

# Past and present: the status and distribution of otters (Carnivora: Lutrinae) in China

FEI LI and BOSCO PUI LOK CHAN

**Abstract** Three species of otters are known from China; the Eurasian otter *Lutra lutra* is widespread throughout the country and the smooth-coated *Lutrogale perspicillata* and Asian small-clawed otters *Aonyx cinereus* occur in tropical and subtropical regions. We summarize the past status and distribution of otters in China, and provide an update based on a literature review, interviews and field surveys. Otter populations have undergone a dramatic countrywide decline, and are extirpated over much of their former ranges. Relict populations persist, however, in well-protected nature reserves, in sparsely populated headwaters of the Qinghai–Tibetan Plateau, at remote sites along international borders, and in densely populated deltas and floodplains. Recent records were mostly of the Eurasian otter, and we could find no confirmed recent record of the smooth-coated otter. The otters that survive in certain well-protected sites could act as source populations for recolonization if adequate conservation interventions are implemented. Urgent, focused action is needed to protect the remaining populations, and to study the taxonomy and ecology of China's otters.

**Keywords** *Aonyx cinereus*, Asian small-clawed otter, China, Eurasian otter, *Lutra lutra*, *Lutrogale perspicillata*, population, smooth-coated otter

## Introduction

Otters are top predators in many freshwater ecosystems and serve as indicators of healthy aquatic environments (Kruuk, 2006). In Europe and the Americas they are fairly common research subjects, and flagships for freshwater conservation (Mason & Macdonald, 1986; González & Utrera, 2004; Recharte Uscamaita & Bodmer, 2010; Stevens et al., 2011; Chanin, 2013; Balestrieri et al., 2016). Although Asian otters are in general decline, otters remain relatively widespread and locally common in the Indian Subcontinent and South-east Asia (Raha & Hussain, 2016; Willcox et al., 2016). In East Asia, however, the Eurasian otter *Lutra lutra* is extinct in Japan (Ando, 2008; Hance, 2012) and has not been recorded on Taiwan Island for over 2 decades (Lee, 2015); and the Asian small-clawed otter *Aonyx cinereus* is either extirpated or extremely rare throughout much of its range in China (Wright et al., 2015).

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Three species of otters are known from China: the Eurasian otter, the Asian small-clawed otter and the smooth-coated otter *Lutrogale perspicillata* (Gao, 1987; Zhang, 1997a; Wang, 2003; Smith & Xie, 2009). Historically, otters in China were hunted for fur and medicine, and eradicated as an aquaculture pest (Cui, 1959; Ni, 1986; Sun, 1991; Liu, 2013). All studies in recent years have reported a marked decline in otter populations throughout China (Lau et al., 2010; Zhang et al., 2014; Chen et al., 2016; He et al., 2016), and all three species are categorized as Endangered on the National Red List (Jiang et al., 2016).

Here we provide a comprehensive overview of the status and distribution of otters in China, based on a literature review, interviews and field surveys, to provide the basis for developing an appropriate conservation strategy for this group of carnivores.

## Methods

### Past status and distribution (1950–2005)

Distribution data were collated from scientific and grey literature (e.g. Hu & Wang, 1984; Feng et al., 1986; Gao, 1987; Zhang, 1997a; Huang et al., 2017). We also checked catalogued otter specimens deposited in the following institutions, for unpublished records: Guangdong Institute of Applied Biological Resources (n = 6), Kunming Institute of Zoology (n = 11) and Beijing Institute of Zoology (n = 5) of the Chinese Academy of Sciences.

We searched government-published wildlife trade records from the 1950s to 1985 for data on otters. During this period wildlife products were considered to be a major source of revenue (State Forestry Administration of the People's Republic of China, 1959; Chen, 1964), the trade was centralized and hunters' kills could be sold only to the nearest state-owned forest product bureau and medicine companies (Yang et al., 2003). As international, and even inter-provincial, trade of pelts was negligible during the period, we assume that government trade statistics accurately reflect changes in the abundance and distribution of game animals over time (Ma & Jia, 1990). The situation changed after 1985 with China's open-door economic policy, and official trade statistics are no longer a reliable indicator of the status of wild species (Zhang, 1997b).

### Present status and distribution (2006–2016)

We consulted 32 species or area experts throughout China to obtain recent information on otters, and compiled all recent records of otters (2006–August 2016) located in scientific

TABLE 1 Data on the trade in pelts of the Eurasian otter *Lutra lutra* in China during 1950–1985 (in some southern provinces pelts may include those of smooth-coated *Lutrogale persipillata* and Asian small-clawed otters *Aonyx cinereus*).

