laevis*, as currently defined, is indigenous to much of southern and sub-Saharan Africa including Namibia, South Africa, Swaziland, Lesotho, Botswana, Zambia, Mozambique, Zimbabwe, Malawi, Democratic Republic of the Congo, and probably Angola (Poynton 1999,

Channing 2001, Measey and Channing 2003). It is unclear if populations of *Xenopus* in African countries further to the northeast and northwest of this range are actually conspecific and more research is required to delineate this species' full indigenous range (Measey and Channing 2003), although Channing and Howell (2006) exclude them from East Africa."

Status in the United States

From Somma (2016):

"**Nonindigenous Occurrences:** **Arizona**: *Xenopus laevis* were intentionally introduced into man-made ponds in Arthur Park Golf Course, Tucson, Pima County, Arizona, in the 1960s (Tinsley and McCoid, 1996). Other *X. laevis* were released into man-made bodies of water in southern Arizona by the same individual (Tinsley and McCoid, 1996). D. Swann (personal communication 1997) also has observed *X. laevis* in golf course ponds in Tucson."

"**California**: In California, *X. laevis* were first collected from several localities in Orange County (Westminster, East Garden Grove-Winterburg Channel, Slater Lake, Fountain Valley [Ocean View Channel and an associated lake], and Greenfield-Banning Channel southeast of the Santa Ana River) in the late 1960s through the early 1970s (Lenaker, 1972; St. Amant and Hoover, 1973; Bury and Luckenbach, 1976; Tinsley and McCoid, 1996). Additional specimens were collected in Irvine, Orange County, in 1989 (Tinsley and McCoid, 1996). Since it was first introduced to California, *X. laevis* has been found in the following counties: San Bernardino County (Prado Basin, Chino Hills State Park) (Stebbins, 2003; B. Goodman in Crayon 2005; Stebbins and McGinnis, 2012), San Diego County (Sweetwater [west Mt. Helix area], San Diego, Otay, Rancho Jamul, and Tijuana Rivers, Tecolote and Dulzura Creeks, and Spring Valley) (Bury and Luckenbach, 1976; Stebbins, 1985, 2003; Tinsley and McCoid, 1996; Kuperman et al., 2004; Stebbins and McGinnis, 2012; output from California Academy of Sciences), Santa Barbara County (Goleta Slough) (Stebbins, 2003; S. Sweet in Crayon, 2005; Stebbins and McGinnis, 2012), Los Angeles County (Santa Clara River, Munz Lake, Palmdale, Upper Rio Hondo, Compton Creek, Vasquez Rocks County Park, Edwards Air Force Base [Piute Ponds], and ponds and streams in Soledad, Agua Dulce and Placerita Canyons) (Bury and Luckenbach, 1976; Stebbins, 1985, 2003; Tinsley and McCoid, 1996; Stebbins and McGinnis, 2012; output from California Academy of Sciences), Riverside County (Arroyo Seco Creek and surrounding ponds, Santa Margarita River drainage, Santa Ana River, Vail Lake, and Riverside city) (McCoid and Fritts, 1980, 1989; Stebbins, 1985, 2003; Tinsley and McCoid, 1996; Kuperman et al., 2004), Imperial County (irrigation canals) (Stebbins, 1985; Stebbins and McGinnis, 2012), Kern County (Edwards Air Force Base) (Stebbins, 2003; Stebbins and McGinnis, 2012), San Francisco County (Lily Pond in Golden Gate Park, San Francisco) (E. Mills in Lagos, 2004), Ventura County (Santa Clara River and estuary, and Vern Freeman Diversion at Saticoy) (Lafferty and Page, 1997; output from California Academy of Sciences), and Yolo County (University of California Davis campus) (Tinsley and McCoid, 1996; Stebbins, 2003; Stebbins and McGinnis, 2012)."

"**Colorado:** In June 1990, a single *X. laevis* was found under a submerged log in a relic beaver pond associated with the North Fork of the Snake River, Summit County, Colorado (Bacchus et al., 1993; Tinsley and McCoid, 1996; Livo et al., 1998). The water was partially frozen and slushy (Bacchus et al., 1993)."

"**Florida:** In 1964, about 200 African Clawed Frogs were released into Hialeah (Red Road) Canal, Hialeah, Mimi-Dade County, Florida, by an animal importer (King and Krakauer, 1966). An additional Florida record includes a single *X. laevis* found near Tampa, Hillsborough County, with no date of collection or voucher recorded (Tinsley and McCoid, 1996), although S. Godley (personal communication 2014), M. McCoid (personal communication 2014), and R. McDiarmid (personal communication 2014) state the specimen was collected sometime during the mid-1970s and give the locality as Riverview, which is in the Tampa Bay area. This specimen has since been lost (R. McDiarmid, personal communication 2014; H. Mushinsky, personal communication 2014). In December 2013 and January 2014 two more *X. laevis* (UF-Herpetology 172054-55) were collected in Riverview, and a third from the same location on 10 June 2014 (UF-Herpetology 173050). On 27 June 2010 at 1430 h, an adult *X. laevis* was collected and vouchered (UF 158477, MorphoBank M88444) while dip-netting in a retention pond on Knox McRae Drive, 0.08 km east of Sussana Lane, Titusville, Brevard County, Florida (Krysko et al., 2011; Dodd, 2013). On 9 August 2014, an adult *X. laevis* (UF-Herpetology 173224 [FWC 47425]) was collected at 19251 SW 318 Terrace, Homestead, Miami-Dade County."

