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Source: BioScience, 55(3) : 256-264

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1641/0006-3568(2005)055[0256:CIETIO]2.0.CO;2

Challenges in Evaluating the Impact of the Trade in Amphibians and Reptiles on Wild Populations

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Amphibians and reptiles are taken from the wild and sold commercially as food, pets, and traditional medicines. The overcollecting of some species highlights the need to assess the trade and ensure that it is not contributing to declines in wild populations. Unlike most countries, the United States tracks the imports and exports of all amphibians and reptiles. Records from 1998 to 2002 reveal a US trade of several million wild-caught amphibians and reptiles each year, although many shipments are not recorded at the species level. The magnitude and content of the global commercial trade carries even greater unknowns. The absence of accurate trade and biological information for most species makes it difficult to establish whether current take levels are sustainable. The void of information also implies that population declines due to overcollecting could be going undetected. Policy changes to acquire baseline biological information and ensure a sustainable trade are urgently needed.

Keywords: trade, harvest, sustainability, amphibians, reptiles

As human population increases and wild habitats shrink, populations of amphibians and reptiles are being seriously reduced throughout the world. Factors responsible for the observed declines include habitat alteration, destruction, and fragmentation; climate change; disease; and impacts from nonindigenous species, ultraviolet radiation, and xenobiotic chemicals (Gibbons et al. 2000, Houlahan et al. 2000). The collection of individual animals from the wild for subsistence or commercial purposes has also been invoked as a factor contributing to the declines of particular species (Gibbons et al. 2000), yet there has not been a comprehensive evaluation of this potential link.

Certain herpetofaunal species have been collected in large numbers for centuries. Historical overcollecting for food or hides has led to extinction or severe population declines for many species, such as tortoises (Pritchard 1996), large freshwater turtles, sea turtles, and virtually all crocodilians (Klemens and Thorbjarnarson 1995). As a result, the trade of a small number of high-profile or commercially important species is now prohibited or regulated by the US Endangered Species Act (ESA), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Robinson 2001), and an assortment of US domestic laws (Levell 1997).

Other studies have reviewed specific components of the global trade, such as the US reptile trade (e.g., Hoover 1998, Franke and Telecky 2001), the trade in snake and reptile skins (Dodd 1986, Jenkins and Broad 1994, Fitzgerald and Painter 2000, Zhou and Jiang 2004), the trade of chameleons (Carpenter et al. 2004) and dendrobatid frogs (Gorzula 1996), and the trade of freshwater turtles destined for the Southeast Asian market (Jenkins 1995, van Dijk et al. 2000). Many of these studies focused on species that are monitored by CITES, and many do not distinguish between captive-raised and wild-caught individuals. Here we focus specifically on individuals taken from the wild, and we ask whether there is evidence that the trade is affecting the persistence of amphibian and reptile species, including those not currently monitored by CITES.

This work was motivated in part by emerging evidence that overcollecting has resulted in the decline or extirpation of several lesser-known herpetofaunal species. For example, more than one-half of all freshwater tortoises and turtles from Southeast and East Asia are currently endangered or critically endangered, largely because of overcollection for the food and traditional medicine industries (Jenkins 1995, Klemens and

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Thorbjarnarson 1995, van Dijk et al. 2000). The gecko *Goniurosaurus luii* was extirpated from its type locality in China by the time it was formally described, allegedly as a result of collections made for the pet trade in the United States, Europe, Japan, and Taiwan (Grismer et al. 1999). Several species of Malagasy chameleons were collected for the pet trade in unsustainable quantities, even after they were listed under CITES (Jenkins et al. 1999). Endangered and threatened species often generate special interest because of their rarity (Reed and Gibbons 2003), and the illegal food and pet trades may exacerbate the situation of populations in the wild (e.g., 62 Fed. Reg. 59605–59623 [1997], TRAFFIC 1999, Webb et al. 2002). A recently completed Global Amphibian Assessment commissioned by IUCN (the World Conservation Union) reveals that utilization represents a threat for 281 amphibian species, and that the population status of 153 (54 percent) of these species is vulnerable, endangered, or critically endangered (as of 22 November 2004; see *www.globalamphibians.org*).

