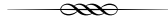


Chapter 5

Cultural Memory of Recent Extinctions

A Chinese Perspective

Samuel T. Turvey



Insights about Extinction from Indigenous Knowledge

Determining the amount of biodiversity loss that has already taken place as a result of past human pressures is integral to conservation science, management and policy. Data on historical species extinctions and population declines can identify unsustainable human–environmental interactions and taxonomic, ecological and geographic patterns of vulnerability and resilience, and thus make predictive hypotheses about the likely impact of future anthropogenic activities to guide conservation priority-setting.¹ Understanding the extent to which landscapes have been disrupted from historical baseline conditions is also necessary to inform appropriate management, restoration and rewilding strategies.²

However, although humans have impacted biodiversity for millennia, long-term environmental datasets that can capture the duration and outcome of past anthropogenic activities are rarely used in conservation, with ‘long-term’ in ecology typically meaning decadal or multi-decadal.³ This data constraint has led to a widespread ‘extinction filter’ effect, whereby information on past extinctions is excluded from analysis of human-caused biodiversity loss, thus limiting and biasing our understanding of human impacts through time.⁴ Even recent environmental baselines, based on systematically collected ecological data sampled directly by trained scientists, remain unavailable to assess changes in the status of many threatened taxa and conservation ‘hotspots’.⁵ Assessing the information-content of

alternative data sources, and their ability to provide new insights into past human-mediated biodiversity loss, is thus of substantial importance for evidence-based conservation.

Most traditional (Indigenous and/or rural) communities around the world possess a rich body of knowledge about local biodiversity.⁶ This Indigenous knowledge is increasingly recognized as having invaluable applications for conservation, including monitoring of target species, environmental conditions and threats,⁷ identification of sustainable environmental resource management strategies,⁸ and provision of social frameworks to support biodiversity preservation based on local value systems.⁹ Indigenous knowledge can be subdivided into two broad categories: local ecological knowledge (LEK), representing experiential knowledge derived from an individual's lived interactions with their environment; and traditional ecological knowledge (TEK) or 'cultural memory', the cumulative body of knowledge, beliefs, values and traditions about the natural world that is passed down between generations.¹⁰ Both of these knowledge domains have the potential to provide novel conservation-relevant information about past biodiversity loss across different timescales.

LEK can provide information about species that have been encountered during an individual's lifetime but might now be regionally extinct. Quantitative analysis of last-sighting datasets can assess whether species are likely to be extinct, and model the timing of extinction events.¹¹ In many cases, LEK has provided the most recent records for now-extinct species that were otherwise the subject of limited historical monitoring or survey effort (e.g. mammals from central Australian deserts).¹² Indeed, in some instances LEK might provide the only possible evidence for recent survival of species that are otherwise recorded only from older fossil or archaeological archives. For example, Woods et al.¹³ collected several reports from Hispaniola, dating from the 1970s or earlier, of a large arboreal animal locally called the comadreja, which did not match the description of any living native mammal but might represent one of the large extinct rodents (possibly *Plagiodontia velozii*) known from the island's recent fossil record: 'One man . . . even demanded why we had no drawings or photographs of the comadreja to show him. It was many years, he said, since he had seen the animal, and he would have liked to have seen it again'.¹⁴

Although in some cases respondents are aware that now-extinct species have declined and disappeared from their local environments,¹⁵ LEK about such species is not necessarily associated with awareness that they are extinct, but instead simply that individual respondents have not encountered them for some time. Conversely, TEK has the potential to record information about past environmental conditions and changes, often framed explicitly in terms of differences from present conditions. On occa-

sion, such information might be extremely ancient, particularly in isolated non-literate societies with a strong attachment to their landscape; as an example, Aboriginal stories about coastal inundation from around Australia seemingly refer to postglacial sea-level rise that occurred over seven thousand years ago.¹⁶ Whereas conflict with Christian theology meant that the possibility of extinction only became accepted in Western thought around two hundred years ago,¹⁷ the TEK of some non-Western Indigenous cultures includes ideas about past species losses expressed in terms similar to the scientific concept of extinction. For example, the Yukaghir people of the Russian Far East thought that mammoth remains preserved in permafrost represented animals called 'xolhut' that had existed long ago, but disappeared because they ate all the trees in northern Siberia and turned the landscape into tundra.¹⁸ Other Indigenous cultures also recognize the possibility that species may disappear locally.¹⁹