"**Massachusetts:** Newly transformed *X. laevis* were collected from a small pond at the Acton Arboretum, Acton, Middlesex County, Massachusetts, in 1993 (Cardoza et al., 1993)."

"**North Carolina:** A population of *X. laevis* existed in fish hatchery ponds at an unknown locality in North Carolina during an unspecified period of time (Tinsley and McCoid, 1996). This is probably the same population cited by McCoid (in McCoid and Kleberg, 1995)."

"**Virginia:** A nonindigenous population of *X. laevis* was first observed in an artificial pond in a nature preserve (unnamed) in Virginia, "south of Washington, D.C.," in 1982 and sampled by R. Tinsley in 1987 (Tinsley and McCoid, 1996). Afterwards, local conservation personnel systematically collected hundreds of adults and juveniles (Tinsley and McCoid, 1996). Ernst et al. (1997) mention 30 recently transformed *X. laevis* collected from a pond at the Gulf Branch Nature Center, Arlington, Arlington County, between 15 May and 30 June 1984 (C. Ernst, personal communication 1997). These probably represent the same population mentioned by Tinsley and McCoid (1996)."

"**Wisconsin:** In 1972, a "large number" of late-stage larval *X. laevis* were collected from an artificial pond in Greenfield Park, Milwaukee, Milwaukee County, Wisconsin (Tinsley and McCoid, 1996)."

"**Other U.S. western states:** African Clawed Frogs are "rumored" to occur in Nevada, New Mexico, Utah, and Wyoming (Smith and Kohler, 1978). Perhaps these are the other unnamed states vaguely alluded to by Tinsley and McCoid (1996). *Xenopus laevis* has been collected from an undisclosed locality in Texas (Dixon, 2013)."

"**Status: Massachusetts:** The status of *X. laevis* at first remained unclear in Massachusetts, as the collection of newly transformed frogs (Cardoza et al., 1993) suggested that a breeding population could have spread; however, they are not established at this time (Kraus, 2009).

"**Virginia:** Large numbers of *X. laevis* were removed from the artificial pond in Virginia through 1987 up to 1988; this may have eliminated them from this immediate vicinity (Tinsley and McCoid, 1996). They are not established (Ernst et al., 1997; Kraus, 2009)."

"**North Carolina:** *Xenopus laevis* was eliminated from the fish hatchery ponds in North Carolina by draining the ponds (Tinsley and McCoid, 1996; Kraus, 2009)."

"**Florida:** Dodd (2013) speculates the individual *X. laevis* from Brevard County could be indicative of a population, and more recent collections (December 2013-January 2014) indicate African Clawed Frogs are established in Riverview, near Tampa, Hillsborough County. These Riverview frogs are from a population inhabiting a surrounding complex of aquaculture ponds (many abandoned) and could have been established since the 1970s. It is not known if African Clawed Frogs are currently established in Miami-Dade County."

"**Wisconsin:** No further *X. laevis* were collected from the artificial pond in Milwaukee, Wisconsin, in subsequent years after 1972, indicating they are not established (Tinsley and McCoid, 1996; Kraus, 2009)."

"**Colorado:** Further collecting at the nonindigenous site in Summit County, Colorado, in June 1991 revealed no more African clawed frogs (Bacchus et al., 1993); thus, they are not established (Kraus, 2009)."

"**Arizona:** The only established population of *X. laevis* in Arizona is in the golf course ponds in Tucson, Pima County (Stebbins, 1985, 2003; Tinsley and McCoid, 1996; D. Swann, personal communication 1997; Crayon, 2005; Brennan and Holycross, 2006; Kraus, 2008, 2009, 2012; Elliott et al., 2009; Measey et al., 2012; Powell et al., 2012; Dodd, 2013). It is probably this population that caused Howland (1996) to consider them established but not widespread in Arizona. African Clawed Frogs are unlikely to spread from the Tucson area, due to the surrounding desert habitat (Brennan and Holycross, 2006)."

"**California:** African Clawed Frogs are well established in California (Stebbins, 1985, 2003; Laudenslayer et al., 1991; McCoid and Fritts, 1993; McCoid and Kleberg, 1995; Tinsley and McCoid, 1996; Lemm, 2006; Kraus, 2008, 2009, 2012; Elliott et al., 2009; Measey et al., 2012; Powell et al., 2012; Dodd, 2013). Those populations of *X. laevis* in Orange, San Bernardino, San Diego, Los Angeles, Santa Barbara, Riverside, Imperial, Kern, and Ventura Counties are clearly established and invasive (Lenaker, 1972; St. Amant and Hoover, 1973; Bury and Luckenbach, 1976; McCoid and Fritts, 1980, 1989, 1993; Stebbins, 1985, 2003; Tinsley and McCoid, 1996; Lafferty and Page, 1997; Kuperman et al., 2004; Crayon, 2005; Measey et al., 2012; Stebbins and McGinnis, 2012; Dodd, 2013). The population of *X. laevis* at the University of California Davis campus, Davis, Yolo County, was successfully eradicated through poisoning by the California Department of Fish and Game, and as of 1992 was no longer present (Tinsley and McCoid, 1996; Stebbins, 2003; Measey et al., 2012; Stebbins and McGinnis, 2012). Efforts to eradicate *X. laevis* in Golden Gate Park, San Francisco (Lagos, 2004) appear successful as of 2011 (Measey et al., 2012). In southern California, *X. laevis* will continue to spread, assisted by the presence of numerous irrigation canals and ditches that are seasonally or anthropogenically flooded with water."

