5-Year Review of the Chinese River Dolphin (*Lipotes vexillifer*)

March 2025

National Marine Fisheries Service
Office of Protected Resources
Silver Spring, MD

National Marine Fisheries Service
5-Year Review of the

Endangered Chinese River Dolphin

Recommendation resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change is needed

Review Conducted By (Name and Office):

E.C.M. Parsons, Affiliate, Office of Protected Resources, Chris.Parsons@noaa.gov
Jennifer Schultz, Office of Protected Resources, Jennifer.Schultz@noaa.gov

HEADQUARTERS APPROVAL:

☒ Concur ☐ Do Not Concur

RAUCH.SAMUEL.DEAN.1365850948

Digitally signed by RAUCH.SAMUEL.DEAN.1365850948
Date: 2025.03.27 16:59:21 -04'00'

Acting Assistant Administrator, NOAA Fisheries

Table of Contents

List of Figures

List of Tables

5-YEAR REVIEW
of the
CHINESE RIVER DOLPHIN
(*Lipotes vexillifer*)

The National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA) conducted this review in accordance with the Endangered Species Act of 1973, as amended (ESA).

1 GENERAL INFORMATION

1.1 Reviewers

E.C.M. Parsons, Affiliate, Office of Protected Resources (OPR), NMFS, *Chris.Parsons@noaa.gov*

Jennifer Schultz, OPR, NMFS, *Jennifer.Schultz@noaa.gov*

1.2 Introduction

Section 4(c)(2) of the ESA requires us to conduct a review of listed species at least once every 5 years. During a 5-year review, we determine whether a species should be removed from the list (i.e., delisted), reclassified from an endangered species to a threatened species (i.e., downlisted), or reclassified from a threatened species to an endangered species (i.e., uplisted; 16 U.S.C. 1533(c)(2)). Section 4(b)(1)(A) of the ESA requires us to make the determination based solely on the best scientific and commercial data available at the time of the review and after taking into account efforts to protect the species (16 U.S.C. 1533(b)(1)(A)). Any recommendation to delist or reclassify the species would require a separate rulemaking process.

1.3 Methodology Used to Complete the Review

As required under 50 CFR 424.21, we announced initiation of the 5-year review in the Federal Register (FR) and solicited relevant information (89 FR 80542; October 3, 2024). We specifically requested electronic submission of data that have become available since the publication of the previous 5-year review (Dean 2017). We did not receive any public comments during the 60-day comment period.

We gathered available information since publication of the last review (2017) through October 2024. This information included peer-reviewed publications and government and technical reports, which we reviewed, synthesized, and evaluated to make our recommendation.

1.4 Listing and Review History

Section 4 of the ESA requires us promulgate regulations to list threatened and endangered species (16 U.S.C. 1533 et seq.), which are listed at 50 CFR 17.11. At least once every 5 years, we are required to conduct a review of all species included in this list (16 U.S.C. 1533(c)(2)). For this species, we have completed the following actions under section 4 of the ESA.

1.4.1 Initiation of this 5-Year Review

FR notice: 89 FR 80542
Date published: October 3, 2024

1.4.2 Listing History

Original Listing
FR notice: 54 FR 22906
Date listed: May 30, 1989
Entity listed: Species
Status: Endangered

1.4.3 Review History

- Dean R (2017) Baiji/Chinese River Dolphin/Yangtze River Dolphin (*Lipotes vexillifer*). 5-Year Review: Summary and Evaluation. 12 pages.
    - Recommendation: no change (remains endangered)
- NMFS (2012) Baiji/Chinese River Dolphin/Yangtze River Dolphin (*Lipotes vexillifer*). 5-Year Review: Summary and Evaluation. 13 pages.
    - Recommendation: no change (remains endangered)

2 DESCRIPTION OF LISTED ENTITY

Under the ESA, the term “species” includes any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any vertebrate species that interbreeds

when mature (16 U.S.C. 1532(16)). On May 30, 1989, the Chinese river dolphin was listed as an endangered species throughout its range (54 FR 22906). The species is also called baiji and Yangtze River dolphin. We refer to this species as the Chinese river dolphin (*i.e.*, the listed entity) throughout the remainder of this review.

2.1 Species Description

The Chinese river dolphin has a blueish-gray dorsum with a white underside and a low triangular dorsal fin, which is more substantial than the dorsal fins of other river dolphin species. Adult Chinese river dolphins are approximately 2.45m (8 feet) in length, with females slightly larger than males (Zhou and Li 1989). Calves are approximately 90 cm (3 feet) in length (Zhou and Li 1989).

2.2 Taxonomy

There have been no changes in the taxonomic classification or nomenclature of the Chinese river dolphin since publication of the previous 5-year review.

2.3 DPS Analysis

The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the ESA (61 FR 4722; February 7, 1996) provides principles to guide the listing, delisting, and reclassification of DPSs. Under the DPS Policy, we consider the following:

1. Discreteness of the population segment in relation to the remainder of the species to which it belongs;
2. The significance of the population segment to the species to which it belongs; and
3. The population segment's conservation status in relation to the ESA standards for listing (*i.e.*, is the population segment, when treated as if it were a species, endangered or threatened?).

This species was listed prior to the 1996 DPS Policy. The application of the DPS Policy is not warranted because there are no data with which to evaluate discreteness or significance.

3 BIOLOGY, LIFE HISTORY, AND RANGE

The biology, life history, and range of a species are important to understanding its demography, how it is impacted by threats, and what conservation efforts are needed for its survival and recovery. Chinese river dolphins generally occur in small groups (2-4

animals), but larger groups have been observed. Like other river dolphins, their eyes are much-reduced (Zhou 1989; Zhou 2006), and they use acoustic senses, rather than vision, to find their prey (mainly fish), communicate, and navigate in their turbid environment (Wang et al. 1992). They reach sexual maturity at 4-6 years of age (Zhou 2006). The species inhabits the Yangtze River in China (Figure 1).

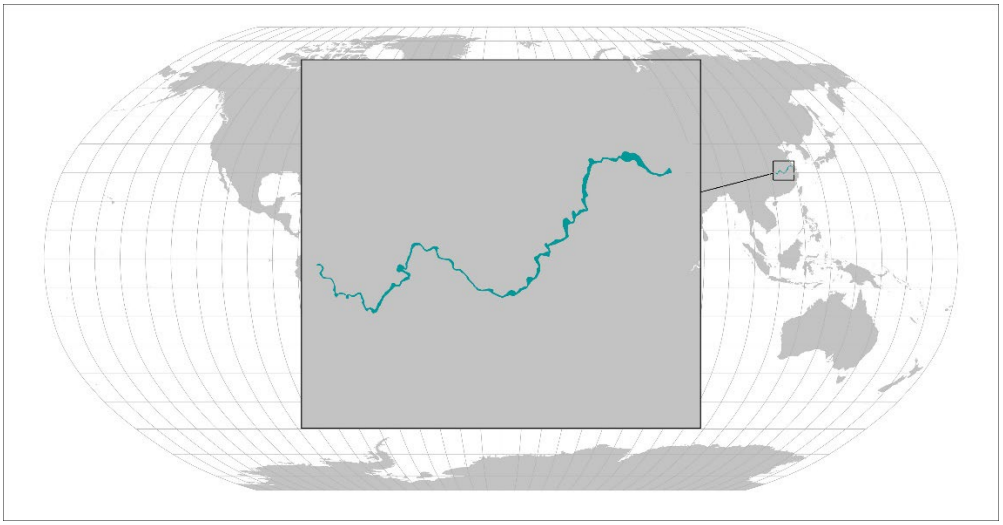

FIGURE 1. RANGE OF THE SPECIES
The historical range of the Chinese river dolphin in the Yangtze River in China (green shaded areas).

4 DEMOGRAPHIC FACTORS

A species' survival and recovery is dependent upon the viability (*i.e.*, continued existence) and growth of its populations. Population viability can be evaluated using four key demographic factors (McElhany *et al*. 2000):

- abundance
- productivity
- spatial distribution, and
- diversity.

These demographic factors are reliable indicators of a species' persistence and reflect the manifestation of past and current threats, which are described in detail in section 5.

4.1 Abundance

Abundance refers to the total population size of the species. The Chinese river dolphin exhibits extremely low abundance (*i.e.*, a few individuals).

The Chinese Government restricted research and surveys of the Chinese river dolphin until the late 1970s (Turvey 2008). From 1979 to 1999, researchers detected 10-108 individuals and used these results to estimate population abundance (Table 1).

TABLE 1. ABUNDANCE ESTIMATES IN THE YANGTZE RIVER (1979-1999)

Survey area	Year	km surveyed	No. of surveys	No. sighted	Population Estimate	Reference
Wuhan–Chenglingji	1979	230	1	19	—	Chen *et al.* (1980)
Nanjing–Taiyangzhou	1979	170	2	10	—	Zhou *et al.* (1980)
Nanjing–Guichi	1979–1981	250	6	3–6 groups	400	Zhou *et al.* (1982)
Yichang–Nantong	1978–1985	1600	9	>20 groups	156	Lin *et al.* (1985)
Yichang–Jiangyin	1985–1986	1510	2	283-287; 42 groups	300	Chen and Hua (1989)
Fujiangsha–Hukou*	1979–1986	630	18	78–79	100	Zhou and Li (1989)
Yichang–Shanghai	1987–1990	1669	12	108	200	Chen *et al.* (1993)
Hukou–Zhenjiang	1989–1991	500	5	29	120	Zhou *et al.* (1998)
Xinchang–Wuhan	1991–1996	413	10	42	<100	Wang *et al.* (1998)
Yichang–Shanghai	1997–1999	1687	3	17 (1997) 7 (1998) 2 (1999)	13+	Zhang *et al.* (2003)

*Only the lower reaches of the Yangtze River were surveyed.

The last confirmed stranding was in 2001, and the last photograph of a possible Chinese river dolphin was taken in 2002 (Turvey *et al.* 2007). In 2006, a team including NMFS biologists visually and acoustically surveyed the main Yangtze channel between Yichang and Shanghai. The team did not detect any Chinese river dolphins and concluded that the species was likely extinct, or at least functionally extinct (Turvey *et al.* 2007; Turvey 2008; Rosel *et al.* 2017; Smith *et al.* 2017). Turvey *et al.* (2010) conducted interviews with members of local fishing communities, who reinforced this conclusion. In 2012, Mei *et al.* (2014) surveyed the river for the Yangtze finless porpoise (*Neophocaena asiaeorientalis*), which occupies the same range, and failed to sight any Chinese river dolphins.

Although occasional sightings of Chinese river dolphins have been reported since 2001, such sightings have not been confirmed by scientific investigations (Osterloff 2022). For example, in August 2007, a large white animal was videoed in the Yangtze River, near

Tongling in Anhui province. Scientists at the Institute of Hydrobiology of the Chinese Academy of Sciences identified it as a Chinese river dolphin (Liang 2007; Reuters 2007). Subsequently, Turvey (Institute of Zoology, Zoological Society of London) indicated that the animal was likely a Yangtze finless porpoise (Phillips 2016). In 2017, the China Biodiversity Conservation and Green Development Foundation reported sightings of Chinese river dolphins and posted a video (Wen and Wu 2017). However, the arched rounded back, rounded head, and lack of dorsal fin or rostrum may be more indicative of a finless porpoise. In April 2018, Liu (2019) reported a possible sighting of a Chinese river dolphin amongst a group of Yangtze finless porpoises near Tongling. A photograph was taken but could not be confirmed as a definitive sighting. Due to possible sightings, the International Union for Conservation of Nature (IUCN) Cetacean Specialist Group has classified the Chinese river dolphin as "Critically Endangered (Possibly Extinct)," rather than "Extinct" on the IUCN Red List (Smith *et al.* 2017).

Uncertainty regarding extinction is common, especially when few individuals remain and are difficult to detect. For mammals, Lee *et al.* (2017) found that body mass and population density are good predictors of extinction, while body mass and search efforts are good predictors of detectability. For the Chinese river dolphin, they calculated a 72% probability of extinction based on its large-size, sparse density, and high search effort (Lee *et al.* 2017). Lee *et al.* (2017) concluded that if the species is not detected by 2034, it is likely extinct.

Another modeling exercise suggests that the Chinese river dolphin may already be extinct. Wu *et al.* (2022) conducted a population viability analysis (via the Vortex software), starting in 1985 with estimated population sizes of 156 and 312. Wu *et al.* (2022) estimated the time to extinction to be 23 and 29 years from 1985, which extrapolates to 2008 and 2014, respectively.