Our goal is to investigate whether the take of wild-caught individuals is biologically sustainable (i.e., whether human use of wildlife does not result in a consistent decline or increased probability of extinction for a given species) (Robinson 2001). Determining sustainable rates of take is a complex undertaking that depends on many factors, such as the abundance, behavior, and life-history characteristics of a species, and a host of socioeconomic factors (e.g., Klemens and Thorbjarnarson 1995, Reynolds et al. 2001). As a necessary first step in assessing whether the take of amphibians and reptiles represents a potential threat to wild populations, we set out to quantify the number of wild-caught animals imported to and exported from the United States during a recent 5-year period. We focus on the United States because it represents one of the largest markets in the world for wild-caught amphibians and reptiles (possibly along with China, although we are unaware of analogous documentation on imports and exports for that country) and because the US Fish and Wildlife Service (USFWS) maintains records of all legally imported and exported amphibians and reptiles. We acknowledge that the international US trade represents only a fraction of the global market and that total trade numbers will be much larger than those reported here. In analyzing the USFWS database, our objectives were (a) to summarize the total volume of wild-caught amphibians and reptiles traded with the United States, (b) to quantify the number of wild-caught shipments that did not carry species-specific information, (c) to quantify the percentage of the most commonly traded species that are currently managed under CITES, and (d) to identify species and genera that we believe are particularly vulnerable to overcollecting and therefore worthy of further investigation and possibly increased protection.

Methods

We obtained 1,362,653 records of shipments of amphibians and reptiles into or out of the United States, from 1998 to 2002, from the USFWS Law Enforcement Management Information System (LEMIS) under the Freedom of Information Act. The content of each shipment is specified in the LEMIS database with a four-letter species code, which corresponds to a binomial scientific name (e.g., NAJN = *Naja naja,* or cobra). In some cases, a shipment may be entered into the database identified only to genus (e.g., CHA? = *Chamaeleo* sp.). Genus-level codes, or more general codes (e.g., NONR = non-CITES reptile), are sometimes used for convenience when processing large shipments containing a mixture of species, even when the full scientific name is reported on USFWS declaration documents. We used these codes when ranking the most commonly traded taxa.

The following protocols were used in analyzing LEMIS. A column in the LEMIS database labeled "source code" was used to determine whether an animal was wild caught, captive bred, or of unspecified origin. We grouped all records with "unknown," "other," "null," or blank source codes into an "unknown" category. Records with "wild-caught," "ranched," or "F1" source codes were lumped into a "wild-caught" category. (Ranched individuals either are directly removed from the wild and reared in a controlled environment or are progeny from gravid females captured from the wild; F1 progeny are born in captivity to wild-caught parents but are not considered as captive bred under CITES). Records with a "captive-bred" source category were assigned to the "captive-bred" category. Because we are primarily interested in the impact of the trade on wild populations, our analyses focus only on wild-caught animals unless otherwise noted.

The LEMIS database also contains a "wildlife description" code to describe the nature of a shipment. We reduced wildlife description codes into three categories: (1) whole individuals, (2) body parts and products, and (3) mass. Wildlife description codes that corresponded to a single entire individual were assigned to the "whole individual" category: live individual, dead whole body, whole skeleton, scientific specimens, whole skin, live egg, or dead egg. All remaining wildlife description codes, such as bone products, claws, feet, garments, leather products, meat, medicinal products, shoes, tails, shells, oil, rugs, trim, jewelry, and carvings, were placed into the "body parts and products" category. Shipments of body parts and products in mass units could not be accurately converted into number of individuals and as a result are also reported separately.

A "purpose" code associated with each shipment indicated whether the use of the animals was commercial, noncommercial, personal, educational, scientific, or for zoos, breeding, biomedical research, or circuses.

Results

Our main findings are that (a) millions of individuals, millions of body parts and products, and more than one million kilograms (kg) of amphibians and reptiles are shipped across US borders each year, the vast majority (> 96 percent) of which are for commercial purposes; (b) more than 2.5 million whole, wild-caught amphibians and reptiles were imported into the United States between 1998 and 2002 but not recorded

in the LEMIS database at the species level, and for 12 amphibian and reptile families, more than 50 percent of the animals are recorded at or above the genus level; and (c) only a very small number of commonly traded species are monitored or regulated at the species level, particularly among amphibians.

The US trade in amphibians and reptiles. The annual trade in wild-caught amphibians and reptiles across US borders is measured on the scale of millions of individuals, millions of body parts and products, and millions of kilograms (figure 1). For example, during 1998–2002, the United States imported 14.7 million wild-caught whole amphibians, 5.2 million kg of wild-caught amphibians, and 18.4 million wild-caught reptile parts and products, and exported 26 million wild-caught whole reptiles. With the possible exception of exported whole reptiles, the majority of shipments were declared as wild caught (figure 2).