"**Other U.S. western states:** The rumors of *X. laevis* existing in Nevada, New Mexico, Utah, and Wyoming have never been verified (Smith and Kohler, 1978). Although collected in Texas, they are not established (Dixon, 2013)."

"The possession or importation of *X. laevis* is prohibited or regulated in the states of Arizona, California, Hawaii, Nevada, Oregon, Washington, Utah, Louisiana, Kentucky, Virginia, North Carlolina, and New Jersey (Levell, 1997; Stebbins, 2003; Lemm, 2006; Elliott et al., 2009; Stebbins and McGinnis, 2012)."

Means of Introductions into the United States

From Somma (2016):

"In most cases of nonindigenous occurrences the exact means of introduction is not clearly known. However, *X. laevis* has long been used in laboratory research, for studies in genetics, physiology, biochemistry, developmental biology, human pregnancy diagnosis (Shapiro and Zwarenstein, 1934; Deuchar, 1975; Thompson and Franks, 1978, 1979; Stebbins, 1985, 2003; Tinsley and McCoid, 1996; Fouquet, 2001; Reed, 2005; Anonymous, 2007; Evans et al., 2008; Elliott et al., 2009; Kraus, 2009; Stebbins and McGinnis, 2012; Dodd, 2013), and it became established in many laboratory aquaria throughout the world during the 1950s and 1960s (Tinsley and McCoid, 1996; Stebbins and McGinnis, 2012; Dodd, 2013; Vredenburg et al., 2013). Earliest reports of established nonindigenous populations of *X. laevis* worldwide are coincident with the end of their use in human pregnancy diagnosis (Tinsley and McCoid, 1996; Measey et al., 2012). […] Moreover, *X. laevis* are popular aquarium pets, known for being nondemanding, unusual pets (von Filek, 1973; Alderton, 1986; Bartlett, 1989; Tinsley and McCoid, 1996; Davies and Davies, 1997; Elliott et al., 2009; Dodd, 2013). Because these frogs live relatively long lives […] they are often simply dumped into nearby waters due to loss of interest, the end of an experiment, or misguided ethics (Tinsley and McCoid, 1996). The release of 200 African clawed frogs into a canal in Miami-Dade County, Florida, was simply due to an animal importer carelessly dumping unwanted stock (King and Krakauer, 1966). The *X. laevis* collected in Brevard County, Florida, was likely an escaped or released pet (Krysko et al., 2011). The release of *X. laevis* into the Tucson area and nearby areas of southern Arizona was intentionally caused by a single individual (Tinsley and McCoid, 1996) – simple curiosity?"

Remarks

From Somma (2016):

"Stebbins (1985) and Frost (2000) discussed the possibility that nonindigenous *X. laevis* may represent a composite of different undescribed species; thus, the actual identity of frogs in the United States may be unclear. However, Kobel et al. (1996), in listing the six tentatively identified subspecies of *X. laevis* in Africa, suggest that several could be full species. Since all reports of nonindigenous and aquarium-raised *X. laevis* are typically of the nominate subspecies, *X. laevis laevis* from the Cape region of South Africa (Tinsley and McCoid, 1996), the question of species identity is rendered moot if *X. l. laevis* is treated with full specific status, and the origin of captive populations continues to be the Cape of South Africa (Measey and Channing, 2003)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2016):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Tetrapoda
Class Amphibia
Order Anura
Family Pipidae
Genus *Xenopus*
Species *Xenopus laevis*"

"Taxonomic Status: valid"

Size, Weight, and Age Range

From Somma (2016):

"SVL (snout-vent length) of 50-over 140 mm (2-over 5 in)."

"The hardy adults live up to 12 years, with a record of over 30 years (McCoid and Fritts, 1989; Tinsley and McCoid, 1996; Channing, 2001; Tinsley et al., 2012)."

Environment

From Somma (2016):

"Xenopus laevis is a primarily aquatic, highly adaptable frog that can inhabit almost any body of water, natural or man-made, and tolerates sewage and relatively saline (up to 14%; or 40% seawater) waters (Passmore and Carruthers, 1995; Tinsley et al., 1996; Lafferty and Page, 1997; Channing, 2001; Elliott et al., 2009; Dodd, 2013)."

From CABI (2016):

"It reaches its highest densities in eutrophic water. It breeds in water; there are no records of it breeding in flowing water."

"*X. laevis* exhibit high salt tolerance (40% seawater), pH (5-9) […] variation […]"

Climate/Range

From Somma (2014):

"They can survive fairly cold, temperate climates […]"

From CABI (2016):

"*X. laevis* exhibit high […] tolerance [of] temperature variation (2-35+)."

Distribution Outside the United States

Native

From Somma (2016):

"*Xenopus laevis*, as currently defined, is indigenous to much of southern and sub-Saharan Africa including Namibia, South Africa, Swaziland, Lesotho, Botswana, Zambia, Mozambique, Zimbabwe, Malawi, Democratic Republic of the Congo, and probably Angola (Poynton 1999, Channing 2001, Measey and Channing 2003). It is unclear if populations of *Xenopus* in African countries further to the northeast and northwest of this range are actually conspecific and more research is required to delineate this species' full indigenous range (Measey and Channing 2003), although Channing and Howell (2006) exclude them from East Africa."