Strange creatures in folktales of numerous Indigenous cultures have been interpreted as possible cultural memories of species that became extinct centuries or millennia ago. For example, an ogre in Madagascar folklore with a human face and an animal's body, and that cannot move across smooth rock outcrops, is suggested to be a representation of a sloth lemur (*Palaeopropithecus ingens*), which has been extinct for several centuries;²⁰ and tales about giant beavers in north-eastern Algonquian legends have been proposed as folk memories of a real species of giant beaver (*Castoroides ohioensis*), which became extinct around ten thousand years ago.²¹ However, these potential identifications are highly speculative, with storytelling an obvious alternative hypothesis to explain the origin of such accounts. Overall, the potential for TEK to reconstruct past biodiversity baselines and provide information about extinct species has been surprisingly understudied.

Conversely, the existence of several sociocultural phenomena caution against the likelihood of widespread cultural retention of TEK about extinct species. Historical records reveal that local species concepts can change rapidly following extinction events, taking on fantastical and non-natural characteristics, or with the names of vanished species becoming transferred to other taxa. For example, reports of dodos (*Raphus cucullatus*) from Mauritius during the second half of the seventeenth century actually referred to the island's other flightless bird, the (also now extinct) Mauritius red hen (*Aphanapteryx bonasia*), as 'true' dodos were probably already extinct by this time.²² This is just one instance of a wider issue: TEK does not provide a fixed record of the past, but instead constitutes an inherently dynamic body of information that is continuously updated and changed with successive generations.²³ Furthermore, TEK in Indigenous communities around the world is now experiencing erosion and loss of con-

tent associated with globalization, exposure to Western cultural and economic norms, and concomitant disruption of traditional social-ecological systems.²⁴ These major sociocultural changes are often associated with changing patterns and levels of intergenerational communication; this process can lead to a phenomenon known as ‘shifting baseline syndrome’, whereby lack of knowledge transfer between generations leads to younger people having less awareness of biodiversity patterns from the recent past, and incorrectly interpreting more degraded environmental conditions as the norm.²⁵ Therefore, even if extinct species were regarded as sufficiently ‘important’ at a cultural level to become incorporated within TEK when they still existed, this in itself provides no guarantee that any awareness about them will remain once they are gone.

It is thus essential to critically evaluate the ability of TEK to reconstruct historical biodiversity baselines and reveal patterns and dynamics of ecosystem change over time – an important role that this body of knowledge can potentially contribute to the modern conservation toolkit. Such evaluation should include assessment of whether extinct species are remembered by local communities; if so, how long they are remembered for; whether there is variation in knowledge between different species and systems, and what determines such variation; and which types of information are most likely to persist. Such research must be conducted within systems for which independent data exist on the identity and timing of regional extinctions, as a benchmark against which to compare the information content of TEK. It should also be conducted in a region with high biodiversity and high anthropogenic threats, in order to determine the direct practical benefit that TEK can provide towards strengthening the conservation evidence-base by supplying historical baselines on the vulnerability or resilience of biodiversity through time.

China: A Study System for Human-Caused Extinction

China is a huge (~9.6 million km²) ‘megadiverse’ country containing 14 per cent of the world’s vertebrate species, and covering a wide range of ecosystems.²⁶ China also has a long history of human occupation, and has suffered biodiversity loss associated with increasing human overpopulation, resource overexploitation and habitat modification throughout recent millennia and the historical era.²⁷ These anthropogenic impacts have escalated over the past century. Although national efforts are underway to protect regional biodiversity, natural resources and ecosystem services,²⁸ China’s biota has experienced extensive recent population declines and extirpations, and even extinctions of endemic species.²⁹ Overall, Chinese

terrestrial vertebrate populations decreased by 50 per cent between 1970 and 2010.³⁰

Throughout history, Chinese thought has been primarily interested in the workings of human society, and has usually considered nature only in terms of its utility for philosophical or political analogies and moral insights. However, this perspective is grounded in a holistic, interconnected worldview whereby human actions can influence the workings of nature, often with unexpected and undesirable consequences. Both Confucian and Daoist thinkers promoted moral and moderate usage of natural resources to avoid their depletion, thus demonstrating an understanding of concepts associated with biodiversity loss.³¹ There is little evidence for specific awareness or understanding of extinction in historical Chinese texts, although a passage written by the third-century BCE Legalist philosopher Han Fei has been interpreted as indicating recognition of local species disappearances: 'People rarely see living elephants, but if they obtain the bones of a dead elephant, they can imagine a living elephant based on their form. Because of this, everything people use to form an idea or mental image is called "elephant"'³² [the Chinese word 象 *xiang* means both 'elephant' and 'appearance/image']. Regional species losses and former occurrences of now-vanished animals are also reported in several Imperial Era gazetteers or *difangzhi*, which served as handover documents for civil servants and often included considerable information on local biodiversity and environmental resources.³³