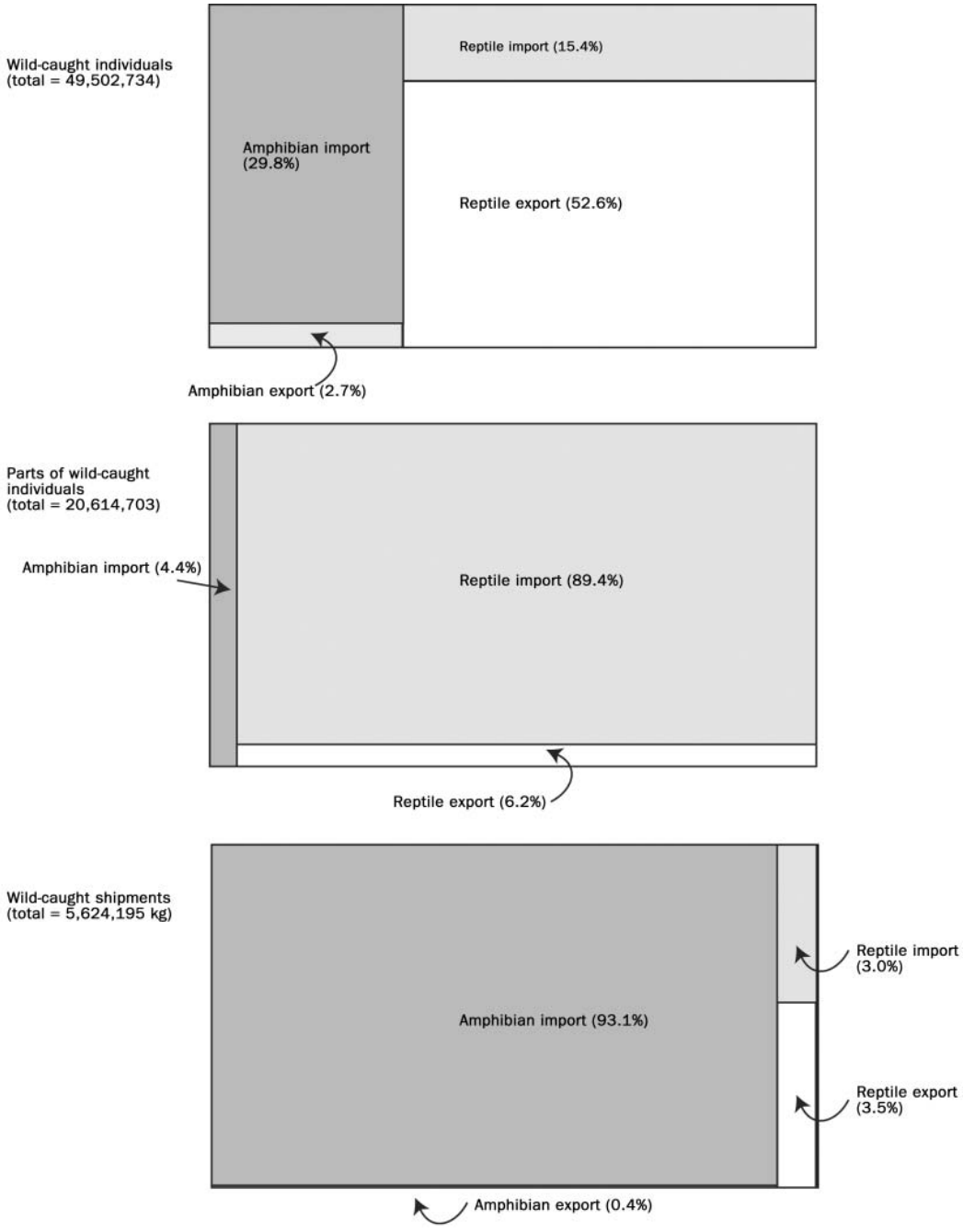

Figure 1. US trade of amphibians and reptiles from 1998 to 2002, broken down by order (amphibian versus reptile), direction (import versus export), and nature of shipments (whole organisms, body parts and products, or mass). Only individuals of wild-caught origin are considered.

The purpose codes on each shipment indicate that the vast majority (> 96 percent) of all imported or exported amphibians and reptiles were for commercial purposes. The "noncommercial" and "null" purpose codes were the second and third most common, representing approximately 1 to 3 percent of shipments. In all four categories, scientific specimens represented less than 0.1 percent of all shipments.

Most commonly traded species codes. The most commonly traded species codes are presented in table 1. Reptiles are imported primarily for the pet trade (e.g., geckos of the genus *Hemidactylus*) and skin trade (e.g., the radiated rat snake, *Elaphe radiata,* used in the shoe industry). Reptiles are primarily exported or reexported for the pet trade (e.g., the red-eared slider, *Trachemys scripta*). Amphibians are traded

Table 1. Most frequently traded species of wild-caught amphibians and reptiles, according to species codes recorded for 1998–2002, by volume and primary trade purpose.