Introduced

From Somma (2016):

"**Mexico:** Nonindigenous *X. laevis* have spread into Baja California, Mexico, through the Tijuana River and intersecting irrigation canals from California (Murphy, 1983; Tinsley and McCoid, 1996; Peralta-García et al., 2014)."

"**Chile:** Nonindigenous African clawed frogs were first reported in Chile in 1985 (Tinsley and McCoid, 1996), although their original introduction may have taken place as early as 1973 (Jaksic, 1998). Additional specimens were captured on land with Sherman traps, in the Santiago area, in 2001 (Lobos and Garín, 2002). *Xenopus laevis* has since spread into IV Region (Limari River Basin), VI Region, and throughout Metropolitan Region, and V Region (Lobos and Jaksic, 2005)."

"**Atlantic:** Nonindigenous *X. laevis* were collected from Ascension Island in the southern Atlantic, in 1944 and 1958, near the summit of Green Mountain (Loveridge, 1959). Additional *X. laevis* were observed in a mountaintop pond (probably from the same aforementioned population) in the early 1980s (Tinsley and McCoid, 1996)."

"**Europe:** *Xenopus laevis* specimens have been collected in the Hamburg area, Germany, and Gorichem and Utrecht, the Netherlands (Tinsley and McCoid, 1996; Rabitsch et al., 2013), France, Italy (Sicily) (Fouquet, 2001; Lillo et al., 2005; Eggert and Fouquet, 2006; Fouquet and Measey, 2006; Faraone et al., 2008; Kraus, 2009; Measey et al., 2012), Sweden, Portugal, and Spain (Rebelo et al., 2010; Mateo et al., 2011; Measey et al., 2012). Additional *X. laevis* were

released in Germany by animal rights activists in the 1990s. In the United Kingdom, populations of *X. laevis* have been found on the Isle of Wight, southern Wales, London, Kent (East Sussex border), Humberside (Scunthorpe), and various southwestern waterways in England (Arnold, 1995; Tinsley and McCoid, 1996; Arnold and Ovenden, 2002; Measey et al., 2012; Tinsley et al., 2012)."

"**Japan:** African Clawed Frogs have been collected from various localities in Japan (Kraus, 2009; Measey et al., 2012)."

"**Israel:** A single individual was recorded in Emek Hefer, Israel, in 1996 (Measey et al., 2012)."

"**Status:** […] **Mexico:** *Xenopus laevis* was considered established in Baja California, Mexico (Murphy, 1983; Flores-Villela, 1993; Smith and Smith, 1993; Mahrdt et al., 2003; Stebbins, 2003; Kraus, 2009). Although these populations need to be monitored to determine their current status (Measey et al., 2012), another established population in Baja California has been verified (Peralta-García et al., 2014)."

"**Other worldwide localities:** African Clawed Frogs are established in the United Kingdom but might be extirpated on Ascension Island (Arnold, 1995; Tinsley and McCoid, 1996; Measey, 1998a, 2001; Measey and Tinsley, 1998; Arnold and Ovenden, 2002; Kraus, 2009; Measey et al., 2012; Tinsley et al., 2011a, 2011b, 2012), and in Chile they are an established, highly invasive species (Tinsley and McCoid, 1996; Jaksic, 1998; Lobos and Garín, 2002; Lobos and Measey, 2002; Lobos and Jaksic, 2005; Kraus, 2009; Measey et al., 2012). The status of *X. laevis* in Germany, Sweden, the Netherlands, and Israel remains unknown (Tinsley and McCoid, 1996; Kraus, 2009; Measey et al., 2012; Rabitsch et al., 2013). African Clawed Frogs were eradicated from Spain (Measey et al., 2012). This pipid is established in France, Italy (Sicily), Portugal, and Japan (Fouquet, 2001; Lillo et al., 2005, 2011, 2013; Eggert and Fouquet, 2006; Fouquet and Measey, 2006; Faraone et al., 2008; Kraus, 2009; Rebelo et al., 2010; Measey et al., 2012)."

Means of Introduction Outside the United States

From CABI (2016):

"*Xenopus laevis* (the African clawed frog) is the standard experimental amphibian used in laboratories pan-globally. Escapees have formed viable and invasive populations in many climates […]"

From Somma (2016):

"Loveridge (1959) claims that the established nonindigenous population of *X. laevis* on Ascension Island, in the southern Atlantic, was caused by the use of this species in diagnostic testing on that island during the World War II years. Lillo et al. (2013) demonstrated that *X. laevis* in Sicily were probably derived from laboratory animals of South African stock."

From NIES (2016):

"Deliberate: as pet, and as biological research material"

Short Description

From Somma (2016):