| Province                   | Mean annual harvest (No. of individuals) |                 |                       |               | % decline | Source                              |
|----------------------------|--|-----------------|-----------------------|---------------|-----------|-------------------------------------|
|                            | 1950s                                    | 1960s           | 1970s                 | 1980–1985     |           |                                     |
| Heilongjiang               | 700                                      |                 | 177 (Mudanjiang only) |               |           | Ma (1986); Cheng (1980)             |
| Jilin (Changbai Mountains) | > 1,000                                  |                 |                       | < 10          | > 99      | Yang (1990)                         |
| Liaoning                   |  |                 |                       | 27 (in 1980)  |           | Xiao (1986)                         |
| Henan                      | 239                                      | 253             | 135                   | 45            | 82.2      | Ge (1983)                           |
| Anhui                      | > 300                                    |                 | 121                   | 28            | > 90.7    | Wang (1990)                         |
| Shannxi                    |  |                 | 340 (in 1979)         |               |           | Shaanxi Institute of Zoology (1981) |
| Hubei                      | 14,000 (in 1955)                         |                 |                       |               |           | Li et al. (1963)                    |
| Hunan                      | 25,733 (highest annual yield)            |                 |                       |               |           | Xie & Li (1991)                     |
| Jiangxi                    |  | > 1,000         |                       |               |           | Sheng & Lu (1975)                   |
| Zhejiang                   | > 1,000                                  |                 | 339                   |               | > 66.1    | Zhuge (1982); Zhuge & Huang (1988)  |
| Fujian                     |  | 3,223 (in 1965) | 355 (in 1979)         | 66 (in 1983)  | 98.0      | Zhan (1985)                         |
| Guangdong*                 | > 10,000                                 | 3,075 (in 1967) |                       | 382 (in 1981) | 96.2      | Xu (1984)                           |
| Hainan                     | 4,307 (in 1955)                          | 864 (in 1966)   |                       |               | 79.9      | Xu (1984)                           |
| Guangxi                    | 4,975 (in 1957)                          |                 | 36 (in 1979)          | 0 (post-1981) | > 99.9    | Wu (1993)                           |
| Yunnan (Honghe)            |  |                 |                       | 62            |           | Li et al. (1987)                    |
| Guizhou (Weining)          |  |                 | 1 (in 1976)           | 0             |           | Luo (1993)                          |
| Sichuan                    |  | 3,000 (in 1964) | 700 (in 1977)         |               | 76.7      | Hu & Wang (1984)                    |
| Xizang (Changdu)           |  |                 | 319 (in 1970)         |               |           | Feng et al. (1986)                  |

\*Hainan Island was part of Guangdong Province until 1988, and therefore these data include otters harvested from Hainan Island.

publications, grey literature and social media platforms. For grey literature and social media posts, only those supported by photographic evidence were treated as positive records.

We conducted otter surveys during 2012–August 2016, using interviews with local people, transects and camera-trapping (Kruuk et al., 1993; Kruuk, 2006; Delibes et al., 2012; Willcox et al., 2016). We walked transects of up to 1,000 m in length along watercourses and lotic habitats at 15 sites: two were in the Irrawaddy Basin, three in the Pearl River Basin, nine on Hainan Island and one in the Huaihe River Basin. During the transect surveys we searched for otter signs such as spraints, footprints, latrine and den sites, and food remains. Camera-trapping was conducted at seven sites for which local interviewees reported recent sightings of otters: two in the Irrawaddy Basin, one in the Pearl River Basin and four on Hainan Island. Camera traps (Loreda L510, Loreda, Shenzhen, China; Ltl Acorn 6210, AcornCamera, Shenzhen, China; SG-990 V, Shenzhen Siyuan Digital Technology Co., Shenzhen, China) were set up in front of latrine sites and otter dens, with a total effort of 2,330 trap nights. Commercial bait (Hawbaker's Otter Lure, Fort Loudon, USA) was applied to 24 of the 39 camera-trap stations. Coordinates of surveyed sites and otter records were recorded using a global positioning system. To avoid sampling bias, all surveys were carried out by the same core survey team.

## Results

### Past status and distribution (1950–2005)

According to provincial pelt trade statistics for 1953–1985, otters were abundant in many provinces, particularly in the Yangtze and Pearl River Basins, and > 10,000 individuals were killed annually in each of these basins before the 1960s. In 1957 alone, > 40,000 pelts were officially traded in China (Wu, 1993). However, by 1980–1985 the annual harvest of otter pelts had decreased dramatically (Table 1). The Eurasian otter was the most widespread otter species in China, with records from all major basins, including Hainan and Taiwan Islands (Fig. 1a); the majority of records were from the Yangtze and Pearl River Basins (Table 2). The Asian small-clawed otter was restricted to the tropical and subtropical regions of the country. Historical records were from the Brahmaputra, the Irrawaddy, the Mekong, the Red River and the Pearl River Basins, as well as Hainan Island (Fig. 1b). The species has been reported from south-western Sichuan Province in the Yangtze Basin (Hu & Wang, 1984), as well as Kinmen Island of Taiwan, close to the Fujian coast (Allen, 1938; Lee, 1996), but these records are outside the species' known range and are not supported by unequivocal evidence, and thus we consider them erroneous. The smooth-coated otter

