PRO WILDLIFE

ROBIN DES BOIS

Deadly Dish

Role and responsibility of the European Union in the international frogs' legs trade

Content

Executive Summary

Native frogs in the member states of the European Union are protected against capture and killing by the Habitats Directive[1]. In contrast, the import of wild-caught frogs from other parts of the world for human consumption (or as pets) is still allowed and mostly unregulated, as most frog species in trade are not internationally protected.

In 2011, our report "Canapés to Extinction" provided comprehensive data on the international trade in frogs' legs, its ecological impact, and the EU's central role as a consumer market (Altherr *et al.* 2011). The present report provides an update for the decade since then, presenting new information on trade volumes and trends.

Frogs are traditionally consumed in many countries in Latin America, Africa, and Asia for subsistence and local consumption. While this consumption presumably was sustainable for centuries, increased commercialisation of frog products, combined with an increase of human population, change of land use, pollution, diseases, and climate change have decimated wild frog populations in many regions.

Nevertheless, the USA and Europe are still importing enormous amounts of frogs' legs. While frogs imported into the USA are mostly farmed, the European Union's imports until today mostly derive from wild-caught specimens from Indonesia. Accordingly, the EU's demand for frogs' legs makes it the largest global importer of wild-caught frogs, giving it a central responsibility to establish conservation measures to prevent decline of certain species and serious negative ecological impact.

According to EUROSTAT (the European statistics database) the EU has been importing about 40,700 tonnes of frogs' legs within the period 2011-2020, which correlates with 814 million to 2 billion frogs. The main EU importers are Belgium (70 %), France (16.7 %), and the Netherlands (6.4 %). However, as EUROSTAT only records processed frogs' legs as a commodity group, it cannot be excluded that in addition live frogs are imported for human consumption (DESTATIS 2022), as in the case of Switzerland (Bundesrat der Schweiz 2010).

With 74 % of the market Indonesia is still the main supplier to the EU, followed by Vietnam (21 %) and Turkey (4 %). Almost all frogs from Indonesia and a large portion of frogs from Turkey are caught from the wild – and recent field studies from Turkey have shown alarming decline of targeted frog populations: Çiçek *et al*. (2020) warn that native water frogs may go extinct until 2032 if current exploitation levels remain.

We summarize the level of exploitation in the EU's most relevant supplier countries and its conservation impact. Even the import of farmed frogs, which aims to unburden wild frog populations, is not *per se* sustainable, having in mind the potentially severe ecological risks that those farms pose to the environment.

Our report highlights the EU's ongoing central role as destination for billions of frogs, causing huge animal welfare problems and a negative impact on wild frog populations and their ecosystems. It also describes the tremendous challenges for enforcement, with large portions of imported products being mislabelled and taxonomic uncertainties remaining.

To cope with its Biodiversity Strategy 2030 and its ambitious Green Deal the European Union should therefore urgently:

- Take the lead in developing CITES listing proposals for species, which are preferentially targeted for the international market and those species that may be collected because they look like the targeted species – a measure which would not only facilitate enforcement but also incorporate the precautionary principle.
- Launch awareness campaigns in the main EU markets to reduce demand for frogs' legs, highlighting the associated problems for biodiversity, ecology, and animal welfare.

Additional recommendations to exporting and importing countries are given in chapter 7.2.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31992L0043&from=EN

1. Introduction

At all life stages frogs play a key role in their ecosystem as predators, prey, and biological services. Tadpoles help to stabilise water quality in ponds and other water bodies, acting as antagonists to eutrophication (Montaña *et al.* 2018). Frogs and tadpoles also significantly add to disease vector control (Propper et al. 2020; Murugan *et al.* 2015; Bowatte *et al.* 2013). In the absence of frogs, insect numbers and other agricultural pests may rise, resulting in increased use of pesticides (Khatiwada *et al.* 2016; Oza 1990).

Against this background it is alarming that amphibians are the most threatened group among vertebrates (IUCN Red List 2021). The threats are multiple and interconnected (Ford *et al.* 2020; Hof *et al.* 2011): Apart from pollution, climate change, habitat loss, and pathogenic fungal diseases, such as *Batrachochytrium dendrobatidis*, frogs are also globally threatened by direct exploitation (Scheele *et al.* 2018; Warkentin *et al.* 2009). They are collected for leather production and souvenirs, pet trade and cultural reasons, including traditional medicine (Kusrini & Alford 2006; Gonwouo & Rodel 2008). Moreover, international trade in frogs and frog products has significantly increased over recent decades and this commercialisation has driven exploitation to harmful levels (Auliya *et al.* 2016; Akiniyemi & Efenakpo 2015, Altherr *et al.* 2011).

The report turns the spotlight on humans' consumption of billions of frogs annually, of which a large number are taken from the wild. In some regions of Asia and Africa, frogs are referred to as "jumping chickens", as the taste is perceived to be similar to chicken (D'Silva 2015; Sheeladevi & Sundareswran 2013).

The vast majority of frog species are not protected by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and therefore international trade is poorly monitored or regulated or not regulated at all (Auliya *et al.* 2016). While the international pet trade often targets frog species with a more limited range and of smaller body size, collection for food is mainly focusing on large-sized frog species, most of which have a larger range (Chen *et al.* 2019).

In the recent past, frog farming has increased ostensibly to relieve collecting pressure from wild populations. However, in practice farming causes several problems for natural environments and even to wild frog populations (Ribeiro *et al.* 2019; Mercante *et al.* 2014).

As common names for frog species may vary our report refers to scientific names. For an overview of species in the international food trade see Table 1.

Table 1: Scientific and common names of frogs in the international food trade

* = considered a hybrid of *P. lessonae* and *P. ridibundus* (Hermaniuk *et al.* 2020)

Scientific name	Common names
Fejervarya cancrivora	Asian brackish frog, crab-eating frog, Mangrove frog, crab-eating grassfrog
Fejervarya limnocharis	Asian grass frog, rice field frog, Boie's wart frog, slpine cricket frog
Hoplobatrachus tigerinus	Indian bullfrog, Indus Valley bullfrog, Asian bullfrog
Hoplobatrachus rugulosus	East Asian bullfrog, Chinese edible bullfrog, Taiwanese frog, Asian rugose bullfrog
Limnonectes blythii	Blyth's wart frog, Blyth's river frog, Blyth's frog, giant Asian river frog
Limnonectes kuhlii	Large-headed frog, Kuhl's creek frog
Limnonectes macrodon	Malaya wart frog, giant Javan frog, fanged river frog, Javan giant frog, stone creek frog
Lithobates catesbeianus	American bullfrog
Lithobates forreri	Forrer's leopard frog, Forrer's grass frog
Pelophylax bedriagae	Bedriaga's frog, Levent water or green frog, Levantine green frog
Pelophylax caralitanus	Beyşehir frog, Anatolian frog
*Pelophylax esculentus complex**	edible frog, common water frog
Pelophylax kurtmuelleri	Balkan (water) frog, Greek marsh frog
Pelophylax ridibundus	Eurasian (marsh) frog
Pelophylax shqipericus	Albanian water frog, Balkan frog
Quasipaa spinosa	Chinese spiny frog, giant spiny frog, Chinese edible frog, spiny paa frog
Quasipaa verrucospinosa	(Granular) spiny frog, Verrucosa Spiny Frog

2. Frogs as Food & Medicine

The exploitation of edible frogs in several geographic regions is uncontrolled and unregulated, making its sustainability and perpetuation of viable populations uncertain (e.g., Gansa *et al.* 2021; Chan *et al.* 2014; Warkentin et al. 2009).

In general, large frogs are preferred for food over smaller ones (Chen *et al.* 2019; Ruland & Jeschke 2017; Mohneke *et al.* 2010). In several countries, smaller species are mainly used for the local market, while larger species are destined for commercial markets in larger cities or abroad (Grano 2020; Kusrini & Alford 2006).

2.1. Africa

Frog meat is a common and increasing protein source in several African countries. With a continuously growing human population and a simultaneous decline of protein resources such as fish the exploitation of amphibians has significantly increased, especially in Western Africa (Gansa *et al.* 2021; Mohneke *et al.* 2011):

In **Nigeria and Benin**, the African tiger frog *(Hoplobatrachus occipitalis)* is the most sold frog, followed by African bullfrogs *(Pyxicephalus edulis)*, grass frogs, e.g. *Ptychadena* spp., or African clawed frog, e.g., *Xenopus tropicalis* and *X. fishbergi* (Gansa *et al.* 2021). Mohneke *et al.* (2010) report intense cross-border trade between both countries. Other frog species are used for medicinal purposes (Efenakpo *et al.* 2016; Mohneke *et al.* 2011). According to a survey conducted in Ibadan, Nigeria, almost 2,850 frogs are annually sold per frog consumer (Akiniyemi & Efenakpo 2015). In the absence of known farming facilities, this trade is likely fully supplied by wild-caught specimens (Efenakpo *et al.* 2016). Collectors now report walking longer distances than previously to find enough frogs to viably harvest (Mohneke *et al.* 2009).

Surveys in **Côte d'Ivoire** showed that 55.2 % of households consumed frog meat (Blé *et al.* 2016). In **Cameroon and Equatorial Guinea**, frog meat is used for human consumption, mainly targeting the goliath frog *(Conraua goliath)* and the Cameroon slippery frog *(Conraua robusta)* (Altherr *et al.* 2011). The goliath frog, classified by the IUCN Red List as Endangered, has been seriously over-collected for subsistence and bushmeat markets (IUCN SSC Amphibian Specialist Group 2019). For the Togo slippery frog *(Conraua derooi)* the situation has become even worse: The total population size has dropped to less than 250 mature animals and is now classified as Critically Endangered (IUCN SSC Amphibian Specialist Group 2020b). In the highlands of Babanki, frogs and tadpoles of night frogs (*Astylosternus* spp., e.g., *A. [Trichobatrachus] robustus*) are often consumed (Doherty-Bone & Gvoždík 2017), with some species being endemic and highly threatened.

In **Southern Africa**, the giant African bullfrog *(Pyxicephalus adspersus)* is intensely exploited for human consumption, which has caused regional population declines (IUCN SSC Amphibian Specialist Group 2013). In northern **Namibia**, the species is considered a delicacy by several native tribes, who collect the frogs for subsistence and for sale at local markets (Okeyo *et al.* 2015). While globally classified as Least Concern in the IUCN Red List, the species is considered as Near Threatened in South Africa, based on estimated regional population declines of 50-80 %, due to habitat loss and collection for human consumption. Collection for consumption is especially high in the Provinces of Limpopo and Gauteng. Populations in Swaziland even have allegedly gone extinct (Yetman 2012).