"*Xenopus laevis* is a dorsoventrally flattened frog with a relatively small […] (Passmore and Carruthers, 1995; Kobel et al., 1996; Channing, 2001; Stebbins, 2003; Elliott et al., 2009; Stebbins and McGinnis, 2012). The small, lidless eyes are located dorsally and turned upward (Stebbins, 2003; Stebbins and McGinnis, 2012). There is no visible tympanum (Channing, 2001; Dodd, 2013). The forefeet have slender, unwebbed fingers (Channing, 2001; Stebbins, 2003; Stebbins and McGinnis, 2012; Dodd, 2013), which are generally held pointed in a forward direction. In mature adults, the hindfeet are large, fully webbed, and have sharp black claws on the three innermost toes (Channing, 2001; Stebbins, 2003; Powell et al., 2012; Stebbins and McGinnis, 2012; Dodd, 2013), hence the comman [*sic*] name African Clawed Frog. These frogs have no tongue (Stebbins, 2003), and a minute tentacle is located beneath each eye (Passmore and Carruthers, 1995; Channing, 2001; Stebbins, 2003). The skin is very smooth except where the lateral line sensory system gives it a "stitched" appearance (Stebbins, 2003; Stebbins and McGinnis, 2012; Dodd, 2013). The dorsal coloration of *X. laevis* is olive to brown, often with blotches, spots, or mottling (Passmore and Carruthers, 1995; Kobel et al., 1996; Channing, 2001; Stebbins, 2003; Stebbins and McGinnis, 2012; Dodd, 2013). It does not hold its legs beneath itself to raise its body above the substrate when on land. No other frog in North America looks like this representative from the family Pipidae."

Biology

From Somma (2016):

"In Africa and Chile, *X. laevis* often migrates over land in swarms containing hundreds or thousands of individuals (Tinsley et al., 1996; Channing, 2001; Lobos and Jaksic, 2005). Some of these mass migrations are stimulated by droughts (Tinsley et al., 1996; Tinsley and McCoid, 1996; Channing, 2001; Lobos and Jaksic, 2005; Dodd, 2013). Nocturnal overland excursions may be quite common (Tinsley et al., 1996; Lobos and Garín, 2002). In Chile, it is spreading at a rate of 3.1-3.9 km/year through both overland migration and the use of irrigation canals in agricultural areas (Lobos and Jaksic, 2005). African Clawed Frogs can survive droughts by burrowing into the substrate (Tinsley et al., 1996; Channing, 2001; Dodd, 2013). Their unique sliding pelvis apparatus allows them to avoid predators by diving backwards from the water surface (Videler and Jorna, 1985). Moreover, powerful toxins in the skin can deter some predators (McCoid and Fritts, 1993; Tinsley et al., 1996; Channing, 2001). These carnivores mostly consume aquatic invertebrates, but also include small vertebrates, including other *X. laevis*, in their diet (McCoid and Fritts, 1980, 1993; Tinsley et al., 1996; Lafferty and Page, 1997; Measey, 1998a; Channing, 2001; Crayon, 2005; Lobos and Jaksic, 2005; Dodd, 2013). Additionally, it is capable of capturing terrestrial prey (Measey, 1998b). *Xenopus laevis* can survive starvation conditions for at least 12 months and can rapidly regain lost weight when food is once again available (Tinsley et al., 1996). […] African Clawed Frogs are highly fecund and mate underwater; the amplectant male fertilizing thousands of eggs as the female oviposits (von Filek, 1973; McCoid and Fritts, 1993; Channing, 2001; Crayon, 2005; Brennan and Holycross, 2006; Lemm, 2006; Stebbins and McGinnis, 2012; Dodd, 2013). Mating may be stimulated by a sudden increase in water or nutrient levels, including sewage outflows (Tinsley et al., 1996;

Channing, 2001). The tadpoles feed on planktonic organisms while suspended upside-down in the water and can occur in such numbers that they can almost sterilize the immediate waters (Channing, 2001; Stebbins, 2003; Lemm, 2006; Stebbins and McGinnis, 2012)."

From CABI (2016):

"Gravid females are recorded as containing from 1,000 to 27,000 eggs, with larger females producing larger clutches. They will produce multiple clutches in a season under favourable conditions."

"African clawed frogs (*Xenopus laevis*) are noted for being principally aquatic throughout their lives. Sexual maturity within one year is possible. Eggs are laid singly. Tadpoles typically take 3 months to metamorphosis."

Human Uses

From CABI (2016):

"Laboratory use
Pet/aquarium trade"

Diseases

From Somma (2014):

"Clawed Frogs also carry a rather diverse parasite load (Prudhoe and Bray, 1982; Tinsley, 1996; Lafferty and Page, 1997; Crayon, 2005; Tinsley et al., 2011a, 2011b, 2012; Dodd, 2013) and individuals from nonindigenous populations in California harbor a variety of parasites (Kuperman et al., 2004); however, there are no studies to verify if these parasites pose a direct threat to nonindigenous ecosystems. Moreover, they are asymptomatic carriers of the virulent amphibian fungus *Batrachochytrium dendrobatidis* (chytrid) and may be responsible for infecting indigenous amphibians in California and other localities worldwide (Kraus, 2009; Stebbins and McGinnis, 2012; Vredenburg et al., 2013)."

From Robert et al. (2011):

"Ranaviruses like frog virus 3 (FV3) are responsible for emerging infectious diseases spreading worldwide to fish, amphibian and reptilian species. […] In our study, we took advantage of an experimental system in which healthy *Xenopus* adults or larvae are co-housed in an aquarium with an infected immunocompromised adult congener that releases FV3 into the water. With this system we have been able to show that FV3 released by the infected animals can disseminate within 3 h by the water route into other animals."

Infection with *Batrachochytrium dendrobatidis* (chytridiomycosis) and infection with a ranavirus are OIE-reportable.

Threat to Humans

From Somma (2016):

"In many parts of its indigenous and nonindigenous range, *X. laevis* is regarded a pest (Rundquist, 1978; Channing, 2001). In South Africa, mass migrations lead to large numbers of clawed frogs invading houses and clogging up irrigation pipes (Tinsley et al., 1996). Migrating individuals in Africa also invade fish farms, consuming both fish and fish food, and are difficult to keep out (McCoid and Fritts, 1993; Channing, 2001)."