Amphibians			Reptiles		
Category	**Volume**	**Trade purpose**	**Category**	**Volume**	**Trade purpose**
Imported amphibians			**Imported reptiles**		
Whole bodies (count)			Whole bodies (count)		
Rana catesbeiana	3,886,546	Food	*Hemidactylus* spp.	793,591	Pet
Hymenochirus curtipes	2,376,647	Pet	*Python regius*	584,508	Pet
Cynops orientalis	1,635,362	Pet	*Trachemys scripta*[b]	305,038	Pet, food
Bombina orientalis	1,016,579	Pet	*Varanus salvator*	299,447	Pet, whole skins
Rana forreri	679,937	Research	*Iguana iguana*	298,632	Pet
Body parts and products (count)			Body parts and products (count)		
Rana catesbeiana	293,908	Food	*Elaphe radiata*	4,782,607	Skin products
Rana macrodon	164,591	Food	*Tupinabis tequixin*	2,591,370	Skin products
Rana spp.	112,289	Food	*Tupinabis rufescens*	1,689,813	Skin products
Hoplobatrachus tigerinus[a]	22,417	Food	*Elaphe carinata*	1,268,591	Skin products
Rana tigerina[a]	17,010	Food	*Varanus niloticus*	1,094,709	Skin products
Mass (kilograms)			Mass (kilograms)		
Rana catesbeiana	2,816,693	Food	*Chinemys reevesi*	105,957	Traditional medicine
Rana macrodon	1,193,383	Food	*Elaphe radiata*	8,685	Traditional medicine
Rana spp.	534,318	Food	*Gekko gecko*	8,503	Traditional medicine
Hoplobatrachus tigerinus[a]	462,763	Food	*Boa constrictor*	8,182	Skin products
Rana pipiens	113,050	Food, research	*Pelodiscus (Trionyx) sinensis*	5,233	Traditional medicine, food
Exported amphibians			**Exported reptiles**		
Whole bodies (count)			Whole bodies (count)		
Hymenochirus curtipes	188,622	Pet	*Trachemys scripta*[c]	23,655,553	Food, pet
Cynops pyrrhogaster	112,901	Pet	*Alligator mississippiensis*	577,440	Whole skins
Hyla cinerea	87,536	Pet	*Anolis carolinensis*	258,284	Pet
Bombina orientalis	78,606	Pet	*Anolis sagrei*	100,894	Pet
Hymenochirus spp.	72,832	Research, pet	*Pseudemys* spp.	100,279	Food, pet
Body parts and products (count)			Body parts and products (count)		
Non-CITES entry	137	Various	*Tupinambis rufescens*	513,774	Skin products
Ambystoma spp.	47	Pet	*Alligator mississippiensis*	359,734	Skin products
Rana macrodon	9	Food	*Python reticulatus*	124,659	Skin products
Ambystoma laterale	9	Pet	*Tupinambis teguixin*	75,467	Skin products
Rana spp.	8	Food	*Varanus salvator*	54,637	Skin products
Mass (kilograms)			Mass (kilograms)		
Rana tigerina	16,330	Food	*Alligator mississippiensis*	101,151	Food, skin
Rana spp.	6,000	Food	*Crotalus atrox*	72,683	Food
Rana macrodon	1,932	Food	*Apalone ferox*	15,007	Food
Rana catesbeiana	319	Food	*Chelydra serpentina*	6,729	Food
Litoria spp.	50	Pet	*Apalone* spp.	943	Food

a. *Hoplobatrachus tigerius* and *Rana tigerina* are synonymous species names.
b. Most likely contains a large number of exports accidentally labeled as imports.
c. The concatenation of *Pseudemys scripta, Trachemys scripta,* and *Chrysemys scripta.*

primarily for the pet trade (e.g., the African dwarf frog, *Hymenochirus curtipes*) and the food trade (e.g., the American bullfrog, *Rana catesbeiana*). Many species are traded for multiple purposes. For example, many turtle species are used in the pet trade, the food trade, and traditional Chinese medicine. The United States also plays a major role as a reexporter of previously imported reptiles and amphibians, particularly for the pet trade, presumably as a result of its central geographical location and well-established pet trade industry. For example, large numbers of iguanas (*Iguana iguana*) are imported to well-established businesses in the United States from El Salvador and other Central American countries, and then reexported to Europe and Asia to supply the demand for pets overseas.