2.2. Asia

Consumption of frogs is common in many regions and is an important protein source for local people in Cambodia, China, Hong Kong, Lao PDR, Malaysia, Vietnam (Grano 2020), India (Talukdar *et al.* 2020) and Indonesia (Kusrini & Alford 2006). In **India**, intense collection of wild frogs is reported from different regions: In Nagaland, 13 frog species were recorded during local food market surveys, including some rare species such as the Manipur frog *(Euphlyctis ghoshi)* and Khare's frog *(Pterorana khare)* (Talukdar *et al.* 2020). In Sikkim, local collectors pretend to catch more than allowed and being sustainable – with *Amolops* spp., *Nanorana* spp. and *Xenophrys* spp. being the most preferred species (Chettri *et al.* 2011). Frog meat is still sought-after for food and considered to have medicinal value in Ayurveda (D'Silva 2015).

In **Nepal's** mountainous regions, frog hunting for food and medicinal use is common, affecting the Sikkim paa frog *(Nanorana liebigii)*, Sikkim Asian frog *(Ombrana sikimensis)*, and Assam sucker frog *(Amolops formosus)*. Interviews with local people indicate serious declines of these species (Shrestha & Gurung 2019).

In **China**, the giant spiny frog *(Quasipaa spinosa)*, considered a delicacy, is classified as Vulnerable by the IUCN Red List due to over-exploitation (Lau *et al.* 2004). More recent studies confirm the serious level of overexploitation, causing a reduction of abundance by at least 59 % in five years, and similar developments are feared for other amphibian species exploited in China, such as *Quasipaa verruscospinosa* (Chan *et al.* 2014). Whether these species are among those exported as frogs' legs to the EU is not known.

In **Thailand**, live frogs are commonly seen at food markets, such as those in Bangkok. Previously, frog trade was mainly for domestic Thai consumption, but in the 1980s, more than six million East-Asian bullfrogs *(Hoplobatrachus rugulosus)* were exported to Hong Kong (Grano 2020). In the early 1990s, Thai farmers started farming frogs, mainly *Hoplobatrachus tigerinus* and *Lithobates catesbeianus*, neither of which are native to Thailand. Exports of frog meat is now common (Ribas & Poonlaphdecha 2016), with the USA being a main destination (see Chapter 2.2). Older residents of Khon Kaen, Isaan region, expressed regret that the only frogs normally available now are farm-raised (Dixon *et al.* 2007).

Throughout **Cambodia**, frogs are collected as a food source for local people (Grano 2020). Larger species such the Thai paa frog *(Quasipaa fasciculispina)*, *H. rugulosus*, baloon frog *(Glyphoglossus molossus)*, and the Asian black-spined toad *(Duttaphrynus melanostictus)* are preferably targeted, but some smaller species, such as the Asian grass frog *(Fejervarya limnocharis)*, are favoured as "snack frogs" (Neang 2010). *G. molossus* has been reported in cross-border trade to Thailand, where this species has already experienced serious declines; now evaluated by the IUCN as Near-Threatened (IUCN SSC Amphibian Specialist Group 2021). Exploitation has already led to local depletion of wild populations, especially where wholesale collecting takes place.

In **Vietnam**, a broad range of amphibian species are used for both human consumption and are fed to domestic animals. Large-sized species, such as *H. rugulosus*, giant spiny frog *(Quasipaa spinosa)*, and large-headed frogs *(Limnonectes kuhlii)* are preferably consumed (Grano 2020; Truong 2000). Vietnam is exporting *H. rugulosus* in large numbers (e.g., to North America, see Chapter 2.2), and according to import documents in Canada, animals are labelled as captive-bred (Gerson 2012).

In **Malaysia**, frogs are among the most intensely collected forest products for both subsistence and commercial sale (Howell *et al.* 2010). In the 1990s, commercial frog farms were established for two non-native species: *L. catesbeiana* and *H. tigerinus* (Hardouin 1997). However, the domestic market absorbs the entire domestic production of farmed frogs (Altherr *et al.* 2011).

In **Indonesia**, frogs are intensely used for food and additionally for medicinal purposes (Ainun *et al.* 2019; Kusrini & Alford 2006). While most wild-caught frogs are consumed locally, larger specimens are destined for exports, mainly as processed frogs' legs to Europe (see Chapter 4.2). Most frogs are caught in Java (Kusrini & Alford 2006), where the biggest exporter companies are based in Karawang, Indramayu, and Banten (Ainun *et al.* 2019). Members of the *Fejervarya limnocharis-*

iskandari complex, *F. cancrivora* and *Limnonectes macrodon* are among the most heavily exploited species (Kusrini 2005).

2.3. Latin America

Frog consumption is widespread in Latin America; however, there are few recent scientific studies. In the absence of more recent data for Argentina and Uruguay, we refer to Altherr *et al.* (2011) in these cases.

In **Mexico**, the endemic big-footed leopard frog *(Lithobates megapoda)* is heavily collected for local human consumption and medicinal purposes. The species' large body size and legs make it highly sought-after (Barragán-Ramírez *et al.* 2021). The species has declined by almost 30 % over the last decade and is now classified as Near Threatened, close to Vulnerable, in the IUCN Red List (IUCN SSC Amphibian Specialist Group 2020). In addition, Forrer's leopard frog *(Lithobates forreri)* is caught in large numbers for local demand and export to the USA (see chapter 2.4.).

In **Peru and Bolivia**, species of the genus *Telmatobius*, are used for food and the production of medicinal products (Serrano-Martínez *et al.* 2017; Catenazzi *et al.* 2010; Angulo 2008). This consumption is, next to water pollution, the biggest threat for these species, which led to the IUCN Red List classification as Endangered for e.g., Lake Titicaca water frog *(Telmatobius culeus)* and the shortsnout water frog *(T. brevirostris)* (IUCN SSC Amphibian Specialist Group 2020a, 2018).

In **Chile**, the endemic helmeted bullfrog *(Calyptocephalella gayi)* is collected for human consumption and for live exports as exotic pets, e.g., to the USA and Japan. Attempts to farm the species (since the 1970s) do not meet the commercial demand; hence captures from the wild are ongoing, although the species is classified by the IUCN Red List as Vulnerable (IUCN SSC Amphibian Specialist Group 2019a). Field studies indicate that tadpoles are taken in large numbers from the wild to restock the farms (Mora *et al.* 2021).

In **Brazil**, the non-native *Lithobates catesbeianus* is the most sold and farmed frog species. Consumption of frog meat has increased in recent years and new ways for marketing are explored (de Oliveira *et al.* 2017). The number of frog farms is also on their rise in Brazil: In 2019, at least 151 frog farms were recorded, producing 200 net tonnes of bullfrog meat. In the past, bull frog meat was exported to the USA; but those exports ceased as they were not economically viable (Ribeiro & Toledo 2021).

2.4. United States

The USFWS LEMIS Database (available for the period 2015-2020) records that the **USA** imported four frog species for human consumption:

- The most dominant species imported is *Lithobates catesbeianus*, under its previous name *Rana catesbeiana* (see Figure 1). Within the period 2015-2020, the USA imported more than 11.7 Mio live individuals and more than 14.5 Mio kg (live, as legs or meat). Main suppliers were Mexico, Ecuador, and China. Many specimens from Mexico were caught in the wild, while frogs from Ecuador and China were recorded as farmed.
- Imports of *H. rugulosus* individuals increased since 2018 (see Figure 1) and totalled to 350,016 kg as legs, 785,613 kg as meat and 2,785 live animals. Specimens from Thailand were labelled as captive-bred or ranched, while many specimens from Vietnam were labelled as wild-caught.
- Forrer's leopard frog *(Lithobates forreri)* are imported from Mexico, most of them alive (1,083,300 animals), but also as legs or meat (together 185,564 kg) and are recorded as wild-caught.

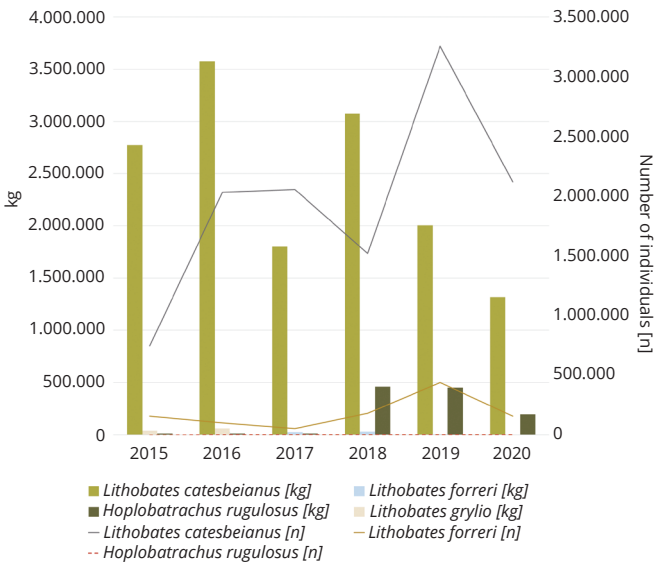

Figure 1: Frog imports by the USA for consumption (2015-2020, according to USFWS LEMIS Database 2021).

- Although the pig frog *(Lithobates grylio)* is native to USA, 91,000 kg meat were imported from China in 2015-2016, marked as captive-bred.

In contrast to the EU market there were no imports of frogs (*Fejervarya* spp., *Limnonectes* spp.) recorded from Indonesia or from Eastern Europe (*Pelophylax* spp).

3. Europe: a Main Consumer of Frogs' Legs

Switzerland imports live frogs and frogs' legs for human consumption. In 2006, the last year when frogs' legs were recorded separately in the import statistics, 150 t were imported, with 13 t from Turkey, 1.5 t from Belgium, and the remaining bulk from Indonesia (Bucheli & Moos 2015). Furthermore, an annual number of 450,000 live frogs is imported, mainly originating from Turkey and all caught from the wild, according to a statement by the Swiss Government (Bundesrat 2010).

Within the period 2010 to 2019, the **European Union** has been importing the total volume of 40,698 t of frogs' legs (EUROSTAT 2021). As based on calculations by Veith *et al.* (2000) one kilogram of frogs' legs correlates to 20-50 individual frogs, thus reflecting an import of 814 million to 2 billion frogs. Given an estimated pre-export mortality of 10-20 % (Niekisch 1986) – for more than 35 years no such studies were conducted – the EU is responsible for even higher number of dead frogs, the majority sourced from the wild.

3.1. Main consumers within the EU

For the period 2010-2019, Belgium has been by far the largest direct importer of frogs' legs of all EU Member States, summing up to 28.43 Mio. kg (= 69.85 %). France ranks second, with 6.79 Mio. kg (= 16.69 % of direct imports), followed by the Netherlands (2.62 Mio. kg, = 6.44 %), Italy (1.79 Mio. kg, = 4.39 %), and Spain (923,400 kg, = 2.27 %). Smaller volumes were imported by the United Kingdom (68,800 kg), Croatia (28,500 kg), Czech Republic (27,800 kg), Poland (12,500 kg), Romania (2,800 kg), and Germany (1,800 kg). Compared to the previous decade Belgium's role as primary destination has risen, from 53 % to now 70 % of imports (see Fig. 2).