In summary, the Chinese river dolphin exhibits extremely low abundance. Since the last 5-year review, unconfirmed sightings have been reported. We conclude that a few individuals may still exist.

4.2 Productivity and Population Trends

Productivity refers to population growth rate, recruitment, and other population trends. In the short-term, unstable or declining productivity may reflect stochasticity; however, long-term instability and reduction increase the risk of extinction (Lande 1993).

For the Chinese river dolphin, no new information on productivity or trends has become available since the previous 5-year review. Variation in abundance estimates from 1979

to 1999 (Table 1) likely reflect the stochasticity of small populations, and the lack of confirmed sightings in the past two decades likely indicates overall population decline.

4.3 Spatial Distribution

Broad geographic distribution across diverse climate and geographic regions increases resilience and reduces species-wide impacts due to catastrophes (*e.g.*, droughts, floods, hurricanes, *etc.*). As shown in Figure 2, the Chinese river dolphin has a contracted distribution in the Yangtze River from Jingzhou to Jiangyin (Turvey *et al.* 2010).

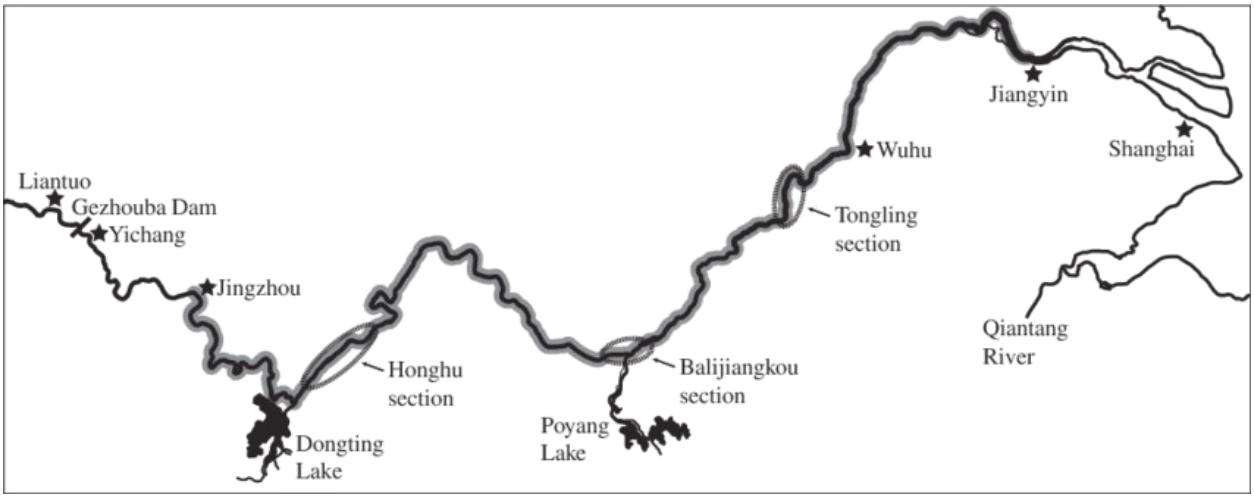

FIGURE 2. CURRENT AND HISTORICAL DISTRIBUTION
Gray shading shows the spatial distribution of the species as of 1990; black lines show the historical distribution, which included the Yangtze River north of Jingzhou, Donting and Poyang Lakes, and the Quiantang River (Turvey *et al.* 2010).

Historically, Chinese river dolphins occurred from mouth of the Yangtze River at Shanghai to the Three Gorges area near Yichang, Hubei province (Zhou and Li 1989; Zhou 2006). Their range included the Dongting and Poyang Lakes, the Qiantang River, and the Fuchun River (not shown), which is a lower section of the Qiantang River (Zhou and Yuemin 1977; Liu *et al.* 2000). Construction of several dams between 1950 and 1990 reduced the spatial distribution of the species to its current range.

No new information on the species' spatial distribution has become available since the previous 5-year review.

4.4 Diversity

For the purposes of this report, diversity refers to intraspecific genetic and phenotypic (*e.g.*, morphological, physiological, and behavioral) variation. Diversity is essential to a species' resilience, and reduced diversity may hinder its capacity to adapt to future ecological and environmental changes.

Genetic diversity provides the raw material for adaptation and evolution. The Chinese river dolphin has very low genetic diversity with little variation among individuals (Zhou *et al.* 2013). Zhou *et al.* (2013) reported that the species went through a genetic bottleneck event at the end of the last ice age (*i.e.*, the species had been reduced to a very low population size with an accompanying loss of genetic diversity). No new information has become available on the diversity of the species since the previous 5-year review.

5 ESA SECTION 4(A)(1) FACTORS OR THREATS

Section 4(a)(1) of the ESA requires us to determine whether any species is an endangered species or a threatened species because of any of the following factors (16 U.S.C. 1533(a)(1)):

(A) the present or threatened destruction, modification, or curtailment of its habitat or range;
(B) overutilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) the inadequacy of existing regulatory mechanisms; or
(E) other natural or manmade factors affecting its continued existence.

We identified the following other natural or manmade factors affecting the species' continued existence:

- fisheries bycatch and prey reductions
- vessel strike and noise

In the sections below, we review the impact of these 4(a)(1) factors or threats on the species. For each threat, we identify the magnitude of the impact on the species (*e.g.*, high, moderate, low, or unknown) and the trend of the impact (*e.g.*, increasing, decreasing, stable, or unknown). We also identify how the threat impacts the demographic factors described above (*e.g.*, changes to the species' abundance, recruitment, distribution, or diversity). Because regulatory mechanisms are intended to reduce the other threats, we address their inadequacy last.

5.1 Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

Habitat modification and range curtailment are major threats to the Chinese river dolphin. Dam construction, water depletion, climate change, and pollution have curtailed the species' range and reduced the quality of the remaining habitat. In the sections below, we review the impacts of each of these threats. Following these sections, we provide a summary regarding the overall threat of habitat degradation and loss to the species.

These threats are a result of development, shipping, and industry. The Yangtze River is the longest river in Asia, and the third longest river in the world. The Yangtze basin has the longest history of human occupation in China and is currently home to over 400 million people, almost a third of China's population. It hosts some of China's largest cities, including Chengdu, Chongqing, Wuhan, Nanjing, and Shanghai. The river has been an important shipping and trade route for thousands of years, and the region has been a major driver of China's economic development since the 1950s. By 1992, there were 221 ports along the Yangtze (Turvey *et al.* 2010). Industries use the river for energy production, shipping, and waste disposal.

5.1.1 Dam Construction

Several major dams provide hydroelectric power to the cities and industries in the Yangtze basin. Starting in the 1950s, the dams reduced the spatial distribution of the species by fragmenting previously connected stretches of the Yangtze River and eliminating access to other waterways (Chen and Hua 1989; Zhou and Li 1989; Liu *et al.* 2000; Smith *et al.* 2000; Xie 2017).

The Xinan Dam in Zhejiang province was constructed between 1957 and 1977. At that time, it was the largest dam in China (105m tall and 465m long). As noted above, construction of the dam led to the extirpation of Chinese river dolphins in the Qiantang and Fuchun Rivers (Liu *et al.* 2000; Zhou 2006; Turvey 2008).

The Wanan Dam in Jiangxi Province was constructed between 1981 and 1990. By 1984, the dam had blocked the Gan River from entering Poyang Lake and altered the habitat of the lake and its tributaries, leading to the extirpation of the Chinese river dolphin in this area (Smith *et al.* 2000).

The Gezhouba Dam in Yichang, Hubei province, was constructed on the Yangtze River between 1960 and 1989. Construction of the dam eliminated access to habitat upstream

of the dam (Smith *et al.* 2000). Construction, associated dredging, and inadequate water management eliminated Chinese river dolphin habitat in a 410 km section of the river downstream of the dam, from Zhicheng to Chenglingji (Smith *et al.* 2000).

In addition to habitat loss, dam construction and operation has reduced the quality of Chinese river dolphin habitat via entrapment risk and prey loss. In 1979, a Chinese river dolphin died in a lock in the Guganhe River, Jiangsu province (Smith *et al.* 2000). In 1997, the Three Gorges Dam in Sandouping (40 km upstream of Yichang, Hubei province) blocked and diverted the Yangtze River. While the Gezhouba Dam had already eliminated access to this upstream habitat, the blockage led to major changes in the hydrology, biodiversity, and ecology of the river downstream, depleting the fish stocks that comprise the Chinese river dolphin's diet (Liu *et al.* 2000; Smith *et al.* 2000; Wu *et al.* 2003; Xie 2003; Hvistendahl 2008).

5.1.2 Water Depletion

Between 1950 and 2010, the central and lower reaches of the Yangtze River lost approximately two thirds of its lakes (equivalent to 20 million Olympic-sized swimming pools) due to agricultural and industrial activities. This water depletion reduced the water storage capacity of the lakes, increasing their susceptibility to droughts and reducing their capacity to absorb the impacts of flooding (WWF 2011).

5.1.3 Climate Change

Climate change is likely to increase the magnitude and frequency of flooding and droughts in the Yangtze basin. Drought reduces the availability of habitat, whereas flooding displaces individuals and exposes them to unsuitable water quality.

Located in the subtropical monsoon zone, the middle and lower sections of the Yangtze River receive 40% of their total annual precipitation during the flood season, which is from June to August (H. Wang *et al.* 2016). In 2020, high levels of rainfall led to unprecedented flooding in parts of the Yangtze basin (P Yang *et al.* 2021). In 2022, rainfall was 20-80% lower than average for the flood season, causing a severe drought. Water levels in the Yangtze River, Dongting Lake, and Poyang Lake dropped to the lowest levels since records began in 1865 (WWF 2022). The surface areas of Dongting and Poyang Lakes shrank by 75% (WWF 2022), and water levels in Poyang Lake dropped 12 meters (Figure 3).

FIGURE 3. POYANG LAKE DURING THE 2022 DROUGHT
Image credit: NASA Earth Observatory 2022.

Rainfall and temperature are likely to increase over time in the Yangtze basin, increasing the frequency of flooding and droughts. Between 1956 and 2018, rainfall increased by 11% and temperature increased by 1.4 °C (WWF 2022). Su *et al.* (2017) predicted temperatures to increase 1.0-3.3 °C by 2065 and 0.9-6.1 °C by the end of the century (Table 2). Su *et al.* (2017) predicted that precipitation would likely increase 1.4-7.2% by 2065 and 0.5-21.8% by the end of the century. Thus, climate change is increasingly likely to reduce the quality and quantity of Chinese river dolphin habitat.

TABLE 2. CLIMATE CHANGE PREDICTIONS

Su *et al.* (2017) predicted increases in temperature and precipitation based on various emissions scenarios (*i.e.*, representative concentration pathways or RCPs) relative to 1981-2010.

	Temperature Increase by 2065 (°C)	Temperature Increase by 2099 (°C)	Precipitation Increase by 2065 (%)	Precipitation Increase by 2099 (%)
RCP 2.6	1.0–2.3	0.9–2.1	1.4–6.8	0.5–10.1
RCP 4.5	1.5–2.5	1.9–3.2	1.9–10.2	6.8–12.7
RCP 6.0	1.2–2.1	2.2–3.7	−4.2–4.4	−1.6–13.8
RCP 8.5	1.9–3.3	3.5–6.1	0.1–7.2	3.9–21.8

5.1.4 Pollution

Yangtze River pollutants include excess nutrients, persistent organic pollutants (POPs), trace elements, and plastics. Industry is the greatest source of pollution, although agriculture use of pesticides and fertilizers is also a major contributor (Xu *et al.* 2022).

5.1.4.1 EXCESS NUTRIENTS

The Yangtze River has elevated nitrogen and phosphorus levels (Yang *et al.* 2024). Agriculture is the main source of these excess nutrients. In 2012, an estimated 6 billion kg (6.6 million tons) of dissolved inorganic nitrogen entered Yangtze River and its tributaries as a result of natural and chemical fertilizers used in agriculture (Chen *et al.* 2020). The resulting eutrophication may reduce oxygen levels for the Chinese river dolphin and its prey.