Many shipments of unknown species identity. Shipments with unknown source codes or without recorded species names represent an impediment to assessing the origin and number of individuals taken from the wild for each species. Unknown source codes became rare by 2001, and virtually disappeared by the following year (figure 2), presumably as a result of a revised USFWS declaration form that included the source of the wildlife as a required field. Shipments in the database without recorded species-specific names, however, remain common, particularly among imported, wild-caught, whole individuals: 2,611,251 amphibians and 2,567,411 reptiles (representing 18 percent and 34 percent of the totals in each category, respectively) were recorded above the species level. Millions of turtles that were exported from the United States

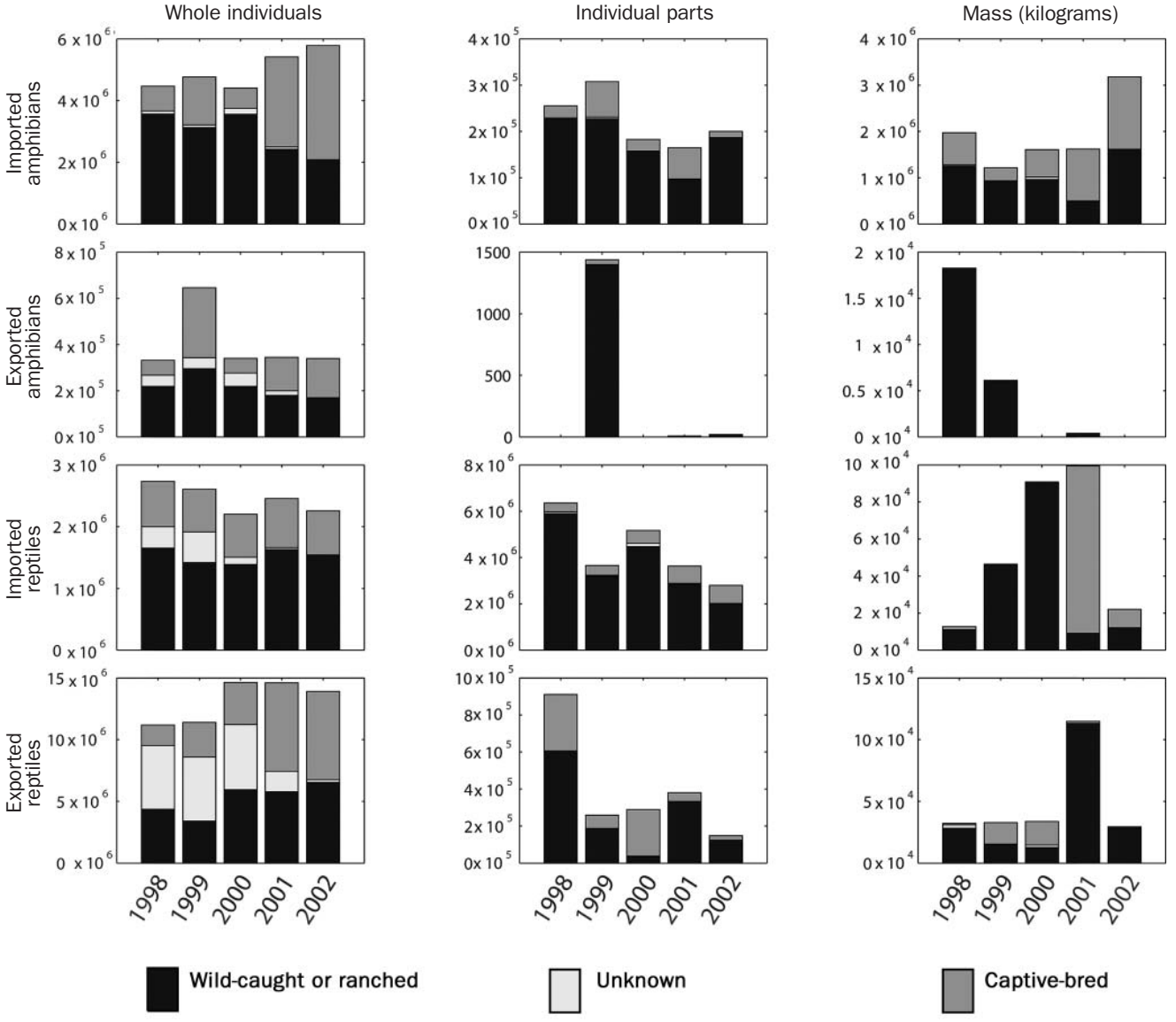

Figure 2. US trade in amphibians and reptiles from 1998 to 2002, broken down by year and source (wild-caught origin, captive-bred, or unknown).

Table 2. Families of amphibians and reptiles imported or exported from the United States from 1998 to 2002 for which more than 100,000 individuals traded, or more than 50 percent of all individuals, had no species-specific identification.