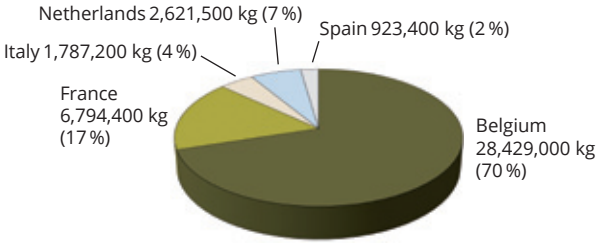

Figure 2: Main importers by weight and share of the EU's imports of frogs' legs for the period 2010-2019 (EUROSTAT 2021)

However, when looking at the internal EU trade data for 2010-2019, it becomes clear that the majority of Belgium's frogs' legs imports were re-exported to other EU Member States, with 20.92 Mio. kg alone sold to France and 1.41 Mio. kg to the Netherlands.

Already in the 1980s, France was identified as the main consumer for frogs' legs, with a peak in 1983, then reaching 4,522 tonnes (Le Serrec 1988). In reaction to its central role as destination for this trade France has started several steps to analyse the affected species range and potential ecological impact (Ohler & Nicolas 2017; MNHN 2012).

Case study France

According to French customs statistics, **France imported 30,015 tonnes of fresh, refrigerated or frozen frogs' legs between 2010 and 2019[2], which correlates to 600 to 1,5 million frogs**. Among the top supplying countries are Indonesia (24,102 t, 80.3 %), Vietnam (3,941 t, 13.1 %), Turkey (1,017 t, 3.4 %), and Albania (219.6 t, 0.7 %). The yearly imported quantities fluctuated **between 2,410 and 3,791 tonnes**. Subsequently, it can be noted that in 2021, the import declined to still 1,826 tonnes, despite a paralysis of international trade that year due to Covid-19.

Missing or incorrect labeling

A survey of the French market on the internet carried out in December 2021 by the non-governmental organization Robin des Bois found 20 different products at the websites of the major supermarket and frozen food brands (Auchan, Cora, Monoprix, Picard, etc.) and those specializing in culinary products, including Asian products. Among those products, 11 indicate Indonesia as the source, three Vietnam, one France (but offering wild *"Rana macrodon"* endemic to Indonesia) and one referring to "Turkey, Albania" as origin. In four sources, the country of origin is not provided to the consumer in the product description or visible on the internet pictures of the packages. In four sources, the species indicated is *Rana macrodon* (see also 4.2. for large-scale mis-labelling), for three *Fejervarya cancrivora*, for three others *Hoplobatrachus rugulosus*, for one „*Rana macrodon* or *Fejervarya cancrivora*", and for one *„Rana esculenta"*.

For six sources, the species is neither indicated in the product description nor visible on the internet pictures of the packages. **The lack of mention of the country of origin and the species contained in the product constitutes a violation of European Union law**. The „wild" nature of the frogs is highlighted for eight different products, three others indicate „fishing" and one indicates that the frogs have been „collected". None of the products mention a captive-bred or farmed origin.

In addition to raw or cooked frogs' legs, „frairine" is also offered for sale as a packaged product. This is described as a mix made from pork and frogs' legs seasoned with white wine. Neither the origin of the frogs nor the species of frogs used in the „frairine" are indicated.

In the framework of an additional market survey with e-mail alerts carried out between November 2021 and February 2022, Robin des Bois counted 38 commercial offers for frogs' legs, 20 of which came from Belgium and 18 from France.

French frogs on the plate

In addition to imports, the French market is also supplied by **wild frogs caught domestically**. Restaurants are supplied with grass frogs *(Rana temporaria)* through short marketing circuits (i.e., supply with a single intermediary). **This species is protected throughout the country** (Decree of November 19, 2007, establishing the list of protected amphibians and reptiles). However, many exemptions are granted. More than two million grass frogs are legally caught every year in the Franche-Comté region alone, according to the Direction régionale de l'environnement, de l'aménagement et du logement (DREAL 2022).

When the request for exemption concerns the capture of less than 1,500 frogs, consumption is considered as „family". **Poaching is also noted** (catching without a permit, exceeding quotas, catching outside authorised periods, etc). For example, in October 2018, two persons were fined 2,500 € for the capture of 4,000 grass frogs, with their permit only for 1,000 individuals (Robin des Bois 2019). In the same year, 17,950 grass frogs, which were seized alive, were returned to the natural environment by the French State services.

[2] LeKiosque.finances.gouv.fr, data extracted on 16 April 2019 and 26 April 2022

3.2. Main suppliers for the EU

With 30.02 Mio. kgs (= 74 %) of frogs' legs Indonesia was by far the leading supplier to the European Union's frogs' legs imports within the period 2010-2019, followed by Vietnam (8.44 Mio. kg, 21 %), Turkey (1.59 Mio. kg, 4 %), and Albania (0.59 Mio. kg, 1 %) (see Figure 3). China (37,700 kg), India (15,000 kg), Thailand (9,200 kg), Malaysia (7,600 kg), and South Korea (300 kg) only provided comparatively small amounts, summing up to less than 1 % of the EU's imports. Remarkably, India exported 5,000 kg of frogs' legs to the Netherlands in 2018, despite its export ban of 1987. This might be either a mix-up of country codes (ID/IN) in the EUROSTAT database or the export ban in India has been undermined.

Since India and Bangladesh successfully proposed listing of their most relevant frog species in CITES Appendix II in 1985 and stopped exports shortly afterwards (in 1987 and 1989, respectively) Indonesia stepped in and became the main supplier of frogs' legs to the EU.

For several decades, the EU has been the major importer of Indonesian frogs' legs, taking in more than 83 % of Indonesia's exports (Kusrini 2005). In 1987, 3,004 tonnes of frogs' legs were shipped from Indonesia to the European Union. In 1993, Indonesia increased its exports to the EU up to 4,700 tonnes (Veith *et al.* 2000). With one kilogram containing 20-50 individuals, the 1993 exports correspond with 94-235 million frogs.

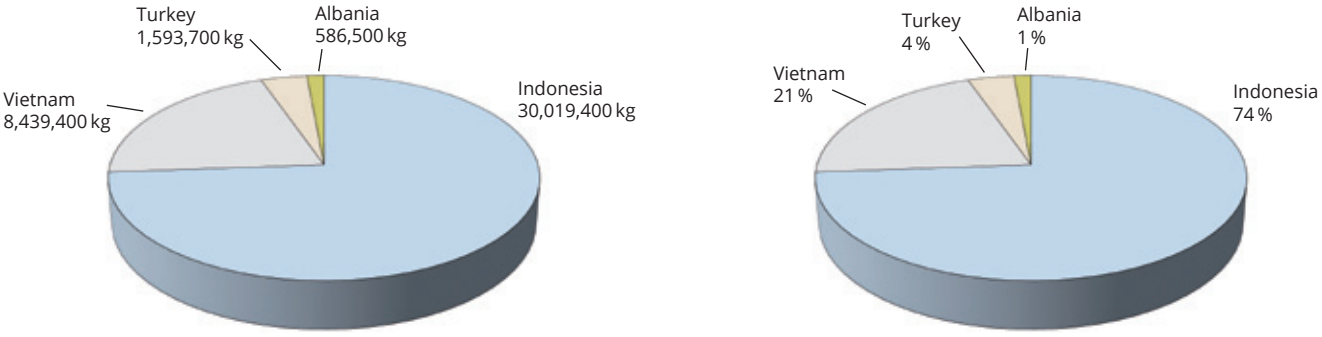

Figure 3: Main suppliers, by total weight (left) and share (right) of the EU's imports of frogs' legs for the period 2010-2019 (EUROSTAT 2021)

3.3. Trends in EU frogs' legs imports

Comparing the data for the period 2010-2019 with data of the previous decade (2000-2009, Altherr *et al.* 2011) three trends were noticed:

- The EU's imports of frogs' legs have slightly decreased, from 46.4 Mio. kg to 40.7 Mio kg. This is a drop by 12.29 %, compared to the previous decade, with imports for 2000-2009 reached 46,400 tonnes. This decline was not a continuous process but showed annual fluctuation and several peaks, e.g., in 2001, 2007, and 2010.
- Belgium's role as the main direct importer has increased from 53 % to 70 %, while direct imports by France and the Netherlands have declined from 23 % and 17 % within the period 2000-2009 to 17 % and 7 % at present.
- While Indonesia is, by a large margin, the leading supplier, Vietnam's role has increased from 8 % to 21 % and China has fallen from 3 % to much less than 1 %.

4. Over-Exploitation & Ecological Impact

In reaction to the serious depletion of frog populations in several supplying countries and/or trade shifts to other countries, species experts warn that these "extinction dominos" would continue to fall (Çiçek *et al.* 2020; Warkentin *et al.* 2009). Nevertheless, until today no relevant national or international measures (except the listing of two species, *Euphlyctis hexadactylus* and *Hoplobatrachus tigerinus*, in CITES App. II) were taken to halt the over-exploitation and/or reduce offtakes to sustainable levels.

In addition, an uncertain number of frogs caught and processed would need to be added to the actual documented export figures as many specimens arrive dead at the processing plants and are sorted out from the intended export (Grano 2020; Niekisch 1986).

Over-exploitation of frogs does not only cause the collapse of targeted populations but also has a much broader impact, the so-called "Ripple-effect", which impacts the ecological balance, causing a cascade of plagues of insects, snails and other prey of frogs, resulting in agricultural harvest losses, increased use of toxic and expensive pesticides, and increase of related risks for humans and ecosystems (Proper *et al.* 2020; Khatiwada *et al.* 2016; Truong 2000; Abdulali 1985). Such consequences illustrate the complexity of these interrelationships, on which harvest and trade of wild frog populations are largely based.

4.1. India and Bangladesh

Globally in the 1980s, India was the largest frogs' legs exporter (Abdulali 1985). In 1984, an export quota of 4,000 tonnes was established, which was reduced to 2,500 t in 1985. Since the 1970s, ecologists warned against the ecological impact of such massive offtakes, which would result in the increase of pests such as insects and crabs. Nevertheless, *E. hexadactylus* and *H. tigerinus* (at that time assigned to the genus *Rana*) were still intensely collected and exported to Europe (le Serrec 1988). In 1985, a survey among farmers confirmed the dramatic decrease of wild frog populations (Abdulali 1985). Because of the ongoing intense exploitation and the subsequent collapse of wild frog populations the use of pesticides dramatically increased (Oza 1990; Niekisch 1986; Pandian & Marian 1986).