5.1.4.2 PERSISTENT ORGANIC POLLUTANTS (POPS)

POPs include polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), and pharmaceuticals and personal care products (PPCPs). Because POPs are lipid soluble and slow to degrade, they can bioaccumulate (*i.e.*, continually buildup throughout the life of an individual), biomagnify (*i.e.*, become more concentrated at higher trophic levels), and be compartmentalized in the blubber of cetaceans. As lipids from the blubber become mobilized (*e.g.*, during pregnancy and lactation, if diseased, or during periods of low food availability), POPs are released into circulation and/or transferred to offspring. High concentrations of POPs may impair the growth, development, reproduction, and immunity of cetaceans (Zhang *et al.* 2020) and their prey (Y Yang *et al.* 2021). The risk quotients (concentration and toxicity) of POPs were compared at multiple locations in the Yangtze River (Figure 4 and Table 3; Y. Yang *et al.* 2021). Past international (*e.g.*, Stockholm Convention on Persistent Organic Pollutants) and national regulatory mechanisms (Appendix) have

banned the production and use of certain POPs; however, they continue to be detected in the Yangtze River. The 2020 Yangtze River Protection Law (Appendix) requires the reduction of agricultural pollution, investigation of major point sources, and the use of pollution reduction technology. Even with continuous implementation, monitoring, and enforcement of the law, these legacy chemicals are likely to persist for years.

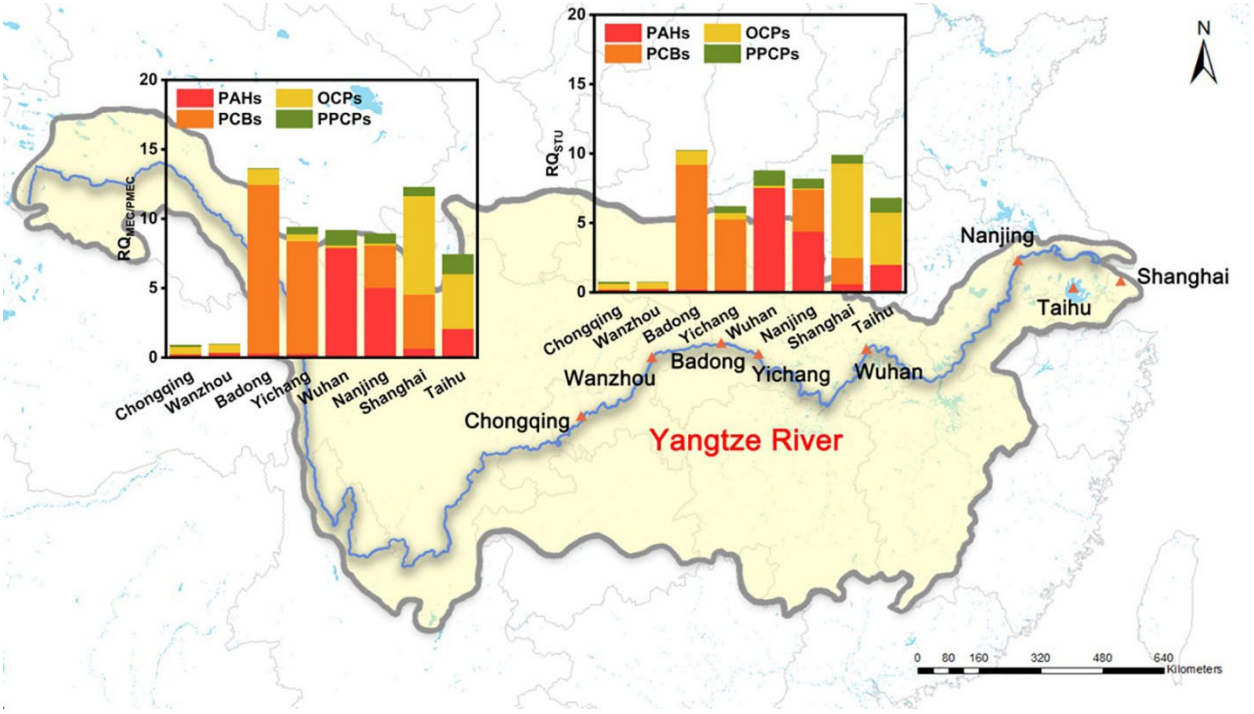

FIGURE 4. POP CONCENTRATIONS IN THE YANGTZE RIVER
Concentrations (left graph) and toxicity (right graph) of POPs at multiple locations in the Yangtze River (map) (Y. Yang *et al*. 2021)

TABLE 3. POPS IN YANGTZE RIVER SURFACE WATERS
Concentrations of POPs (ng/L) at various locations in the surface waters of the Yangtze River (Y. Yang *et al.* 2021) - the highest levels are in bold.

	PCBs	PAHs	OCPs	PPCPs
Panzhihua	24 PCBs were detected, with the highest concentration in Badong ((PCB 187: 14 ng/L)	**151,151**		
Chongging		43	2	**5,400**
Wanzhou		21	3	413
Badong		19	4	994
Yichang		19	3	733
Wuhan		1,353	4	1,000
Nanjing		1,449	2	1,062
Taihu		241	73	1,089

	PCBs	PAHs	OCPs	PPCPs
Shanghai		113	**86**	1,532

Despite lower concentrations (0.11 to 19.32 ng/L) compared to other POPs, PCBs are the greatest upstream concern, due to the toxicity of specific compounds and their potential impacts on aquatic species (Y. Yang *et al.* 2021). Two of the PCBs found in the Yangtze River can induce neurotoxicity, developmental toxicity, immunotoxicity, and reproductive toxicity in fish and other prey species (Y. Yang *et al.* 2021).

Midstream near Wuhan, PAHs (0.004 to 295,900 ng/L) pose the greatest environmental risk of all POPs (Y. Yang *et al.* 2021). The highest concentrations in water samples were found near Panzhihua, possibly due to the coal-to-chemical and steel industries (Y. Yang *et al.* 2021). Elevated levels of PAHs were also found in sediments (Floehr *et al.* 2015; C. Wang *et al.* 2016).[1] Wang *et al.* (2016) identified the major sources of sediment PAHs as emissions from vehicles and ships (41%) and the burning of coal (24%), petroleum (24%), and wood (11.5%). PAHs can be carcinogenic and genotoxic (causing mutations in DNA, which may lead to birth defects). Floehr *et al.* (2015) attributed genetic damage in the red blood cells of benthic fishes to PAHs.

Downstream near the cities of Shanghai and Taihu, OCPs levels are high (up to 20 mg/L) and comprise the greatest environmental risk. OCPs include dichlorodiphenyltrichloroethane (DDT) and delta-hexachlorocyclohexane, which have been banned in China since 2002. DDT is carcinogenic and can impair mammalian development, reproduction, and immunity.

Water samples also contain high concentrations of pharmaceutical and personal care products (Y. Yang *et al.* 2021). Diclofenac sodium was detected at the highest concentrations (up to 4935 ng/L; Y. Yang *et al.* 2021). Diclofenac sodium is a pain medication manufactured in more than 100 factories throughout China (Research and Markets 2019) and is potentially toxic to aquatic organisms. Triclocarban, a preservative and antimicrobial agent used in personal care products, was also detected at high levels in water and sewage effluent throughout China (Chen *et al.* 2019). It is very toxic to aquatic organisms (Braush and Rand 2011; Geer *et al.* 2017), including fish and other prey species (Y. Yang *et al.* 2021). Triclocarban is an endocrine disrupter that can

[1] In river sediments, Floehr *et al.* (2015) found PAH levels of up to 1653 ng/g and estimated daily deposition rates of 16–636 kg (0.2-0.6 mg/m^2). In estuary sediments, Wang *et al.* (2016) recorded concentrations of 16 PAHs ranging from 27.2 to 621.6 (average = 158) ng/g dry weight.

impair immune and reproductive systems (Yueh *et al.* 2012; Halden 2014). Zhu *et al.* (2018) predicted that triclocarban use would quadruple in China between 2000 and 2030. It is banned in many other countries.

While there is no information on POPs in Chinese river dolphins, such information is available for the Yangtze finless porpoise. K. Zhang *et al.* (2020) measured levels of DDT, hexachlorocyclohexanes (HCHs), polybrominated diphenyl ethers (PBDEs), and PCBs in the blubber of stranded Yangtze finless porpoises.[2] DDT levels were relatively high (up to 266 µg/g) compared to other POPs, other small cetaceans, and Yangtze sediment samples, and could pose a relatively high health risk to the Yangtze finless porpoise (K. Zhang *et al.* 2020). DDT was banned for agricultural use in China in 1983, but it is still used for the production of antifouling paints and dicofol (K. Zhang *et al.* 2020). Therefore, the presence of DDT may be a result of current use, bioaccumulation, and/or legacy, *i.e.*, a historically used chemical lingering in the environment. HCHs were also at a level that may cause health impacts. In particular, the pesticide lindane, which was banned in 2019, was detected in notable amounts (K. Zhang *et al.* 2020). Levels of PCBs and PBDEs were relatively low compared to other POPs and other small cetaceans. The two Yangtze cetaceans occupy the same habitat, but the finless porpoise feeds at a lower trophic level (*e.g.*, on smaller fish and prey items) such that biomagnification is likely to result in higher levels in the Chinese river dolphin.

5.1.4.3 Trace Elements

Trace elements and heavy metals are another form of pollutant. In China, mercury levels are high in both the air and water (Lin *et al.* 2012), due to emissions from coal combustion, metal smelting, and other industrial sources. Cadmium contamination is widespread due to mining, smelting, and agriculture (Wang *et al.* 2019). Elevated levels of cadmium (190 ng/g) have been found in the sediments of the Yangtze Delta (Zhuang and Zhou 2021). In the Yangtze Estuary, Yin *et al.* (2016) detected mercury, cadmium, arsenic, chromium, copper, nickel and zinc. In Table 4, we compared the concentrations of dissolved trace elements reported by Yin *et al.* (2016) to those reported by Müller *et al.* (2008) and Zhang (1995). Lead, cadmium, copper, nickel, and zinc have increased since 1995. Since 2008 (measurements were not available in 1995), chromium and mercury have increased, but arsenic has decreased. Müller *et al.* (2008) concluded that elevated levels of trace elements are a result of anthropogenic pollutants. Yin *et al.*

[2] Contaminant levels (ng/L lipid weight): ΣHCH 30.0–20,400; ΣDDT 873–266,000; ΣPBDEs 7.30–941; ΣPCBs 82.6–4970 (K. Zhang *et al.* 2020).

(2016) concluded that sediment suspension and wastewater discharge from local cities are the major causes of heavy metal pollution in the Yangtze River.

TABLE 4. TRACE ELEMENT CONCENTRATIONS
We compared concentrations of dissolved trace elements (µg/L) from three studies. The highest values detected are in bold.

	Zhang 1995	Müller *et al.* 2008	Yin *et al.* 2016
Arsenic		**3.3 ± 1.3**	3.05 ± 1.57
Lead	0.054	0.087 ± 0.023	**1.34 ± 0.57**
Cadmium	0.003	0.024 ± 0.009	**0.30 ± 0.19**
Chromium		0.57 ± 0.09	**4.54 ± 1.24**
Copper	1.65	1.9 ± 0.7	**2.89 ± 1.30**
Nickel	0.15	0.50 ± 0.49	**1.35 ± 0.69**
Mercury		**0.011 ± 0.009**	0.0078 ± 0.0025
Zinc	0.06	1.5 ± 0.6	**9.53 ± 7.49**

At high levels, trace elements and heavy metals disrupt the physiology, reproduction, and development of aquatic organisms. Mercury is highly toxic, causing neurological damage, reproductive abnormalities, and liver and kidney damage (Berlin *at al.* 2007). Cadmium is a toxic, carcinogenic element that can accumulate in tissues.

No information is available regarding the impacts of trace elements and heavy metals on the Chinese river dolphin. Studies of the Yangtze finless porpoise have demonstrated elevated levels of toxic mercury and cadmium, relative to other small cetaceans (Xiong *et al.* 2019).[3] These trace elements were found in ovary tissue, which has not been previously noted in studies on cetaceans, and they could have an impact on reproductive potential (Xiong *et al.* 2019).