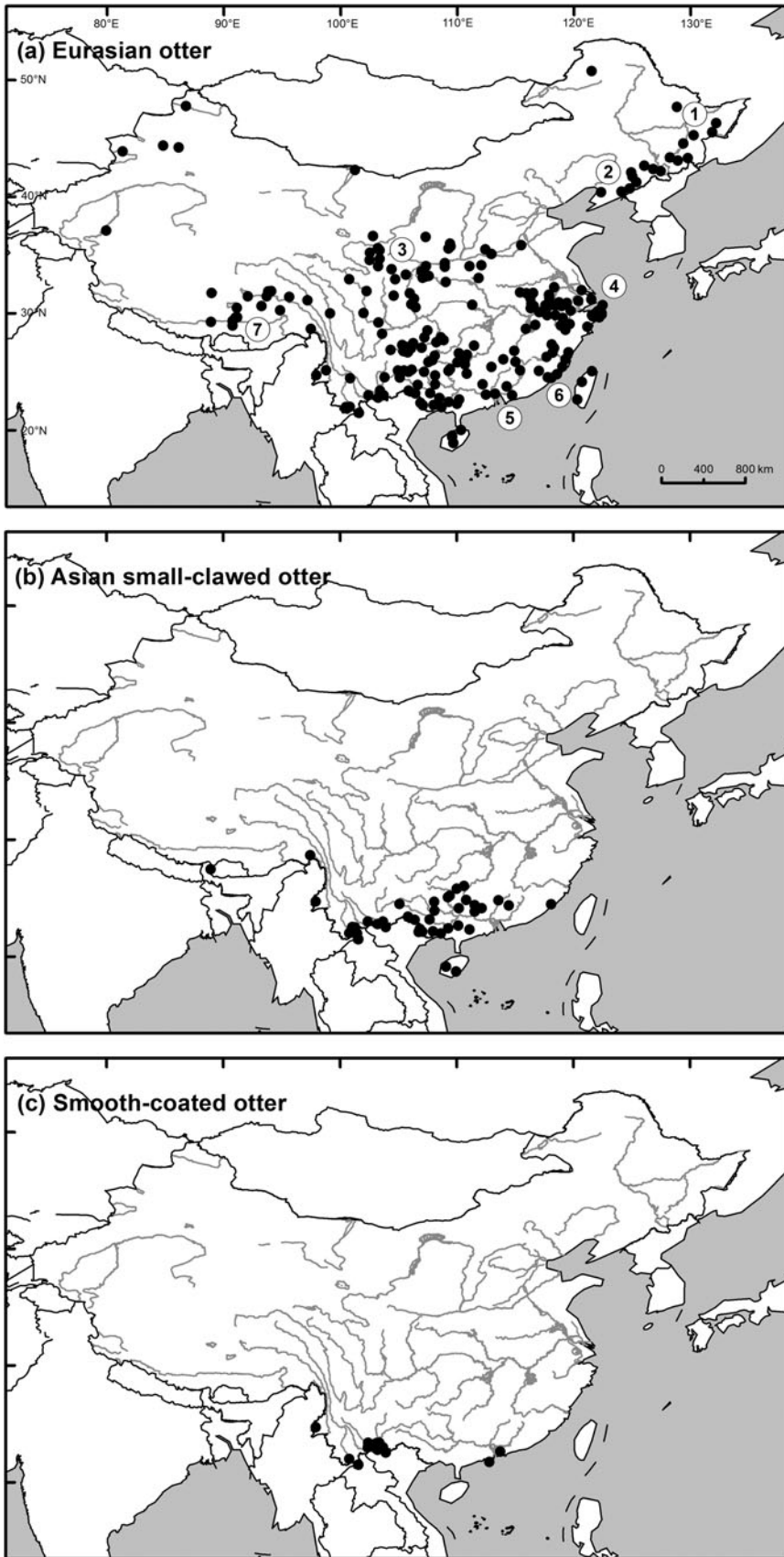


FIG. 1 Historical distribution (1950–2005) of (a) the Eurasian otter *Lutra lutra*, (b) the Asian small-clawed otter *Aonyx cinereus*, and (c) the smooth-coated otter *Lutrogale perspicillata* in China. Major river basins are numbered as follows: 1, Amur River; 2, Liao River; 3, Yellow River; 4, Yangtze; 5, Pearl River; 6, South-east coast; 7, Brahmaputra.

TABLE 2 Historical distribution (1950–2005) of the Eurasian otter in major river basins of China (Fig. 1).

| River basin      | No. of records | % of total |
|------------------|----------------|------------|
| Amur River       | 12             | 5.7        |
| Liao River       | 6              | 2.9        |
| Yellow River     | 18             | 8.6        |
| Yangtze          | 80             | 38.1       |
| Pearl River      | 38             | 18.1       |
| South-east coast | 17             | 8.1        |
| Brahmaputra      | 9              | 4.3        |
| Others           | 30             | 14.3       |
| <i>Total</i>     | 210            | 100        |

occurred only in the Pearl River Delta of Guangdong Province and the international borders of the Red River and the Irrawaddy in Yunnan Province (Fig. 1c). The records from Guangdong Province represent a disjunct distribution at the easternmost limit of the species' continental range. An adult male was collected from Taishan County, Guangdong, and its tail length was substantially shorter than those of specimens from Yunnan (Xu et al., 1989; Liu, 1992, cited in Zhang, 1997a).

#### Present status and distribution (2006–2016)

Our surveys confirmed the presence of otters at three sites in southern China, and nine of the 32 wildlife experts consulted had recent information on otters. Altogether, we confirmed 19 sites in 10 river basins with recent records of otters during 2006–August 2016 (Table 3; Fig. 2); more than one-third of these sites are outside China's official protected area system. The Eurasian otter was recorded at 17 sites, and the Asian small-clawed otter was recorded at two sites. We could find no recent record of the smooth-coated otter in China.

