Canapés to EXTINCTION

THE INTERNATIONAL TRADE IN FROGS' LEGS AND ITS ECOLOGICAL IMPACT

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CANAPÉS TO EXTINCTION:
The International Trade in Frogs' Legs and Its Ecological Impact

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Indian bullfrog

Executive Summary

In some regions of India, frogs are called "jumping chickens," as their taste is similar to chicken. Their palatability to humans is why billions of frogs are consumed annually. In many countries in Asia, Africa, and Latin America frogs are collected for subsistence or local consumption. Some of these same countries are engaged in the commercial trade of frogs and frog products—including frogs' legs—supplying markets in the European Union (EU) and the United States of America (USA), where native frog populations have been seriously depleted (Mohneke 2011, Lannoo et al. 1994). While frog farming plays an increasing role in meeting the global demand for frogs' legs, in several countries millions of frogs are still taken from the wild to satisfy international demand. The exploitation of wild frogs to sustain this trade mainly focuses on larger-bodied species of the family Ranidae, such as the Asian brackish frog (*Fejervarya cancrivora*) and giant Javan frog (*Limnonectes macrodon*, formerly *Rana macrodon*). Some experts warn that even for common, fast-growing and fecund amphibian species, present levels of exploitation may be far from sustainable (Mohneke 2011, Bickford *pers. comm.* 2010, Lau *et al.* 2008).

Within the last 20 years, Indonesia has become the world's leading exporter of frogs' legs, followed by China, Taiwan

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skinned frogs

and Vietnam. Prior to this, India and Bangladesh had been the main suppliers to the international export market—that is, until their frog populations collapsed, resulting in the loss of a major natural control agent for agricultural pests and mosquitoes (Oza 1990, Abdulali 1985). As a consequence of this unsustainable exploitation, in 1985, two of the most sought after species in the frogs' legs trade—the green pond frog (*Euphlyctis hexadactylus*, formerly *Rana hexadactyla*) and the Indian bullfrog (*Hoplobatrachus tigerinus*, formerly *Rana tigrina*)—were listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). India banned export of frogs' legs in 1987 and Bangladesh followed in 1989. The CITES listing and subsequent export bans helped local populations of these two species recover from over-exploitation. Today the International Union for the Conservation of Nature (IUCN) describes populations of both species as stable *(see 2010 IUCN Red List)*.

However, the international demand for frogs and their parts and products continues to exist. Now that Indonesia has assumed the role of leading supplier of frogs' legs to the world market, it is feared that this country will suffer or may already be suffering a negative ecological impact similar to that of India and Bangladesh.

The unsustainable trade in frogs and their parts/products led Germany in 1992 to propose listing of 16 Asian frog species[1] in CITES Appendix II. The effort failed (CITES 1992, CoP8 Prop 57-72). Since then, the frogs' legs trade—though still enormous—has been neglected by CITES. Considering recent scientific publications that reemphasize the alarming volume and serious ecological consequences of the amphibian trade, including the trade in frogs and frogs' legs (Warkentin *et al.* 2009, Gratwicke *et al.* 2009, Lau *et al.* 2008), comprehensive national and international conservation measures are urgently needed.

While the frogs' legs trade poses a serious threat to wild populations, farming is not an ecologically responsible alternative due to the potential for farmed frogs to spread deadly diseases such as the chytridiomycosis fungus, ranaviruses, and Salmonella bacteria to other farmed stocks and wild populations (Gratwicke *et al.* 2009, Schloegel *et al.* 2009). The amphibian trade has been identified as a major contributor to the worldwide spread of *Batrachochytrium dendrobatidis* (Kriger & Hero 2009, Schloegel *et al.* 2009, Fisher & Garner 2007). Furthermore, farming of non-native species may cause serious ecological problems if those species are released or escape and become invasive, as has been documented for several frog species that have been farmed for food. For example, the American bullfrog (*Lithobates catesbeianus*, formerly *Rana catesbeiana*) is singled out in the "100 of the World's Worst Invasive Alien Species" list published by the IUCN Species Survival Commission's Invasive Species Specialist Group (Orchard 2009). Other frog species are also known to be a risk as invasive species and in the transmission of diseases *(see Section 5, Table 4)*.

The present report gives an overview of recent developments, trends, and the impacts of the frogs' legs trade since the 1980s. The role of the EU and the USA as the main consumer markets is documented. During the last decade the EU imported an annual mean volume of 4,600 tonnes of frogs' legs. With 84% of total imports, Indonesia is by far the leading supplier for the EU market (with the vast majority of those frogs being wild-caught). Belgium, France and the Netherlands are the main importers within the EU *(see Section 3.1)*. In recent years, the USA has been annually importing on average 2,280 tonnes of frogs' legs of the species *Rana* spp. Almost the same volume of live frogs (2,216 tonnes)—mainly American bullfrogs—is imported by the USA to supply the Asian-American market *(see Section 3.2)*.

The report recommends measures exporting and importing countries should take to reduce the extreme burden on wild frog populations as well as avoid other ecosystem risks within both range states and importing countries.

[1]Arfak Mountains frog (*Hylarana arfaki*, CoP8 Prop. 57), giant Asian river frog (*Limnonectes blythii*, CoP8 Prop. 58), Asian brackish frog (*Fejervarya cancrivora*, CoP8 Prop. 59), Jerdon`s bullfrog (*Hoplobatrachus crassus*, CoP8 Prop. 60), Indian skipper frog (*Euphlyctis cyanophlyctis*, CoP8 Prop. 61), Amboina wart frog (*Limnonectes grunniens*, CoP8 Prop. 62), rough-backed river frog (*Limnonectes ibanorum*, CoP8 Prop. 63), greater swamp frog (*Limnonectes ingeri*, CoP8 Prop. 64), large-headed frog (*Limnonectes kuhlii*, CoP8 Prop. 65), common pond frog (*Fejervarya limnocharis*, CoP8 Prop. 66), giant Javan frog (*Limnonectes macrodon*, CoP8 Prop. 67), giant Philippine frog (*Limnonectes magnus*, CoP8 Prop. 68), peat-swamp frog (*Limnonectes malesianus*, CoP8 Prop. 69), Moluccas wart frog (*Limnonectes modestus*, CoP8 Prop. 70), masked swamp frog (*Limnonectes paramacrodon*, CoP8 Prop. 71), and East Asian bullfrog (*Hoplobatrachus rugulosus*, CoP8 Prop. 72)

1. Introduction

Frogs and tadpoles have a central role in ecosystems as predators and prey. They also play a key role in balancing or stabilizing aquatic environments. As prey, frogs contribute to the diet of many species. An absence of frogs in an ecosystem may boost the presence of agricultural pests and mosquitoes (Abdulali 1985) given their important role as predators. Furthermore, tadpoles are able to consume bacteria and algae, thereby acting as antagonists to the eutrophication of water bodies (Mohneke 2011).

Amphibians are especially susceptible to changes in their natural environment brought on, for example, by pollution and climate change—which can lead to increased ultraviolet (UV) radiation and temperature, and changes in humidity (Bickford *et al.* 2010, Pounds *et al*. 2006, Semlitsch 2003). Frogs' highly permeable skin means they can rapidly absorb toxic substances. Such substances, including pesticides, may have a hormone-disruptive effect (Khan & Law 2005).

According to the IUCN Amphibian Assessment (2008), amphibians belong to the most threatened taxa of wildlife. The IUCN Red List classifies one-third of the 6,000 described amphibian species as threatened and 42% of amphibian species as declining. For another 25% of amphibian species, data are insufficient to determine their threat status. While habitat loss and pollution are the leading threats—affecting two-thirds of all amphibian species—fires, invasive species, diseases, and utilization are also relevant factors for hundreds of frog species (IUCN Amphibian Assessment 2008).

Large-bodied frogs are under additional pressure by the national and international demand for their meat. In some cultures—notably Asian, Greek and Roman—frog meat has been considered a delicacy for centuries (Teixeira *et al.* 2001). However, in recent times consumption of frogs and frog products has increased to levels that are not sustainable. The combination of increasing human population, rising purchasing power, and expanding destruction and degradation of suitable habitat has had fatal consequences for many wild frog populations. Only a decade ago, almost 95% of the world's demand for frogs' legs was supplied by wild-caught specimens (Teixeira *et al.* 2001). Since then, despite increased production of frogs in captive farming operations, a significant portion of frogs' legs in trade still come from the wild (Mohneke 2011, Lau *et al.* 2008, Kusrini 2005).

The trade in frogs' legs is undertaken to satisfy local, national and international demand. The trade is ubiquitous in many regions of the world including Latin America *(see Section 2.3)*, Asia *(see Sections 2.1 and 3)*, and Africa *(see Section 2.2)*. The main importing entities are the EU and USA *(see Section 3.1 and 3.2)*. More than 200 amphibian species are used as food on a subsistence level. Only about 20 species, however, are affected by international trade, including the giant Javan frog (*Limnonectes macrodon*), Asian brackish frog (*Fejervarya cancrivora*), wide mouth toad *(Calyptocephalella gayi)* and Indian bullfrogs (*Hoplobatrachus tigerinus*) (Carpenter *et al.* 2007, US LEMIS trade database 2010).

Despite a considerable increase in public awareness in the 1980s as to the ecological problems inherent to the frogs' legs trade *(see Section 4)*, such awareness has since decreased while the pressure on wild frog populations has increased. Every year, hundreds of millions of frogs, most of whom are imported, are consumed by gourmets in the EU and the USA, while the source populations in the countries of origin are collapsing. Furthermore, with the vast quantities of live frogs and frogs' legs being traded internationally, experts fear the introduction and expansion of invasive species and amphibian pathogens *(see Section 5)*. Accordingly, there is a dire need for action at the international, national, and local levels to reduce and monitor the frogs' legs trade, to strengthen laws related to this trade, to substantially improve law enforcement capacity and to educate consumers as to the consequences of their culinary choices. Politicians in both consumer and range countries are urged to take immediate steps to gain control of this trade to prevent ecological disasters in both range states and importing countries *(see Section 8)*.

frozen frogs' legs in a French supermarket

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2. Domestic Consumption in Countries of Origin

2.1 Southeast Asia

In **China**, 39 species of ranid frogs are already negatively impacted by utilization, with twelve of these species in rapid decline (Carpenter *et al.* 2007). Fortunately, in recent years the domestic demand for frogs as food has significantly changed. While frogs' legs were considered a fashionable food choice in the 1990s resulting in large-scale frog production, demand has decreased as frogs have been replaced by high value seafood. Approximately a dozen frog farms are producing American bullfrogs and other frog species, but the farms have experienced technical problems, impairing operations (Teixeira *et al.* 2001). Nevertheless, several native species, including the East Asian bullfrog (*Hoplobatrachus rugulosus*), Eurasian marsh frog (*Pelophylax ridibundus*), Chinese brown frog (*Rana chensinensis*), and Eastern golden frog (*Pelophylax plancyi*), are still exploited for local and regional consumption (Mohneke 2011).