In reply to the collapse of wild frog populations the Governments in Bangladesh and India initially discussed management programs, including seasonal or temporary bans or reduction of export quotas (Grano 2020). However, as seasonal bans were widely ignored, both countries finally decided to implement permanent export bans, India in 1987 and Bangladesh in 1989 (Grano 2020).

4.2. Indonesia

In Indonesia, approximately 14 frog species are exploited for human consumption, with four species dominating the international trade, i.e., *Fejervarya cancrivora, F. limnocharis, Limnonectes macrodon*, and the non-native *Lithobates catesbeianus* (Kusrini 2005). While native frog species are still taken from the wild, *L. catesbeianus* is raised on farms (Dittrich *et al.* 2017; Susanto 1994).

Calculated from present EU imports, Indonesia exports at least 28-142 million frogs per year, but Kusrini (2005) estimated that 2-7 times as many frogs are consumed within the country. While larger specimens (i.e., minimum snout-vent length 100 mm) are destined for export, smaller frogs are sold at local markets (Kusrini & Alford 2006, Kusrini 2005). In recent years, Indonesia has set export quotas; however, numbers strongly fluctuate, raising doubts on a scientific profound basis (see Table 2). While no export quota was set for frogs' legs of *L. macrodon*, there was a quota of 10,350 skins in 2015 and the same number in 2016, plus 1,350 live animals for the pet trade (Ditjen KSDAE 2015-2020).

Table 2: Indonesia's annual export quotas for frogs for consumption (Ditjen KSDAE 2015-2020).

Year	*F. cancrivora*	*F. limnocharis*
2015	0	12,150
2016	83,599, 250	0
2017	78,498,000	0
2018	72,086,805	0
2019	4,100,850	0
2020	56,985,845	0
2021	56,985,845	0

Indeed, indications of the lack of sustainability of Indonesia's frog exports are manifold:

In the early 1980s, a restocking program in Indonesia failed as the released frogs were collected faster than they could be replaced (Niekisch 1986). In the 1990s, researchers again warned against the decline of large-sized frogs in many parts of Java and Sumatra (Ohler & Nicolas 2017; Veith *et al.* 2000), from where most exported frogs' legs originate. In the 1980s, *L. macrodon, F. cancrivora*, and *L. blythii* reportedly dominated the frogs' legs exported from Indonesia to Europe (Le Serrec 1988). In 2005, the species range had obviously shifted, *F. cancrivora* accounted for 75 % of exports and *L. macrodon* for 19 % (Kusrini 2005). However, these figures are not only inconsistent with species labelling at the time of shipment, but also with genetic and biochemical analyses carried out in the EU for forensic purposes.

Limnonectes blythii (see Table 3), which in the past was among the most imported species for the frogs' legs trade in Europe (le Serrec 1988), is presently no longer in European trade, which may indicate a severe population decline in the wild. Recent field studies in West Sumatra hardly found the species outside sanctuaries (Hendri *et al.* 2018). According to an outdated IUCN Red List assessment of 2004 the species was intensively collected for consumption, at that time already with decreasing populations (van Dijk & Iskandar 2004).

Wild populations of *L. macrodon* are decreasing (see Table 3). While the IUCN Red List assessment does not indicate the massive collection from the wild as a reason for the decline (IUCN SSC Amphibian Specialist Group 2018a), Ohler & Nicolas (2017) found that this large-legged species has almost vanished from frogs' legs imported to Europe: Although a very large portion of frogs' legs from Indonesia at the French market are labelled as *"Limnonectes macrodon"*, only 0.96 % were correctly labelled, while the others (except one) were in fact *F. cancrivora*. According to Ohler & Nicolas (2017) this may indicate a significant decline of *L. macrodon* in the wild, at least from the centres of commercial collection.

Unfortunately, *F. cancrivora*, the species caught in largest numbers for the frogs' legs trade, has not been reassessed in the IUCN Red List since 2004 (see Table 3). At that time the species was considered as Least Concern, with increasing populations (Zhigang *et al.* 2004). While we are not aware of more recent population studies, there are strong indications for substantial regional population declines.

As reported from India and Bangladesh in the 1980s, history appears to be repeating itself in Indonesia: The absence of natural predators has led to plagues of key rice agriculture pests – and since 2002, when eased regulations came into effect, Prihandiani *et al.* (2021) documented "a tsunami of pesticide uses for rice production" in Java.

Table 3: Major frog species from Indonesia, exploited for human consumption in Europe

Fejervarya cancrivora

Asian brackish frog, crab-eating frog

IUCN Red List: Least Concern (2004, outdated)

Population Trend: Increasing (as of 2004)

Range States: Thailand, peninsular Malaysia, Indonesia (Kalimantan, Sumatra, Java, Bali) (Yodthong *et al.* 2019); according to recent studies also in coastal China and northern Vietnam (Zheng *et al.* 2021).

Threats: Exploitation for food, habitat loss

Remarks: Indonesia's export quota sharply increased in 2016 to more than 83 Mio animals for consumption and since then strong fluctuations. Assumed over-exploitation.

Fejervarya limnocharis

Asian grass frog, rice field frog

IUCN Red List: Least Concern (2004, outdated)

Population Trend: Increasing (as of 2004)

Range States: Brunei Darussalam?; Cambodia; China; Hong Kong?; India; Indonesia; Lao PDR; Macao; Malaysia; Myanmar; Singapore?; Taiwan; Thailand; Vietnam (Frost 2021; Chandramouli *et al.* 2020)

Threats: Exploitation for food, habitat loss

Remarks: Cryptic-species complex. Since 2015, no export quota by Indonesia for consumption (Ditjen KSDAE 2015-2020).

Limnonectes blythii

Blyth's wart frog

IUCN Red List: Near Threatend (2004, outdated)

Population Trend: Decreasing (as of 2004)

Range States: Indonesia; Lao PDR?; Malaysia; Myanmar; Singapore; Thailand; Vietnam?

Threats: Exploitation for food, habitat loss

Remarks: In the 1980s one of the most dominant frogs in Indonesia's exports but seems to have vanished from international frogs' legs market since then; in West Sumatra hardly found outside protected areas.

Limnonectes macrodon

Malaya wart frog, giant Javan frog

IUCN Red List: Least Concern (2017)

Population Trend: Decreasing

Range States: Indonesia (Java, Sumatra)

Threats: Habitat loss, water pollution, exploitation for food

Remarks: Species seems to have vanished from international frogs' legs market, according to French DNA study (Ohler & Nicolas 2017). In recent years Indonesia set no export quota for consumption, only for skins and pets in 2015 and 2016 (Ditjen KSDAE 2015-2020).

4.3. Vietnam

In Vietnam, several frog species are consumed as food, including *Limnonectes kuhlii, Hoplobatrachus rugulosus, Quasipaa spinosa*, and *Q. verrucospinosa* (Grano 2020).

As wild frog populations have been in serious decline due to over-exploitation since the 2000s, farming of frogs has been increasing in Vietnam. In 2010, the Vietnamese government recognized the potential of the frog farming industry as a food source and poverty alleviation strategy and included frog farming as an element to expand in the aquaculture industry by 2020. Nevertheless, according to Nguyen (2017) frog farming in Vietnam is characterised by low profitability. Frog farming focuses on three species:

- The native *H. rugulosus* is commonly exported for the international frogs' legs trade. It has become popular in frog farms due to its short life cycle and its easy adaptation to farming conditions, accepting static food (Le 2012).
- *H. tigerinus*, listed in CITES App. II since 1985, a non-native species, and
- *Lithobates catesbeianus* (non-native species).

All three species are farmed in large numbers, with all related ecological risks (see Chapter 5).

Nevertheless, wild frogs are still collected to supply the market and to (re)stock the growing number of frog farms (Borzée *et al.* 2021; Le 2012). Farming of *Q. spinosa* particularly, classified by the IUCN Red List as Vulnerable (Lau *et al.* 2004), remains difficult (Yu *et al.* 2016) as does the farming of *H. rugulosus* (Borzée *et al.* 2021). Unfortunately, *H. rugulosus* has not been reassessed by IUCN since 2004, when it was classified as Least Concern with stable populations (Diesmos *et al.* 2004).

Frogs are mainly exported by Vietnam to China, and as frogs' legs to the European Union (Belgium, followed by Spain, the Netherlands), and the USA (Vietnam Trades 2021; Nguyen 2017). According to the USFWS LEMIS Trade Database (2021) a large portion of Vietnam's exports of *H. rugulosus* are labelled as wild-caught (see Chapter 2.4), while exports to the EU were proven to be farmed (Dittrich *et al.* 2017). In March 2020, the Ministry of Agriculture ordered a ban on trade in wildlife. Since then, the sale of wild native *H. rugulosus* has been discontinued in the country and the populations may improve from a break in wild harvests (Borzée *et al*. 2021).

Table 4: Frog species from Vietnam, exploited for human consumption (selection)

Hoplobatrachus rugulosus

East Asian frog, Chinese edible bullfrog

IUCN Red List: Least Concern (2004, outdated)

Population Trend: Stable (as of 2004)

Range States: Cambodia; China; Hong Kong; Lao PDR; Macao?; Malaysia; Myanmar; Taiwan; Thailand; Vietnam; introduced to Borneo and the Philippines (Frost 2021)

Threats: Habitat loss, water pollution, exploitation for food

Remarks: Still caught from the wild in large numbers, either directly to be marketed or to restock farms, e.g., in Vietnam

Quasipaa spinosa

Chinese edible frog, giant spiny frog

IUCN Red List: Vulnerable (2004, outdated)

Population Trend: Decreasing (as of 2004)

Range States: China; Hong Kong; Vietnam; likely in parts of Lao PDR and Myanmar (Frost 2021)

Threats: Habitat loss, exploitation for food

Remarks: Heavily exploited for human consumption for many decades, considered a delicacy in China. Reduction of abundance in Hong Kong by at least 59% in five years. Exports to Europe not confirmed.

4.4. Turkey

In Turkey, there is no domestic consumption of frogs except in some tourist restaurants. However, Turkey is a leading supplier of frogs' legs for the European market (Çiçek *et al.* 2020; Le Serrec 1988). Exports are primarily to e.g., Italy, France and Switzerland (Şereflişan & Alkaya 2016). In addition to frogs' legs, exports to Switzerland also include hundreds of thousands of live frogs, all caught from the wild (Bundesrat 2010).

At present, Turkey exports almost 700 tonnes of frogs annually (~ 14-35 million individuals), mostly of the Anatolian water frog complex, *Pelophylax* spp. (Çiçek *et al.* 2020, Veith *et al.* 2000, see Table 5).