Class/family	Individuals without species identification	
	Number	Percentage
Amphibia		
Salamandridae	597,301	22.2
Pipidae	439,256	13.2
Ranidae	361,858	7.1
Discoglossidae	193,642	16.0
Rhacophoridae	176,949	71.5
Hylidae	171,844	35.7
Bufonidae	169,276	83.5
Hyperoliidae	12,503	67.2
Pelobatidae	7207	55.0
Plethodontidae	6513	98.7
Leptodactylidae	4321	64.1
Reptilia		
Gekkonidae	1,079,447	64.9
Lacertidae	392,743	92.5
Scincidae	206,365	61.4
Agamidae	185,168	29.1
Emydidae	166,573	27.7
Teiidae	116,922	25.7
Iguanidae	100,978	17.2
Cheloniidae	13,919	67.1
Kinosternidae	5684	87.9
Chelidae	4643	59.8

Note: Only families with at least 1000 whole, wild-caught individuals imported into the United States during 1998–2003 were considered for this analysis.

Table 3. Number and percentage of the top 10, 25, and 50 most commonly traded reptiles and amphibians (US trade only) monitored by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Appendix I or II), 1998–2002.

Category	Number (percentage) monitored		
	10 most commonly traded species	25 most commonly traded species	50 most commonly traded species
Imported amphibians			
Whole	0 (0)	0 (0)	2 (4)
Parts	1 (10)	2 (8)	2 (4)
Mass	1 (10)	2 (10)[a]	NA[b]
Exported amphibians			
Whole	0 (0)	0 (0)	2 (4)
Parts	0 (0)	0 (0)[d]	NA[b]
Mass	1 (17)[c]	NA[b]	NA[b]
Imported reptiles			
Whole	4 (40)	13 (52)	19 (38)
Parts	7 (70)	12 (48)	26 (52)
Mass	2 (20)	9 (36)	19 (38)
Exported reptiles			
Whole	2 (20)	7 (28)	11 (22)
Parts	10 (100)	14 (56)	20 (40)
Mass	3 (30)	5 (36)[e]	NA[b]

a. Only 21 recorded species of amphibians were imported by mass.
b. The number of species in this category was too small to calculate a ratio.
c. Only 6 recorded species of amphibians were exported by mass.
d. Only 11 recorded species of amphibians were exported as body parts and products.
e. Only 14 recorded species of reptiles were exported by mass.

were recorded only at the genus level as *Trachemys, Chrysemys,* or *Pseudemys* species, although many of these were most likely *T. scripta* (Reed and Gibbons 2003). There were seven families of amphibians and seven families of reptiles in which more than 100,000 whole, wild-caught individuals were imported into the United States without recorded species names (table 2). Furthermore, there were six families of amphibians and six families of reptiles in which more than 50 percent of all individuals were without recorded species names (table 2). For example, more than 1 million wild-caught geckonids (including 501,452 individuals from Vietnam and 288,946 individuals from Thailand) were imported into the United States over 5 years without species-specific identification being recorded in the LEMIS database.

Few species with legal protection. The majority of the most heavily traded species and genera are currently not regulated by CITES or by the ESA, particularly among amphibians. For example, not one of the 25 most common species codes for imported or exported whole amphibians represents a species that is regulated by CITES. In contrast, a greater proportion of reptiles are regulated by CITES (28 to 56 percent of the top 25 most commonly used codes; table 3).

Discussion

LEMIS is a unique database for estimating the volume of commercially traded animals and plants, and may be one of the best of its kind in the world. A few shortcomings, however, complicate the analysis of the trade data. These problems include species entered into the database under multiple species codes, incorrect import–export codes, typographical errors, and incorrect source codes. For example, the huge export in *T. scripta* almost certainly contains a significant proportion of farm-raised turtles incorrectly labeled as wild caught. The prevalence of each of these problems remains difficult to estimate, but they most likely would not change our general findings. Some of these problems (e.g., unknown source codes) have been addressed. An important remaining concern is the large proportion of shipments identified only to genus or as "non-CITES" individuals within the database (table 2). The lack of accurate species-level data is particularly worrisome in the case of genera that include many highly endemic and rare species, such as the gecko genera *Hemidactylus* and *Gekko* (Kluge 2001), of which 791,841 and 155,415 wild-caught individuals, respectively, were imported into the United States without species names entered into the LEMIS database. Such large numbers of unidentified animals taken from the wild, coupled with a fad-driven pet trade and food market, have the

Table 4. Some species that are expected to be particularly vulnerable to commercial take on the basis of their life-history characteristics, geographic distribution, and levels of US trade, 1998–2002.