5.1.4.4 PLASTICS

Annually, China generates 12 million metric tons of plastic waste (*i.e.*, plastic that is not recycled, incinerated, or sealed in landfills). The Yangtze catchment area generates

[3] The maximum levels (µg/g) of trace elements (in each organ) were vanadium 0.109, nickel 0.154, zinc 429, and lead 0.254 (in skin); chromium 0.521, manganese 6.61; copper 24.7 selenium 116 and mercury 250 (in liver); arsenic 0.407 (in blubber); and cadmium 7.91 (in kidney).

much of this waste (Meijer *et al.* 2021), and the river has the highest plastic concentration in the world (Lebreton *et al.* 2017; Schmidt *et al.* 2017). Zhoa *et al.* (2014) reported 4,137 microplastic particles/m^3 and 170 macroplastic pieces/m^3 at the mouth of the Yangtze River. In the middle and lower reaches, Xiong *et al.* (2019) found 195,000 to 900,000 items/km^2 (average = 492,000 items/km^2).

Plastic pollution impacts marine mammals via ingestion and entanglement (Kruse *et al.* 2023). They may ingest plastic directly, mistaking plastic for prey items, or indirectly via plastic-contaminated prey (Unger *et al.* 2016). These indigestible items can block, extend, or ulcerate the digestive system of cetaceans, which results in necrosis and/or suppression of their appetite. Toxic chemicals can also leach out of ingested plastics and into cetaceans' bloodstream.

Larger pieces of plastic such as nets, ropes, and straps (including discarded or ghost fishing gear) can entangle, injure, and kill cetaceans (Butterworth 2016; Stelfox *et al.* 2016). Entanglement around flukes and flippers acts like a tourniquet, cutting off blood circulation to the limb. Entanglement can also cause drag, decreasing a cetacean's ability to swim or manoeuver and increasing the energetic cost of movement. Entanglement in active fishing gear (*i.e.*, bycatch) is discussed in section 5.4.

Microplastics have increasingly been found in the tissues of marine mammals and may cause changes in gene expression, inflammation, and disruption of the immune system (Nelms *et al.* 2018; Kahane-Rapport *et al.* 2022; Merrill *et al.* 2023).

5.1.5 Summary (Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range)

Based on the best available information, we conclude that numerous threats have curtailed the species' range and degraded its habitat. Historically, dam construction and water depletion reduced habitat availability. Climate change and pollution have reduced the quality of the remaining habitat for the species and its prey. Drought and flooding have become more frequent and intense since the last 5-year review and are likely to increase in the future. In addition to degrading habitat, pollution impairs the health, development, and reproduction of any remaining Chinese river dolphins, as well as their prey. Despite the banning of certain POPs, they remain in the environment and in the tissues of the surrogate species. Toxic trace elements appear to have increased since past reviews. Plastic pollution causes entanglement and health issues if ingested. Thus, habitat loss and degradation continue to be among the greatest threats to the species.

5.2 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Historically, overutilization of the Chinese river dolphin for commercial and educational purposes was a major threat that reduced the species' abundance. No new information has become available since the last 5-year review. Given the species' extremely low abundance, it is unlikely that overutilization continues.

5.2.1 Historical Commercial Overutilization

Chinese river dolphins have been hunted for millennia, despite being considered sacred and venerated as the avatars of the Yangtze River goddess (Carwardine 2007; Sample 2007). Commercial uses included meat for consumption, skin for leather, and oil for lighting, warfare, and medicine (Pilleri 1979; Carwardine 2007; Sample 2007; Turvey 2008). Nearly 1,000 years ago, hunting levels were so high that Chinese writers commented on over-exploitation and local depletion (Pilleri 1979). High levels of hunting likely occurred during the Great Chinese Famine from 1959 to 1961 (Carwardine 2007; Sample 2007; Turvey 2008). While killing of Chinese river dolphins was banned in the 1970s, illegal hunting likely continued into the 1980s. For example, Adams and Carwardine (1990) described a banquet where a Chinese river dolphin and its fetus were cooked and presented to foreign visitors involved with Three Gorges Dam.

5.2.2 Historical Educational Overutilization

Table 5 summarizes the six Chinese river dolphins captured for educational purposes (*i.e.*, public display). In 1980, a young male Chinese river dolphin (named Qi Qi 淇淇), was found entangled and injured by fishing gear and brought to the Institute of Hydrobiology in Wuhan to rehabilitate and recover (Chen and Liu 1989; Turvey 2008). Additional individuals were captured to establish a research, captive breeding, and release program; however, the facilities were not equipped to do so and such plans never materialized (Dudgeon 2005). Four of the six dolphins died within weeks or months of capture. Qi Qi remained in captivity for 22.5 years, and one female survived for 2.5 years. When a species' abundance is extremely low, it is difficult to weigh the educational value of public display against the removal of individuals from the wild. Given the low survival rate and lack of captive breeding and release programs (Dudgeon 2005), the utilization of individuals for public display likely had a net negative effect on the species. As stated in the 2002–2010 Action Plan of the IUCN Cetacean Specialist Group (Reeves *et al.* 2003):

Removal of live cetaceans from the wild, for captive display and/or research, is equivalent to incidental or deliberate killing, as the animals brought into captivity (or killed during capture operations) are no longer available to help maintain their populations. When unmanaged and undertaken without a rigorous program of research and monitoring, live-capture can become a serious threat to local cetacean populations.

TABLE 5. CAPTIVE CHINESE RIVER DOLPHINS

Name	Date range	Facility	Sex	Survival
Qi Qi	12 Jan 1980 – 14 July 2002	Institute of Hydrobiology, Wuhan	Male	22.5 years
Rong Rong	22 April 1981 – 3 Feb 1982	Institute of Hydrobiology, Wuhan	Male	228 days
Lian Lian	31 Mar 1986 – 14 June 1986	Institute of Hydrobiology, Wuhan	Male	76 days
Zhen Zhen	31 Mar 1986 – 27 Sept 1988	Institute of Hydrobiology, Wuhan	Female	2.5 years
Su Su	3 Mar 1981 – 20 Mar 1981	Nanjing Normal University	Female	17 days
Jiang Jiang	12 July 1981 – 16 April 1982	Nanjing Fisheries Research Institute	Male	129 days

5.3 Disease or Predation

The magnitude and trend of these threats are unknown. No information on disease or predation was available for the previous 5-year review (Dean 2017), and no information has become available since then.

5.4 Fisheries Bycatch and Prey Reductions

Historically, bycatch in illegal fisheries (*i.e.*, rolling hooks, nets, electrofishing, and explosives) was a major source of mortality that reduced the abundance of the Chinese river dolphin. In addition, overfishing likely reduced prey availability.

On January 1, 2020, the Yangtze River Protection Law (Appendix) created a 10-year fishing ban in the Yangtze River, the Estuary, and its major tributaries (Mei *et al.* 2020). The Chinese Government provided compensation for surrendering nets and boats, monthly allowances, pension insurance, and resettlement and employment assistance. In total, 111,000 fishing boats were decommissioned, and 231,000 people were

resettled and/or assisted (WWF 2022). Similar long-term fishing bans have resulted in the recovery of fish stocks in biological reserves of the Yangtze basin (Mei *et al.* 2020) and the Chishui River, a major tributary of the Yangtze River (Liu *et al.* 2023). The law requires strict enforcement to reduce illegal fishing.

Prior to this ban, rolling hooks (lines of hooks intended to snag demersal fishes), gillnets, and fyke nets (cylindrical fish traps) entangled Chinese river dolphins (Zhou *et al.* 1998; Zhou and Wang 1994). In the 1970s and 1980s, 50-60% of dead stranded Chinese river dolphins had injuries attributed to rolling hooks or nets (Zhou and Wang 1994). Although banned in 1986, rolling hooks were implicated in the deaths of Yangtze finless porpoises in Poyang and Dongting Lakes as recently as 2013 (Mei *et al.* 2019; Thomas *et al.* 2019).

Illegal electrofishing and explosive fishing were also major threats to the species and its prey (IWC 2001; Zhang *et al.* 2003; K. Wang *et al.* 2006; Thomas *et al.* 2019). Between 1978 and 1986, explosive fishing killed six Chinese river dolphins (Zhou and Li 1989). There is no information on electrofishing impacts on the species. However, electrofishing killed nine Yangtze finless porpoises: seven in Poyang Lake between 2008 and 2013 (Mei *et al.* 2019) and two or more in Dongting Lake in 2012 (Thomas *et al.* 2019). Between 2014 and 2017, 34,600 cases of illegal electric fishing were reported in the Yangtze basin (Yin *et al.* 2022). Such examples suggest that illegal fishing may continue despite the 2020 law, highlighting the importance of monitoring and enforcement.

High past fishing effort (along with pollution, dams, and other habitat modifications) has led to the collapse of numerous fish populations (Yin *et al.* 2022), likely including prey species of the Chinese river dolphin. Overfishing is the main reason for biodiversity decline in the Yangtze basin (Yin *et al.* 2022). More than 30% of Yangtze fish species are nearly extinct (Cao *et al.* 2016). The Yangtze sturgeon (*Acipenser dabryanus*) is extinct in the wild, and the Chinese paddlefish (*Psephurus gladius*) was declared extinct in 2022 (H. Zhang *et al.* 2020; Yang *et al*. 2024). Reeves' shad (*Tenualosa reevesii*) and the long, spikey-headed carp (*Luciobrama macrocephalus*) may also be extinct (Yang *et al.* 2024). Larval abundance of the four major Chinese carp species declined by over 90% since 1950s, and more that 70% of the total catch was immature fish that had not yet had chance to breed and replenish fish stocks (H. Zhang *et al.* 2020; Yin *et al.* 2022; WWF 2022). These and similar declines reduced the availability of prey for the Chinese river dolphin. Information is not yet available to determine whether implementation and enforcement of the 2020 law has been adequate to replenish the depleted fish stocks and restore the prey base.

5.5 Vessel Strike and Noise

High levels of shipping in the Yangtze River pose a major threat to the species via vessel strike and vessel noise. In 2005, 0.86 million tons of cargo was shipped down the river, and this increased to 2.93 million tons by 2019 (Wang *et al.* 2021). In the early 2010s, there were nearly 300,000 motorized fishing boats registered in the Yangtze River basin (H. Zhang *et al.* 2020). During the 2006 survey for Chinese river dolphins, the team counted 19,830 large shipping vessels and 1,175 fishing vessels between Yichang and Shanghai (Turvey *et al.* 2007; Turvey 2008).

Vessel strike causes injury and mortality via blunt force trauma and propeller lacerations. Historically, it reduced the abundance of the species. Zhou and Li (1989) reported that vessel strikes killed 10 Chinese river dolphins between 1978 and 1985. More recent information is not available for this species. However, vessel strikes killed three Yangtze finless porpoises in Dongting Lake between 2008 and 2012 (Thomas *et al.* 2019). Interviews with fishing communities suggested that vessel strike killed more Yangtze finless porpoises than fisheries bycatch (Turvey *et al.* (2013), possibly indicative of the relatively high level of this threat to the Chinese river dolphin.

Vessel traffic also exposes Chinese river dolphins to a substantial amount of underwater noise. Underwater noise can result in hearing loss (*i.e.*, temporary or permanent threshold shifts, TTS and PTS), behavioral changes, and masking (*i.e.*, the acoustic smothering) of communication calls and echolocation clicks (Richardson *et al.* 1995; NOAA 2013; Erbe *et al.* 2016; NMFS 2016, 2018; Erbe *et al.* 2018; Putland *et al.* 2018). The Chinese river dolphin has limited eyesight and is dependent upon sound for communicating, navigating, and finding prey (Wang *et al.* 1992). Therefore, hearing loss would likely reduce their health and survival.

While there is no information on TTS or PTS in Chinese river dolphins, such information is available for the Yangtze finless porpoise. Wang *et al.* (2020, 2021) investigated noise levels in the Yangtze River and found that sound exposure levels ranged from 96 to 162 (median = 105) dB re 1μPa^2. For the Yangtze finless porpoise, these sound levels exceeded TTS at 68-72% of the sites tested and exceeded PTS at 8% of the sites tested, with an additional 8% of sites within one decibel of the PTS threshold (Wang *et al.* 2020, 2021). Such levels were lower than those measured in 2012, possibly due to efforts to reduce shipping noise, design vessels to be more hydrodynamic, and make engines more energy efficient (McKenna *et al.* 2014; Wang *et al.* 2021).

In conclusion, vessel strike continues to be a major and increasing threat to the Chinese river dolphin. Vessel noise, however, appears to be decreasing due to improvements in

technology. The 2020 Yangtze River Protection Law (Appendix) reduced the number of fishing vessels and allows for the restriction of shipping, which could reduce the risk of vessel strike and noise.