However, environmental attitudes and knowledge of biodiversity loss recorded in historical Chinese texts written by scholars and officials may have little relationship with the TEK of rural communities across China that interact directly with nature. Indeed, in contrast to the relatively homogeneous body of formal Han Chinese thought and narratives of nature, China includes a diverse range of ethnic groups, each with distinct cultures and traditions, bodies of Indigenous knowledge, and interactions with their environments.³⁴ This extensive sociocultural variation makes it difficult to infer likely patterns of TEK about extinct species within communities in different Chinese landscapes that have experienced historical and recent biodiversity loss, or whether general patterns of cultural memory about extinction might exist across China.

Here, I summarize the findings of a series of interview surveys conducted in rural communities across different parts of China by myself and colleagues, which provide new insights into regional cultural memory of several recently extinct aquatic and terrestrial vertebrates. These studies establish a new understanding of patterns and levels of biodiversity-related TEK loss and retention within different social-ecological systems across China, and also provide a wider comparative baseline on the usefulness of

TEK to reconstruct past environments and the timing and dynamics of species losses.

Case Study 1: Yangtze Freshwater Megafauna

The Yangtze River, Asia's longest river system, supports high levels of aquatic biodiversity but also provides food, other resources and ecosystem services for 10 per cent of the world's human population, and has experienced severe degradation associated with overpopulation and industrialization.³⁵ The endemic Yangtze River dolphin or baiji (*Lipotes vexillifer*, Illustration 5.1A) declined rapidly during the 1980s and 1990s due to incidental by-catch in fishing gear, vessel strikes and wider-scale habitat degradation, and although a few individuals persisted into the twenty-first century, a range-wide survey in late 2006 failed to detect any surviving dolphins.³⁶ The river's fisheries have also experienced severe declines, with several fish species now regionally or globally extinct. These casualties include the Yangtze paddlefish (*Psephurus gladius*), probably the largest freshwater fish in the world (mature individuals were estimated to reach up to seven metres), which was impacted by overfishing and construction of dams that prevented these fish from reaching their upstream spawning grounds. Paddlefish catches declined rapidly from the 1980s, with few records after the mid-1990s, and the species is estimated to have become extinct by 2005.³⁷ Both species were culturally or economically important within Yangtze fishing communities. Baiji held an almost sacred status;³⁸ they were the subject of many local stories and legends,³⁹ and killing them

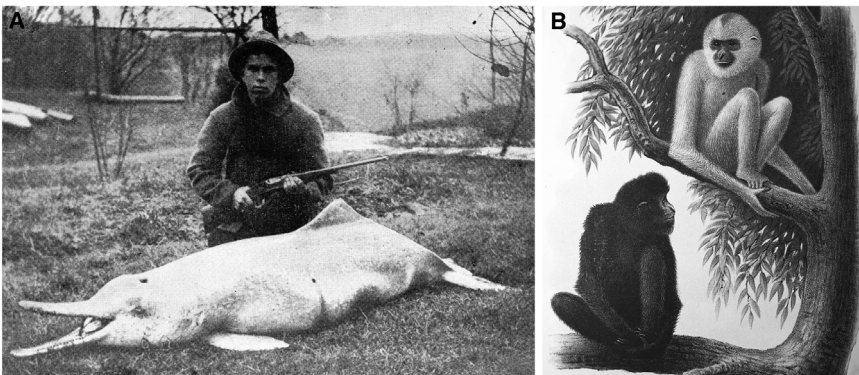


Illustration 5.1 Recent species extinctions and declines in China. (A) Yangtze River dolphin or baiji (*Lipotes vexillifer*) (from Hoy, 'The "White-Flag" Dolphin'). (B) Hainan gibbon (*Nomascus hainanus*) (from Pocock, 'Observations Upon a Female Specimen').

was considered to result in bad fortune.⁴⁰ Paddlefish were conversely targeted for food, and were formerly widely available in riverside markets, with ~25 tonnes harvested annually during the 1970s.⁴¹