3 Impacts of Introductions

From Somma (2014):

"In Riverside and San Diego Counties, California, *X. laevis* consumes native invertebrates, the eggs, tadpoles, and adults of native frogs, and the nonindigenous Western Mosquito Fish, *Gambusia affinis* (McCoid and Fritts, 1980; Stebbins, 2003). Nonindigenous *X. laevis* inhabiting the Santa Clara River estuary in Ventura County, California, includes the endangered Tidewater Goby, *Eucyclogobius newberryi*, in its diet (Lafferty and Page, 1997; Stebbins and McGinnis, 2012; Dodd, 2013). Additional native Californian vertebrates consumed by *X. laevis* include Western Toads (*Anaxyrus boreas*), Arroyo Chubs (*Gila orcutti*), and locally endangered Three-spined Stickleback (*Gasterosteus aculeatus*) (Stebbins, 2003; Stebbins and McGinnis, 2012; Dodd, 2013). In Sicily, Italy, *X. laevis* has caused population and, perhaps, recruitment declines in many indigenous amphibian species (Lillo et al., 2011). It in turn is prey for indigenous Two-striped Garter Snakes, *Thamnophis hammondii*, fish, and the nonindigenous Bullfrog, *Lithobates catesbeianus* (Lafferty and Page, 1997)."

From Lillo et al. (2011):

"A large population of *X. laevis* occurs in Sicily and our main aim of this work was to assess the consequences of introduction of this alien species on local amphibian populations. In this study we compare the occurrence of reproduction of native amphibians in ponds with and without *X. laevis*, and before and after the alien colonization. The results of our study shows that, when *X. laevis* establishes a conspicuous population in a pond system, the populations of *Discoglossus pictus*, *Hyla intermedia* and *Pelophylax* synklepton *esculentus* show clear signs of distress and the occurrence of reproduction of these native amphibians collapses. In contrast, the populations of *Bufo bufo* do not appear to be affected by the alien species."

From Soto-Azat et al. (2016):

"We collected *X. laevis* and dead native amphibians in Chile between 2011 and 2013. We conducted post-mortem examinations and molecular tests for Ranavirus and Bd [*Batrachochytrium dendrobatidis*]. Eight of 187 individuals (4.3 %) tested positive for Ranavirus: seven *X. laevis* and a giant Chilean frog (*Calyptocephallela gayi*). All positive cases were from the original area of *X. laevis* invasion. Bd was found to be more prevalent (14.4 %) and widespread than Ranavirus, and all *X. laevis* Bd-positive animals presented low to moderate levels of infection. Sequencing of a partial Ranavirus gene revealed 100 % sequence identity

with Frog Virus 3. This is the first report of Ranavirus in Chile, and these preliminary results are consistent with a role for *X. laevis* as an infection reservoir for both Ranavirus and Bd."

From Lafferty and Page (1997):

"We investigated whether the introduced African clawed frog (*Xenopus laevis*) eats endangered tidewater gobies (*Eucyclogobius newberry*) where they coexist in the Santa Clara River estuary. […] Dissections of four clawed frogs in 1995 revealed only notonectids (order Hemiptera) in the stomachs. In 1996, three of six frogs had full stomachs. All three contained 1-3 tidewater gobies (representing two-thirds of the contents by count). Also eaten were an arroyo chub, a mosquitofish, an amphipod, and a beetle […] At 54 mm, the arroyo chub consumed was as long as (and sufficiently larger than) a full size tidewater goby. This suggests that tidewater gobies do not have a refuge in size from predation by clawed frogs. Although the abundance of clawed frogs is difficult to assess, they were the only type of frog seen and were relatively common in traps. If clawed frogs persist in abundance, they may be a substantial cause of mortality for tidewater gobies at this site."

From NIES (2016):

"Potentially: predation or competition to native freshwater animals.
Actually: In Shizuoka Pref., predation on juveniles of aquafarming carp occurred.
Native organism(s) affected: Native amphibians, fishes, freshwater invertebrates, and juveniles of aquafarming fishes."

From Schramm (1987):

"Predation by African clawed frogs *Xenopus laevis* threatened fry and fingerlings of common carp *Cyprinus carpio* and Chinese silver carp *Hypophthalmichthys molitrix* in nursery ponds in Transkei, Southern Africa. Competition for food (phytoplankton) between *Xenopus* tadpoles and silver carp appeared to affect the growth of the fish. However, the potential competition between *Xenopus* adults and common carp for benthic prey was not realized."

Despite the numerous above citations indicating impacts, at least one study did not observe negative impacts on native anuran populations.

From Tinsley et al. (2015):

"The most conclusive indication of failure of *Bd* [*Batrachochytrium dendrobatidis*] to establish in native populations [in the U.K.] comes from habitats where local amphibians co-occurred with *X. laevis* known to carry chytrid infection. Sites in both Wales (Croescwtta) and Lincolnshire (the reclamation site) provide this test. In our overall sample of 174 native amphibians, no *Bd* was recorded in the subset of 55 individuals from those localities where co-occurrence was recorded and exposure to cross-infection over many years would have been most intense. These data from our 4 year study must still be interpreted cautiously, constrained by sample size, the sensitivity of swab testing, and the finding that individuals of some susceptible species may carry fluctuating low-level infection (Briggs et al., 2010). However, concerns that introduced *X. laevis*

might have long-term population consequences for native amphibians are not substantiated for the two study areas. If significant negative effects had occurred then these should have been evident after exposure to *Bd* during several decades (up to half a century for the population in Wales). Solis et al. (2010) recorded *Bd* in introduced *X. laevis* in Chile and, whilst emphasising the need for greater monitoring, observed that no declines of native anurans had been noted in areas of co-occurrence after almost 40 years."