5.6 Inadequacy of Existing Regulatory Mechanisms

Since 1979, there have been numerous regulatory mechanisms to protect the Chinese river dolphin and its habitat, including enacting wildlife protection laws (Appendix) and creating natural reserves. Historically, these regulatory mechanisms have been inadequate to prevent the decline of the species. International and non-governmental organization involvement has also been minimal (Reeves and Gales 2006; Turvey 2008). New regulations enacted since the last 5-year review may improve the habitat of the species (see Section 7, Efforts to Protect the Species).

Regulations reviewed in previous 5-year reviews include the protection of the species, prohibition of deliberate killing, and prohibition of electrofishing (Appendix). Uneven and under-enforcement of such laws contributed to the decline in abundance of the species due to overutilization for commercial and educational purposes and fisheries bycatch (Dudgeon 2005; Turvey 2008; Stern 2013; Yee *et al.* 2016; Esarey *et al.* 2020; He *et al.* 2020; Harrell 2023). Historically, environmental regulation has lagged behind industrial development in China (Dudgeon 2005; Lim 2007; Silk 2013; Stern 2013; Esarey *et al.* 2020; Wu and Kan 2021; Harrell 2023).

Between 1986 and 1993, five natural reserves were created along the middle and lower Yangtze River to protect Chinese river dolphins (D. Wang *et al.* 2006; Figure 5). Despite bans on rolling hooks, fyke nets, and electrofishing, these illegal fishing practices continued in the reserves due to poor enforcement (Turvey 2008). The only Chinese river dolphin placed in a natural reserve (a female) was found dead, entangled in a net, after just 7 months in the Tian-e-Zhou Lake (Dudgeon 2005). She died before Qi Qi (the captive male at the Institute of Hydrobiology in Wuhan) could be relocated to the reserve in order to have a breeding pair (Dudgeon 2005; Turvey 2008; Stephen Leatherwood in Rose *et al.* 2023). Thus, such reserves were ineffective as a conservation tool for the species (D. Wang *et al.* 2006).

FIGURE 5. LOCATIONS OF NATURAL RESERVES FOR THE CHINESE RIVER DOLPHIN

6 RECOVERY PLAN

Section 4(f)(1) of the ESA requires us to develop and implement recovery plans for listed species, unless such a plan will not promote the conservation of the species (16 U.S.C. 1533(f)(1)). For the Chinese river dolphin, we did not develop a recovery plan because the species occurs entirely in foreign waters, and the United States does not contribute to the threat of the species. Therefore, an ESA recovery plan is not likely to promote the conservation of the species.

7 EFFORTS TO PROTECT THE SPECIES

Section 4(b)(1)(A) of the ESA requires us to make our determinations based solely on the best scientific and commercial data available at the time of the review and after taking into account efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species, whether by predator control, protection of habitat and food supply, or other conservation practices, within any area under its jurisdiction, or on the high seas to protect the species (16 U.S.C. 1533(b)(1)(A).

Within the past decade, Chinese authorities have passed several laws to address environmental issues, including the impact of pollution and habitat degradation on human health, natural resources and the economy (Silk 2013; Esarey *et al.* 2020; Harrell 2023). Of these laws, the Yangtze River Protection Law (2020) is the most significant because it addresses pollution, overfishing, illegal fishing, and wildlife

conservation (Appendix). In response to collapsing fish stocks in the Yangtze River (H. Zhang *et al.* 2020), the law bans fishing for 10 years (Mei *et al.* 2020). It also calls for strict enforcement and investigation of electrofishing and fishing with poison and explosives. The law calls for pollution reduction, such as the establishment of water quality standards and monitoring; reduction of pesticide use and agricultural pollution; identification of sources of pollution; development and use of pollution-reducing technology for industries; and the reduction of plastics. The law requires the development of wildlife conservation plans and decadal surveys of wildlife and habitat. It encourages research on protected species. It requires environmental and ecological restoration and allows for the designation of nature reserves and national parks. The law also addresses other potential threats to Chinese river dolphins by allowing restrictions on shipping and aquaculture and requiring sufficient water flows in the river to maintain ecosystems in the dry season.

In the past, pollution and illegal fishing methods have continued despite bans, likely due to inadequate monitoring and enforcement. We do not yet know the efficacy of the 2020 law, but it contains elements that may aid in its enforcement. Under the law, private citizens and organizations would be rewarded for conserving the Yangtze River and may file charges if environmental damage has occurred. Government officials and officers may be held responsible (*e.g.*, demoted or dismissed) for instances or corruption and failure to monitor, enforce, and address environmental issues.

If the law is implemented and enforced, reductions of over- and illegal fishing, pollutants, and vessel traffic are likely to have a positive impact on the species' habitat and prey. At the time of this review, however, we are unable to evaluate whether the law has had the intended effects.

8 SYNTHESIS

The Chinese river dolphin (*Lipotes vexillifer*), also called baiji and Yangtze River dolphin, was listed as an endangered species under the ESA in 1989. By then, abundance estimates were already low (*i.e.*, 100-200 individuals). The last confirmed sighting (a dead stranded individual) was in 2001. The lack of visual or acoustic detections during a 2006 river-wide survey led to scientists to conclude that the species was likely extinct or functionally extinct (Turvey *et al.* 2007; Turvey 2008; Rosel *et al.* 2017; Smith *et al.* 2017). As recently as 2017 and 2018, there have been reported sightings (Wen and Wu 2017; Lin 2019), but none have been confirmed by scientific investigations (Osterloff 2022). Such sightings may be misidentified Yangtze finless porpoises. Recent modeling studies suggest that the species is likely to be extinct if not detected by 2034, 72% likely

to be extinct (Lee *et al.* 2017), or already extinct (Wu *et al.* 2022). Due to possible sightings, the IUCN Red List classifies the Chinese river dolphin as “Critically Endangered (Possibly Extinct),” rather than “Extinct” (Smith *et al.* 2017). Consistent with the last 5-year review (Dean 2017), we conclude that a few individuals may still exist.

The species is endangered throughout its entire range because of several major threats. The construction of dams between 1950 and 1990 reduced its historical range, such that the species only occurs in the Yangtze River and has been extirpated from Dongting and Poyang Lakes and Qiantang and Fuchun Rivers (Figure 2; Turvey *et al.* 2010). The species’ habitat has been degraded by water depletion, pollution, and drought, which have increased since the last 5-year review. Historically, the species’ abundance was reduced by overexploitation (for meat, oil, leather, and educational display), bycatch in illegal fisheries (such as electrofishing and rolling hooks), and vessel strike. Overfishing reduced prey availability, and vessel noise may have interfered with the species’ navigation, communication, and locating of prey. Past regulations (*e.g.*, bans on pollutants and illegal fishing) lacked adequate enforcement. Nature reserves failed to protect the species from such threats and did not promote conservation (*e.g.*, through a breeding program). Therefore, these regulatory mechanisms were inadequate to protect the species from decline.

Recent regulatory actions have the potential to reduce most current threats. The 2020 Yangtze River Protection Law bans all fishing on the river and its tributaries for 10 years, requires strict enforcement of environmental laws against pollution and illegal fishing, ensures adequate water flow, and allows for the restriction of vessel traffic. Its success is dependent upon continuous implementation, monitoring, and enforcement, and such information is not yet available for review.

Thus, the best scientific information available since the previous 5-year review indicates that the Chinese river dolphin continues to be in danger of extinction throughout all of its range. While the species is likely functionally extinct, the unconfirmed sightings in 2017 and 2018 prevent us from concluding that it is extinct.

9 RESULTS

Based on the best available scientific and commercial data, we provide the following recommendations. The Chinese river dolphin continues to be endangered by increasing, high magnitude threats (Table 6). Unconfirmed sightings prevent us from recommending delisting due to extinction at this time.

TABLE 6. SUMMARY OF 4(A)(1) FACTORS (THREATS)
Magnitude and trend of each threat and how it impacts the species.

Threat	Magnitude of Threat	Trend of Threat	Impact to Species
Habitat Loss and Modification	High	↑ Increasing	Spatial distribution; Productivity and population trends
Overutilization	Historically high; now low	↔ Stable	Abundance
Disease/Predation	Unknown	? Unknown	Unknown
Fisheries Bycatch	Historically high; now unknown	? Unknown	Abundance
Vessel Strike	High	↑ Increasing	Abundance
Regulatory Inadequacy	Historically high; now unknown	? Unknown	Abundance; Spatial distribution

9.1 Recommended Classification

_____**Downlist to Threatened**
_____**Uplist to Endangered**
_____**Delist** *(Indicate reason for delisting per 50 CFR 424.11):*

_____*Extinction*
_____*Recovery*
_____*Original data for classification in error*

__X__**No change is needed**

10 RECOMMENDED FUTURE ACTIONS

Because a few individuals may continue to exist, we recommend the following future actions to protect the Chinese river dolphin and its habitat. Completion of these recommendations is not required, and the results of subsequent reviews are not dependent on the completion of these recommendations.

Considering the difficulty in assessing whether the Chinese river dolphin is extant, we recommend a thorough survey to investigate the presence of Chinese river dolphin DNA in the Yangtze River environment (*i.e.*, an eDNA survey).

We recommend implementation and enforcement of the 2020 Yangtze River Protection Law and other regulatory mechanisms (Appendix), which:

- ban fishing in the Yangtze River and its associated lakes and tributaries;
- allow restriction of vessel traffic and shipping in the Yangtze River;
- reduce water pollution including pesticide use, agricultural wastes, POPs, and plastics;
- ensure sufficient water is released from dams to provide adequate water flow for the Yangtze ecosystem;
- introduce plans and projects to restore areas of the Yangtze ecosystem;
- improve monitoring and research on pollution and aquatic wildlife in the Yangtze River;
- improve education and outreach to local communities and stakeholders regarding the need to conserve the Yangtze ecosystem and to encourage the reporting of illegal activities;
- develop measures to reduce the negative impacts of climate change on aquatic wildlife species;
- improve enforcement of environmental and wildlife regulations and laws.

We recommend efforts to develop, manage, and enforce natural reserves and protected areas, as these may benefit any remaining Chinese river dolphins.

11 REFERENCES

Adams D, Carwardine M (1990) Last chance to see. Ballantine books, New York.

Berlin M, Zalups RK, Fowler BA (2007) Pages 675-729 in GF Nordberg, BA Fowler, M Nordberg, LT Friberg (eds.) Handbook on the toxicology of metals, 3rd ed. Academic Press, Cambridge, MA.

Braulik GT, Reeves RR, Wang D, Ellis S, Wells, RS, Dudgeon D (2005) Report of the workshop on conservation of the baiji and Yangtze finless porpoise. IUCN, Gland, Switzerland.

Brausch J, Rand G (2011). A review of personal care products in the aquatic environment: Environmental concentrations and toxicity. Chemosphere 82(11): 1518–1532.

Butterworth A (2016) A review of the welfare impact on pinnipeds of plastic marine debris. Frontiers in Marine Science 3: 149. DOI: 10.3389/fmars.2016.00149.

Cao L, Zhang E, Zang C, Cao W (2016) Evaluating the status of China's continental fish and analyzing their causes of endangerment through the red list assessment. Biodiversity Science 24(5): 598-609.

Carwardine M (2007) The baiji: so long and thanks for all the fish. New Scientist, September 12, 2007. http://www.newscientist.com/article/mg19526210-800-the-baiji-so-long-and-thanks-for-all-the-fish/.

Chen J, Meng X, Bergman A, Halden RU (2019) Nationwide reconnaissance of five parabens, triclosan, triclocarban and its transformation products in sewage sludge from China. Journal of Hazardous Materials 365: 502-510,

Chen P, Hua Y (1989) Distribution, population size and protection of *Lipotes vexillifer*. Pages 81–85 in WF Perrin, RL Brownell Jr, K Zhou, J Liu (eds.) Biology and conservation of the river dolphins. Occasional papers of the IUCN Species Survival Commission (SSC) 3. IUCN, Gland, Switzerland.

Chen P, Liu R (1989) Captive husbandry of the baiji, *Lipotes vexillifer*. Pages 146-149 in WF Perrin, RL Brownell Jr, K Zhou, J Liu (eds.) Biology and conservation of the river dolphins. Occasional papers of the IUCN Species Survival Commission (SSC) 3. IUCN, Gland, Switzerland.