The current pattern of otter distribution in China can be divided into three broad categories: (1) otters in well-protected nature reserves, whose survival there may be a by-product of intensive efforts to protect other flagship species, such as the Siberian tiger *Panthera tigris altaica* at site 1, the giant panda *Ailuropoda melanoleuca* at sites 3, 4 and 11, and rare waterbirds at site 9 (Table 3; Fig. 2); (2) otters in sparsely populated remote areas (sites 12–16 are located at the headwaters of the Qinghai–Tibetan Plateau, where local spiritual beliefs prevent excessive hunting; sites 17–18 are along remote international borders, with low human population density); (3) otters in suburbs with plentiful freshwater, where they can survive provided that extensive coastal and freshwater habitats are available (sites 2, 5–10).

## Discussion

Otters were once widespread and common in China, but sustained, large-scale commercial hunting had wiped out

many populations by 1980. Various reports indicate a 90% decline in harvest (Liu & Yuan, 1981; Li et al., 1982; Luo & Zhang, 1988; Xiao, 1988; Huang, 1989; Xu et al., 1989; Ruan & Gong, 1999; Zhang et al., 1999) and, in some areas, local extinctions (Luo, 1993; Zhu, 2006). Although all otter species native to China are legally protected, by the time commercial harvesting was curbed, in 1989, the damage had already been done and otter numbers were at a historical low.

Research on and conservation of otters in China have been minimal. We located only 10 scientific articles on the conservation and/or ecology of Chinese otters published after the 1990s (e.g. Piao et al., 2011; Chen et al., 2016; He et al., 2016; Zhang et al., 2016). Apart from the Eurasian otters on Taiwan's Kinmen Island (Lee, 1996, 2013, 2014, 2015) and in Hong Kong (Yoxon & De Silva, 2017), little has been done to protect the dwindling populations. Although it is possible other relict populations persist in remote parts of China, the low number of confirmed records for 2006–2016 suggests that all three otter species are on the verge of extinction in China.

Otters are resilient to highly modified anthropogenic landscapes (Melisch et al., 1998; Shek, 2006; Lee, 2015; Theng & Sivasothi, 2016), flexible in habitat selection (Aadreaan et al., 2010; Meijaard, 2014; Weinberger et al., 2016), and can recover from low numbers (Kruuk, 2006; Romanowski, 2006; Marcelli & Fusillo, 2009; Recharte Uscamaita & Bodmer, 2010). Thus, the Chinese Government, together with scientists, NGOs and the general public, can still save China's otters from extinction if effective conservation interventions can be implemented. We recommend three actions:

*National otter survey* There has never been a coordinated national survey of otters in China. According to Chinese law, the management of most protected areas is under the jurisdiction of the State Forestry Administration, whereas protection of otters is the responsibility of the Ministry of Agriculture, which manages all aquatic wildlife. This separation of responsibilities can be counter-productive. It is imperative that the government remove this administrative obstacle and organize a national otter survey, so that significant populations and priority sites can be identified.

*Conservation measures at priority sites* We urge local and international research institutes and NGOs to collaborate with government authorities to implement conservation actions at priority sites. The best opportunity is probably to safeguard a few source populations of each species in protected areas, for future recolonization of unoccupied habitats (Romanowski, 2006; Delibes et al., 2012; Weinberger et al., 2016). Conservation of the Guangdong population of Eurasian otters (and possibly the smooth-coated otter, if still present) lies in the effective management of aquatic ecosystems in the Pearl River Delta, including the mangrove-lined bays, waterways, marshes and fish ponds of Mai Po–Inner Deep Bay Ramsar Site of Hong Kong, Macau, the

TABLE 3 Records of otters in China during 2006–August 2016 (Fig. 2), with site, river basin/drainage system, status/inferred status, and type of record.

| Site (Province)   | River basin    | Inferred status | Records               |                             |                                  |                       |                |
|---|----------------|-----------------|-----------------------|-----------------------------|----------------------------------|-----------------------|----------------|
|   |                |                 | Inside protected area | Photographed by camera trap | Photographed by hand-held camera | Dead or injured otter | Fresh spraints |
| <b>Eurasian otter</b>                                     |                |                 |                       |                             |                                  |                       |                |
| 1. Hun Chun (Jilin Province)                              | Tumen River    | Unknown         | Yes                   | *                           |                                  |                       |                |
| 2. Yangkou (Jiangsu Province)                             | Yangtze        | Unknown         | No                    |                             | *                                |                       |                |
| 3. Zhou Zhi (Shaanxi Province)                            | Yellow River   | Unknown         | Yes                   |                             |                                  | *                     |                |
| 4. Fo Ping (Shaanxi Province)                             | Yellow River   | Unknown         | Yes                   |                             | *                                |                       |                |
| 5. Liling (Hunan Province)                                | Yangtze        | Insecure        | No                    |                             |                                  | *                     |                |
| 6. Chaozhou (Guangdong Province)                          | Han River      | Insecure        | No                    |                             |                                  | *                     |                |
| 7. Taipa (Macau Special Administrative Region)            | Pearl River    | Insecure        | No                    |                             | *                                | *                     |                |
| 8. Hengqin Island (Guangdong Province)                    | Pearl River    | Insecure        | No                    | *                           |                                  |                       | *              |
| 9. Mai Po Marsh (Hong Kong Special Administrative Region) | Pearl River    | Stable          | Yes                   | *                           | *                                | *                     |                |
| 10. Kinmen Island (Taiwan)                                | Jiulong River  | Stable          | Yes                   | *                           |                                  | *                     | *              |
| 11. Qingchuan (Sichuan Province)                          | Yangtze        | Stable          | Yes                   |                             | *                                |                       |                |
| 12. Maqin (Qinghai Province)                              | Yellow River   | Stable          | Yes                   |                             | *                                |                       |                |
| 13. Jiuzhi (Qinghai Province)                             | Yellow River   | Stable          | Yes                   |                             | *                                |                       |                |
| 14. Dari (Qinghai Province)                               | Yellow River   | Stable          | No                    |                             | *                                |                       |                |
| 15. Yushu (Qinghai Province)                              | Yangtze        | Stable          | Yes                   |                             | *                                |                       |                |
| 16. Angsai (Qinghai Province)                             | Mekong         | Stable          | Yes                   | *                           |                                  |                       |                |
| 17. Medog (Tibet)   | Brahmaputra    | Insecure        | Yes                   | *                           |                                  |                       |                |
| <b>Asian small-clawed otter</b>                           |                |                 |                       |                             |                                  |                       |                |
| 18. Yingjiang (Yunnan Province)                           | Irrawaddy      | Insecure        | No                    | *                           |                                  |                       | *              |
| 19. Lingshui (Hainan Province)                            | Lingshui River | Insecure        | Yes                   |                             |                                  | *                     | *              |