A large-scale interview survey was conducted in February–November 2008 (Illustration 5.2A), collecting data from 599 fishers (age range: 22–90) in twenty-seven fishing communities along a 1,700 km transect of the middle-lower Yangtze channel and around the appended Dongting and Poyang lake systems, primarily to ascertain whether any baiji might still survive but also collecting wider local knowledge about the Yangtze ecosystem. Respondents across all age classes were strongly aware of the Yangtze’s overall resource depletion and environmental degradation, but showed statistically significant age-related differences in experience and awareness of particular species. Younger fishers were, unsurprisingly, less likely than older fishers to have seen or caught baiji or paddlefish; however, they were also less likely to have even heard of either species, despite being prompted during interviews with photographic cue cards, appropriate local names and verbal descriptions.⁴²

When measured in terms of the calendar year when they started fishing, the number of new fishers who had not heard of baiji or paddlefish increased markedly from the 1980s onwards, corresponding with the timing of major population declines in both species. In total, 10.3 per cent of all interviewed fishers had not heard of baiji, and 33.8 per cent had not heard of paddlefish, but these percentages increased to 15.6 and 56.8 respectively in respondents who had started fishing from the 1980s onwards, and to 19.2 and 67.0 in those who had started fishing from the 1990s onwards. The difference in awareness levels between these species is likely to reflect

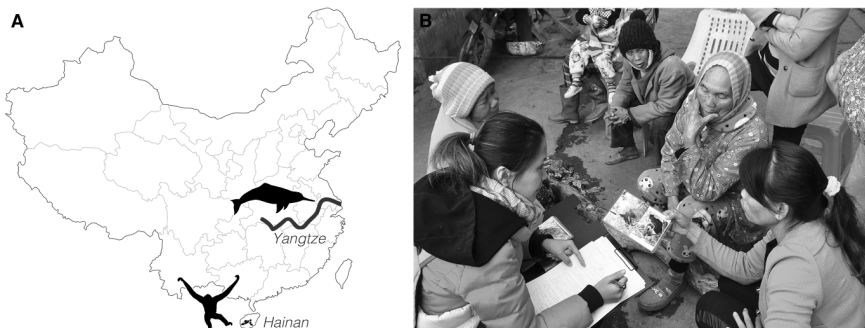


Illustration 5.2 (A) Map of China highlighting the middle-lower Yangtze River and the montane forests of Hainan, where interviews were conducted with rural respondents to collect data on freshwater megafauna and Hainanese mammals, respectively. (B) Conducting interviews in a rural community near Bawangling National Nature Reserve, Hainan. Photograph courtesy of Helen Nash.

the extensive regional media publicity that promoted past baiji conservation efforts (e.g. television programmes, local government and fisheries publicity, newspapers, posters), rather than differences in TEK within fishing communities. Of the subset of fishers who had never seen these species but were still aware of them, 60.8 per cent had heard about baiji from regional publicity, versus only 47.6 per cent from local community members; in contrast, 80.4 per cent had heard about paddlefish from local community members, versus only 19.6 per cent from regional publicity.⁴³

Case Study 2: Gibbons and Other Mammals on Hainan

Hainan, China's southernmost province, is a 33,920 km² subtropical/tropical island in the South China Sea. Different environmental archives (recent fossil record, historical *difangzhi* gazetteer record, specimens collected by nineteenth-century naturalists) document progressive anthropogenic depletion of its biodiversity, and the former occurrence of numerous mammal species that are now regionally extinct. Species such as elephants, tapir, wild buffalo and tigers apparently disappeared from Hainan due to human impacts in recent prehistory, whereas Père David's deer (*Elaphurus davidianus*) persisted until at least the nineteenth century, and two large carnivores (wolf, *Canis lupus*; dhole, *Cuon alpinus*) persisted into the mid-twentieth century.⁴⁴ This biodiversity loss is ongoing, and the endemic Hainan gibbon (*Nomascus hainanus*; Illustration 5.1B) is now one of the world's rarest mammals, with a global population of only ~35 individuals. Gibbons were esteemed in local cultures across China, including on Hainan,⁴⁵ and were formerly distributed across much of Hainan's forested interior, but underwent a precipitous range collapse during the 1960s and 1970s caused by habitat loss and hunting. They only survive today as a remnant population within Bawangling National Nature Reserve.⁴⁶