4 Global Distribution

Figure 1. Known global distribution of *Xenopus laevis*. Map from GBIF (2016). Because of current disagreement over species delineation in the genus *Xenopus*, locations on the African continent north of Mozambique, Zambia, and the Democratic Republic of Congo were not included as source locations for the climate matching analysis (see Native Range and Remarks, above). Other locations were excluded from climate matching because they did not represent established populations, including those in Massachusetts, Virginia, Wisconsin, Colorado, and Spain.

5 Distribution Within the United States

Figure 2. Known U.S. distribution of *Xenopus laevis*. Map from Somma (2016). Locations in Wisconsin, Massachusetts, Virginia, North Carolina, and Colorado do not represent established populations and were excluded from climate matching.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was high through much of the states of Florida, Texas, New Mexico, Arizona, and California. Medium matches occurred in coastal areas of the South, coastal New England, the Central Plains, around Puget Sound in Washington, and in scattered locations throughout the remainder of the West. Low matches occurred along the Appalachian Mountains, in the North-Central region, in the coastal Pacific Northwest, and in the Mississippi Delta region. Climate 6 score indicated a high climate match overall. Scores above 0.103 signify a high match; Climate 6 score for *Xenopus laevis* in the contiguous U.S. was 0.218. This climate matching analysis was somewhat conservative in that it excluded from the source locations regions of East Africa which may or may not be part of the native range of *X. laevis*.

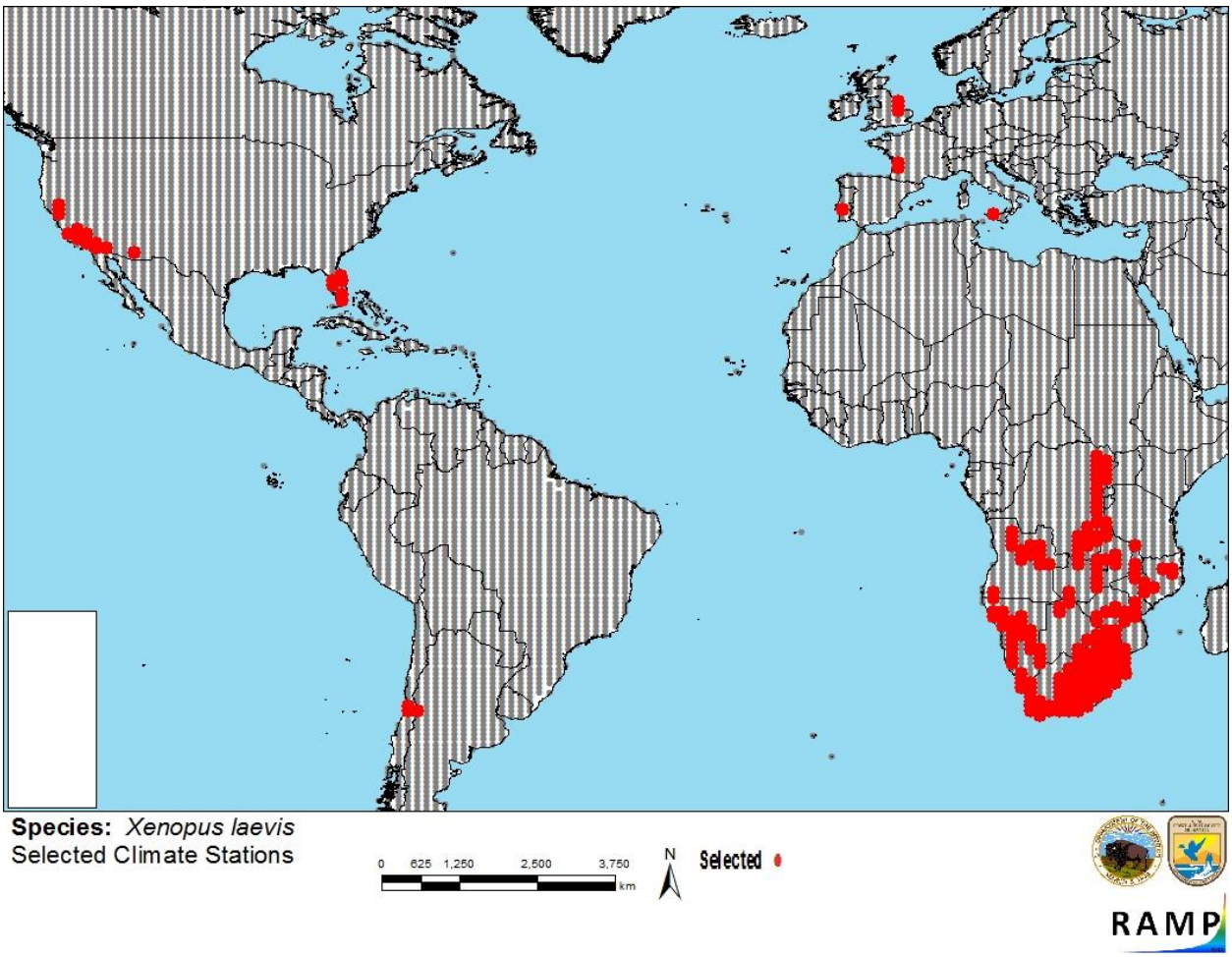

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Xenopus laevis* climate matching. Source locations from GBIF (2016) and Somma (2016).