Chen P, Liu P, Liu R, Lin K, Pilleri G (1980) Distribution, ecology, behaviour and protection of the dolphins in the middle reaches of the Changjiang River (Wuhan-Yueyang). Oceanologia et Limnologia Sinica 11: 73–84.

Chen P, Zhang X, Wang D (1992) Conservation of the endangered baiji, *Lipotes vexillifer*, China. IAAAM Conference Proceedings 1992. International Association for Aquatic Animal Medicine. Available from: https://www.vin.com/apputil/content/defaultadv1.aspx?pId=11110&meta=Generic&catId=29035&id=3981456&ind=5&objTypeID=17.

Chen P, Zhang X, Wei Z, Zhao Q, Wang X, Zhang G, Yang J (1993) Appraisal of the influence upon baiji *Lipotes vexillifer* by the Three-gorge project and conservation strategy. Acta Hydrobiologica Sinica 17: 101–111.

Chen X, Stroka M, Kroeze C, Supit I, Wang M, Ma L, Chen X, Shi X (2020) Modeling the contribution of crops to nitrogen pollution in the Yangtze River. Environmental Science and Technology 54(19): 11929–11939.

Dean R (2017) Baiji/Chinese river dolphin/Yangtze river dolphin (*Lipotes vexillifer*) 5-year review: summary and evaluation. NMFS, National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

Dudgeon D (2005). Last chance to see …: *ex situ* conservation and the fate of the baiji. Aquatic Conservation 15: 105–108.

Erbe C, Dunlop R, Dolman S (2018) Effects of noise on marine mammals. Pages 277-309 in H Slabbekoorn, RJ Dolling, AN Popper, RF Fay (eds.) Effects of anthropogenic noise on animals. Springer Nature, New York.

Erbe C, Reichmuth C, Cunningham K, Lucke K, Dooling R (2016) Communication masking in marine mammals: a review and research strategy. Marine Pollution Bulletin 103(1-2): 15-38.

Esarey A, Haddad MA, Lewis JI, Harrell S (eds.) (2020). Greening East Asia: the rise of the eco-developmental State. University of Washington Press, Seattle.

Floehr T, Scholz-Starke B, Xiao H, Koch J, Wu L, Hou J, Wolf A, Bergmann A, Bluhm K, Yuan X, Roß-Nickoll M, Schäffer A, Hollert H (2015) Yangtze Three Gorges Reservoir, China: a holistic assessment of organic pollution, mutagenic effects of sediments and genotoxic impacts on fish. Journal of Environmental Sciences 38: 63-82.

Geer LA, Pycke BFG, Waxenbaum J, Sherer DM, Abulafia O, Halden RU (2017) Association of birth outcomes with fetal exposure to parabens, triclosan and triclocarban in an immigrant population in Brooklyn, New York. Journal of Hazardous Materials 323: 177-183.

Halden RU (2014) On the need and speed of regulating triclosan and triclocarban in the United States. Environmental Science & Technology 48(7): 3603–3611.

Harrell S (2023). An ecological history of modern China. University of Washington Press, Seattle.

He G, Wang S, Zhang B (2020) Watering down environmental regulations in China. Quarterly Journal of Economics 135(4): 2135–2185.

He G, Wang S, Zhang B (2020) Watering down environmental regulations in China. Quarterly Journal of Economics 135(4): 2135–2185.

Hvistendahl M (2008) China’s Three Gorges Dam: an environmental catastrophe? Scientific American, March 25, 2008: https://www.scientificamerican.com/article/chinas-three-gorges-dam-disaster/.

IWC (2001) Report of the standing sub-committee on small cetaceans. Journal of Cetacean Research and Management 3(suppl.): 263-291.

Kahane-Rapport SR, Czapanskiy MF, Fahlbusch JA , Friedlaender AS , Calambokidis J, Hazen EL, Goldbogen JA, Savoca MS (2022) Field measurements reveal exposure risk to microplastic ingestion by filter-feeding megafauna. Nature Communications 13: 1-11.

Kruse K, Knickmeier K, Brennecke D, Unger B, Siebert U (2023) Plastic debris and its impacts on marine mammals. Pages 49-62 in D Brenneke, K Knickmeier, I Pawliczka, U Siebert, M Wahlberg (eds.). Springer Marine mammals. A deep dive into science. Nature, Cham, Switzerland.

Lande R (1993) Risks of population extinction from demographic and environmental stochasticity and random catastrophes. The American Naturalist 142:911-927.

Lebreton LCM, Van der Zwet J, Damsteeg JW, Slat B, Andrady A, Reisser J (2017) River plastic emissions to the world’s oceans. Nature Communications 8: 15611.

Lee TE, Fisher DO, Blomberg SP, Wintle BA (2017) Extinct or still out there? Disentangling influences on extinction and rediscovery helps to clarify the fate of species on the edge. Global Change Biology 23: 621–634.

Li L, Geng S, Wu C, Song K, Sun F, Visvanathan C, Xie F, Wang Q (2019) Microplastics contamination in different trophic state lakes along the middle and lower reaches of Yangtze River Basin. Environmental Pollution 254(Part A): 112951.

Liang Y (2007) "Extinct" white-flag dolphin spotted in Yangtze River. Xinhua, August 29, 2007:
https://web.archive.org/web/20090709060701/http://news.xinhuanet.com/english/2007-08/29/content_6627940.htm.

Lim L (2007) Air pollution grows in tandem with China's economy. NPR.org. May 17, 2007: https://www.npr.org/2007/05/17/10221268/air-pollution-grows-in-tandem-with-chinas-economy.

Lin K, Chen P, Hua Y (1985) Population size and conservation of *Lipotes vexillifer*. Acta Zoologica Sinica 5: 77–85.

Lin Y, Vogt R, Larssen T (2012) Environmental mercury in China: a review. Environmental Toxicology and Chemistry 31(11): 2431-2444.

Liu F, Wang Z, Xia Z, Wang J, Liu H (2023) Changes in fish resources 5 years after implementation of the 10-year fishing ban in the Chishui River, the first river with a complete fishing ban in the Yangtze River Basin. Ecological Processes 12: art. 51.

Liu H (2019) The search for the river goddess. The World of Chinese, February 20, 2019: https://www.theworldofchinese.com/2019/02/the-search-for-the-river-goddess/.

Liu R, Wang D, Zhou K (2000) Effects of water development on river cetacean in China. Pages 40–42 in RR Reeves, BD Smith, T Kasuya (eds.) Biology and conservation of freshwater cetaceans in Asia. Occasional papers of the IUCN Species Survival Commission (SSC) 23. IUCN, Gland, Switzerland and Cambridge, UK.

McElhany P, Rucklelshaus MH, Ford MJ, Wainwright TC, Bjorkstedt EP (2000) Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce NOAA Technical Memorandum NMFS-NWFSC-42.

McKenna MF, Wiggins SM, Hildebrand JA (2013) Relationship between container ship underwater noise levels and ship design, operational and oceanographic conditions. Scientific Reports 3: 1–10.

Mei Z, Zhang X, Huang S L, Zhao X, Hao Y, Zhang L, Qian Z, Zheng J, Wang K, Wang D (2014) The Yangtze finless porpoise: On an accelerating path to extinction? Biological Conservation 172: 117–140.

Mei Z, Han Y, Dong L, Turvey ST, Hao Y, Wanh K, Wang D (2019) The impact of fisheries management practices on the survival of the Yangtze finless porpoise in China. Aquatic Conservation 29:639–646

Mei ZG, Cheng PL, Wang KX, Wei QW, Barlow J, Wang D (2020) A first step for the Yangtze. Science 367: 1314-1314.

Meijer LJJ, Van Emmerik T, Van der Ent R, Schmidt C, Lebreton L (2021) More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. Science Advances 7(18): DOI: 10.1126/sciadv.aaz5803.

Merrill GB, Hermabessiere L, Rochman CM, Nowacek DP (2023) Microplastics in marine mammal blubber, melon, & other tissues: evidence of translocation. Environmental Pollution 335: 122252.

Ministry of Agriculture (2001) Action plan for conservation of Chinese river dolphins. Ministry of Agriculture, People's Republic of China.

Müller B, Berg M, Yao ZP, Zhang XF, Wang D, Pfluger A (2008) How polluted is the Yangtze river? Water quality downstream from the Three Gorges Dam. Science of the Total Environment 402: 232-247.

Nelms SE, Galloway TS, Godley BJ, Jarvis DS, Lindeque PK (2018) Investigating microplastic trophic transfer in marine top predators. Environmental Pollution 238: 999-1007.

NMFS (2012) Baiji/Chinese River Dolphin/Yangtze River Dolphin (*Lipotes vexillifer*). 5-Year Review: Summary and Evaluation. National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

NMFS (2016) Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: underwater acoustic thresholds for onset of permanent and temporary threshold shifts. U.S. NOAA Technical Memorandum NMFS-OPR-55. National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

NMFS (2018) Revisions to: technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 2.0): underwater thresholds for onset of permanent and temporary threshold shifts. NOAA Technical Memorandum NMFS-OPR-59. National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

NOAA (2013) Draft guidance for assessing the effects of anthropogenic sound on marine mammals: acoustic threshold levels for onset of permanent and temporary threshold shifts. National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

Nordberg GF, Nogawa K, Nordberg M, Friberg LT (2007) Pages 445-486 in GF Nordberg, BA Fowler, M Nordberg, LT Friberg (eds.) Handbook on the toxicology of metals, 3rd ed. Academic Press, Cambridge, MA.

Osterloff E (2022) The baiji: Why this extinct river dolphin still matters. Natural History Museum (London), September 15, 2022: https://www.nhm.ac.uk/discover/baiji-why-this-extinct-river-dolphin-still-matters.html.

Peng Y, Fang W, Krauss M, Brack W, Wang Z, Li F, Zhang X (2018) Screening hundreds of emerging organic pollutants (EOPs) in surface water from the Yangtze River Delta (YRD): occurrence, distribution, ecological risk. Environmental Pollution 241: 484-493.

Pilleri G (1979) The Chinese river dolphin (*Lipotes vexillifer*) in poetry, literature and legend. Investigations on Cetacea 10: 335-349.

Phillips T (2016) China's 'extinct' dolphin may have returned to Yangtze River, say conservationists. The Guardian, October 10, 2016: https://www.theguardian.com/world/2016/oct/11/china-extinct-dolphin-returned-yangtze-river-baiji.

Putland RL, Merchant ND, Farcas A, Radford CA (2018) Vessel noise cuts down communication space for vocalizing fish and marine mammals. Global Change Biology 24: 1708–1721.

Reeves RR, Gales NJ (2006) Realities of baiji conservation. Conservation Biology 20(3): 626–628.

Reeves RR, Smith BD, Crespo EA, Notarbartolo di Sciara G (2003) Dolphins, whales, and porpoises: 2002-2010 conservation action plan for the world's cetaceans. IUCN, Gland, Switzerland.

Research and Markets (2019) Investigation Report on China's Diclofenac Market, 2019-2023. Research and Markets Dublin, Ireland.

Reuters (2007) Rare dolphin seen in China, experts say. The New York Times, August 30, 2007: https://www.nytimes.com/2007/08/30/world/asia/30china.html?ref=science.

Richardson WJ, Greene CR, Malme CI, Thomson DH (1995) Documented disturbance reactions. Pages 241-324 in WJ Richardson, CR Greene Jnr, CI Malme, DH Thomson (eds.) Marine mammals and noise. Academic Press, San Diego.

Rose NA, Soller AS, Parsons ECM (2023) The case against marine mammals in captivity. 6th edition. Animal Welfare Institute and World Animal Protection, Washington, DC.

Rosel PE, Baker CS, Berta A, Boness DJ, Brownell RL Jr, Domning DP, Fordyce RE, Srembaa A, Jefferson TA, Kinze C, Mead JG, Oliveira LR, Perrin WF, Rice DW, Wang JY, Yamada TK (2017) List of marine mammal species and subspecies. The Society for Marine Mammalogy. https://www.marinemammalscience.org/species-information/list-marine-mammal-species-subspecies/.

Sample I (2007) Yangtze dolphin driven to extinction. The Guardian, August 8, 2007: https://www.theguardian.com/environment/2007/aug/08/endangeredspecies.conservation.

Schmidt C, Krauth T, Wagner S (2017) Export of plastic debris by rivers into the sea. Environmental Science and Technology 51: 12246–12253.

Silk R (2013) China weighs environmental costs; Beijing tries to emphasize cleaner industry over unbridled growth after signs mount of damage done. Wall Street Journal,

July 23, 2013:
https://www.wsj.com/articles/SB10001424127887324879504578597462908226052.