A large-scale interview survey was conducted in January–April 2015 (Illustration 5.2A and 5.2B) to collect data on sightings and knowledge of gibbons and other mammals, from 709 respondents (age range: 20–94) in seventy villages situated around Bawangling and six other nature reserves that contained gibbon populations during the 1970s or later.⁴⁷ Most respondents belonged to Indigenous Li or Miao ethnic minorities, and communities across the study area used animal and plant resources collected inside reserves and were thus familiar with local forest biodiversity. For respondents living close to the last surviving gibbon population at Bawangling, 73.8 per cent recognized photographs of gibbons and 65.4 per cent were familiar with the standard Chinese word for gibbon (*changbiyuan*), whereas these percentages were 30.6–70.3 and 23.0–80.2 respectively for

respondents living near the six reserves where gibbons had disappeared during living memory. Some but not all of these levels of local awareness differed statistically from the levels observed at Bawangling.⁴⁸

All respondents were asked an open-ended question about their TEK of gibbons ('Have you heard any stories about gibbons or anything else about them, such as uses?'), with 99 respondents (14 per cent) providing information. Older respondents were statistically more likely to report gibbon-specific TEK; the mean age of respondents reporting TEK was 57.6, while that of other respondents was 49.0, and only three respondents younger than 30 reported TEK. Gibbon-specific TEK included information on their ecology, behaviour and other natural history; practical/utilitarian knowledge (e.g. hunting, traditional medicine); cultural values/attitudes; and folktales, including six different folktale categories. Interestingly, there were statistically significant differences in TEK content between landscapes with different histories of gibbon survival or extinction. Respondents from Bawangling and the two landscapes where gibbons apparently died out most recently (Jiaxi, Yinggeling) were more likely to report gibbon-related folktales, whereas respondents from landscapes where gibbons had been absent for several decades were instead more likely to report knowledge about practical information or interactions with gibbons (e.g. natural history or hunting information)⁴⁹.

Respondents were also asked whether they knew about any animals that had existed in the past but no longer occurred locally, or knew any old stories about animals that had only existed in the past. Only 20 out of 709 respondents (2.8 per cent) named specific animals, including pangolin, bear, parrot, snake/python, turtle, gibbon, tiger, wild pig and muntjac. Of these species, only tigers (named by a single respondent) are regionally extinct across the study area. These are culturally significant zodiac animals across China,⁵⁰ but they disappeared thousands of years ago on Hainan, which was described as 'without horses or tigers' as early as 80 CE.⁵¹ Most of the other responses were probably 'cued' from previous interview questions about specific named animals (pangolin, bear, gibbon, wild pig).⁵²

Why Is There Little Evidence for Cultural Memory of Extinct Species?

These large-scale systematic investigations of the TEK content of natural resource users in China, conducted across different social-ecological systems and distinct local cultures, reveal a common pattern of shifting baseline syndrome and surprisingly little cultural memory of past extinctions, even for species that until recently were culturally important (e.g.

baiji, gibbons) or economically important (e.g. paddlefish). Rapid loss of Indigenous knowledge about recently extinct animals is observed amongst younger community members within both Yangtze fishing communities and Hainanese forest-users immediately following regional species disappearances, even while older community members who remember encountering these species are still alive. Indeed, much of the knowledge that younger community members possess about such species is demonstrated to have been obtained from external sources rather than intergenerational knowledge transfer within their communities. These surveys also reveal that Hainan's Indigenous knowledge record is an extremely poor source of information on older extinctions that took place before the lifetime of living respondents, with seemingly no local awareness of formerly occurring species that are likely to have been culturally significant (e.g. large carnivores) and that disappeared as recently as the mid-twentieth century. Different domains of TEK relating to recently extinct species appear to be lost at different rates, with folklore about gibbons vanishing first in Hainan; this pattern might reflect the fact that older members of Indigenous communities are typically the 'cultural repositories' of stories, traditions and worldviews, whereas knowledge about practical interactions with biodiversity (e.g. hunting methods) might be shared more widely with younger community members.⁵³

These findings indicate that, at least for rural communities surveyed across China, TEK is unfortunately of little direct use for reconstructing biodiversity baselines and human-caused turnover, even for the very recent past. Indeed, Turvey et al.⁵⁴ noted that once species such as baiji and paddlefish 'ceased to be encountered on a fairly regular basis, they immediately started to become forgotten by local communities. The adage "out of sight, out of mind" may appropriately apply to community awareness of rare, cryptic, and recently extinct species'. Conversely, the flipside of this finding is that the existence of cultural knowledge and traditions about otherwise-cryptic species might indicate that such species still persist in local landscapes, thus providing an indirect tool for guiding further conservation research. However, reconstructing past ecosystem states and faunal change across recent centuries will likely require the use of alternative environmental archives (e.g. the fossil or archaeological records), at least in China.