Neilingding Island–Futian National Nature Reserve and Zhuhai City. If properly managed, this landscape could provide a sanctuary for otters amidst megacities, as in the case of Singapore's smooth-coated otters (Theng & Sivasothi, 2016) and Java's Asian small-clawed otters (Meijaard, 2014).

*Scientific study of Chinese otters* Knowledge of the ecology and phylogeny of various populations is important to identify evolutionarily significant units for informed conservation actions (Crandall et al., 2000). There are major gaps

in our understanding of otter taxonomy and ecology in China (Jia et al., 2002; Lei & Li, 2008; Piao et al., 2011). Chinese mammalogists currently recognize five subspecies of Eurasian otter native to China, namely *L. lutra lutra*, *L. lutra chinensis*, *L. lutra nairi*, *L. lutra kutab* and *L. lutra hainana* (Wang, 2003). This classification is subject to debate and the exact distribution boundaries between subspecies are unclear. A comparative study, combining molecular and morphometric work, of Eurasian otters across China and from neighbouring countries is required. The disjunct

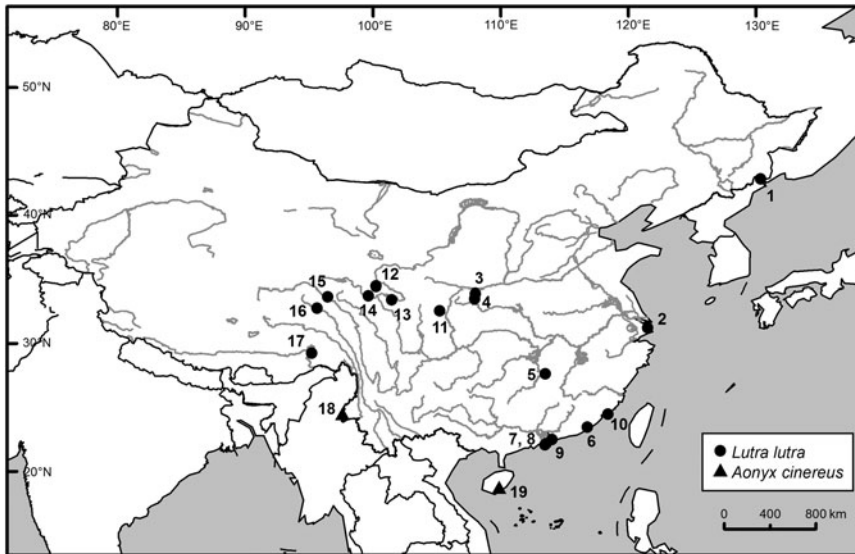


FIG. 2 Locations in China where otters were recorded during 2006–August 2016. See Table 3 for site details.

population of smooth-coated otters in the Pearl River Delta also merits study of its status, distribution and taxonomy.

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### Author contributions

Both authors contributed equally to data collection during surveys and interviews, the literature review, and the writing of the article.

### References

- AADREAN, SALMAH, S., SALSABILA, A. & RIZALDI (2010) Tracks and other signs of otters in rice fields in Padang Pariaman, West Sumatra: a preliminary study. *IUCN Otter Specialist Group Bulletin*, 27, 6–11.
- ALLEN, G.M. (1938) *The Mammals of China and Mongolia. Part 1*. The American Museum of Natural History, New York, USA.
- ANDO, M. (2008) *The Japanese Otter: Lessons from its Extinction*. University of Tokyo Press, Tokyo, Japan. [In Japanese]