According to the IUCN Red List this trade is a significant threat to local populations of *Pelophylax ridibundus, P. caralitanus*, and *P. bedriagae* in Turkey (Kuzmin *et al.* 2009; Öz *et al*. 2009; Papenfuss *et al.* 2009).

More than 1/3 of total captures are originating from Seyhan and Ceyhan Deltas in Adana Province, representing c. 17 million frogs per year just from that region (Çiçek *et al.* 2020). Other Turkish provinces with intense frog collection are Edirne, Hatay, and Toplam (Şereflişan & Alkaya 2016).

Exploitation of frogs over four decades has decimated wild frog populations in Turkey: During a 3-year field study Çiçek *et al.* (2020) recorded an annual

Table 5: Frog species from Turkey, exploited for human consumption in Europe (selection)

Pelophylax bedriagae

Levant water frog

IUCN Red List: Least Concern (2008, outdated)

Population Trend: Decreasing (as of 2008)

Range States: Cyprus; Egypt; Greece; Israel; Jordan; Lebanon; Syria; Turkey

Threats: Habitat loss, excessive drought, exploitation for food

Remarks: Population in Turkey significantly threatened by extensive captures for western Europe. High extinction risk until 2032.

Pelophylax caralitanus

Anatolian frog, Beyşehir frog

IUCN Red List: Near Threatend (2008, outdated)

Population Trend: Decreasing

Range States: Turkey

Threats: Habitat loss, exploitation for food, hybridization

Remarks: Largest edible frog in Turkey; **now considered endangered** due to overcollection for European frogs' legs market (Erişmiş 2018). High extinction risk until 2032.

Pelophylax ridibundus

Marsh frog

IUCN Red List: Least Concern (2008, outdated)

Population Trend: Increasing

Global Range: Western Europe across the Arabian Peninsula via Central Asia, and east to Russia, China

Threats: Decline of breeding habitats, droughts (likely inclined by global warming), regional exploitation for food

Remarks: Invasiveness proven in western and central Europe. Intense commercial harvest, likely results in demographic changes, "commercial collectors prefer collecting larger sized individuals" (Erişmiş 2011).

population reduction of c. 20 % and warned that ongoing overexploitation will fuel future rapid decline, with extinction highly likely by 2032. Although frog farming was initiated in recent years, wild-caught frogs still constitute the vast majority of exports. Collectors require a licence issued from the provincial Agriculture authority.

The Turkish frog exporting companies are labelling all frogs as *"Pelophylax esculentus"*, a hybrid form that has to date not been recorded in Turkey (Çiçek *et al.* 2020; Gerson 2012). This practice ignores taxonomic uncertainties and thus hinders the establishment of species-specific management measures. Furthermore, exported frogs are not only caught in the regions of frog processing companies, but are also caught in other parts of Turkey and even in neighbouring Syria. Çiçek *et al.* (2020) notes that the impact of overharvesting may therefore not be immediately reflected in export figures. In recent years, however, ongoing over-exploitation is indicated by the decreasing body size of targeted frogs, resulting in lower export prices. Şereflişan & Alkaya (2016) therefore consider a hunting ban for frogs as necessary.

4.5. Albania

While frog exports from Montenegro declined after years of excessive exploitation for exports (UNEP-WCMC 2007), Albania remains the fourth biggest supplier for the EU market (see Chapter 3.2).

Albania has, so far, no specific management plan for the conservation of the threatened *Pelophylax shqipericus* (Eco Albania 2019). The species is classified by the IUCN Red List as Vulnerable, with declining wild populations. In the northern parts of its range, it is significantly threatened by over-collection for human consumption, for national and international markets (IUCN SSC Amphibian Specialist Group 2020c; Eco Albania 2019). It is also collected for the international pet trade, which further contributes to the decline of populations (Frank *et al.* 2018).

At least in northern parts of its native range *P. kurtmuelleri* (see Table 6) is significantly threatened by over-collection for commercial purposes (Uzzell *et al.* 2009).

In the past, Albanian populations of *P. epeiroticus* were targeted for national and international trade for consumption; however, at present there is no evidence that excessive collection of this species remains ongoing (IUCN SSC Amphibian Specialist Group 2020d).

Table 6: Frog species from Albania, exploited for human consumption in Europe (selection)

Pelophylax kurtmuelleri

Balkan water frog

IUCN Red List: Least Concern (2008, outdated)

Population Trend: Stable (as of 2008)

Range States: Albania, Greece

Threats: Habitat loss, water pollution, exploitation for food, IAS

Remarks: Exploitation for human consumption for both national and international trade. Wild populations are also threatened by non-native water frogs, introduced for commerce.

Pelophylax shqipericus

Albanian water frog

IUCN Red List: Vulnerable (2019)

Population Trend: Decreasing

Range States: Albania, Montenegro

Threats: Habitat loss, water pollution, exploitation for food, IAS

Remarks: Exploitation for human consumption for both national and international trade. Wild populations are also threatened by non-native water frogs, introduced for commerce.

5. Is Frog Farming a Way Out?

Globally, farming of bullfrogs emerged as an alternative to overharvesting native amphibian species (Ribeiro *et al.* 2019). According to the FAO (2020) global frog farming has steadily increased, from 79,600 tonnes in 2010 to 107,300 tonnes in 2018. After initial technical challenges commercial farming operations (especially for *L. catesbeianus*) developed in Taiwan since the 1950s and in Brazil since the mid-1970s. According to their reports to the FAO, both countries are the largest producers of bull frogs; however, farms commercially breeding *L. catesbeianus* also exist in many other countries, e.g., Mexico, Guatemala, El Salvador, Panama, Ecuador, Argentina, Thailand, Indonesia, the Lao People's Democratic Republic, Vietnam, and Malaysia (FAO 2020).

In Vietnam, hundreds of frog farms have been established, with 33 in just one single commune (Nguyen 2017), and a large portion of exported frogs' legs are produced by these farms. A further increase of frog farms has been recommended in several countries, including Turkey, India, Vietnam, and Cambodia (Ribeiro *et al.* 2021; Çiçek *et al.* 2020; Nary 2020; Nguyen 2017; D'Silva 2015). Recently, frog farming has started in France, with presently five farms known, producing about 10 t per year (AFP 2020) – an amount that is still far below the actual national demand for consumption.

In practice, many attempts to establish frog farms failed for different reasons. A major challenge is to switch the diet of frogs from live and moving prey to non-live food (Helfrich *et al.* 2009; Miles *et al.* 2004) and provisioning of frogs with live prey is expensive and too time consuming to make it profitable (Dittrich *et al.* 2017). In addition, cannibalism among tadpoles causes high mortality (Nguyen 2017; Pandian & Marian 1986).

Where successfully established, frog farms have been proven to place serious risks on ecosystems (see below). To prevent negative ecological effects from frog farms to the environment – in terms of native frog populations, biodiversity, and water pollution – strict requirements are needed, e.g.:

- Ban non-native and hybrid farmed species (which are potentially invasive) to prevent genetic pollution
- Water systems should be closed and other methods to avoid pathogen transmission need to be implemented,
- Locations (e.g., regarding water supply, light, space) should be geographically restricted,
- Treatment of diseases should be strictly regulated,
- A ban of restocking from the wild should be implemented.

However, in practice, regulations are often lax, if extant at all, and monitoring and enforcement is often poor (Nguyen & Tran 2021; Chan *et al.* 2014).

5.1. Invasive species

The most intensely farmed frog species worldwide is *Lithobates catesbeianus*, considered as one of the world's worst invasive species (ISSG 2009). Escapees of *L. catesbeianus* from farms have led to the establishment of invasive bullfrog populations in the wild, which is suspected to cause substantial ecological damage, including negative impact on native wild amphibians (Ribeiro *et al.* 2019; Louette *et al.* 2013).

Accordingly, authorities in Vietnam advise farmers to avoid *L. catesbeianus* and cultivate native species instead (Nguyen 2017).

Non-native species of the European water frog complex (*Pelophylax* spp.) have been repeatedly introduced to several European countries, in which they do not naturally occur, including Belgium, France, Italy, Germany, and Spain, due to uncontrolled commercial trade (Domeneghetti *et al.* 2013; Holsbeek *et al.* 2008).

5.2. Pathogens

More than 200 commercial frog farms in Argentina produce American bullfrogs to meet the demand especially from markets in large cities (Altherr *et al.* 2011; Coppo *et al.* 2005). However, concerns have been raised about these farms as potential sources for virulent zoospores of the frog-killing fungus being released into the natural environment (Ribeiro *et al.* 2019).

Farm-raised frogs are an important reservoir of a variety of bacteria, including *Klebsiella, Streptococcus,* and *Salmonella* (FAO 2022; Ribas & Poonlaphdecha 2016). Antibiotics, other pharmaceuticals, and chemicals (such as Chlorine or Ammonia) are often used, even as prophylactic measures (D'Silva 2015). In addition, *L. catesbeianus* is highly tolerant to the fungal disease chytridiomycosis, caused by the frog-killing fungus *Batrachochytrium dendrobatidis (Bd)*, and serves as pathogen reservoirs and vectors (Eskew *et al.* 2015; Schloegel *et al.* 2012). The farming of *Bd*-infected bullfrogs can create ideal conditions for outbreaks of chytridiomycosis and declines of native fauna – in terms of high frog densities in the farms, escaped frogs, and the release of water from the farming operations into the natural environment (Ribeiro *et al.* 2015).

5.3. Use of hybrids in frog farms

According to surveys among farmers, *H. rugulosus* is the favoured species for Vietnamese farms. However, they have been hybridised with other frog species and genetically pure *H. rugulosus* are now hardly available for farmers. This has resulted in lower breeding yields than had existed previously (Nguyen 2017). In Bangladesh, hybrids between *H. tigerinus* and *H. litoralis* were recently tested for their suitability in farming (Lutz 2020).

Highly invasive: North-American bullfrog (Lithobates catesbeianus)

6. Control & Enforcement

6.1. Look-alike problems

Several studies and reports document the enormous difficulties distinguishing frogs' legs in trade and a substantial level of mislabelling:

- All frogs' legs imported into Canada from Indonesia were indiscriminately labelled as *"Limnonectes macrodon"* (Gerson 2012), although collection in and export by Indonesia target several large-sized species native to the country.
- DNA analysis by Veith *et al.* (2000) showed that frozen frogs' legs imported into Belgium, labelled as four different species, are in fact only ascertained *F. cancrivora* specimens – even the samples labelled as farmed *L. catesbeianus*.
- Via DNA barcoding Ohler & Nicolas (2017) found that 99.04 % of frogs' legs in French supermarkets were incorrectly labelled.