Out of 450 anuran species in **Indonesia,** approximately 14 are exploited for human consumption. Four species dominate the trade including the Asian brackish frog, common pond frog (*Fejervarya limnocharis*), giant Javan frog, and the non-native American bullfrog, which had been introduced in 1983 to meet the demand for frogs' legs. There is no farming of native frogs in Indonesia as most frogs in trade are taken from the wild. Only the American bullfrog is farmed (Kusrini & Alford 2006). While Indonesia annually exports 28-142 million frogs, an estimated seven times as many frogs are consumed within the country (Kusrini 2005). While larger specimens (i.e., snout-vent length 100 mm and longer) are destined for export, smaller frogs are sold at local markets (Kusrini & Alford 2006, Kusrini 2005). Local consumers prefer fresh frog meat, meaning that the animals are typically offered alive at the markets. Consumers also have an aversion to the taste of the non-native and farmed American bullfrog and prefer native frogs (Kusrini & Alford 2006).

In **Malaysia**, the domestic market absorbs the entire domestic production of farmed frogs, which equates to 80 tonnes per year. A considerable portion of this is from the non-native American bullfrog (Sepangstac 2010). Additional frogs' legs are imported from Indonesia and Thailand (Teixeira *et al.* 2001).

In **Thailand**, most of the frogs are consumed locally, with only the surplus exported to neighboring countries (Hong Kong, Singapore, and Malaysia) and to Europe. Farming has become popular recently due to progress in developing feeding techniques (Teixeira *et al.* 2001).

In **Vietnam**, a variety of frog species are consumed as traditional food, including Gunther's amoy frog (*Hylarana guentheri)*, large-headed frog *(Limnonectes kuhlii)*, Asian greenback frog *(Odorrana livida)*, common pond frog, East Asian bullfrog, giant spiny frog *(Quasipaa spinosa),* and spiny frog *(Quasipaa verrucospinosa).* In urban restaurants, East Asian bullfrogs are sought after as a delicacy (Truong 2000).

2.2 Africa

In Africa, frogs are mainly used for local consumption and, to a lesser extent, for traditional medicine.

In **Cameroon,** large-sized ranid frogs, such as the endangered goliath frog (*Conraua goliath)* and Cameroon slippery frog (*Conraua robusta*), which is classified by the IUCN as Vulnerable, are heavily hunted and sold in bushmeat markets (Herrmann *et al*. 2005). Indeed, the exploitation for food is considered the major threat to those species (Amiet 2004/IUCN 2010). Also hairy frogs *(Trichobatrachus robustus)*, running frogs *(Kassina decorata)*, volcano clawed frogs *(Xenopus amieti)* and night frogs *(Astylosternus* spp.) are locally consumed in all developmental stages—from tadpoles to adult specimens. The collection of frogs for regional and international trade has started only within the last decade and is increasing according to reports of collectors (Mohneke 2011, Gonwouo & Rödel 2008).

In **Madagascar**, apart from the introduced Indian bullfrogs, many restaurants offer endemic amphibians on their menus, including the Grandidier's stream frog (*Mantidactylus grandidieri)*, warty stream frog *(Mantidactylus guttulatus),* and Goudot's bright-eyed frog *(Boophis goudotii)* (Jenkins *et al.* 2009). Jenkins *et al*. suggest that during the 20-week peak collection period a minimum of 15,000 frogs are delivered to three restaurants in Moramanga alone. Although capture season is permitted between February and May, demand from restaurants is constant and income from edible frogs is 0.32 USD per specimen (Jenkins *et al.* 2009).

In **Burkina Faso, Benin** and **Nigeria**, surveys have been conducted of the trade in frogs for human consumption. The dominant species in trade is the African tiger frog (*Hoplobatrachus occipitalis*) followed by edible bullfrog (*Pyxicephalus edulis)*, broad-banded grass frog (*Ptychadena bibroni)*, South African sharp-nosed frog *(Ptychadena oxyrhynchus)*, and Dakar grassland frog *(Ptychadena trinodis)* (Mohneke 2011). For these large-bodied species population declines have been noticed already by villagers (Mohneke 2011). In Nigeria, Muller's platanna (*Xenopus muelleri)* is also among the traded species. In Benin and Nigeria, a massive cross-border trade has been documented. In Nigeria, 32 surveyed frog collectors reported a catch of more than 2.7 million frogs a year. This trade is concentrated in northern Nigeria, which is the destination for frogs originating from Benin and Niger (Mohneke 2011). The trade in Burkina Faso is largely on a local scale with survey results reporting that villagers consumed about 6kg (=120 frogs) per household per week. Frogs are also on the menu of restaurants.

Andy McLemore

northern leopard frog

In the **Democratic Republic of Congo,** frogs for local consumption are collected from wild populations to supply restaurants. Efforts to farm the Angola river frog (*Amietia angolensis*) have been described by Mushambani (2002).

There are already indications that present exploitation levels in several African countries are unsustainable. Collection sites are increasingly distant from villages indicating that frogs in ponds and rivers near villages have been depleted (Mohneke 2011, Jenkins *et al.* 2009, Gonwouo & Rödel 2008). Despite these reductions, national, regional, or local collection regulations do not exist and data on population status are scarce. Moreover, studies to assess the ecological impact of the unsustainable exploitation of frogs from ecosystems throughout Africa are urgently needed (Jenkins *et al.* 2009).

2.3 Latin America

In **Argentina**, where frog meat is traditionally considered a healthy food, the weekly consumption in Buenos Aires alone is estimated at 2 tonnes. While cities are primarily supplied by around 20 frog farms within the country and by imports from Brazil, in rural provinces frogs may be taken from the wild (Teixeira *et al.* 2001).

Brazil is one of the leading countries for farming of the American bullfrog and there are seven frog processing plants within the country. Annual production of frog meat totals approximately 450 tonnes, which is almost entirely consumed domestically (Teixeira *et al.* 2001). What is not consumed domestically is exported to the USA *(see Section 3.2)*, Argentina, and Chile.

In **Chile**, at least one species, the Chilean helmeted bullfrog (*Calyptocephalella gayi*), is used for human consumption and for medicinal purposes at the local and international level. During the last decade, there has been overexploitation of the species in the wild for the international food trade (Días-Páez 2003, Taibo 2000). The USA has been the main importer of wild Chilean helmeted bullfrogs and the trade is for commercial purposes (as opposed to scientific, personal or educational purposes) (US LEMIS database 2010).

Cuba historically exported up to 500 tonnes of frogs a year. After 1993, the quantity of exports sharply decreased to less than 5 tonnes, as frogs became a lower priority export product compared to other foodstuffs. Initial attempts to establish frog farms have failed (Teixeira *et al.* 2001).

In **Mexico**, frogs have been eaten by ethnic groups for centuries and are still a relevant protein source for rural families. Until recently, the abundant wild stocks of northern leopard frog (*Lithobates pipiens*, formerly *Rana pipiens)* were able to sustain the considerable offtakes, but now populations suffer from the fatal combination of habitat loss and continuous exploitation (Warketin *et al.* 2009, Gardner *et al.* 2007). Accordingly, frog farming has been expanded recently. During 1973-1974, the authorities introduced 6,023 adult specimens and 247,500 froglets of American bullfrogs into the wild in several areas of Mexico. In 1980, as part of a plan to promote the species as a food source, 300 adult specimens were introduced to an aquaculture facility and in a field at the Universidad Autónoma de Aguascalientes (CONABIO 2009). By 1997, there were seven farms with an annual production of 225,000 American bullfrogs and northern leopard frogs (Teixeira *et al.* 2001). According to the US Law Enforcement Management Information System (LEMIS) database, the Forrer's grass frog (*Lithobates forreri*, formerly *Rana forreri),* northern leopard frog, and American bullfrog are the major species exported live from the wild for commercial purposes based on data from 2000-2010.

Frogs of the genus *Telmatobius* have been traditionally consumed as food and medicine in the Andean regions of **Peru** and **Bolivia**. Vendors at markets offer the frogs live to be cooked or dried and primarily used to prepare soups. The marbled water frog (*Telmatobius marmoratus)*, classified as Vulnerable by the IUCN, and the Titicaca water frog (*Telmatobius culeus)*, classified as Critically Endangered, have been identified in a market in Cusco, Peru. Although detailed data on the trade volume for these species are not available, seizures containing thousands of frogs indicate an intense trade. Considering that both species are declining according to the IUCN (2010), this level of trade is likely unsustainable. Vendors in Cusco seem not to be aware of national legislation, which bans collection and sale of threatened species, such as the Titicaca water frog (Angulo 2008).

In **Uruguay**, the American bullfrog was introduced for farming in 1987. Presently, however, most farms are closed and experts warn that this species is becoming invasive in the country, displacing native amphibians (Laufer *et al.* 2008). Wild frogs are collected for trade. Frogs' legs are mostly sold in domestic markets in Montevideo and Punta del Este, but some are occasionally exported to Argentina (Teixeira *et al.* 2001).

3. International Frogs' Legs Trade

The leading importer for frogs' legs worldwide is the EU *(see Section 3.1)*, with France, Belgium, Italy and the Netherlands being the major destinations. The second largest importer is the USA *(see Section 3.2)*, followed by Canada, and Japan (Teixeira *et al.* 2001). Switzerland also represents a considerable market *(see Section 3.3)*, further increasing the role of Europe as a main consumer region.