- BALESTRIERI, A., MESSINA, S., PELLA, F., PRIGIONI, C., SAINO, N. & FASOLA, M. (2016) Eurasian otter *Lutra lutra* in developing countries: a resurvey of Albania 22 years after the fall of communism. *Oryx*, 50, 368–373.
- CHANIN, P. (2013) *Otters*. Whittet Books Ltd, London, UK.
- CHEN, L. (1964) Strive for hunting development of China. *Journal of Zoology*, 6, 310–312. [In Chinese]
- CHEN, S.W., YU, J.P., CHEN, X.N., SHEN, X.L., LI, S. & MA, K.P. (2016) Camera-trapping survey on the diversity of mammal and pheasant species in Gutianshan National Nature Reserve, Zhejiang Province. *Acta Theriologica Sinica*, 36, 292–301. [In Chinese]
- CHENG, J.Z. (1980) Investigate and study on the utilization status of animal resources in Mudanjiang. *Territory & Natural Resources Study*, 2, 30–45. [In Chinese]
- CRANDALL, K.A., BININDA-EMONDS, O.R.P., MACE, G.M. & WAYNE, R.K. (2000) Considering evolutionary processes in conservation biology. *Trends in Ecology & Evolution*, 15, 290–295.
- CUI, Z.P. (1959) Keeping and breeding otters. *Chinese Journal of Zoology*, 3, 210–212. [In Chinese]
- DELIBES, M., CALZADA, J., CLAVERO, M., FERNÁNDEZ, N., GUTIÉRREZ-EXPÓSITO, C., REVILLA, E. & ROMÁN, J. (2012) The Near Threatened Eurasian otter *Lutra lutra* in Morocco: no sign of recovery. *Oryx*, 46, 249–252.
- FENG, Z.J., CAI, G.Q. & ZHENG, C.L. (1986) *The Mammals of Tibet*. Science Press, Beijing, China. [In Chinese]
- GAO, Y.T. (1987) *Fauna Sinica: Mammalia, Volume 8: Carnivora*. Science Press, Beijing, China. [In Chinese]
- GE, Y.R. (1983) Geographical distribution and resource utilization of fur-bearing mammals in Henan province. *Journal of Xinxiang Normal College*, 40, 76–86. [In Chinese]
- GONZÁLEZ, I. & UTRERA, A. (2004) Distribution of the Neotropical otter *Lontra longicaudis* in the Venezuelan Andes: habitat and status of its population. *IUCN Otter Specialist Group Bulletin*, 21, 86–92.
- HANCE, J. (2012) Japan declares its river otter extinct. <http://news.mongabay.com/2012/0828-hance-japanese-river-otter.html> [accessed 7 April 2017].
- HE, B.S., SUN, R.Q., CHEN, P., DONG, W., WANG, J., WANG, D.J. & LI, S. (2016) Baseline survey of mammal and bird diversity using camera-trapping in the Changqing National Nature Reserve of Shaanxi Province. *Acta Theriologica Sinica*, 36, 348–356. [In Chinese]