Smith BD, Sinha RK, Zhou K, A. Chaudhry A, Liu R, Wang D, Ahmed B, Haque AKMA, Mohan RSL, Sapkota K (2000) Register of water development projects affecting river cetaceans in Asia. Pages 22-39 in RR Reeves, BD Smith, T Kasuya (eds.) Biology and conservation of freshwater cetaceans in Asia. Occasional papers of the IUCN Species Survival Commission (SSC) 23. IUCN, Gland, Switzerland and Cambridge, UK.

Smith BD, Wang D, Braulik GT, Reeves R, Zhou K, Barlow J, Pitman RL (2017) *Lipotes vexillifer*. The IUCN Red List of Threatened Species 2017: e.T12119A50362206.

Stelios M, Hudgins J, Sweet M (2016) A review of ghost gear entanglement amongst marine mammals, reptiles and elasmobranchs. Marine Pollution Bulletin 111(1-2): 6-17.

Stern RE (2013) Environmental litigation in China: a Study in political ambivalence. Cambridge University Press, Cambridge, UK.

Su B, Huang J, Zeng X, Gao C, Jiang T (2017) Impacts of climate change on streamflow in the upper Yangtze River basin. Climatic Change 141: 533–546.

Su L, Xue Y, Li L, Yang D, Kolandhasamy P, Li D, Shi H (2016) Microplastics in Taihu Lake, China. Environmental Pollution 216: 711-719.

Thomas PO, Gulland FMD, Reeves RR, Kreb D, Ding W, Smith B, Malik MI, Ryan GE, Phay S (2019) Electrofishing as a potential threat to freshwater cetaceans. Endangered Species Research 39: 207-220.

Turvey S (2008) Witness to extinction: how we failed to save the Yangtze River dolphin. Oxford University Press, Oxford, UK.

Turvey ST, Barrett LA, Hao Y, Zhang L, Zhang X, Wang X, Huang Y, Zhou K, Hart T, Wang D (2010) Rapidly shifting baselines in Yangtze fishing communities and local memory of extinct species. Conservation Biology 24(3): 778-787.

Turvey ST, Pitman RL, Taylor BL, Barlow J, Akamatsu T, Barrett LA, Zhao X, Reeves RR, Stewart BS, Wang K, Wei Z, Zhang X, Pusser L, Richlen M, Brandon JR, Wang D (2007) First human-caused extinction of a cetacean species? Biology Letters 3(5): 537–540.

Turvey ST, Risley CL, Moore JE, Barrett LA, Hao YJ, Zhao XJ, Zhou KY, Wang D. (2013) Can local ecological knowledge be used to assess status and extinction drivers in a threatened freshwater cetacean? Biological Conservation 157: 352-360.

Unger B, Bravo Rebolledo EL, Deaville R, Gröne A, IJsseldijk LL, Leopold MF, Siebert U, Spitze J, Wohlsein P, Herr H (2016) Large amounts of marine debris found in sperm

whales stranded along the North Sea coast in early 2016. Marine Pollution Bulletin 112(1–2): 134–141.

Wang C, Zou X, Gao J, Zhao Y, Yu W, Li Y, Song Q (2016) Pollution status of polycyclic aromatic hydrocarbons in surface sediments from the Yangtze River Estuary and its adjacent coastal zone. Chemosphere 162: 80-90.

Wang D, Zhang X, Liu R (1998) Conservation status and the future of baiji and finless porpoise in the Yangtze River of China. Pages 218–226 in Z Huang, B Fu, Z Yang (eds.) Ecology and environment protection in the large water conservancy projects of the Yangtze River. Environmental Science Press, Beijing, China.

Wang K, Wang D, Zhang X, Pfluger A, Barrett L (2006) Range-wide Yangtze freshwater dolphin expedition: The last chance to see Baiji? Environmental Science and Pollution Research 13(6): 418-424.

Wang D, Wang K, Xiao Y, Sheng G (1992) Auditory sensitivity of a Chinese river dolphin, Lipotes vexillifer. Pages 213–221 in JA Thomas, RA Kastelein, AY Supin (eds.) Marine mammal sensory systems. Plenum Press, New York.

Wang D, Zhang X, Wang K, Wei Z, Würsig B, Braulik GT, Ellis, S (2006). Conservation of the Baiji: No simple solution. Conservation Biology 20(2): 623-625.

Wang D (2015) Progress achieved on natural ex situ conservation of the Yangtze finless porpoise. IUCN SSC – Cetacean Specialist Group, 2015. Available from: https://iucn-csg.org/progress-achieved-on-natural-ex-situconservation-of-the-yangtze-finless-porpoise/.

Wang D, Turvey ST, Zhao X, Mei Z (2013) *Neophocaena asiaeorientalis* ssp. *asiaeorientalis*. The IUCN Red List of Threatened Species 2013: e.T43205774A45893487. https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T43205774A45893487.en.

Wang HZ, Liu XQ, Wang HJ (2016) The Yangtze River floodplain: threats and rehabilitation. American Fisheries Society Symposium 84: 263–291.

Wang P, Chen H, Kopittke PM, Zhao FJ (2019) Cadmium contamination in agricultural soils of China and the impact on food safety. Environmental Pollution 249: 1038-1048.

Wang ZT, Akamatsu T, Duan PX, Zhou L, Yuan J, Li J, Lei PY, Chen YW, Yang YN, Wang KX, Wang D (2020) Underwater noise pollution in China's Yangtze River critically endangers Yangtze finless porpoises (*Neophocaena asiaeorientalis asiaeorientalis*). Environmental Pollution 262: 114310.

Wang ZT, Li J, Zhou L, Liu MC, Yang YN, Fan F, Wang KX, Ding Wang D (2021) Riverside underwater noise pollution threaten porpoises and fish along the middle and

lower reaches of the Yangtze River, China. Ecotoxicology and Environmental Safety 226: 112860.

Wang ZT, Peng-Xiang Duan PX, Akamatsu T, Chen YW, An X, Yuan J, Lei PY, Li J, Zhou L, Liu MC, Yang YN, Fan F, Wang KX, Wang D (2021) Riverside underwater noise pollution threaten porpoises and fish along the middle and lower reaches of the Yangtze River, China. Ecotoxicology and Environmental Safety 226: 112860

Waples KA, Gales NJ (2002) Evaluating and minimising social stress in the care of captive bottlenose dolphins (*Tursiops truncatus*). Zoo Biology 21: 5–26.

Wei Z, Wang D, Zhang X, Zhao, Q, Wang K, Kuang X (2002) Population size, behavior, movement pattern and protection of Yangtze finless porpoise at Balijiang section of the Yangtze River. Resources and Environment in the Yangtze Basin 11: 427–432.

Wen X, Wu Y (2017) The Chinese baiji dolphin is suspected to have reappeared in the Yangtze River ten years after being functionally extinct. The scientific expedition team said they photographed two. The Paper, May 14, 2017: https://m.thepaper.cn/wifiKey_detail.jsp?contid=1684992&from=wifiKey# [in Chinese].

Wu B, Wang W, Wang H, He G (2022) A retrospective analysis on the population viability of the Yangtze river dolphin or baiji (*Lipotes vexillifer*). Indian Journal of Animal Research 6(6): 775-779.

Wu J, Huang J, Han X, Xie Z, Gao X (2003) Three-Gorges Dam–experiment in habitat fragmentation? Science 300(5623): 1239–1240.

Wu J, Kan K (2021) The Chinese companies polluting the world more than entire nations. Bloomberg News, October 24, 2021: https://www.bloomberg.com/graphics/2021-china-climate-change-biggest-carbon-polluters/.

WWF (2011) Yangtze Conservation and Development Report 2011. Worldwide Fund for Nature, Gland, Switzerland.

WWF (2022) Living Yangtze report 2022. Worldwide Fund for Nature, Gland, Switzerland.

Xie P (2003) Three-Gorges Dam: risk to ancient fish. Science 302(5648): 1149–1151.

Xie P (2017) Biodiversity crisis in the Yangtze River: the culprit was dams, followed by overfishing. Journal of Lake Science 29: 1279–1299.

Xiong X, Qian Z, Mei Z, Wu J, Hao Y, Wang K, Wu C, Wang D (2019) Trace elements accumulation in the Yangtze finless porpoise *(Neophocaena asiaeorientalis asiaeorientalis*) – a threat to the endangered freshwater cetacean. Science of the Total Environment 686: 797–804.

Xiong X, Wu C, Elser JJ, Mei Z, Hao Y (2019) Occurrence and fate of microplastic debris in middle and lower reaches of the Yangtze River – from inland to the sea. Science of the Total Environment 659: 66–73.

Xu H, Gao Q, Yuan B (2022) Analysis and identification of pollution sources of comprehensive river water quality: Evidence from two river basins in China. Ecological Indicators 135: 108561.

Yang H, Shen L, He Y, Tian H, Gao L, Wu J, Mei Z, Wei N, Wang L, Zhu T, Hu F, Gong J, Du H, Duan X, Deng H, Wang D, Zhu F, Li Y, Wu F, Ru H, Zhang Y, Li J, Yang J, Zhou Y, Fang D, Wang Y, Lin D, Yang Y, Li P, Liu S, Yang J, Zhuang P, Wang S, Zhang T, Yang G, Yang W, Yuan L, Cao K, Xu S, Liu H, Liang Z, Wang C, Li H, Yuan X, Yang X, Fu Y, Zhang Y, Zhang H, Tao Z, Wang S, Gao X, Jin B, Li K, Wang G, Jian S, Li Y, Xue C, Lei C, Xue S, Sun Y, Zhu B, Shao K, Hu X, Xiong M, Du J, He B, Yan T, Huang Y, Zou Y, Xie B, Wang Y, Li B, Liu F, Zhang Y, Fan F, Wang Z, Huang J, Gu H, Ge H, Dan Y, Li Y, Wang S, Zhang C, Zhou L, Wang X, Zeng S, Xiang Y, He X, Qin J, Xia C, Hou J, Shi Y, Gao L, Zhu Z, Shen H, Du Y, Duan X, Xiong J, Yang D, Liu S, Ni Z, Zhang H, Liu K, Zhao F, Li Y, Wang J, Wei Q (2024) Status of aquatic organisms resources and their environments in Yangtze River system (2017–2021). Aquaculture and Fisheries 9(5): 833-850.

Yang P, Xia J, Luo X, Meng L, Zhang S, Cai W, Wang W (2021) Impacts of climate change-related flood events in the Yangtze River Basin based on multi-source data. Atmospheric Research 263: 105819.

Yang Y, Chen Z, Zhang J, Wu S, Yang L, Chen L, Shao Y (2021) The challenge of micropollutants in surface water of the Yangtze River. Science of the Total Environment 780: 146537.

Yee WH, Tang SY, Lo CWH (2016) Regulatory compliance when the rule of law is weak: evidence from China's environmental reform. Journal of Public Administration Research and Theory 26(1): 95-112.

Yin S, Wu Y, Xu W, Li Y, Shen Z, Feng C (2016) Contribution of the upper river, the estuarine region, and the adjacent sea to the heavy metal pollution in the Yangtze Estuary. Chemosphere 155: 564-572.

Yin S, Yi Y, Liu Q, Luo Q, Chen K (2022) A review on effects of human activities on aquatic organisms in the Yangtze River Basin since the 1950s. River 1(1): 104-119.

Yueh MF, Li T, Evans RM, Hammock B, Tukey RH, Appanna VD (2012) Triclocarban mediates Induction of xenobiotic metabolism through activation of the constitutive androstane receptor and the estrogen receptor alpha. PLoS ONE 7(6): e37705.

Zhang H, Kang M, Shen L, Wu J, Li J, Du H, Wang C, Yang H, Zhou Q, Liu Z, Gorfine H, Wei Q (2020) Rapid change in Yangtze fisheries and its implications for global freshwater ecosystem management. Fish and Fisheries 21(3): 601-620.

Zhang J (1995) Geochemistry of trace metals from Chinese river/estuary systems: an overview. Estuarine and Coast Shelf Science 41: 631–658.

Zhang K, Qian Z, Ruan Y, Hao Y, Dong W, Li K, Mei Z, Wang K, Wu C, Wu J, Zheng J, Lam PKS, Wang D (2020) First evaluation of legacy persistent organic pollutant contamination status of stranded Yangtze finless porpoises along the Yangtze River Basin, China. Science of the Total Environment 710: 136446.