While Indonesia *(see Table 1)* and Vietnam *(see Table 2)* are by far the largest suppliers for wild-caught frogs, Taiwan, Ecuador, Mexico and China are the leading exporters for farmed frogs (US LEMIS database 2010).

3.1 Imports by the European Union

Frogs have been eaten in Europe for centuries, but after the Second World War demand escalated. European frog populations, particularly of the European green frog complex (*Pelophylax* spp.) were heavily exploited, especially in France (with 40-70 tonnes of frogs captured per year), followed by Belgium and the Netherlands (Mohneke 2011). In Romania, native frogs were also intensely collected, reaching an annual volume of 120 tonnes in the period 1960-1970. This resulted in local extinctions (Török 2003). After populations were heavily depleted, France banned the collection, transport and sale of native frogs in 1980 (Neveu 2004). Two years later the Berne Convention on the Conservation of European Wildlife and Natural Habitats came into effect in the EU and regulated capture of native species.

In 1992, the EU Fauna and Flora Habitat Directive was promulgated. It requires strong protection for more than 20 frog species. However, consumption of frogs' legs continues with the EU's demand now being met by imports, mainly from Asia. For those imports, EU legislation exists but only addresses health and hygiene of the imported products *(see box.)*

During the period 2000 to 2009, the EU imported a total quantity of 46,400 tonnes of frogs' legs, mainly from Asia (Eurostat 2010). If one kilogram of frogs' legs correlates to 20-50 individual frogs (Veith *et al.* 2000), the EU imports for the past decade may represent 928 million to 2.3 billion frogs.

INDONESIA EXPORTS OF WILD-CAUGHT FROGS

YEAR	US DOLLARS	WEIGHT (TONNES)
2006	16,670,286	4,388
2005	11,506,826	3,428
2004	11,162,611	3,330
2003	12,336,067	3,633
TOTAL EXPORTS		**14,779**

TABLE 1: *Indonesia's exports of frogs' legs 2003-2006: (from UN Commodity Trade Statistics Database 2010, http://comtrade.un.org/db/)*

VIETNAM EXPORTS OF WILD-CAUGHT FROGS

YEAR	US DOLLARS	WEIGHT (TONNES)
2006	2,863,010	573
2005	3,718,175	744
2004	2,356,848	471
2003	2,139,657	411
TOTAL EXPORTS		**2,199**

TABLE 2: *Vietnam's exports of frogs' legs 2003-2006: (from UN Commodity Trade Statistics Database 2010, http://comtrade.un.org/db/)*

EU legislation on frogs' leg imports

*According to **Regulation (EC) No 853/2004** only approved establishments with the required facilities, having due regard to handling and preparation, may prepare and kill frogs to ensure specific hygiene rules.*

*According to **Regulation (EC) No. 2074/2005** health certificates for shipments of chilled, frozen or prepared frogs' legs intended for human consumption are required. This certificate declares frogs' legs to have been bled, prepared, and eventually processed, packaged and stored in especially constructed and equipped facilities, fulfilling the regulatory criteria.*

3.1.1 Which EU countries are the main importers

According to Eurostat, the statistic authority of the EU, among EU countries, Belgium imported the largest amount of frogs' legs from 1999-2009 (24,696 tonnes, or 53% of total EU imports), followed by France (10,453 tonnes or 23%), the Netherlands (7,960 tonnes or 17%), Italy (2,603 tonnes or 6%) and Spain (566 tonnes or 1%) *(see Figure 1)*. Bulgaria (2 tonnes), Cyprus (0.5 tonnes), Czech Republic (14.9 tonnes), Denmark (1 tonne), Estonia (1.1 tonnes), Germany (14.5 tonnes), Greece (1.9 tonnes), Lithuania (2.2 tonnes), Malta (1.8 tonnes), Poland (2.4 tonnes), Romania (23.7 tonnes), Sweden (1.5 tonnes), Slovenia (35.3 tonnes), and United Kingdom (16.9 tonnes) imported smaller quantities.

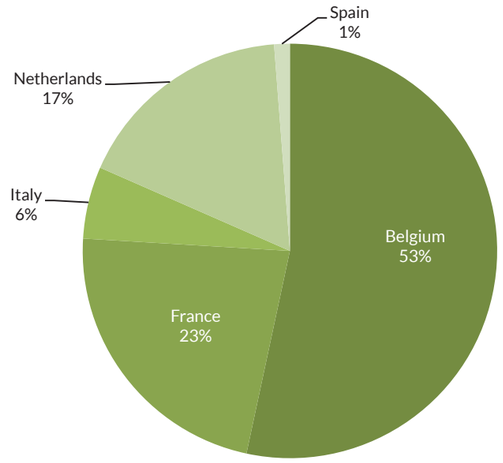

FIGURE 1
Leading importers of frogs' legs amoung EU member states for the period 1999-2009 (Eurostat 2010)

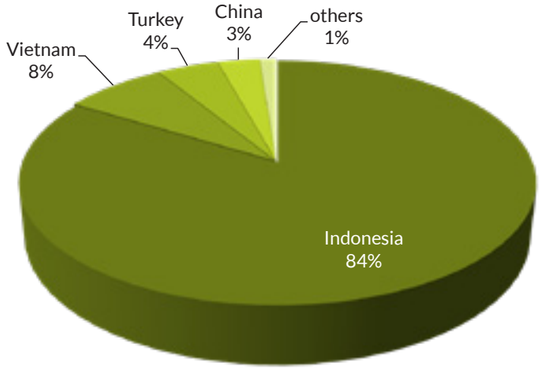

FIGURE 2
Leading suppliers of frogs' legs to the EU for the period 1999-2009 (Eurostat 2010)

Furthermore, in addition to these import data, frogs' legs are traded between the individual EU member states. For example, France re-exported 1,978 tonnes of frogs' legs from 1999-2009 with the majority destined for Belgium, while smaller amounts are shipped to the Netherlands, Italy, Luxembourg and Spain. During the same time period, Belgium re-exported 497 tonnes of frogs' legs to France, Luxembourg and Italy, while Spain re-exported 68.1 tonnes to Belgium and France (Eurostat 2010). As France is often described as the main consumer for frogs' legs, EU-internal trade, (e.g. from Belgium to France) may be under-reported.

3.1.2 Where the frogs' legs come from

Indonesia exports the largest quantity of frogs' legs to the EU. Indeed, 84% of all frogs' legs imported by the EU come from Indonesia (Eurostat 2010, Kusrini & Alford, 2006). Additional EU imports originate in Vietnam (8%), Turkey (4%), China (3%), and Albania (1%) *(see Figures 2 and 3)*.

Indonesia's frogs' legs exports to the EU increased in the 1980s when India and Bangladesh, which had historically been the main exporters of frogs' legs to the EU, imposed regulations to control their frog trade *(see also Section 4.1, Figure 11)*. Total frogs' legs exports from Indonesia have increased from less than 1,000 tonnes in the early 1970s to 5,600 tonnes in 1992, declining to around 3,300 tonnes in 2000 (Kusrini 2005, Eurostat 2010). Since 2000, EU import data again indicate a subsequent increase *(see Figure 3)*.

EU imports of frogs' legs from Vietnam—now the EU's second largest supplier—have also increased during the last decade, with imports increasing from 99 tonnes in 2000 to 569.2 tonnes in 2009. The total volume of imports since 2000 is 3,509.5 tonnes (Eurostat 2010) *(see Figure 3)*. Many Vietnamese exporters sell frogs' legs via the Internet (Alibaba 2011).

Turkey's annual production of frogs' legs has been estimated at 800-1,000 tonnes (Özogul *et al*. 2008, Tokur *et al*. 2007). Although frog farming in Turkey is increasing, Özugel *et al*. (2008) report that the protein content in farmed specimens is lower than in wild-caught frogs (50-60% versus 92% based on dry weight), resulting in a higher demand for wild-caught specimens *(see Figure 3)*.

In 2000 and 2001, China was the second largest exporter of frogs' legs to the EU; however, since then export quantities have sharply decreased *(see Figure 3)*.

3.1.3 Which amphibian species are affected

In compiling its frogs' legs import statistics, the EU does not collect information at the genus or species level. Species involved

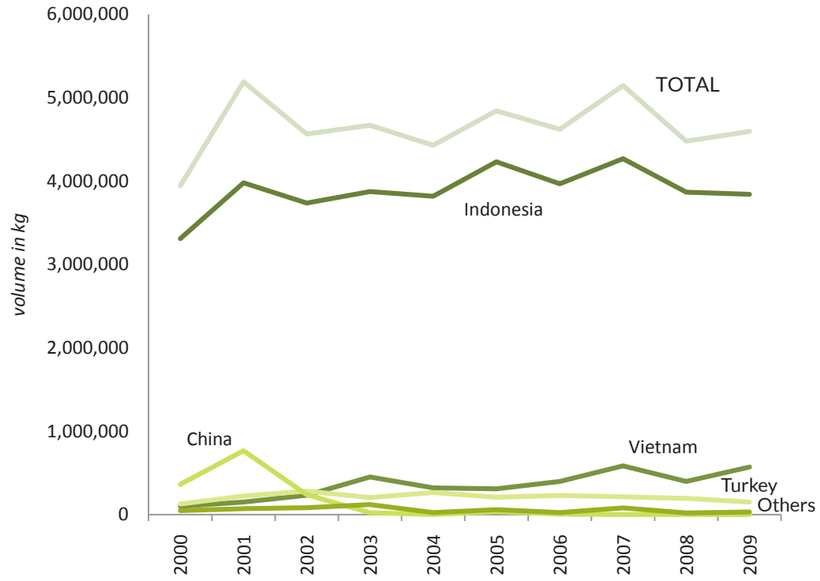

FIGURE 3
Volume of frogs' legs imports to the EU for the period 1999-2009 (Eurostat 2010)

in the international trade in frogs' legs are difficult to identify, as the product is shipped in a skinned, processed and frozen form (Kusrini & Alford 2006). Kusrini (2005) identified the Asian brackish frog, giant Javan frog, and American bullfrog as the species of highest economic value for Indonesian exports. Labeling of exports, however, is often incorrect. For example, whereas export documents apparently support Kusrini's data—that frogs' legs exported from Indonesia to the EU were taken from giant Javan frogs, Asian brackish frogs, common pond frogs, and American bullfrogs—biochemical analysis of frogs' legs revealed that all surveyed frog shipments were from one single species, the Asian brackish frog (Veith *et al*. 2000). The authors conclude that exporters are simply unable to identify the correct species.