Species	Common name	Protection	Trade volume (import/export)[a, b]
Geochelone pardalis	Leopard tortoise	CITES II	10,395 (import)
Geochelone radiata	Radiated tortoise	CITES I	321 (import)[c]
Geochelone elegans	Indian star tortoise	CITES II	279 (import)
Kinixys homeana	Bell's hingeback tortoise	CITES II	12,126 (import)
Testudo graeca	Spur-thighed tortoise	CITES II	4385 (import)
Testudo horsfieldi	Horsfield's tortoise	CITES II	79,395 (import)
Chinemys reevesii	Reeve's turtle	None	2382 (import, whole bodies) plus 53,708 (import, parts and products) and 106,040 (import, kilograms)
Cuora amboinensis	Southeast Asian box turtle	CITES II	48,335 (import, whole bodies) plus 99 (import, kilograms)
Cuora trifasciata	Chinese three-striped box turtle	CITES II	490 (import)
Rhacodactylus spp.	Giant geckos	None	4451 (import)
Corucia zebrata	Prehensile-tailed skink	CITES II	5924 (import)
Callagur borneoensis	Painted terrapin	CITES II	263 (import)
Indotestudo elongata	Elongated tortoise	CITES II	199 (import)
Macroclemys temminckii	Alligator snapping turtle	None	63,457 (export)
Trachemys gaigae	Big bend slider	None	300 (export)
Malaclemys terrapin	Diamondback terrapin	None	877 (export)
Clemmys guttata	Spotted turtle	None	982 (export)
Graptemys spp.	Map turtles	None	95,069 (export)
Graptemys nigrinoda	Black-knobbed map turtle	None	2754 (export)

CITES, Convention on International Trade in Endangered Species of Wild Fauna and Flora.
a. Numbers are whole, wild-caught individuals, unless otherwise noted.
b. Some exported specimens (e.g., *Macroclemys temminckii, Clemmys guttata,* and *Graptemys*) may contain mislabeled captive-bred individuals.
c. Scientific specimens. May include some blood or tissue samples mistakenly entered as whole bodies.

potential to deplete populations or species before declines are observed.

Species of particular concern. A small number of commercially important species (e.g., *Tupinambis* [tegu lizards], iguanas, and crocodilians) are harvested according to guidelines based on social and biological parameters (Shine et al. 1995, Fitzgerald and Painter 2000). Frequently, however, commercial or subsistence harvesting has contributed to a species' decline (e.g., Klemens and Thorbjarnarson 1995, Bartlett 1997, van Dijk et al. 2000, Webb et al. 2002, Reed and Gibbons 2003). The most commonly traded species are not necessarily those that are most at risk from overcollecting. A species with a large range, high density, and high reproductive productivity, for example, may be able to sustain a relatively large take. In contrast, species with restricted ranges, high levels of endemism (e.g., small island species), or life-history strategies that depend on high adult survivorship could be detrimentally affected by even a small number of individuals being removed from the wild. Furthermore, many amphibian and reptile species predictably aggregate in small areas during breeding or hibernation, making them particularly vulnerable to intensive collecting efforts (Klemens and Thorbjarnarson 1995, Milner-Gulland 2001).

In table 4, we have highlighted a few examples of species for which the number of individuals collected from the wild is not compatible with what we know about their current distribution and biological characteristics. We do not intend this as a comprehensive list of the most vulnerable species, but rather as a selection of representative examples of species at risk. Nor do we mean to insinuate that overcollecting is solely responsible for the dramatic declines experienced by many of these species relative to their historic ranges. Indeed, habitat alteration is believed to represent the primary threat to most species, both in the United States (Wilcove et al. 1998) and globally (*www.globalamphibians.org*). We argue, however, that overcollecting will compound other negative forces and, therefore, should also be mitigated.

Many turtle and tortoise species depend on high adult survivorship to offset high egg and juvenile mortality in the wild. Removing even a small fraction of adults can cause a population to decline or can delay a population recovery (e.g., Congdon et al. 1994, Heppell 1998). *Chinemys reevesii* and *Cuora amboinensis* are two relatively abundant Southeast Asian turtles, but the US import volume needs to be considered in light of a much larger trade in these species throughout Southeast Asia and the substantial declines in their range as a result of aggressive collecting for the traditional medicine trade (van Dijk et al. 2000). The alligator snapping turtle, *Macroclemys temminckii,* is a large, long-lived freshwater turtle from the southeastern United States that is collected for its meat and has also experienced significant range reductions (Ernst et al. 1994). The Big Bend slider, *Trachemys gaigeae,* and the black-knobbed map turtle, *Graptemys nigrinoda* (and

Graptemys turtles in general), have ranges limited to a few watersheds and life-history characteristics that make them particularly vulnerable to overharvesting (Reed and Gibbons 2003). We also highlight some highly endemic species: *Rhacodactylus* geckos and the prehensile-tailed skink, *Corucia zebrata,* both popular species in the pet trade, are restricted to the small oceanic islands of New Caledonia and the Solomon Islands, respectively.