Frogs' legs in French supermarket, labelled as "Fejervarya" from Indonesia

- High levels of mislabelling were also proven by Dittrich *et al.* (2017), who examined more than 71 % of frogs' legs in a German supermarket, labelled as *"Limnonectes macrodon"*, were actually *F. cancrivora* specimens.

Some experts assume that this high degree of mislabelling is not intentional but, instead, caused by the inability of the frog processors and exporters to discriminate between the species in trade (Ohler & Nicolas 2017; MNHN 2012; Veith *et al.* 2000). While live frogs can be eventually distinguished by external morphological traits e.g., skin folds, diameter of tympanum, toe webbing, colour pattern, and body proportions (e.g., Kurniawan *et al.* 2011), these identifiers are removed in skinned, processed, and frozen frogs' legs.

Thanks to new methods of DNA barcoding new tools are available to identify which species are used in the frogs' legs trade (Ohler & Nicolas 2017) and distinguish between wild-caught and intensively farmed frogs (Dittrich *et al.* 2017). Amino acid levels are also higher in cultivated marsh frogs, as compared to wild individuals (Alkaya *et al.* 2018).

6.2. Taxonomic uncertainties

Several taxa involved in the European frogs' legs trade, are cryptic and their taxonomic status remains uncertain, e.g., for sympatrically occurring species of the *F. cancrivora* species group (Yodthong *et al.* 2019; Kurniawan *et al.* 2011), *H. rugulosus* (Yu *et al.* 2015) or taxa included in the genus *Pelophylax* (Dufresnes *et al.* 2018). Genetic analysis indicated high divergence within *H. rugulosus*, especially between wild and farmed tiger frogs (Yu *et al.* 2015), meaning that multiple species may exist.

These uncertainties, combined with a high level of phenotypic similarity, make correct identification in the trade an insurmountable obstacle for law enforcement authorities (see Chapter 4.2.).

7. Conclusions & Recommendations

7.1. Conclusions

7.1.1. Lack of Sustainability

Up-to-date population data from the wild as well as the identification of species and related products in trade are both preconditions to ensure sustainability in wildlife trade. Several characteristics of the frogs' legs trade, however, inhibit sustainability:

- For most of the relevant species in trade recent population data are lacking, IUCN Red List assessments are outdated, and the impact of massive off-takes over decades is poorly understood, resulting in manifold uncertainties despite ongoing international trade activities.
- Trade affects species of unclear taxonomy and of cryptic species complexes (Yodthong *et al.* 2019; Dufresnes *et al.* 2018).
- Trade in skinned, processed, and frozen frogs, combined with a high portion packaged with false labels, makes visual identification and enforcement impossible (Veith *et al.* 2000).
- Trade data are often non-specific and incomplete: For instance, EUROSTAT only records the commodity "frogs' legs", ignoring the specific species in trade and omitting import data for live frogs (DESTATIS 2022).
- The lack of, or weakness in, harvest regulations for wild-caught frogs in several supplier countries is alarming, as is also the obviously arbitrary setting of export quotas in Indonesia.

For more than a decade scientists and conservationists advocated for the rigorous implementation of clear policies regulating the domestic and international trade in amphibians to stop the "extinction domino" effect (Çiçek *et al.* 2020; Gratwicke *et al.* 2010; Warkentin et al. 2009).

With new technologies (and their refinement) now available to help identify species in the frogs' legs trade – even for skinned, processed, and frozen products – and to distinguish between wild-caught and farmed animals CITES listings of the most relevant genera in trade will be enforceable and are urgently recommended.

7.1.2. National measures by range states so far

Temporary harvest bans, e.g., during mating season, failed to be successful in India and Bangladesh (Grano 2020). In Turkey, **size limits** are already in place, but enforcement is weak (Çiçek *et al.* 2020). If seasonal bans are considered by range states they need to be adapted to regional conditions, reflecting the biological behaviour of the targeted species – and must be firmly enforced.

As a minimum **catch and export quotas** need to be established, based on precautionary population data and taking into account abundance, demography, and life-history characteristics of targeted species.

While **frog farming** has become an important livelihood in some countries, e.g., in Vietnam and Thailand (Thuy *et al.* 2021; Rongchapho *et al.* 2021), strict regulations and enforcement are needed to prevent negative ecological impacts.

Warkentin *et al.* (2009) urged range states and importing countries to jointly establish a mandatory certification process for the harvest of wild frogs. However, no such process has yet been achieved.

7.1.3. International trade restrictions

To date, very few frog species of those heavily exploited for human consumption have been protected by a listing in the Appendices of CITES:

- In reply to the dramatic decrease of exploited frogs in Bangladesh and India, *Euphlyctis hexadactylus* and *Hoplobatrachus tigerinus* were listed in CITES Appendix II in 1985.
- Chile included its endemic *Calyptocephalella gayi* in CITES Appendix III in 2011.
- In 2016, Bolivia and Peru successfully proposed the CITES Appendix I listing of the Titicaca water frog *(Telmatobius culeus)*.

For all other frog species exploited for the frogs' legs trade this trade remains unregulated today, despite proven direct negative impacts on target species and indirect risks to ecosystems.

After the CITES App. II listing of *H. tigerinus* exports of wild-caught animals from Bangladesh stopped within

few years, while Vietnam started export of farmed individuals (Carpenter *et al.* 2014).

7.2. Recommendations

7.2.1. For export and import countries

In 2010, Gratwicke *et al.* stated that more CITES listings could help reduce the impact of this trade. As indicated by the IUCN Red List assessments for several trade-relevant frog species, there is a need for an improved monitoring and regulation of current trade activities, e.g., for *Pelophylax shqipericus* and *Limnonectes macrodon* (IUCN SSC Amphibian Specialist Group 2020c, 2018a).

While some species in the international frogs' legs trade are not (yet) considered as threatened – at this point it should be noted that many IUCN Red List assessments need an update – other species, often reflecting same taxon and occurring sympatrically with closely related species, reveal declining populations, are much rarer or are considered Vulnerable. Due to inevitably enormous challenges to correctly identify species of skinned, processed, and frozen frogs' legs along trade chains, resulting in unverifiable mislabelling, stricter CITES regulations for international frogs' legs are needed; the CITES Parties should consider the look-alike-problem and look-alike requirements should be passed at least on the genus level – as a preliminary approach for *Fejervarya* spp., *Limnonectes* spp., *Pelophylax* spp., and *Hoplobatrachus* spp.

7.2.2. Exporting countries are required to…

- Conduct field surveys to estimate size and trends of wild frog populations and potential impact of collection for both national consumption and international trade;
- Establish conservative catch and export quotas, based on profound and precautionary data for the targeted wild population and considering other threats, to ensure sustainable offtake levels;
- Develop CITES listing proposals for frog taxa (and hereby considering cryptic species complexes) which are threatened by over-exploitation for human consumption;
- Define strict regulations for farming operations to ensure closed systems, to prevent re-stocking from the wild and release into the environment, as well as to avoid farming of non-native species;
- Establish humane standards to govern capture, handling, and slaughtering of the frogs;
- Provide full transparency with regard to major players, e.g., register all export companies and their suppliers;
- Exporters should be obliged to fully cooperate with relevant personnel regarding DNA analysis of processed frogs' legs to verify species, origin and source.

7.2.3. Importing countries are required to…

- Develop, in cooperation with range states, CITES listing proposals for frog taxa (and hereby considering cryptic complexes) threatened by over-exploitation for human consumption;
- Assist range states in conducting surveys of wild frog populations;
- Launch awareness campaigns in order to reduce demand for frogs' legs;
- Create a biobank with references samples from species/populations of major harvest regions to cross-check genetic identities of shipments imported;
- Conduct random DNA analysis of frogs' legs shipments to determine if shipment labelling is correct;
- Only permit import of skinned, processed, and frozen frogs' legs to avoid the introduction and spreading of diseases and invasive species; and
- Ensure random DNA tests to verify species under a defined test system.

8. References

Abdulali, H. (1985). On the exports of frogs' legs from India. *J. Bombay Nat. Hist. Soc.* 82: 347-375.

AFP (2020). Meet the French frog farmers attempting to crack the local market. News of 12 October.

Ainun, K. et al. (2019). The pros and cons of the using of frog as a medical treatment in society. Meeting Report. *International Halal Conference & Exhibition* 1(1): 79-84.

Akiniyemi, A. & E. Efenakpo (2015). Frog consumption pattern in Ibadan, Nigeria. *J. Stud. Man. Plan.* 1(3): 522-531.

Altherr, S. *et al.* (2011). Canapés to extinction – the international trade in frogs' legs and its ecological impact. Pro Wildlife, Defenders of Wildlife & Animal Welfare Institute (eds.), 36 pp.

Alkaya, A. *et al.* (2018). Comparison of pond-raised and wild female marsh frog *(Pelophylax ridibundus)* with respect to proximate composition and amino acids profiles. Fresenius Env. Bull. 27(9): 6330-6336.

Angulo, A. (2008). Consumption of Andean Frogs of the Genus *Telmatobius* in Cusco, Peru: Recommendations for their Conservation. *TRAFFIC Bull.* 21(3): 95-97.

Auliya, M. *et al.* (2016). The global amphibian trade flows through Europe: the need for enforcing and improving legislation. *Biodiv. Cons.* 25: 2581–2595.

Barragán-Ramírez, J. *et al.* (2021). Feeding habits of *Lithobates megapoda*, a threatened leopard frog used for human consumption, in Lake Chapala, Mexico. *Phyllomedusa* 20(1): 75-88.

Blé, Y. *et al.* (2016). Consumption, proximate and mineral composition of edible frog *Hoplobatrachus occipitalis* from Midwest areas of Côte d'Ivoire. *Afr. J. Sci. Res*. 5(3):16-20.

Borzée, A. *et al.* (2021). Using the 2020 global pandemic as a springboard to highlight the need for amphibian conservation in eastern Asia. *Biol. Cons.* 255: 108973.

Bowatte, G. *et al.* (2013). Tadpoles as dengue mosquito *(Aedes aegypti)* egg predators. *Biological Control* 67: 569-474.

Bucheli, S. & S. Moos (2015). Frösche aus der Türkei sorgen in der Schweiz für Geschrei. Online article, 30 January, umweltnetz-schweiz.ch.

Bundesrat der Schweiz (2010). Stellungnahme vom 3.2.10 zur Interpellation 09.4290 von M. Graf.

Catenazzi, A. *et al.* (2010). *Batrachochytrium dendrobatidis* in the live frog trade of *Telmatobius* (Anura: Ceratophryidae) in the tropical Andes. *Dis. Aquat. Organ*. 92: 187-191.

Chan, H. *et al.* (2014). Demography of *Quasipaa* frogs in China reveals high vulnerability to widespread harvest pressure. *Biol. Cons.* 170: 3–9.