3.2 Imports by the USA

According to the LEMIS database, the USA imported 43,137 tonnes of frogs and frog parts from the *Rana* genus (including the American bullfrog) within the last decade. The total included 21,491 tonnes of frogs' legs. The remainder were imported as live frogs mainly to satisfy the demand of the Asian-American community and companies that breed frogs for the food and pet industries. Apart from the American bullfrog—which is farmed in many countries—the giant Javan frog, northern leopard frog (*Lithobates pipiens*) and Indian bullfrog are the most common amphibian species in the US food trade (Schlaepfer *et al*. 2005).

COUNTRY	YEAR	IMPORT/ EXPORT	US DOLLARS	WEIGHT (TONNES)
USA	2006	I	11,473,698	2,779
USA	2006	E	201,803	56
USA	2005	I	12,386,080	2,876
USA	2005	E	178,811	57
USA	2004	I	8,965,863	2,232
USA	2004	E	237,312	67
USA	2003	I	9,196,417	2,043
USA	2003	E	161,893	75
TOTAL IMPORTS USA				**9,930**
TOTAL EXPORTS USA				**255**

TABLE 3: *USA's imports (I) and exports (E) of frogs' legs 2003-2006: (from UN Commodity Trade Statistics Database 2010, http://comtrade.un.org/db/)4.2.1.*

The USA also exports frogs' legs. According to the UN Commodity Trade Statistics Database, from 2003 through 2006, the US exported 255 tonnes of frogs' legs worth 779,819 USD (*see Table 3)*. During the same time period, the US imported 9,930 tonnes of frogs' legs worth 42,022,058 USD *(see Table 3)*.

3.2.1 Where the frogs' legs come from

The USA records its imports and exports of wildlife—including CITES-listed and non-listed species—in its LEMIS database, maintained by the US Fish and Wildlife Service Office of Law Enforcement, within the Department of the Interior. Import/export data contained in LEMIS is available to the public through Freedom of Information Act (FOIA) requests.

A number of countries supply the demand of the US market for frogs and frogs' legs. The countries that consistently maintain a high level of exports to the USA are China, Taiwan, Ecuador, Brazil, the Dominican Republic, Vietnam, Mexico and Indonesia. In contrast to the EU, the USA imports a limited amount of frogs' legs from the genera *Limnonectes* and *Fejervarya* (from 2000-2010 only 5.9 tonnes and 28.63 kg, respectively, according to LEMIS). The bulk of US imports consist of species of the former *Rana* complex. Figure 4 identifies those countries that are exporting American bullfrogs (*Lithobates catesbeianus*, identified as Rana catesbeiana in the LEMIS database) to the USA from 2000-2009. Export data for all other former *Rana* species are shown in Figure 5.

Other species of the former and present *Rana* genus, including northern leopard frogs, are imported from Mexico (43%), Vietnam (14%), Indonesia (12%), China (8%), Azerbaijan (7%) and Taiwan (7%) *(see Figure 5)*. Unlike China, the majority of Mexico's exports of *Rana* species to the USA are from the wild and the specimens are used mainly for commercial purposes. Mexico is, however, the only country to export *Rana* spp., other than the American bullfrog, for educational purposes. The percentage of exports for educational purposes varies from year to year—from, for example, 0% in 2000 (i.e., 100% for commercial purposes) up to 97% or 34 tonnes in 2004. There is no clear explanation for these vastly divergent statistics on the reported use of exported frogs, though it could represent a mistake in completing the customs forms or in entering the customs data into the LEMIS system.

Taiwan and Ecuador also play an important role in the exports of the former *Rana* spp. to the USA according to LEMIS data. From Ecuador, all trade is of live frogs for commercial purposes and 100% of exports are from captive-bred facilities. Taiwan's exports primarily involve live frogs with a very miniscule percentage exported as frozen products. Nearly all of the trade (99.99%) is for commercial purposes with the remainder for scientific and medicinal purposes. Frogs collected in the wild constitute 35% of the trade while all other frogs exported from Taiwan come from captive-bred/captive-born/ranch facilities *(see Figure 7)*.

Exports to the USA of wild American bullfrogs from all countries between 2000 and 2009 declined until 2003 and then increased steadily through 2009, but was relatively modest compared to frogs exported to the USA from captive-bred/captive-born/ranched sources. An exception to this trend is clear from 2007-2009 import data, which revealed an increase in trade of frogs from the wild while imports from captive breeding operations declined *(see Figure 8)*.[2] The reasons for this shift are not known. Prior to 2001, the majority of American bullfrogs exported to the USA were collected from the wild (e.g., 1,145.7 tonnes in 2000) with substantially lower quantities from captive-bred specimens (e.g., 443.7 tonnes in 2000). There was no ranch trade at that time.

3.2.2 What the USA is importing: frogs' legs versus whole frogs

Rana spp. imports to the US from 2000-2009, including live frogs and frogs' legs, totalled 43,137 tonnes (US LEMIS

[2]The terms *captive-bred*, *captive-born*, *ranch* and *wild* as used in Figures 6 and 8 are derived from the following US Fish and Wildlife Service LEMIS Database source codes, used to distinguish the source of imports:

C (captive-bred)—Animals bred in captivity.

F (captive-born)—Animals born in captivity (F1 or subsequent generations) that do not fulfill the definition of "bred in captivity" in Resolution Conf. 10.16.

R (ranch)—Specimens originating from a ranching operation.

W (wild)—Specimens taken from the wild.

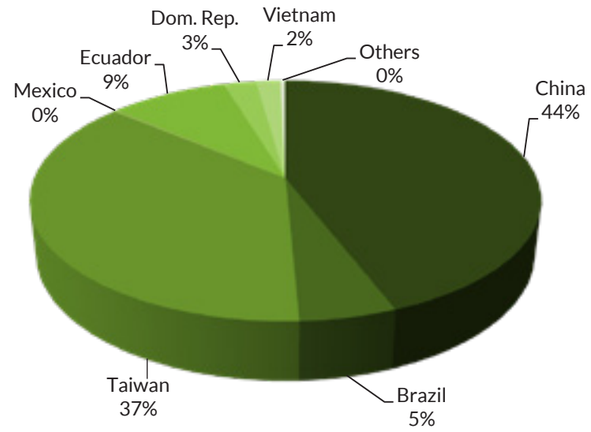

FIGURE 4
Countries of origin for US imports of American bullfrogs (Lithobates catesbeianus, *recorded as* Rana catesbeiana, *i.e. the old nomenclature), 2000-2009 (US LEMIS Database).*

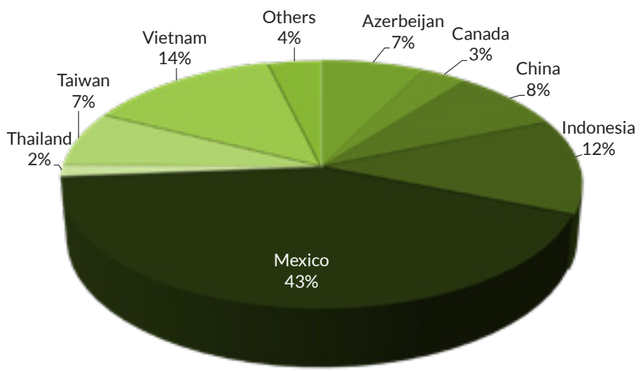

FIGURE 5
Countries of origin for US imports of other Rana *species, 2000-2009 (US LEMIS Database)*

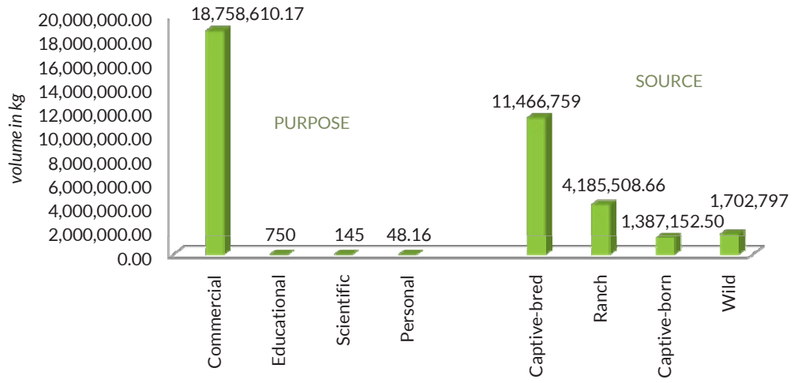

FIGURE 6
US imports of different Rana *species from China to the USA (2000-2010): purpose and source (US LEMIS Database)*

database). Since the quantity of American bullfrogs (39,084 tonnes) in trade is significantly higher than that of other *Rana* species (4,053 tonnes), the relevant import data are evaluated separately in this report. Of the total 39,084 tonnes of American bullfrogs imported by the US, 19,768 tonnes consisted of frogs' legs. Of the 4,053 tonnes imported from other *Rana* species, 1,722 tonnes were in frogs' legs. The remaining trade involved live frogs.

From 2000-2009, trade patterns were completely different for American bullfrogs compared to other *Rana* species. Imports of American bullfrogs have increased in quantity from 1,605 tonnes in 2000 to 5,144 tonnes in 2009 *(see Figure 9)*, while imports of other *Rana* species have declined from 751 tonnes in 2000 to 321 tonnes in 2009 *(see Figure 10)*. These trends may be due to an increase in demand for frogs' legs versus live frogs and/or a growing preference for American bullfrogs in the food market.