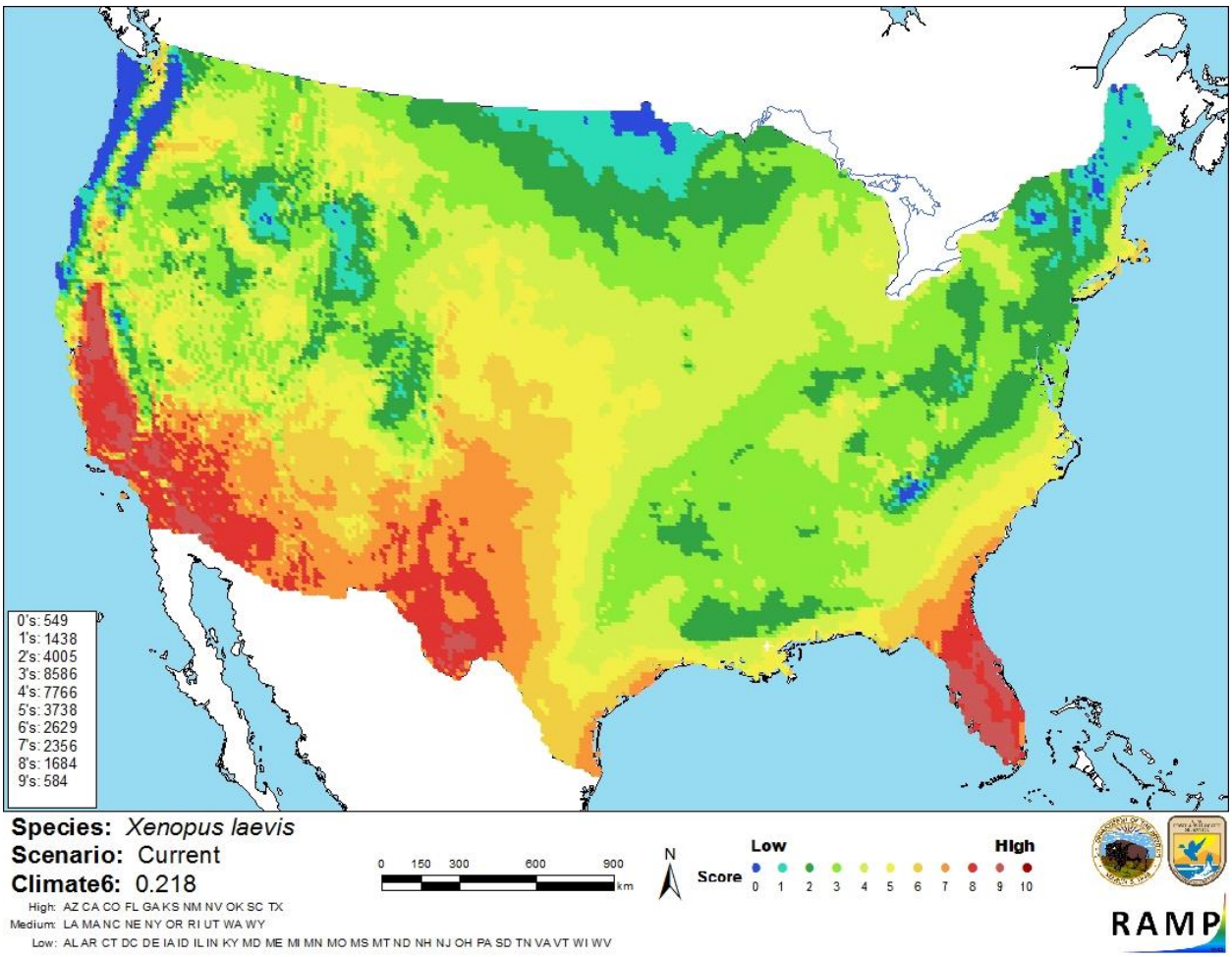

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Xenopus laevis* in the contiguous United States based on source locations reported by GBIF (2016) and Somma (2016). 0=Lowest match, 10=Highest match. Climate match scores are tabulated on the left.

The "High", "Medium", and "Low" climate match categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

7 Certainty of Assessment

Information on the biology, invasion history and impacts of this species is substantial, including considerable peer-reviewed literature. There is enough information available to describe the risks posed by this species. Some taxonomic uncertainty exists for this species, although the nonindigenous *X. laevis* thus far appear to belong to a single subspecies, the nominate subspecies *X. l. laevis*. Certainty of this assessment is medium.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Xenopus laevis is a large frog species native to sub-Saharan Africa that has become established in the Americas, Europe, and Asia. The species has been used globally as a laboratory research specimen and is also found in the pet trade. As an introduced species, it has been shown to suppress reproduction in native amphibians in Italy, to consume an endangered fish species in the U.S., and transmit disease to native amphibians in Chile. *X. laevis* is also a pest in carp aquaculture. The species shows a high climate match to the contiguous U.S. Overall risk posed by *X. laevis* is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Medium**
- **Overall Risk Assessment Category: High**

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