Chandramouli, S. *et al.* (2020). On the identity of two *Fejervarya* frog (Dicroglossidae) species from the Andaman and Nicobar Archipelago. *Taprobanica* 9(2): 194–204.

Chen, C. *et al.* (2019). Ecological correlates of extinction risk in Chinese amphibians. *Div. & Distr.* 25: 1586–1598.

Chettri, B. *et al.* (2011). An overview of the herpetofauna of Sikkim with emphasis on the elevational distribution pattern and threats and conservation issues, In: *Biodiversity of Sikkim: Exploring and Conserving a Global Hotspot*. M. Arrawatia & S. Tambe (eds.), Department of Information and Public Relations, Government of Sikkim, India, pp. 233–254.

Çiçek, K. *et al.* (2020). Unsustainable harvest of water frogs in southern Turkey for the European market. *Oryx* 55(3): 364-372.

Coppo, J. *et al.* (2005). Blood and urine physiological values in farm-cultured *Rana catesbeiana* (Anura: Ranidae) in Argentina. *Rev. Bio. Trop.* 53(3-4): 545-559.

De Oliveira, L. *et al.* (2017). Frog meat in special diets: Potential for use as a functional good. *Bol. Inst. Pesca, São Paulo*, 44(vol. esp.): 99-106.

DESTATIS (2022). *In litt.* to Pro Wildlife, 7 April.

Diesmos, A. *et al.* (2004). *Hoplobatrachus rugulosus*. The IUCN Red List of Threatened Species 2004: e.T58300A11760194.

Ditjen KSDAE (2015-2020). Kuota pengambilan Tumbuhan Alam Dan Penangkapan Satwa Liar Periode Tahun 2015-2020.

Dittrich, C. (2017). Stable isotope analyses — A method to distinguish intensively farmed from wild frogs. *Ecol. Evol.* 7(8): 2525-2534.

Dixon, J. *et al.* (2007). Dietary diversity in Khon Kaen, Thailand, 1988–2006. *Int. J. Epidem*. 36: 518–521.

Doherty-Bone, T. & Gvoždík, V. (2017). The Amphibians of Mount Oku, Cameroon: an updated species inventory and conservation review. *Zookeys* 643: 109-139.

Domeneghetti, D. *et al.* (2013). Discovery of alien water frogs (gen. *Pelophylax*) in Umbria, with first report of *P. shqipericus* for Italy. *Acta Herpetologica* 8(2): 171-176.

DREAL (2022): https://www.bourgogne-franche-comte.developpement-durable.gouv.fr/ranaculture-bourgogne-franche-comte-dossiers-de-a6583.html.

D'Silva, R. (2015). Frog culture – why not? *Int. J. Man. Behav. Sci.* 6-7: 418-426.

Dufresnes, C. *et al.* (2018). Invasion genetics of marsh frogs *(Pelophylax ridibundus sensu lato)* in Switzerland. *Biol. J. Linn. Soc* 123: 402-410.

Eco Albania (2019). Conservation actions for the Albanian water frog *(Pelophylax shqipericus)* in Vlora Bay. Project Summary, 7 April 2019. https://www.ecoalbania.org/en/2019/04/07/conservation-actions-for-the-albanian-water-frog-pelophylax-shqipericus-in-vlora-bay/

Efenakpo, O. *et al.* (2016). Assessment of frog meat utilization in Ibadan, Oyo State, Nigeria. *J. Res. Forest. Wildl & Envi* 8(3): 31-43.

Erişmiş, U. (2018). Age, size, and growth of the Turkish endemic frog *Pelophylax caralitanus* (Anura: Ranidae). *The Anatomical Record* 301: 1224–1234.

Erişmiş, U. (2011). Abundance, demography and population structure of *Pelophylax ridibundus* (Anura: Ranidae) in 26-August National Park (Turkey). *North-Western Journal of Zoology* 7: 5-16.

Eskew, E. *et al.* (2015). American bullfrogs *(Lithobates catesbeianus)* resist infection by multiple isolates of *Batrachochytrium dendrobatidis*, including one implicated in wild mass mortality. *EcoHealth* 12: 513–518.

EUROSTAT (2021). Import data frogs' legs, 2010-2019 (Commodity group 0208 90 70). https://ec.europa.eu/eurostat/de/data/database.

FAO (2022). *Rana catesbeiana*. Cultured Aquatic Species Information Programme. Text by Flores Nava, A., Fisheries and Aquaculture Division [online]. Rome [viewed 10 March 2022].

FAO (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. 224 pp.

Ford, J. *et al.* (2020). Adrift on a sea of troubles: Can amphibians survive in a human-dominated world? *Herpetologica* 76(2): 251-256.

Frank, T. *et al.* (2018). Amphibian and reptile fauna of the Vjosa River, Albania. *Acta ZooBot Austria* 155: 323-336.

Frost, D. (2021). Amphibian Species of the World: an online reference. Version 6.1. Database accessible at https://amphibiansoftheworld.amnh.org/index.php. American Museum of Natural History, New York, USA.

Gansa, H. *et al.* (2021). Exploitation of Frogs in the Ouémé Valley in Benin Republic (West-Africa). *Int. J. Sci. Bas. Appl. Res.* 59(1): 49-62.

Gerson, H. (2012). International trade in amphibians: a customs perspective. *Alytes* 29(104): 103-115.

Gonwouo, L. & Rödel, M. (2008). The importance of frogs for the livelihoods of the Bakossi people around Mount Manengouba, Cameroon, with special consideration of the hairy frog, *Trichobatrachus robustus. Salamandra* 44: 23-34.

Grano, M. (2021). The Asian market of frogs as food for humans during COVID-19. Risk and consequences for public health. *Medicine Papers* 6(4): 77-87.

Gratwicke, B. *et al.* (2010). Is the international frog legs trade a potential vector for deadly amphibian pathogens? *Front Ecol Envi* 8(8): 438–442.

Hardouin, J. (1997). Elevage commercial de grenouilles en Malaisie. *Tropicultura* 15(4): 209-213.

Helfrich, L. *et al.* (2009): Commercial frog farming. Virginia, USA: Polytechnic Institute and State University, Publ. 420-255, 4pp.

Hendri, W. *et al.* (2018). Genetic variation of *Limnonectes blythii* (Anura: Dicroglossidae) using RAPD analysis in West Sumatra. *Int. J. Zool. Res.* 15: 1-5.

Hermaniuk, A. *et al.* (2020). Body size variation in hybrids among populations of European water frogs (*Pelophylax esculentus* complex) with different breeding systems. *Amphibia-Reptilia* 41(3): 361-371.

Hof, C. *et al.* (2011). Additive threats from pathogens, climate and land-use change for global amphibian diversity. *Nature* 480: 516-519.

Holsbeek, G. *et al.* (2008). A cryptic invasion within an invasion and widespread introgression in the European water frog complex: consequences of uncontrolled commercial trade and weak international legislation. *Mol. Ecol.* 17: 5023-5035.

Howell, C. *et al.* (2010). Non-timber forest product dependence among the Jah Hut subgroup of Peninsular Malaysia's Orang Asli. *Environ. Dev. Sustain* 12: 1-18.

ISSG (2009). *Lithobates catesbeianus*. Species profile. Global Invasive Species Database. http://www.iucngisd.org/gisd/species.php?sc=80.

IUCN Red List (2021). Table 1a: Number of species evaluated in relation to the overall number of described species, and numbers of threatened species by major groups of organisms. https://nc.iucnredlist.org/redlist/content/attachment_files/2021-3_RL_Stats_Table_1a_v2.pdf

IUCN SSC Amphibian Specialist Group (2021). *Glyphoglossus molossus*. The IUCN Red List of Threatened Species 2021: e.T57820A117297620.

IUCN SSC Amphibian Specialist Group (2020). *Lithobates forreri*. The IUCN Red List of Threatened Species 2020: e.T58599A53970598.

IUCN SSC Amphibian Specialist Group (2020a). *Telmatobius culeus* (errata version published in 2020). The IUCN Red List of Threatened Species 2020: e.T57334A178948447.

IUCN SSC Amphibian Specialist Group (2020b). *Conraua derooi*. The IUCN Red List of Threatened Species 2020: e.T58253A16281365.

IUCN SSC Amphibian Specialist Group (2020c). *Pelophylax shqipericus*. The IUCN Red List of Threatened Species 2020: e.T58715A89697059.

IUCN SSC Amphibian Specialist Group (2020d). *Pelophylax epeiroticus*. The IUCN Red List of Threatened Species 2020: e.T58592A89698408.

IUCN SSC Amphibian Specialist Group (2019). *Conraua goliath*. The IUCN Red List of Threatened Species 2019: e.T5263A96062132.

IUCN SSC Amphibian Specialist Group (2019a). *Calyptocephalella gayi*. The IUCN Red List of Threatened Species 2019: e.T4055A85633603.

IUCN SSC Amphibian Specialist Group (2018). *Telmatobius brevirostris*. The IUCN Red List of Threatened Species 2018: e.T57328A3057646.

IUCN SSC Amphibian Specialist Group (2018a). *Limnonectes macrodon*. The IUCN Red List of Threatened Species 2018: e.T58351A114921568.

IUCN SSC Amphibian Specialist Group (2017). *Leptodactylus fallax*. The IUCN Red List of Threatened Species 2017: e.T57125A3055585.

IUCN SSC Amphibian Specialist Group (2013). *Pyxicephalus adspersus*. The IUCN Red List of Threatened Species 2013: e.T58535A3070700.

Khatiwada, J. *et al.* (2016): Frogs as potential biological control agents in the rice fields of Chitwan, Nepal. *Agri. Ecosyst. Envi.* 230: 307-314.

Kurniawan; N. *et al.* (2011). Taxonomic status of three types of *Fejervarya cancrivora* from Indonesia and other Asian countries based on morphological observations and crossing experiments. *Zool Sci* 28: 12-24.

Kusrini, M. (2005). Edible frog harvesting in Indonesia: Evaluating its impacts and ecological context. Thesis, School of Tropical Biology, James Cook University.

Kusrini, M. & R. Alford (2006). Indonesia's exports of frogs' legs. *TRAFFIC Bulletin* 21 (1): 13-24.

Kuzmin, S.; Tarkhnishvili, D.; Ishchenko, V. *et al.* (2009). *Pelophylax ridibundus*. The IUCN Red List of Threatened Species 2009: e.T58705A11825745.

Lau, M. *et al.* (2004). *Quasipaa spinosa*. The IUCN Red List of Threatened Species 2004: e.T58439A11781309.

Le, M. (2012). Frog value chain case study in Ho Chi Minh City Vietnam. Master Thesis, Fisheries & Aquaculture, University of Tromso & Nha Trang University, 58 pp.