Total US imports of American bullfrogs for commercial purposes are divided between frogs' legs (49%) and live frogs (51%) with less than 1% of imports consisting of other parts or derivatives *(see Figure 9)*. All frogs' legs imported into the USA from American bullfrogs are for commercial purposes (US LEMIS database). For live frogs, imports are designated as for scientific, personal, educational and commercial purposes (US LEMIS database). Other *Rana* spp. are also imported to be used for commercial purposes, although for these species there is a tendency to import higher numbers of frogs' legs compared to live species (US LEMIS database) *(see Figure 10)*. The market for live species is smaller and mainly limited to demand from the Asian-American community.

Since 2000, the USA has imported 17,004 tonnes of frogs' legs from China. This total included 16,660 tonnes of frogs' legs from American bullfrogs and 344 tonnes from other species, including Forrer's grass frogs and northern leopard frogs. Taiwan exported the second largest quantity of frogs' legs to the USA since 2000 (2,866 tonnes) followed by Vietnam (1,277 tonnes). China provided 83% of the import volume for frogs' legs from American

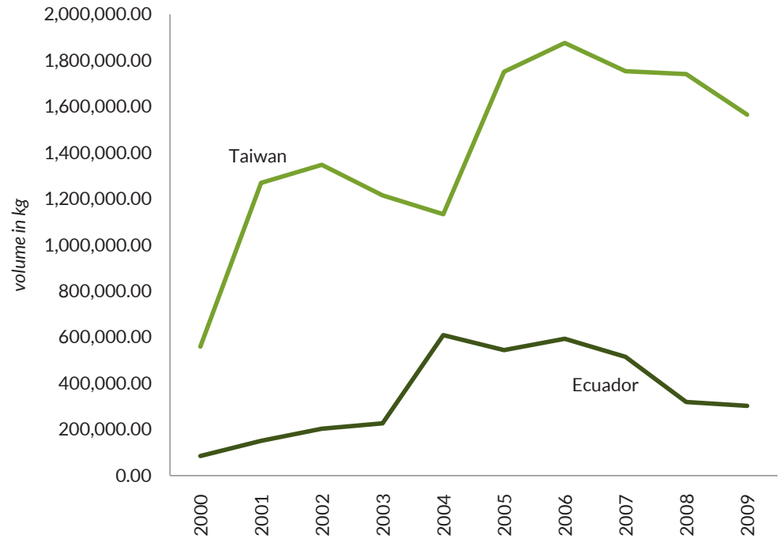

FIGURE 7
US imports of different Rana *species from Taiwan and Ecuador, 2000-2009 (US LEMIS Database)*

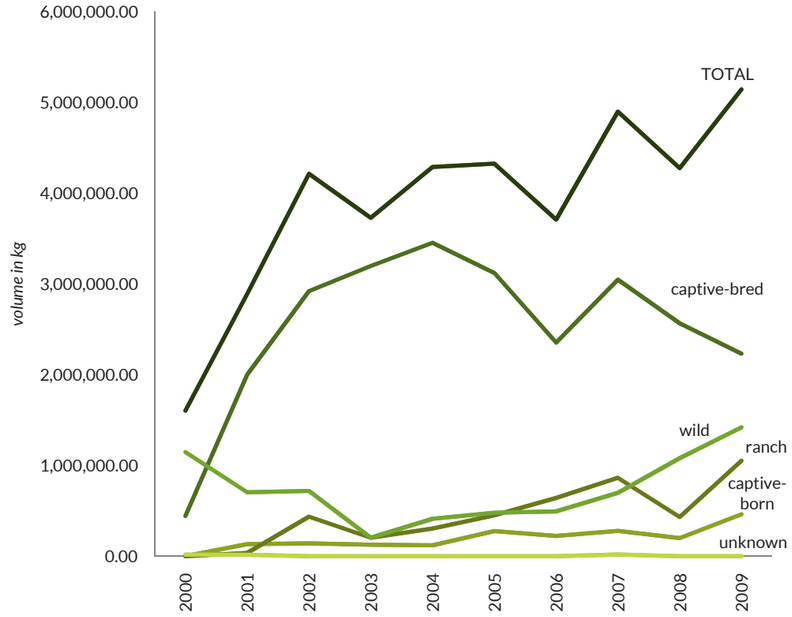

FIGURE 8
US imports of American bullfrogs (Lithobates catesbeianus) *per source, 2000-2009 (US LEMIS Database)*

FIGURE 9
US imports of American bullfrogs: frogs' legs versus live specimens, 2000-2009 (US LEMIS Database)

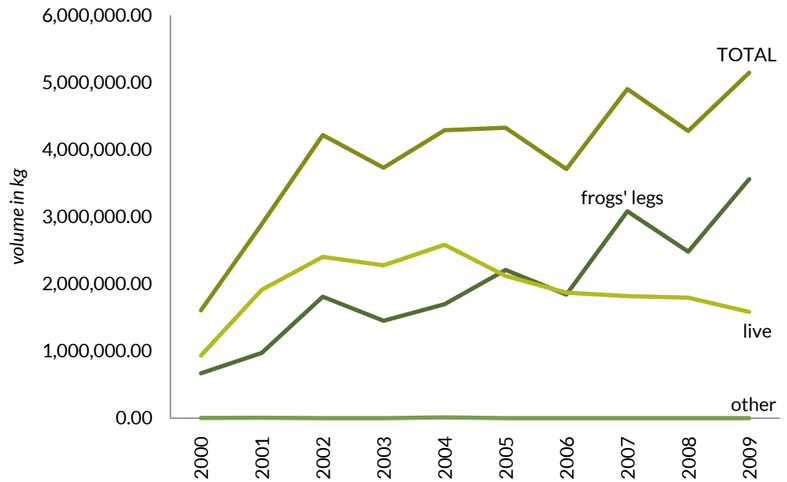

FIGURE 10
US imports of other Rana species: frogs' legs versus live specimens, 2000-2009 (US LEMIS Database)

bullfrogs, followed by Taiwan with 13% and Vietnam with 4%. Import volumes for other countries are negligible.

The trade in frogs' legs of other species excluding American bullfrogs is more variable in terms of exporting countries and export quantities. The available data indicate that exports from certain countries may be high for a few years but then abruptly drop off or cease. For example, Indonesia exported 540 tonnes of frogs' legs to the USA from 2000 to 2003 but, after a peak in 2000 (204 tonnes), export quantities gradually declined.

3.2.3 California import ban

In March 2010, the California Fish and Game Commission set a precedent by banning the sale and import of non-native frogs and turtles, in order to safeguard agricultural interests, public health, and native wildlife from disease, as well as prevent adverse ecological impacts attributable to potentially invasive species. However, following complaints about the ban and several public meetings and discussions with the Asian-American community and other stakeholders in California, the Commission voted in February 2011 to repeal the ban on issuing import permits for non-native turtles and frogs destined for live markets.

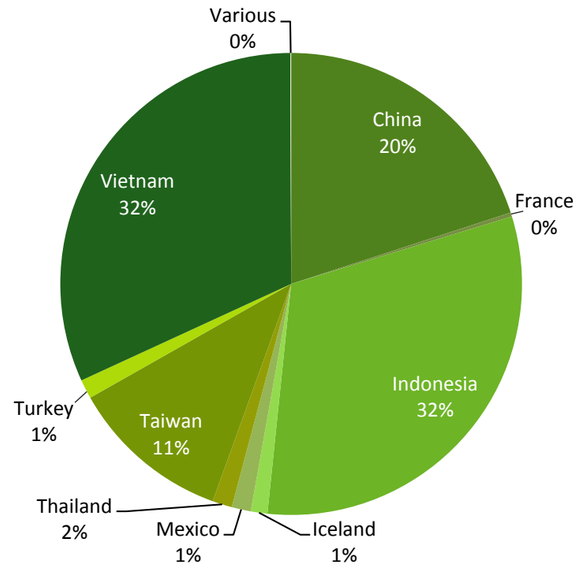

FIGURE 11
*Total US imports of frogs' legs (*Rana *spp. excluding* R. castebeiana*) 2000-2009 in kilograms (US LEMIS Database*

3.3 Other importing countries

While the EU remains the world's leading importer of frogs' legs, they are also shipped to non-EU destinations in Europe. In Switzerland, a considerable market for frog meat exists in the western part of the country. According to custom statistics, Switzerland annually imports 150 tonnes per year—including both live frogs and processed frogs' legs—from Turkey and Indonesia. This corresponds to 7.5 to 10 million frogs (Swiss Interpellation No. 4290 in 2009).

While the EU imports 83.2% of Indonesia's frogs' leg products, 12% are imported by other Asian countries. Of this 12%, Singapore imports more than half, Hong Kong 23% and Malaysia 18.3% (Kusrini & Alford 2006).

Apart from the EU and the USA, Hong Kong, Singapore and Malaysia are the main destinations for frog shipments from Thailand (Teixeira *et al.* 2001). In 1994, Hong Kong alone imported 6 million East Asian bullfrogs from Thailand. All of these frogs were wild-caught (Lau *et al.* 1997).

4. Ecological Impact in Countries of Origin

Large-scale offtakes not only reduce the number of individual frogs in the wild, but as a direct effect of such removals, also disrupt ecological balance resulting in potentially serious impacts on ecosystems and humans. For example, frogs play a vital role in the control of mosquito populations (Mohneke 2011, Raghavendra *et al*. 2008) and other agricultural pests (Abdulali 1985, Kusrini 2005). As early as 1025, ancient Chinese literature referred to the role of frogs as pest control and people were ordered not to eat frogs for this reason (Peng 1983). In the 1980s, experts warned against the negative ecological impact of overexploited wild frog populations, including an increase in insects (e.g. mosquitoes), causing farmers to use more pesticides (Abdulali 1985). Furthermore tadpoles, as filter-feeders, stabilize water quality of ponds and consequently their disappearance may have a negative impact on ecosystems as well as living conditions for rural human populations (Mohneke 2011, Sanderson & Wassersug 1990).

The ecological and biological impact of trade on wild frog populations is not adequately understood for several reasons. First, data on the dimensions of offtakes are often not recorded. Second, in many countries of origin the status of wild amphibian populations is not known. Third, other factors such as climate change, diseases and pollution also put serious pressure on frog populations, making the specific role of the frogs' legs trade in the decline of wild populations and the diminishment of their ecological function difficult to determine.