Zhang K, Xiong X, Hu H, Wu C, Bi Y, Wu Y, Zhou B, Lam PKS, Liu J (2017) Occurrence and characteristics of microplastic pollution in Xiangxi Bay of three Gorges reservoir, China. Environmental Science and Technology 51: 3794–3801.

Zhang X, Wang D, Liu R, Wei Z, Hua Y, Wang Y, Chen Z, Wang L (2003) The Yangtze River dolphin or baiji (*Lipotes vexillifer*): population status and conservation issues in the Yangtze River, China. Aquatic Conservation: Marine and Freshwater Ecosystems 13(1): 51-64.

Zhang Z, Deng C, Dong L, Liu L, Li H, Wu J, Ye C (2021) Microplastic pollution in the Yangtze River Basin: heterogeneity of abundances and characteristics in different environments. Environmental Pollution 287: 117580.

Zhao S, Zhu L, Wang T, Li D (2014) Suspended microplastics in the surface water of the Yangtze estuary system, China: first observations on occurrence, distribution. Marine Pollution Bulletin 86: 562–568.

Zhou K (1989) Review of studies of structure and function of the baiji*, Lipotes vexillifer*. Pages 99-113 in WF Perrin, RL Brownell Jr, K Zhou, J Liu (eds.) Biology and conservation of the river dolphins. Occasional papers of the IUCN Species Survival Commission (SSC) 3. Gland, Switzerland.

Zhou K (2006) Baiji *Lipotes vexillifer*. Pages 71-76 in WF Perrin, B Würsig, JGM Thewissen (eds.) Encyclopedia of Marine Mammals. Academic Press, San Diego, CA.

Zhou K, Li Y (1989) Status and aspects of the ecology and behavior of the baiji, *Lipotes vexillifer*, in the lower Yangtze River. Pages 86-91 in WF Perrin, RL Brownell Jr, K Zhou, J Liu (eds.) Biology and conservation of the river dolphins. Occasional papers of the IUCN Species Survival Commission (SSC) 3. IUCN, Gland, Switzerland.

Zhou K, Li Y, Nishiwaki M, Kataoka T (1982) A brief report on observations of the baiji (*Lipotes vexillifer*) in the lower reaches of the Yangtze River between Nanjing and Guichi. Acta Theriologica Sinica 2: 253–254.

Zhou K, Pilleri G, Li Y (1980) Observations on baiji (*Lipotes vexillifer*) and finless porpoise (*Neophocaena asiaeorientalis*) in the lower reaches of the Chang Jiang. Scientia Sinica 23: 785–795.

Zhou K, Sun J, Gao A, Würsig B (1998) Baiji (*Lipotes vexillifer*) in the lower Yangtze River: movements, numbers threats and conservation needs. Aquatic Mammals 24(2): 123–132.

Zhou K, Wang X (1994) Brief review of passive fishing gear and incidental catches of small cetaceans in Chinese waters. Reports of the International Whaling Commission, Special Issue 15: 347–354.

Zhou X, Sun F, Xu S, Fan G, Zhu K, Liu X, Chen Y, Shi C, Yang Y, Huang Z, Chen J, Hou H, Guo X, Chen W, Chen Y, Wang X, Lv T, Yang D, Zhou J, Huang B, Wang Z, Zhao W, Tian R, Xiong Z, Xu J, Liang X, Chen B, Liu W, Wang J, Pan S, Fang X, Li M, Wei F, Xu X, Zhou K, Wang J, Yang G (2013) Baiji genomes reveal low genetic variability and new insights into secondary aquatic adaptations. Nature Communications 4: 2708.

Zhu Y, Price OR, Kilgallon J, Qi Y, Tao S, Jones KC, Sweetman AJ (2018) Drivers of contaminant levels in surface water of China during 2000–2030: Relative importance for illustrative home and personal care product chemicals. Environment International 115: 161-169.

Zhuang W, Zhou F (2021) Distribution, source and pollution assessment of heavy metals in the surface sediments of the Yangtze River Estuary and its adjacent East China Sea. Marine Pollution Bulletin 164: 112002.

12 APPENDIX

TABLE 7. CHINESE LAWS RELEVANT TO THE SPECIES AND ITS HABITAT

Below we list relevant regulations or laws with links to available on the Food and Agricultural Organization (FAO) or other websites.

Regulation/Law and Date	Description
Regulations on Reproduction and Protection of Aquatic Resources 10 February 1979	Article (art.) 83 stablishes a fishery licensing system; requires registration of fishing vessels; strengthens supervision, inspection, and rational utilization of aquatic resources; lists key aquatic animals and plants which should be protected; restricts harmful fishing gears, fishing methods, and activities.
Law of the People's Republic of China on the Protection of Wildlife 8 November 1988	This law states that wildlife resources are owned by the State (art. 3). Government departments under the State Council are responsible for the protection of terrestrial and aquatic wildlife throughout the country (art. 7). Illegal hunting of wildlife is prohibited (art. 8). Provincial governments (and above) may designate nature reserves (art. 10). Government departments are directed to monitor the environmental impacts on wildlife (art. 11). If a construction project adversely impacts wildlife an Environmental Impact Assessment (EIA) must be produced for consideration (art. 12). When protected wildlife are threatened by a natural disaster local government shall undertake rescue measures (art. 13). Government departments shall conduct regular wildlife surveys (art. 15). Hunting, catching or killing of protected wildlife is prohibited (art. 16). Domestication and breeding of wildlife is encouraged (art. 17). Hunting is prohibited in nature reserves (art. 20); the sale and purchase of protected wildlife is prohibited (art. 22). International trade in listed species (under the Convention on International Trade in Endangered Species of Wild Fauna and Flora, CITES) is limited (art. 24). Foreigners wishing to survey or video protected species must obtain a permit (art. 26).
Fisheries Law of the People's Republic of China 20 January 1986	Establishes a fishing quota system; implements a fishing license system and fisheries management plans; and prohibits of the use of explosives and poisons in fishing.
Environmental Protection Law 26 December 1989	Promotes clean energy and resource recycling; sets up standards for environment quality and the discharge of pollutants; establishes an environmental monitoring and warning system; makes public the environmental impact reports for public consideration; adopts total emission control system for key pollutants; and establishes ecological protection compensation mechanism.
Circular of the General Office of the State Council on Strengthening the Protection and Management of Biological Species Resources 31 March 2002	The circular clarifies various aspects of foreign involvement and obligations when it comes to “biological species resources.” This includes sharing of research and development achievements, and intellectual property rights. The circular also outlines processes for investigating and cataloging of biological species resources, formulating plans for their protection

Regulation/Law and Date	Description
	and utilization, capacity building, scientific research, and the approval system for the export of biological species resources.
Law of the People's Republic of China on Environmental Impact Assessments 28 October 2002	Promotes environmental sustainability via EIA procedures. A construction or development project can be prohibited or stopped if an EIA fails to pass review (Art. 25). Construction can be stopped, and a fine levied, if a project if it doesn't have an approved EIA (Art 31). Also promotes active participation of the communities in the protection of their environment, research, education and widespread awareness on environmental issues.
Measures for the Administration of Aquatic Animal and Plant Nature Reserves (2014) Original: 17 October 1997 Updated: 25 April 2014	This law sets conditions for establishing a nature reserve (art. 6). Art 6(1) and Art. 6(3) outline that nature reserves can be established for aquatic species of national importance and their habitats.
Circular on Regulating the Review and Approval Management of aquatic CITES listed species[4] 20 November 2018	This circular clarifies and standardizes the import and export approval review for aquatic animal species listed under CITES.
Decision to Comprehensively Prohibit the Illegal Trade of Wild Animals and Further Strengthening the Protection and Management of Aquatic Wildlife[5] 4 March 2020	Strengthens law enforcement on illegal acts involving aquatic wildlife; improves relevant archives and labeling systems for aquatic wildlife; and promotes dynamic and traceable management of aquatic wildlife.
Announcement of the General Administration of Market Supervision on the special action of banning fishing in the key waters of the Yangtze River	A ban on fishing in designated key areas of the Yangtze River basin; increased market inspections to identify and seize illegally caught fish; investigations into suspected illegal fishing operations and their sales networks; and a public awareness campaigns to educate consumers about the importance of the fishing ban.

[4] The full title is "Circular of the General Office of the Ministry of Agriculture and Rural Affairs on Regulating the Review and Approval Management of Aquatic Animal Species in the Appendix to the Convention on International Trade in Endangered Species of Wild Fauna and Flora."

[5] The full title is "Circular of the Ministry of Agriculture and Rural Affairs on implementing the "Decision of the Standing Committee of the National People's Congress to Comprehensively Prohibit the Illegal Trade of Wild Animals, Break the Bad Habit of Excessive Consumption of Wild Animals, and Effectively Secure the Life and Health of the People" and Further Strengthening the Protection and Management of Aquatic Wildlife."

Regulation/Law and Date	Description
basin and breaking the sales chain 25 July 2020	
Yangtze River Protection Law of the People's Republic of China 26 December 2020	Establishes water quality standards (art. 7) and a monitoring network (art 9). Requires conducting regular surveys of the natural resources of the river and wildlife and habitat surveys every 10 years (art. 8). Establishes an ecological emergency response program (art. 10). Establishes an advisory committee to advise on development projects and policies and to organize third party assessments (art. 12). Calls for improvements in education and outreach about the Yangtze and to highlight illegal activities (art. 14). Helps support and reward individuals and organizations working to conserve the Yangtze ecosystem (art. 16). Establishes areas prohibited to shipping (art. 27). Ensures a flow of water in the dry season that doesn't negatively impact ecosystems (art. 31). Establishes national parks and nature reserves in the Yangtze basin (art. 39). Requires the formulation of plans for the protection of endangered animals and to encourage research on these species (art. 42). Calls for strengthening the control and monitoring of water pollution in the Yangtze (art. 43). Calls for reducing agricultural pollution including reducing pesticide use (art. 48). Requires investigation of major point sources of pollution and to take appropriate action (art. 50). Development plans for ecological and environmental restoration (art. 52). Fishing banned in the river; strictly enforce ban and investigate and enforce prohibitions on electrofishing, blast fishing and fishing via poison (art. 53). Local Governments throughout the Yangtze basin shall fund ecological restoration projects in the upper reaches of the Yangtze (art. 63). Polluting industries should use technology to reduce pollution (art. 66). Calls for the establishment of green development zones and conducting of regular assessments of energy saving, environmental protection and emissions reductions in development areas (art. 67). Requires planning of aquaculture including establishing no aquaculture zones (art. 70). Calls for restrictions on the use of plastic products (art. 74). Establishes that individuals and organizations have the right to file charges against pollution or environmental damage (art. 79). States that failure to investigate environmental crimes or similar dereliction of duty shall be punished with demotion or dismissal (art. 83).
Guiding Opinions of the Ministry of Agriculture and Rural Affairs on Strengthening the Conservation of Aquatic Biological Resources 20 November 2022	Emphasizes the identification and protection of endangered and vulnerable aquatic species, potentially including measures like establishing protected areas and restricting fishing activities in critical habitats; encourages further research on aquatic biology and ecology to inform effective conservation strategies; notes the importance of raising public awareness about the importance of aquatic conservation and promoting responsible fishing practices; calls for stricter regulations on water pollution are likely included to safeguard aquatic ecosystems from harmful contaminants; calls for restoration and management of important aquatic habitats to

Regulation/Law and Date	Description
	conserve biodiversity; aims to promote sustainable fishing methods like size limits, catch quotas, and closed seasons to prevent overfishing and maintain healthy fish populations.
Law of the People's Republic of China on the Protection of Wildlife 2022 (amending the 1988 Law of the People's Republic of China on the Protection of Wildlife) 30 December 2022	Provincial governments (and above) can establish national parks and natural reserves (art. 12). When protected wildlife are threatened by a sudden pollution incident or natural disaster local government shall undertake rescue measures (art. 15). The sale, purchase and utilization of protected wildlife, or their products, is prohibited; international trade in listed species under CITES is prohibited (art. 37). Protected species may be captive-bred wildlife, and such wildlife, and their products, may be sold and utilized (if marked and traced) (art. 27, 28).[6] This law also attempted to address the potential threat of zoonotic disease spread due to the use and trade of wildlife products.

[6] This controversial article allows the captive breeding and used of parts of wild species for the animal trade market.