Le Serrec, G. (1988). France's frog consumption. *TRAFFIC Bull.* 10 (1/2): 17.

Lutz, C. (2020). Amphibious aquaculture: why frog farming is set for success. Online Article of 21 December, The Fish Site, https://thefishsite.com/articles/amphibious-aquaculture-why-frog-farming-is-set-for-success.

Mercante, C. *et al.* (2014). Bullfrog *(Lithobates catesbeianus)* farming system: water quality and environmental changes. *Acta Limn. Bras*. 26(1) : 9-17.

Miles, J. *et al.* (2004). Frog farming: Investigation of biological and mechanical agents to increase the consumption of pelleted food by adult *Rana temporaria. Appl. Herp*. 1: 271-286.

MNHN (2012). Background for an Information Document on the international trade in of Asian frogs. French Scientific CITES Authority. 52 pp.

Mohneke, M. *et al.* (2011). Medicinal and dietary uses of amphibians in Burkina Faso. *Afr. J. Herp*. 60(1): 78-83.

Mohneke, M. *et al.* (2009). Exploitation of frogs – a review with a focus on West Africa. *Salamandra* 45(4): 193-202.

Mohneke, M. *et al.* (2010). Dried or fried: Amphibians in local and regional food markets in West Africa. *TRAFFIC Bull.* 22(3): 117-128.

Mohneke, M. (2011): (Un)sustainable use of frogs in West Africa and resulting consequences for the ecosystem. Dissertation. Humboldt University, Berlin. 194 pp.

Montaña, C. *et al.* (2018). Revisiting "what do tadpoles really eat?" A 10 year perspective. *Freshwater Biology* 64: 2269-2282.

Mora, M. *et al.* (2021): State of knowledge of the Chilean giant frog *(Calyptocephalella gayi). Gayana* 85(1): 22-34.

Murugan, K. *et al.* (2015). Predation by Asian bullfrog tadpoles, *Hoplobatrachus tigerinus*, against the dengue vector, *Aedes aegypti*, in an aquatic environment treated with mosquitocidal nanoparticles. *Parasitol. Res*. 114: 3601-3610.

Nary, L. (2020). Frog farming encouraged as market demand rising. Online Article of 15 Oct, *Khmer Times*. https://www.khmertimeskh.com/50773462/frog-farming-encouraged-as-market-demand-rising/.

Neang, T. (2010). An investigation into frog consumption and trade in Cambodia. Fauna & Flora International Cambodia Programme (ed.), Phnom Penh, 25 pp.

Nguyen, M. (2017): The future viability of the frog farming industry in Tien Giang Province and Ho Chi Minh City, Vietnam. Doctoral Thesis, Central Queensland University, Australia, 456 pp.

Nguyen, T. & P. Tran (2021). Drugs and chemicals use in frog farming in Dong Thap province. *CTU Journal of Science* 13 (Spec Iss): 73-78.

Niekisch, M. (1986). The international trade in frogs' legs. *TRAFFIC Bulletin* 8: 7-10.

Ohler, A. & V. Nicolas (2017). Which frog's legs do froggies eat? The use of DNA barcoding for identification of deep-frozen frog legs (Dicroglossidae, Amphibia) commercialized in France. *Eur. J. Taxon*. 271: 1–19.

Okeyo, D. *et al.* (2015). Harvesting and consumption of the giant African bullfrog, a delicacy in northern Namibia. In: *Indigenous Knowledge of Namibia*. Chinsembu, K. & A. Cheikhyoussef (eds.), University of Namibia Press, pp. 205-218.

Öz, M. *et al.* (2009). *Pelophylax caralitanus*. The IUCN Red List of Threatened Species 2009: e.T135806A4203649.

Oza, G. (1990). Ecological effects of the frog's legs trade. *The Environmentalist* 10(1): 39-42.

Pandian, T. & M. Marian (1986). Production and utilization of frogs: an ecological view. *Proc. Indian Acad. Sci* 95(3): 289-301.

Papenfuss, T. *et al.* (2009). *Pelophylax bedriagae* (errata version published in 2016). The IUCN Red List of Threatened Species 2009: e.T58559A86622844.

Prihandiani, A. *et al.* (2021). The tsunami of pesticide use for rice production on Java and its consequences. *The Asia Pacific Journal of Anthropology* 22(4): 276-297.

Propper, C. *et al.* (2020). Role of farmer knowledge in agroecosystem science: rice farming and amphibians in the Philippines. *Human–Wildlife Interactions* 14(2): 273–286.

Ribas, A. & S. Poonlaphdecha (2016). Wild-caught and farm-reared amphibians are important reservoirs of *Salmonella*, a study in North-East Thailand. *Zoon. Publ. Health* 64(2): 106-110.

Ribeiro, L. & L. Toledo (2021). An overview of the Brazilian frog farming. *Aquaculture* 548: 737623.

Ribeiro, L. *et al.* (2019). Bullfrog farms release virulent zoospores of the frog-killing fungus into the natural environment. *Sci Rep* 9: 13422.

Robin des Bois (2019). On the Trail, n°23, August 2019. https://robindesbois.org/wp-content/uploads/ON_THE_TRAIL_23.pdf

Rongchapho, P. *et al.* (2021). Clutch size of the Rugose Frog, *Hoplobatrachus rugulosus* (Wiegmann, 1834), from Phu Khiao Wildlife Sanctuary, NE Thailand. *Herp. Notes* 14: 1253-1256.

Ruland, F. & J. Jeschke (2017). Threat-dependent traits of endangered frogs. *Biol. Cons.* 206: 310-313.

Scheele, B. *et al.* (2019). Amphibian fungal panzootic causes catastrophic and ongoing loss of biodiversity. *Science* 363: 1459–1463.

Schloegel, L. *et al.* (2012). Novel, panzootic and hybrid genotypes of amphibian chytridiomycosis associated with the bullfrog trade. *Mol. Ecol.* 21: 5162–5177.

Şereflişan, H. & A. Alkaya (2016). The biology, economy, hunting and legislation of edible frogs (Ranidae) intended for export in Turkey. *Turk. J. Agric* 4(7): 600-604.

Serrano-Martínez, E. *et al.* (2017). Zoonotic parasites in frogs used for preparing beverages for human consumption in Lima, Peru. *Revista de Investigaciones Veterinarias del Perú* (RIVEP) 28(3): 642-649.

Sheeladevi, R. & L. Sundareswran (2013). Froggy affair: Are frogs threatened and endangered species? – A review. *Biomed*. 33(3): 306-312.

Shrestha, B. & M. Gurung (2019). Ethno-herpetological notes regarding the paha frogs and conservation implication in Manaslu Conservation Area, Gorkha District, Nepal. *J. Ethnobiol. Ethnomed*. 15:23.

Susanto, H. (1994). Budidaya kodok unggul. Penebar Swadaya, Jakarta, 126 pp.

Talukdar, S. *et al.* (2020). Cooking methods and medicinal uses of frog species among the Naga tribes in Dimapur. *World News of Natural Sciences* 30(2): 144-149.

Thuy, P. *et al.* (2021). The economic value of the wildlife trade in Vietnam. *CIFOR Infobrief* No. 336.

Truong, N. (2000). Amphibian uses in Vietnam. *FrogLog* 38: 1-2.

UNEP-WCMC (2007). Review of non-CITES amphibia species that are known or likely to be in international trade. Report for the European Commission, 68 pp.

USFWS LEMIS Database (2021). Full set of wildlife trade data 2020, selection for *"Rana"*, *"Hoplobatrachus"*, *"Fejervarya"*, *"Limnonectes"* and *"Pelophylax"*.

Uzzell, T. *et al.* (2009). *Pelophylax kurtmuelleri.* The IUCN Red List of Threatened Species 2009: e.T58637A11817029.

Van Dijk, P. & D. Iskandar (2004). *Limnonectes blythii.* The IUCN Red List of Threatened Species 2004: e.T58329A11767558.

Veith, M. *et al.* (2000). A test for correct species declaration of frog legs imports from Indonesia into the EU. *Biodiv. & Cons.* 9:333-341.

Vietnam Trades (2021). Frog legs export data of Vietnam. https://www.vietnamtrades.com/vietnam-export-data/frog-legs.html.

Warkentin, I. *et al.* (2009). Eating frogs to extinction. *Con. Bio.* 23(4): 1056-1059.

Yetman, C. (2012). Conservation biology of the giant bullfrog, *Pyxicephalus adspersus* (Tschudi 1838). Doctorial Thesis, Dept. Zoology, Uni Pretoria, South Africa, 190 pp.

Yodthong, S. *et al.* (2019). Species delimitation of crab-eating frogs (*Fejervarya cancrivora* complex) clarifies taxonomy and geographic distributions in mainland Southeast Asia. *ZooKeys* 883: 119–153.

Yu, D. *et al.* (2016). Genetic diversity and population structure for the conservation of giant spiny frog *(Quasipaa spinosa)* using microsatellite loci and mitochondrial DNA. *Asian Herp. Res.* 7(2): 75-86.

Yu, D. *et al.* (2015). Do cryptic species exist in *Hoplobatrachus rugulosus*? An examination using four nuclear genes, the Cyt b gene and the complete MT genome. *PLoS One* 10(4): e0124825.

Zheng, Y. *et al.* (2021). Population genetic patterns of a mangrove-associated frog reveal its colonization history and habitat connectivity. *Diversity and Distributions* 27: 1584-1600.

Zhigang, Y. *et al.* (2004). *Fejervarya cancrivora*. The IUCN Red List of Threatened Species 2004: e.T58269A11759

Imprint

A Report by Dr. Sandra Altherr, Dr. Mark Auliya and Charlotte Nithart.

Pro Wildlife

Engelhardstrasse 10
81369 Munich, Germany
mail@prowildlife.de
www.prowildlife.de

Robin des Bois

Association de protection de l'Homme et de l'environnement
14 rue de l'Atlas
75019 Paris, France
contact@robindesbois.org
www.robindesbois.org

Copyright

Citation

Altherr, S.; Auliya, M. and Nithart, C. (2022): Deadly Dish – Role and responsibility of the European Union in the international frogs' legs trade. Pro Wildlife & Robin des Bois (eds.), Munich (Germany), Paris (France), 28 pp.

Acknowledgements

This report was kindly layouted by Natalie Kämmerer. We thank Chris Shepherd and Jordi Janssen for providing helpful information and insights. And we are especially indebted to Bruce Weißgold for his valuable edits and thoughts.

Printed on 100 % recycled paper: dieUmweltDruckerei GmbH (Hannover)

Pro Wildlife

Engelhardstrasse 10
81369 Munich, Germany

mail@prowildlife.de
www.prowildlife.de

Robin des Bois

14 rue de l'Atlas
75019 Paris, France

contact@robindesbois.org
www.robindesbois.org