Nevertheless, the ecological impact of the frogs' legs trade is likely to escalate as the exploitation of frogs for food markets already is, or is expected to become, a severe threat to a variety of large-bodied frogs e.g. the Asian brackish frog, giant Javan frog, giant Asian river frog (*Limnonectes blythii*), giant Philippine frog *(Limnonectes magnus)*, peat swamp frog *(Limnonectes malesianus)*, Shompen frog *(Limnonectes shompenorum)*, Bourret's frog *(Paa bourreti)*, Chinese brown frog, edible frog *(Pelophylax esculentus*, formerly *Rana esculenta)*, Huanren frog *(Rana huanrenensis)*, Balkan frog *(Pelophylax kurtmuelleri*, formerly *Rana kurtmuelleri*, and Albanian water frog (*Pelophylax shqipericus*, formerly *Rana shqiperica) (UNEP-WCMC 2007).*

The species presently dominating the international frogs' legs trade, especially from Indonesia, are the more widespread and common frogs. Consequently, for

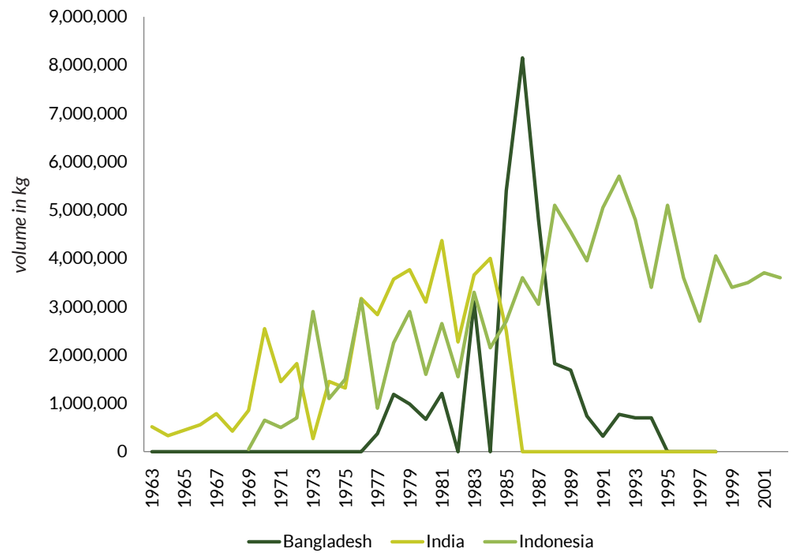

FIGURE 12
India, Bangladesh and Indonesia: dynamics of frogs' legs exports 1963-2001 (based on Kushrini & Alford 2006, Teixeira et al. 2001 and Niekisch 1986)

the most part, they are not among the global IUCN Red List's (2010) species of greatest conservation concern *(see Section 10)*. In contrast, wild populations of most of the large-bodied frogs identified in the previous paragraph are already decreasing. There are clear indications that the millions of frogs taken from Indonesia (most particularly from Java) have already severely impacted local ecosystems—as witnessed 30 years before in India and Bangladesh.

4.1 A case study of India and Bangladesh

Beginning in the 1950s and lasting for over three decades, India and Bangladesh were among the major exporters of frogs' legs *(see Figure 12)*. Green pond frogs and Indian bullfrogs were the most sought-after species, while the Jerdon's bullfrog (*Hoplobatrachus crassus*) and Indian skipper frog *(Euphlyctis cyanophlyctis)* were also targeted (Niekisch 1986, Abdulali 1985). While producing more than 4,000 tonnes of frogs' legs for export per year, both countries were increasingly confronted with the serious consequences of this large scale level of exploitation. As frog populations collapsed, an important natural control agent of agricultural pests and mosquitoes was lost and, accordingly, pesticide imports and use grew exponentially (Teixeira *et al.* 2001, Patel 1993, Pandian & Marian 1986).

A three-year study in India on ecological disturbances in agriculture determined that the average export of 3,000 tonnes of frogs' legs corresponded to a total weight of 9,000 tonnes of actual frogs removed from the wild. This amount of frogs (estimated to represent 54.4 million

frogs), would have been able to consume more than 200,000 tonnes of insects, crabs, snails and other agricultural pests a year (Abdulali 1985). A survey among rural citizens asking for trends in frog populations and related loss/benefit showed that 99% of the responding persons reported considerable depletion or even local extinctions of frogs (Abdulali 1985). Ninety-eight percent of those surveyed bemoaned related agricultural losses and an increase of paddy pests. The findings of the survey also underlined the economic and ecological aspects of the correlated increased use of pesticides, and urged a ban on the trade in frogs' legs (Abdulali 1985). Pesticides are known to delay reaction time, disrupt hormonal balance, diminish productivity, reduce number of offspring, and cause limb deformities in amphibians (Khan & Law 2005, Boone & Bridges 2003). As a consequence of the grave problems caused by massive frog exports, the Government of India started to monitor export quantities, limited the catch season to two months, and set a minimum body size for captured frogs.

Concerns over ecological balance and the cruelty of killing methods *(see Section 6)* have spurred legal protective measures. In 1985, Germany successfully proposed the listing of green pond frogs and Indian bullfrogs on CITES Appendix II. Two years later, India banned trade in frogs (Oza 1990, Pandian & Marian 1986) *(see Figure 12)*. Since then, wild populations have recovered and today the IUCN Red List describes populations of both species as stable. Furthermore, imports of insecticides declined by 40% (Teixeira *et al*. 2001). Poaching for local consumption, however, is still ongoing (Barretto 2010, Humraskar & Velho 2007).

After India's ban, Bangladesh assumed the lead export role for a short period. It was generally assumed, however, that a significant portion of the frogs exported from Bangladesh originated in India (Teixeira *et al*. 2001, Oza 1990). The most heavily exported species was the Indian bullfrog, representing 99% of frogs' legs exports, while green pond frogs, Indian skipper frogs and common pond frogs were caught only occasionally (Niekisch 1986). However, shipments were repeatedly refused by inspectors in the EU and the USA, due to bacterial contamination as a consequence of poor hygienic conditions during processing. This considerably hampered the export business. Furthermore, scientists warned against a serious decline of native frog populations (Niekisch 1986). Limited collection seasons resulted in zero exports in 1982 and 1984, but did not limit exports in other years (Niekisch 1986). Finally, in 1995, Bangladesh ceased exporting frogs' legs altogether (Teixeira *et al*. 2001) *(see Figure 12)*.

4.2 Current developments in Indonesia—is history repeating?

Shortly after India's and Bangladesh's bans of frogs' legs exports, in the late 1980s the Government of Indonesia supported an expansion of the export business (Bazilescu 1996) and quickly developed its export capacity to fill the void left by India and Bangladesh. Indonesian exports of frogs' legs peaked in 1992 with an export volume of 10,331 tonnes (Teixeira *et al*. 2001) *(see Figure 12)*. In 2000, the Government of Indonesia listed 22 companies as frog exporters. Currently, no controls are in place to monitor trade levels (Kusrina & Alford 2006, Kusrini 2005). While Indonesia is presently exporting 4,000-5,000 tonnes of frogs' legs per year, the domestic consumption of frogs' legs is estimated to be two to seven times this export volume—i.e. an additional 8,000-35,000 tonnes (Kusrini & Alford 2006). Combining export and local consumption figures, from 300 million to over 1 billion frogs are exploited annually in Indonesia alone.

Most of the frogs in trade are wild-caught and mainly originate from East and West Java. A smaller number are collected in southern Sumatra, Bali and South Kalimantan. The dominant species in trade are Asian brackish frogs, giant Javan frogs, and, to a lesser extent, common pond frogs and introduced American bullfrogs (Kusrini & Alford 2006). In many parts of Java and Sumatra, such large frog species have already disappeared from many sites, and middlemen (those engaged in annual domestic purchase and trade) report a decreased yield (Kusrini & Alford 2006, Veith *et al*. 2000). However, exporters deny negative trends, pointing to stable export statistics. This inconsistency may indicate that former collection sites are depleted and captures are now taking place in other (likely more remote) areas. Scientists bemoan the lack of information on the status and taxonomy of amphibians in Indonesia, particularly for species in the frogs' legs trade (Iskandar & Erdelen 2006, Kusrini 2005).

According to the IUCN Red List (2010), wild populations of giant Javan frogs—probably restricted to Java and Sumatra—are decreasing (Iskandar *et al*. 2004). The species, classified as Vulnerable, is highly exploited for the food trade. IUCN experts criticize the lack of proper management to ensure sustainable offtakes (Iskandar *et al*. 2004). Currently, specimens caught for market average up to 120 mm in size. This is considerably smaller than the average size of 180 mm for specimens captured only a few decades ago. This is likely a consequence of overexploitation (Iskandar, cited in UNEP WCMC 2007).

Apart from the direct impact on frog populations, secondary consequences—including an increase in agricultural pests—are likely based on historical observations in India and Bangladesh. As in those countries, the depletion of wild frog populations in Indonesia increases the risk for an expansion in the number and range of insect pests. Indeed, between the early 1970s and the middle 1980s, pesticide use in Indonesia annually increased by more than 17%, leading to an increase in pollution (Barfield 1986), due at least in part to the loss of natural insect controls. In 1989, costs of pesticide imports were three times higher than the value of frog exports (Bazilescu 1996).

Frogs' legs exported from the Jakarta International Airport are labeled as giant Javan frogs, but due to the widespread capture of frogs throughout Indonesia, up to 14 different frog species may be involved in this trade (UNEP-WCMC 2007). Without sufficient data documenting the species of frogs in trade, the proper management of these distinct species is impossible.