- HU, J.C. & WANG, Y.Z. (1984) *Sichuan Fauna Economica, Volume 2: Mammalia*. Sichuan Science and Technology Press, Chengdu, China. [In Chinese]
- HUANG, H.X. (1989) The conservation of mammals in Weining County. *Environmental Protection and Technology*, 2, 21–26. [In Chinese]
- HUANG, Y.J., CUI, S.P., LI, N., LI, C.W. & JIANG, Z.G. (2017) Invasion and potential impacts of the first alien carnivore in China: American minks (*Neovison vison*) in Altai region, Xinjiang. *Chinese Science Bulletin*, 62, 279–288. [In Chinese]
- JIA, Z.H., WU, Y.J., ZHANG, J.J., LIU, W. & YANG, Q.Y. (2002) Study on the ecology of *Lutra lutra* in Lishan Natural Reserve. *Shanxi Forestry Science and Technology*, 2, 28–37. [In Chinese]
- JIANG, Z.G., JIANG, J.P., WANG, Y.Z., ZHANG, E., ZHANG, Y.Y., LI, L.L. et al. (2016) Red List of China's vertebrates. *Biodiversity Science*, 24, 500–552. [In Chinese]
- KRUUK, H. (2006) *Otters: Ecology, Behaviour and Conservation*. Oxford University Press, Oxford, UK.
- KRUUK, H., KANCHANASAKA, B., O'SULLIVAN, S. & WANGHONGSA, S. (1993) Identification of tracks and other sign of three species of otter, *Lutra lutra*, *Lutra perspicillata* and *Aonyx cinerea* in Thailand. *Natural History Bulletin of the Siam Society*, 41, 23–30.
- LAU, M.W.N., FELLOWES, J. & CHAN, B.P.L. (2010) Carnivores (Mammalia: Carnivora) in South China: a status review with notes on the commercial trade. *Mammal Review*, 40, 247–292.
- LEE, L.L. (1996) Status and distribution of river otters in Kinmen, Taiwan. *Oryx*, 30, 202–206.
- LEE, L.L. (2013) *Study of Otter Distribution Changes and Population Ecology in Kinmen (1/3)*. Unpublished report. Kinmen National Park administration. [In Chinese]
- LEE, L.L. (2014) *Study of Otter Distribution Changes and Population Ecology in Kinmen (2/3)*. Unpublished report. Kinmen National Park administration. [In Chinese]
- LEE, L.L. (2015) *Study of Otter Distribution Changes and Population Ecology in Kinmen (3/3)*. Unpublished report. Kinmen National Park administration. [In Chinese]
- LEI, W. & LI, Y.C. (2008) The influence of micro-hydropower station construction on the river ecosystem and otters in Hainan Island. *Tropical Forestry*, 36, 18–20. [In Chinese]
- LI, C.Y., MA, S.L., WANG, Y.X. & LIU, G.C. (1987) *Report of Mammalian Survey in the Area of Honghe, Yunnan. Report of Honghe Region. Volume 1, Land Vertebrates*. Yunnan Minority Press, Kunming, China. [In Chinese]
- LI, D.W., XUE, M.G. & LIU, N.J. (1963) A preliminary survey report on fur-bearing mammals in Hubei Province. *Journal of Central China Normal University*, 5, 231–239. [In Chinese]
- LI, D.W., WU, F.Q., HE, D.F. & DAI, Z.X. (1982) Studies on the mammals of the Shennongjia area and its vicinity in Hubei Province. *Journal of Central China Normal University*, 3, 128–137. [In Chinese]
- LIU, Z.B. (2013) Knowledge and utilization of otters in ancient China. *China Three Gorges Tribune*, 3, 37–41. [In Chinese]
- LIU, Z.H. (1992) *The Smooth-Coated Otter in Lower Reaches of Pearl River*. Unpublished report. [In Chinese]
- LIU, Z.H. & YUAN, X.C. (1981) Survey of animal resources of Nanling (mammals of southern Jiangxi and Hunan). *Yearly Report of Guangdong Institute of Entomology*, 13, 57–76. [In Chinese]
- LUO, R. (1993) *The Mammalian Fauna of Guizhou*. Guizhou Science and Technology Publishing House, Guiyang, China. [In Chinese]
- LUO, Q.S. & ZHANG, Y.G. (1988) Wildlife resources and conservation in southern Sichuan. *Sichuan Journal of Zoology*, 7, 25–27. [In Chinese]
- MA, J.Z. & JIA, J.B. (1990) *Wildlife Management*. The Northeast Forestry University Press, Harbin, China. [In Chinese]
- MA, Y.Q. (1986) *Fauna Heilongjiangica: Mammalia*. Heilongjiang Science & Technology Press, Harbin, China. [In Chinese]
- MARCELLI, M. & FUSILLO, R. (2009) Assessing range re-expansion and recolonization of human-impacted landscapes by threatened species: a case study of the otter (*Lutra lutra*) in Italy. *Biodiversity and Conservation*, 18, 2941–2959.
- MASON, C.F. & MACDONALD, S.M. (1986) *Otters: Ecology and Conservation*. Cambridge University Press, Cambridge, UK.
- MEIJAARD, E. (2014) A review of historical habitat and threats of small-clawed otter on Java. *IUCN Otter Specialist Group Bulletin*, 31, 40–42.
- MELISCH, R., YOUNG, L. & SADOVY, Y. (1998) Eurasian otter (*Lutra lutra*) still present in Hong Kong. *IUCN Otter Specialist Group Bulletin*, 15, 45–46.
- NI, H.J. (1986) How to eradicate otter. *China Fisheries*, 13, 24. [In Chinese]
- PIAO, Z.J., SUI, Y.Z., WANG, Q., LI, Z. & ZHU, L.J. (2011) Population fluctuation and resources protection of otter in Changbai Mountain Nature Reserve. *Journal of Hydroecology*, 32, 115–120. [In Chinese]
- RAHA, A. & HUSSAIN, S.A. (2016) Factors affecting habitat selection by three sympatric otter species in the southern Western Ghats, India. *Acta Ecologica Sinica*, 36, 45–49.
- RECHARTE USCAMAITA, M. & BODMER, R. (2010) Recovery of the Endangered giant otter *Pteronura brasiliensis* on the Yavari-Mirín and Yavari Rivers: a success story for CITES. *Oryx*, 44, 83–88.
- ROMANOWSKI, J. (2006) Monitoring the otter recolonisation of Poland. *Hystrix, the Italian Journal of Mammalogy*, 17, 37–46.
- RUAN, S.J. & GONG, H.S. (1999) Mammal resources in Niubeiliang National Natural Reserve, Shaanxi Province. *Chinese Journal of Zoology*, 34, 30–35. [In Chinese]
- SHAANXI INSTITUTE OF ZOOLOGY (1981) *Evaluation of Economic Bird and Mammal Resources of Shaanxi*. Bureau of Shaanxi Agricultural Regionalization, Xi'an, China. [In Chinese]
- SHEK, C.T. (2006) *A Field Guide to the Terrestrial Mammals of Hong Kong*. Agriculture, Fisheries and Conservation Department, Friends of the Country Parks and Cosmos Books Ltd, Hong Kong.
- SHENG, H.L. & LU, H.J. (1975) Utilization of fur-bearing mammal resources in Jiangxi Province. *Chinese Journal of Zoology*, 10, 20–23. [In Chinese]
- SMITH, A. & XIE, Y. (2009) *A Guide to the Mammals of China*. China Science and Technology Publishing House, Beijing, China. [In Chinese]
- STATE FORESTRY ADMINISTRATION OF THE PEOPLE'S REPUBLIC OF CHINA (1959) Instruction to actively develop hunting industry. *Gazette of the State Council of the People's Republic of China*, 4, 67–69. [In Chinese]
- STEVENS, S., ORGAN, J.F. & SERFASS, T.L. (2011) Otters as flagships: social and cultural considerations. *Proceedings of the Xth International Otter Colloquium, IUCN Otter Specialist Group Bulletin*, 28A, 150–161.
- SUN, Y.S. (1991) Research on waterfowl and otter damage to fish resources in reservoirs, and eradication methods. *Journal of Fujian Fisheries*, 13, 49–56. [In Chinese]
- THENG, M. & SIVASOITHI, N. (2016) The smooth-coated otter *Lutrogale perspicillata* (Mammalia: Mustelidae) in Singapore: establishment and expansion in natural and semi-urban environments. *IUCN Otter Specialist Group Bulletin*, 33, 37–49.
- WANG, Q.S. (1990) *The Mammal Fauna of Anhui*. Anhui Science and Technology Press, Hefei, China. [In Chinese]
- WANG, Y.X. (2003) *A Complete Checklist of Mammal Species and Subspecies in China*. China Forestry Publishing House, Beijing, China. [In Chinese]
- WEINBERGER, I.C., MUFF, S., DE JONGH, A., KRANZ, A. & BONTADINA, F. (2016) Flexible habitat selection paves the way for a