We argue that the status of all of the species in table 4 is so dire that the trade of wild-caught animals should be halted or severally reduced. The presence of many CITES-listed species in table 4 also suggests that some species may not be adequately protected against overcollecting despite their legal status.

The global market. The United States represents just a fraction of the world in terms of its consumption of wild-caught amphibians and reptiles, and there is no global database or monitoring program for the trade in non-CITES species between countries outside the United States. Furthermore, the LEMIS database does not cover amphibians and reptiles taken within the United States for the domestic market or for the black market. Large numbers of animals also perish between their point of capture and the time of import or export. As a result, LEMIS captures only a small fraction of the global number of animals collected from the wild.

A very rough measure of the relative importance of the US market can be obtained by comparing the numbers of live, wild-caught CITES-listed amphibians (92,643) and reptiles (2,309,272) imported into the United States between 1995 and 1999 with the global net trade in reptiles and amphibians over the same period (601,092 amphibians and 20,116,616 reptiles). According to this crude measure, the US market represents about 12 to 15 percent of the market made up by all other CITES party nations. The global market currently involves even greater uncertainties with regard to how many individuals of which species are being collected.

Conclusions and recommendations

The data presented in this paper do not provide conclusive evidence of widespread, unsustainable collections. They do, however, reveal that the volume of animals taken from the wild (for the US market alone, let alone globally) is large enough to potentially extirpate populations or species. Our analyses also reveal deficiencies in the current accounting of traded organisms, and identify groups of species that are most likely to be at risk from overcollecting. The trade of wild-caught amphibians and reptiles is largely unregulated, with only a small minority of species monitored by international conventions such as CITES. Furthermore, the removal of wild-caught organisms, including CITES-listed species, generally occurs in a void of knowledge with respect to each species' ability to tolerate current levels of take (Klemens and Thorbjarnarson 1995, Carpenter et al. 2004). In addition to the risk of depleting wild populations, the trade of wild-caught animals carries numerous risks such as the introduction of exotic pests and parasites (Franke and Telecky 2001), the spread of disease to native fauna (Daszak et al. 1999), and habitat disturbance as a result of collecting efforts (Goode et al. 2004).

We recommend policy changes geared toward (a) improving estimates of how many animals can, in theory, be harvested sustainably from the wild and (b) quantifying with greater precision how many animals are actually being removed from the wild. All countries (and states within the United States) should assess the status, ecology, and demography of populations in the wild, including the potential impacts of removing animals for commercial reasons. Initial efforts should focus on species and genera believed to be most vulnerable to the effects of overharvesting. Reed and Gibbons (2003) have developed a model that incorporates the demographic properties, range, and market value of US freshwater turtles to determine each species' vulnerability to commercial collecting. Similar work on other groups of organisms is urgently needed. Governments should consider commercial collection of reptiles and amphibians only after they have gathered the information necessary to determine that such activities will not jeopardize the long-term survival of those species, as required by article IV of CITES. A few US states have banned the commercial collecting of wild-caught amphibians and reptiles, some entirely, others with exceptions (Levell 1997). Partners in Amphibian and Reptile Conservation, or PARC (*www.parcplace.org*), provides specific guidelines for modifying state regulations that pertain to the take of amphibians and reptiles.

The United States, unlike most countries, monitors its imports and exports of reptiles and amphibians. USFWS should ensure that the LEMIS database contains taxonomically accurate species codes on all shipments and should make every effort to verify the accuracy of all elements of the declared wildlife. Ultimately, we hope that every country and US state will begin to monitor the removal of wild amphibians and reptiles from within its political boundaries.

The management and monitoring of amphibians and reptiles may have been historically overlooked because of a perception that the level of take was insignificant relative to natural rates of replenishment. Now, however, amphibians and reptiles are experiencing global declines, and the commercial trade is a global force that has the potential to contribute to these declines. A radical change in research priorities, monitoring efforts, and legislation will be required in the near future to ensure that the commercial take of amphibian and reptile species is compatible with their long-term survival.

Acknowledgments

Thanks to Jonathan Harwood, Marion Dean, Tina Leonard, and Circee Pieters for help with obtaining the data. John P. Friel, Thomas A. Gavin, Harry Greene, Shannon Hedtke, Peter B. McIntyre, Steve J. Morreale, Jeanne M. Robertson, Paul W. Sherman, Kelly R. Zamudio, and five anonymous reviewers helped improve earlier versions of this work. This is

publication no. DH52004-09 of the Nature Conservancy's Conservation Research Fellowship Program.

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