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Asian brackish frog

4.3 Frog farming—a way out?

According to Food and Agriculture Organization (FAO) data, farmed frogs have become more prevalent in the global frog trade market, increasing from 3% in 1980 to 15% in 2002 (Tokur *et al.* 2007). Frog farming is now practiced in several countries including Brazil (Teixeira *et al.* 2001), Taiwan (FAO 2005-2010), the USA (Helfrich *et al.* 2008), Vietnam (Truong 2000), China (Teixeira *et al.* 2001), Mexico, Guatemala, Salvador, Panama, Ecuador, Argentina, Thailand, Laos, and Malaysia (FAO 2005-2010). Global production of farmed American bullfrogs has significantly increased during the 1990s, reaching a level of at least 1,600-2,400 tonnes. Taiwan accounts for the majority of this production, with additional contributions from Uruguay, Brazil, Mexico, Ecuador and Guatemala (FAO 2005-2010). Global aquaculture of amphibians, for both the food and pet markets, has significantly grown within the last decade, from 3,000 tonnes in 1999 to 85,000 tonnes in 2008 (FAO 2009).

In 2001, Teixeira *et al.* reported the existence of up to 300 frog farm operations in Taiwan, 200 in Thailand, and approximately 58 in China's Hainan province, as well as 12 bullfrog farms in Malaysia. The Malaysian farms reportedly produced 80 tonnes of frogs' legs annually, all of which is consumed locally. In addition, Brazil's farms produced 450 tonnes of frogs' legs per year, prepared by seven frog processing plants in the country. These data correspond with import statistics of the USA, which record 34.7% of frogs (437 tonnes) coming from Taiwan (18.6% as frogs' legs). All American bullfrogs imported by the USA from Taiwan are for commercial purposes—in contrast with other species imported for scientific research. On average, around 60% of the imports from Taiwan are farmed (i.e. at least one of the parental animals was taken from the wild) or captive-bred (US LEMIS trade database 2000-2010).

4.3.1 Problems in practice

While the increase in frog farming or aquaculture initially seems to be a promising strategy to reduce depletion of wild frog populations, the practices employed by frog farms highlight serious challenges regarding breeding success, supplementing captive stocks with animals from wild stocks, disease outbreaks, and the risk of farmed species becoming invasive (Mohneke *et al.* 2009, Lau *et al.* 2008). Some experts even state that expectations of large or easy profits from frog farming are unrealistic (Helfrich *et al.* 2008).

In Indonesia, commercial farming of native frogs has failed (Kusrini & Alford 2006, Veith *et al.* 2000). Farming of the non-native American bullfrog started there in 1982 as part of an Indonesian government program to increase frogs' legs exports. Additional captive operations were launched with the aim to annually produce 1.65 tonnes of frogs' legs by 2003, representing one-third of total exports. However, many farmers have since stopped bullfrog farming because of high production costs and the species' susceptibility to disease.

High tadpole mortality due to cannibalism, as well as the need for the constant and ample production of adequate live food for young frogs are two of the primary challenges of frog farming (Helfrich *et al.* 2008, Oza 1990, Pandian & Marian 1986). Feeding behavior of frogs is triggered by the preys' movement. Food pellets, therefore, are hardly accepted as an alternative to live prey (Miles *et al.* 2004). While some farms were able to overcome this hurdle and adapt frogs to food pellets, many frog farms still rely on a supply of frogs from the wild to continuously supplement captive stocks (FAO 2005-2010, Teixeira *et al.* 2001, Pariyanonth & Daorerk 1994). For example, in the Democratic Republic of the Congo, though farming of the common river frog (*Rana angolensis*) was initiated in the late 1990s it remains reliant on the capture of wild specimens (Mushambanyi 2010).

The farming of non-native species inherently carries a severe ecological risk, as some of these species become invaders (Lau *et al.* 2008, Kusrini & Alford 2006) if intentionally or unintentionally released into the wild. In Madagascar, for example, Indian bullfrogs originally introduced as a source of human food, are now considered a pest (Padhye *et al.* 2008). The American bullfrog—the world's most commonly farmed frog species for human consumption—is included in the *100 of the World's Worst Invasive Alien Species* list published by the IUCN Species Survival Commission's Invasive Species Specialist Group (ISSG) (Orchard 2009).

With regard to the effects of disease outbreaks associated with the production and/or trade in frogs, Gratwicke *et al.* (2009) warn: "The risk of disease spread through poorly regulated amphibian trade is probably an even greater risk to amphibian biodiversity than the direct population effects of overexploitation." In Indonesia, frogs destined for national markets—the bulk of frogs' legs trade in the country—are transported alive, facilitating the spread of disease. Evidence of infections by the deadly chytrid fungus, *Batrachochytrium dendrobatidis*, in two ranid populations in Java emphasizes the risk of disease transmission via trade (Kusrini *et al.* 2008). Considering that Indonesia annually exports tens of thousands of live frogs of different species (Gratwicke *et al.* 2009) and that, in total, about 5 million live amphibians were internationally traded in 2006 alone as pets or for human consumption (Schloegel *et al.* 2010), the potential for disease transmission cannot be ignored. Indeed, as documented by Schloegel *et al.* (2009), 62% of live frogs imported to the USA—mainly from Taiwan, Brazil, Ecuador and China—were carriers of the chytrid fungus; 8.5% were carriers of ranaviruses. Experts also see a risk of disease spread through processed and exported frogs' legs if not skinned and frozen properly.

5. Ecological Impact in Importing Countries

International trade in amphibians, whether live or processed, is substantial and involves many millions of individuals a year (Gratwicke *et al*. 2009, Schlaepfer *et al*. 2005). Live specimens are not only potential vectors of pathogens, but may escape, establish feral colonies, and subsequently introduce pathogens to native wild frog populations (Fisher & Garner 2007). Table 4 gives an overview of amphibian species identified as potential invaders and vectors for disease transmission.

5.1 Introduction of invasive species

The most significant threat to amphibians worldwide is habitat loss and degradation followed by pollution, invasive alien species (IAS), diseases, and overexploitation (IUCN GAA, Wilson *et al*. 2010). IAS include non-native amphibians. Indeed, the IISG identifies several frog species in its *100 of the World's Worst Invasive Alien Species* list (ISSG 2008)—including (as noted above) the American bullfrog. In South America, large parts of Europe, and Asia, the American bullfrog

SCIENTIFIC NAME	COMMON NAME	RISK
Ambystoma mexicanum	Mexican salamander	Invasiveness, disease
Bombina variegate	yellow-bellied toad	Invasiveness
Dendrobates auratus	green and black dart-poison frog	Invasiveness, disease
Kaloula pulchra	Asian painted frog	Invasiveness
Litoria aurea	green and golden bell frog	Invasiveness
Litoria caerulea	great green tree frog	Invasiveness, disease
Ptychadena mascareniensis	Mascarene grass frog	Invasiveness
Rana ridibunda	marsh frog	Invasiveness

Table 4: U.S. examples of non-native, amphibians from 2000-2004 readily identifiable as potential invasive species (from Jenkins et al. 2007).

is competing with native species for food and habitat and poses a predation threat to some native species (Crayon 2009).

The cane toad (*Bufo marinus*), native to Central and South America and portions of the Caribbean, is another significant invasive species. Cane toads were introduced in Asia, Australia, the Pacific and other parts of the Caribbean for insect pest control (IUCN/SSC ISSG 2010). The toad's introduction to non-native areas has had devastating consequences. Toxins in the cane toad's body have caused mortality in several native species, including the critically endangered Bermuda skink (*Eumeces longirostris*)—the only endemic terrestrial vertebrate of Bermuda, native snakes in Australia (Shine 2010), and Japan's critically endangered Iriomote cat (*Prionailurus bengalensis iriomotensis*).

In addition to carrying the chytrid fungus to uninfected populations *(see Section 5.2)*, invasive frog species pose other significant threats. For example, great green tree frogs (*Litoria caerulea*), native to Australia, are traded as pets and released in Florida, where they compete with and prey on smaller native frogs. In Hawaii, the coqui (*Eleutherodactylus coqui*), a small tree frog native to Puerto Rico, has spread rapidly in less than 20 years since introduction and may have severe ecosystem impacts in the absence of competing native frogs or predators to control their population growth and expansion. Their extremely loud, disturbing, repeated call—a high-pitched "co-qui"—reaches close to 100 decibels at 0.5 meters and is very troublesome to residents and tourists. Landowners of coqui-infested lands can face difficulty selling their property; coqui infestations have reduced property values on the Island of Hawaii by an estimated total of $8 million per year (Beard et al. 2009).

From 2000 to 2004, the USA imported 172 different live, non-native amphibian species, mostly for use in the pet, live food and scientific trades. These imports do not encompass all species involved in the frogs' legs trade. An analysis prepared by the organization Defenders of Wildlife revealed that 13 of these 172 species represent a high risk of becoming invasive. Yet, none of these 13 known invasive species are restricted from importation due to potential adverse ecological impacts, nor are any amphibian imports subjected to mandatory risk analysis or disease checks (Jenkins *et al*. 2007). There are no US laws or regulations in place governing amphibian imports. Arizona, Nevada, California and Oregon are only some of the US states that have documented adverse impacts of IAS on native amphibians.

At the international level, Fred Kraus of the Bishop Museum in Honolulu assessed the huge numbers of amphibians moved around the world by humans (Kraus *pers. comm*. 2011). He documented at least 1,251 introductions of 184 different non-native species worldwide. Of those, 750 introductions involving 103 species, have "succeeded," meaning that more than half of the introductions resulted in new, established, free-living, non-native populations. The annual rate of introductions has increased exponentially (Kraus 2007). The rate of established invasive populations worldwide likely will continue to rapidly increase unless governments implement both prevention measures and control or eradication programs.

Regarding the threat posed by invasive species, Stuart *et al.* (2008) warns that "rates of invasion will be accelerated owing to rapid adaptive change in the invaders" and adds "as with all alien invasive species, prevention of introduction is the best option, and any management should be undertaken as soon as possible, before the invader has had time to evolve into a more dangerous adversary."

5.2 Spreading of diseases

The chytrid fungus *Batrachochytrium dendrobatidis* is associated with a deadly amphibian disease responsible for dramatic population declines in North, Central and South America, Europe, and Australia (Daszak *et al.* 2007). The fungus causes a thickening of the keratinized layer of the skin and may hinder osmoregulation and respiration, leading to death and precipitating rapid mass die-offs of frog populations (Daszak *et al.* 2007). The chytrid fungus has been implicated in the extinction of up to 94 frog species (IUCN 2010).