- recovery of otter populations in the European Alps. *Biological Conservation*, 199, 88–95.
- WILLCOX, D., VISAL, S. & MAHOOD, S.P. (2016) The conservation status of otters in Prek Toal core area, Tonle Sap Lake, Cambodia. *IUCN Otter Specialist Group Bulletin*, 33, 18–31.
- WRIGHT, L., DE SILVA, P., CHAN, B. & REZA LUBIS, I. (2015) *Aonyx cinereus*. In *The IUCN Red List of Threatened Species 2015*. <http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T44166A21939068.en> [accessed 8 December 2016].
- WU, M.C. (1993) *Guangxi Wild Animals*. Guangxi People's Press, Nanning, China. [In Chinese]
- XIAO, Z.G. (1986) Land mammal resources in Liaoning. *Sichuan Journal of Zoology*, 6, 18–21. [In Chinese]
- XIAO, Z.G. (1988) *Fauna Liaoningica – Mammalia*. Liaoning Science and Technology Press, Shenyang, China. [In Chinese]
- XIE, B.G. & LI, X.Q. (1991) Wildlife resources and utilization in Hunan province. *Territory and Natural Resources Study*, 13, 53–56. [In Chinese]
- XU, L.H. (1984) Species of otters in China and the conservation of their natural resources. *Chinese Wildlife*, 6, 9–11. [In Chinese]
- XU, L.H., WU, P.Y., YU, S.M. & WANG, L.B. (1989) *Economic Animals of Guangdong Mountainous Areas: Mammals*. Guangdong Science and Technology Press, Guangzhou, China. [In Chinese]
- YANG, B.R. (1990) Resources of beasts in Changbai mountain area. *Journal of Yanbian Agricultural College*, 12, 24–29. [In Chinese]
- YANG, Q., MENG, X., XIA, L. & FENG, Z. (2003) Conservation status and causes of decline of musk deer (*Moschus* spp.) in China. *Biological Conservation*, 109, 333–342.
- YOXON, G. & DE SILVA, P. (2017) Otters and wetlands training workshop in China. *Oryx*, 51, 17.
- ZHAN, S.C. (1985) Preliminary survey of fur-bearing mammal resources in Fujian Province. *Wuyi Science Journal*, 5, 189–195. [In Chinese]
- ZHANG, R.Z. (1997a) *Distribution of Mammalian Species in China*. China Forestry Publishing House, Beijing, China. [In Chinese]
- ZHANG, S.N. (1997b) Pelt trade statistics can no longer reflect the status of wildlife. *Wildlife Resources*, 18, 19. [In Chinese]
- ZHANG, M., YANG, Q.R., HE, D.F., DAI, Z.X., PENG, J. & LU, W.M. (1999) Resource and changes of fur-bearing mammals in Yinchang County. In *Chinese Zoology Research – Collected Papers, the Congress of the 65 Anniversary of Chinese Zoological Society*, pp. 682–685. China Forestry Publishing House, Beijing, China. [In Chinese]
- ZHANG, X.H., YOXON, P. & YOXON, G. (2014) Otter populations and their distribution in China – A review. <https://www.linkedin.com/pulse/20140804085509-91346367-otter-populations-and-their-distribution-in-china-a-review?trk=prof-post> [accessed 7 April 2017].
- ZHANG, R., YANG, L., LAGUARDIA, A., JIANG, Z., HUANG, M.J., LV, J. et al. (2016) Historical distribution of the otter (*Lutra lutra*) in north-east China according to historical records (1950–2014). *Aquatic Conservation: Marine and Freshwater Ecosystems*, 26, 602–606.
- ZHU, S.Z. (2006) The exploitation of the main wild animals and their changes in history in Sichuan Liangshan mountain areas. *Journal of Southwest China Normal University*, 32, 34–38. [In Chinese]
- ZHUGE, Y. (1982) Geographical distribution and resource utilization of fur-bearing mammals in Zhejiang Province. *Journal of Hangzhou University*, 9, 474–481. [In Chinese]
- ZHUGE, Y. & HUANG, M.H. (1988) *Fauna of Zhejiang: Mammalia*. Zhejiang Science and Technology Publishing House, Hangzhou, China. [In Chinese]

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