American bullfrog

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The fungus has been detected in farmed and escaped American bullfrogs in South America and other regions (Schloegel *et al.* 2009, Mazzoni *et al.* 2003). In farms in Uruguay, mass die-offs of American bullfrogs were documented, with a loss of more than 90% within a couple of days (Mazzoni *et al.* 2003). Fisher and Garner (2007) documented chytrid fungus infection in several frog species that are traded for food. For example, infection with the chytrid fungus has been found in American bullfrogs, green frogs *(Rana clamitans)*, North American pig frogs (*Lithobates grylio*), Eurasian marsh frog, and edible frogs (Fisher & Garner 2007). Recently, the fungus has been found in wild frog populations in Indonesia (Kusrini *et al.* 2008).

Trade of live, unskinned, unfrozen frogs is not only a potential vector for the chytrid fungus, but also for ranaviruses (Gratwicke *et al.* 2009, Picco & Collins 2008, Schloegel *et al.* 2010, 2009). These pathogens represent the most serious threat to wild frog populations in some regions, and can cause mortality rates of 90% in a single pond (Daszak *et al.* 2007). Die-offs have been reported in the Americas, Europe and Asia (Gray *et al.* 2009). Ranaviruses were found in northern leopard frogs farmed in China for human consumption (Schloegel *et al.* 2009) and led to mass mortality in American bullfrogs farmed in Brazil (Mazzoni *et al.* 2009).

Due to the mounting evidence that the chytrid fungus and ranaviruses are distributed through frogs traded live, in 2009 the *World Organization for Animal Health* (OIE), specified conditions for handling processed and live frogs (e.g., health certificates and risk mitigation measures) in its Aquatic Animal Health Code.

6. Look-Alike Problems

While Indonesia is presently the dominant exporter for frogs' legs, there is controversy as to which species are in trade. According to Kusrini (2005) the majority of frogs are caught in Java, with the Asian brackish frog accounting for 75% and the giant Javan frog for 19% of takes. These data conflict with what was identified in exports to the EU. According to that data the Indonesian frogs' legs shipments to the EU include four species: giant Asian river frogs, Asian brackish frogs, common pond frogs, and giant Javan frogs. However, biochemical analysis (enzyme analysis) identified all imported specimens as Asian brackish frogs (Veith *et al.* 2000). This false labeling may not be intentional but simply indicates that the traders and exporters are not able to identify the frog species in trade (Kusrini & Alford 2006, Veith *et al.* 2000). This reveals two serious problems: First, that reliable monitoring and sustainable management of trade is extremely difficult, especially for shipments of frozen legs. Second, enormous enforcement problems may arise if only trade in individual frog species is managed by CITES or other measures due to look-alike issues and since it is difficult, without genetic testing, to distinguish prepared frog legs by species.

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frozen frogs' legs from Vietnam

7. Animal Welfare Problems

Sentience is rarely taken into account in human handling of amphibians. According to Machin (1999) pain perception in amphibians is likely analogous to that in mammals. Amphibians have appropriate neurological components for transmitting pain from peripheral nerves to the central nervous system. They also demonstrate behavioral and physiological reactions to pain.

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separation of legs

Production of frogs' legs necessarily involves the manual killing of hundreds or even thousands of frogs per day. A study in India stressed the cruelty of the practice to remove the legs from a living body by using knives (Abdulali 1985). In other countries scissors are used, or frogs are just dismembered by hand, as photographic evidence obtained by the French organization *Protection Mondiale des Animaux de Ferme* has documented. None of these methods provide an immediate and humane death to the animal, causing rather extensive bleeding and most likely severe pain. The frogs struggle violently when these methods are used until they reach complete exhaustion (D. Bickford *pers. comm*. 2011).

Another issue of concern is the methods used to hunt frogs. Frogs are hunted by hand, nets, hooks, and spears (Kusrini 2005, Teixeira *et al*. 2001). A portion of those frogs captured with the commonly used three-headed spear on a long pole exhibit such heavy bruising as a result of the capture technique that middlemen and exporters refuse to buy them (Kusrini & Alford 2006).

In Brazil, one of the leading countries in the development of frog farming, frogs are put in plastic boxes with ice, water and salt for the purpose of anaesthesia (Teixeira *et al*. 2001). However, scientists stress that reducing the body temperature of an amphibian is not considered an appropriate or humane method of anesthesia (Hadfield & Whitaker 2005, Bickford *pers. comm*. 2011), as even this method may cause severe stress and pain.

8. Conclusions and Recommendations

For many decades, the demand for frogs' legs in France and the USA was met through captures from native populations. In France, a collapse of the targeted species in the wild was observed in the 1960s and 1970s. As a consequence, France banned the collection and sale of native frogs (Neveu 2004), but concurrently increased imports from other countries. Frog populations in the USA dramatically dropped during the 20th century (Lannoo *et al*. 1994) leading to an increase in imports to satisfy continued demand. Subsequently, until the late 1980s frogs in India and Bangladesh were overexploited to meet international demand, until legal measures were taken to prohibit capture and trade. At present, frog populations in Indonesia and other range states are in peril and local depletions of large-bodied frog populations have already been reported. Experts have identified this pattern as an "extinction domino effect." To address these impacts, exporting and importing countries should collaboratively develop strategies to prevent further collapses of wild frog populations and impede trade-related risks—including the expansion of invasive species and introduction of diseases.

8.1 Regulating trade

In 1985, two species affected by the frogs' legs trade were listed under CITES (Appendix II). This compelled exporting countries to better regulate and monitor the trade to ensure it was sustainable. However, in 1992, an initiative to list 17 frog species *(see Section 1)* in CITES Appendix II failed due to opposition from some range states. Nearly twenty years later, in preparation for CITES CoP15 (2010), the US Fish and Wildlife Service considered listing proposals for the giant Asian river frog, giant Javan frog, giant Philippine frog (all from Asia), broad-headed frog (*Limnonectes laticeps*, South America) and Albanian water frog (*Pelophylax shquipericus*) (Albania and Montenegro) (USFWS 2009). Although, the USA ultimately decided not to proceed with the proposals due to other priorities, such considerations show an increasing awareness of the alarming situation confronting many frog populations.

Nevertheless, recognizing that the frogs' legs trade has had a serious impact on wild populations, it would be prudent to pursue a number of CITES listings. A listing in CITES Appendix II would require that international trade not be detrimental to the survival of the listed species. Monitoring necessary to regulate

the impacts of trade would contribute to sustainable levels of offtakes and create public awareness of the importance of frog conservation in both range and consumer countries.

Frog species in the food trade are difficult to identify and distinguish, which hampers proper monitoring. Such difficulties are particularly relevant to the international trade in frogs' legs since species identification of frozen and skinned products is only possible through genetic testing. Furthermore, for the ranid frogs, striking morphological similarity among various large-sized frogs and the existence of cryptic species complexes make identification difficult (Warkentin *et al*. 2009, Bickford *et al*. 2006). Finally, to complicate matters further, taxonomic uncertainties remain unresolved (e.g., reports on "*Limnonectes macrodon*" may refer to *Limnonectes blythii*, *Limnonectes shompenorum*, *Limnonectes malesianus*, *Limnonectes leprorinus*, *Limnonectes ingeri* or other only recently described taxa) (UNEP-WCMC 2007).

Such look-alike problems inherent in the frogs' legs trade could be overcome by CITES listings of a broader range of species that predominate in trade (or pursuing listings at the genus level). Furthermore, to confirm species identity in trade, biochemical and DNA test methods are available, and provide quick results at a moderate cost (Veith *et al.* 2000).

Independent of the difficulties in identifying the species in trade, data needed to properly conserve frog species in the wild are scarce. According to the IUCN Amphibian Conservation Action Plan, proper and sustainable management is only possible if sufficient data about population size, distribution, trends and threats are available (Carpenter *et al.* 2007). It is imperative that those countries involved in the trade of live frogs and/or frog products address this knowledge gap as a prerequisite to any further international trade.

Countries of origin are recommended to:

a) conduct surveys of wild frog populations to identify population size and trends, habitat-specific density ranges, survival rates, breeding frequency, and suitability, availability and loss rates of remaining habitat;

b) utilize survey data to establish conservative sustainable offtake levels for local consumption and national and international trade;

c) examine subsistence, local and national trade levels (including species variety, number of individuals, body sizes, capture locations) and develop appropriate and sustainable management/collection rules (e.g. restriction of collection to particular seasons and places, licenses, off-take quotas);

d) create public awareness concerning the role of frogs in the ecosystem and as a natural and free biological pest control agent to increase acceptance of such collection restrictions;

e) register all export companies and their suppliers;

f) set sustainable export quotas and assure appropriate enforcement;

g) adopt as mandatory law the non-binding recommendations contained in the OIE Aquatic Animal Health Code on preventing infections with *Batrachochytrium dendrobatidis* (OIE 2009), in order to minimize the risk of pathogen transmission;

h) establish humane standards to govern the capture, handling, packaging and export of live frogs and for the capture, handling, killing and processing of frogs used for food to minimize animal suffering; and

i) restrict commercial farming to native species and establish adequate controls to prevent the replacement or augmentation of breeding stocks with specimens from the wild, as well as the spread of disease from farmed/captive stock to wild frogs.

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green pond frog

Importing countries are recommended to:

a) conduct random DNA analysis of frogs' legs shipments to determine if shipment labeling is correct;

b) assist range states in conducting surveys of wild frog populations, establishing off-take rules, and strengthening enforcement;

c) develop, in cooperation with range states, CITES listing proposals for those species predominant in international trade and, if listed, initiate increased monitoring and regulation of the trade in said species to ensure its sustainability;

d) develop a system to register exports and imports of species indicating the source, purpose and quantity;

e) adopt the OIE Aquatic Animal Health Code (2010) recommendations on diseases of amphibians;

f) regulate and randomly test imports from captive breeding facilities to assess disease status and identify, mitigate and prevent disease introduction; and

g) only permit import of frozen meat to avoid the spread of diseases and invasive species.

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