Why has local knowledge about vanished species been lost so quickly in rural communities across China? And is this pattern likely to constitute a phenomenon specific to this region, or is it a more general finding about the quality of Indigenous knowledge at a global scale? Are individual species somehow not 'important' enough to be remembered for long in cultural memory? These are challenging questions to answer, and appear to have rarely even been raised by researchers.

Consideration of China's recent sociocultural history suggests that this pattern of TEK erosion might be a regional-specific consequence of the huge social upheavals experienced across the country over the past century, when traditional cultural systems and community social-ecological dynamics were widely disrupted by demands for political conformity and national policies such as collectivization.⁵⁵ For example, Indigenous communities on Hainan have been progressively undermined and acculturated by the Chinese state, with their cultural distinctiveness increasingly weakened and assimilated with Han lifestyles, values and beliefs; this loss of traditional social structures and identities escalated during the second half of the twentieth century.⁵⁶ Most rural communities across China are therefore unlikely to fulfil the sociocultural criteria suggested to be necessary to support long-term retention of knowledge about past environmental conditions, such as cultural and political isolation.⁵⁷

Other Indigenous cultures might therefore be predicted to possess more TEK about regionally extinct species than is now observed within China. However, the escalating erosion of TEK in rural and traditional communities around the world means that any such as-yet-unknown Indigenous record of past faunas and environmental baselines is also now in the process of being lost. Indeed, many cultures from which past anthropologists and ethnographers recorded local ideas about extinction and folktales about ancient environmental change are themselves on the verge of extinction, or already gone. For example, Siberian Yukaghir languages are now classified as moribund, and cultural disruption has led to the disappearance of most of Australia's Aboriginal languages.⁵⁸ It would be instructive to see whether such examples of historically recorded TEK still persist in these communities today.

Few social studies have been conducted into changing community perceptions in the immediate aftermath of extinction events. We would inevitably expect to see some loss of cultural knowledge over time about vanished species, differential recall about different types of vanished species, and variation across communities in who retains knowledge about past biodiversity. Wider-scale comparative studies across multiple Indigenous communities and sociocultural contexts are still needed to understand the patterns and determinants of such variation. However, the Chinese case studies investigated here provide the sobering insight that, under cultural contexts that are increasingly widespread around the world, there might be minimal awareness of recent biodiversity loss within those communities that interact directly with local biodiversity, and who might therefore be unaware of the potentially irreversible impacts of human actions on the natural environment. Combatting the continued erosion of Indigenous knowledge about past environmental baselines should therefore be rec-

ognized as an important goal within the wider global mission to conserve biocultural diversity.

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Notes

1. Dietl and Flessa, ‘Conservation Paleobiology’; Rick and Lockwood, ‘Integrating Paleobiology, Archeology, and History’.
2. Hall, *Restoration and History*.
3. Bonebrake et al., ‘Population Decline Assessment’.
4. Balmford, ‘Extinction Filters and Current Resilience’.
5. Boakes et al., ‘Distorted Views of Biodiversity’.
6. Berkes, Colding and Folke, ‘Rediscovery of Traditional Ecological Knowledge’; Berkes, *Sacred Ecology*.
7. Anadón, Gimenez and Ballestar, ‘Linking Local Ecological Knowledge’; Turvey et al., ‘Interview-Based Sighting Histories’.
8. Gómez-Baggethun, Corbera and Reyes-García, ‘Traditional Ecological Knowledge’; Mistry and Berardi, ‘Bridging Indigenous and Scientific Knowledge’.
9. Colding and Folke, ‘Social Taboos’; Shen et al., ‘Viable Contribution’.
10. Berkes, Colding and Folke, ‘Rediscovery of Traditional Ecological Knowledge’.

11. Boakes et al., 'Distorted Views of Biodiversity'; Boakes et al., 'Inferring Species Extinction'.
12. Burbidge et al., 'Aboriginal Knowledge'.
13. Woods, Ottenwalder and Oliver, 'Lost Mammals of the Greater Antilles'.
14. *Ibid.*, 40.
15. Ziembicki, Woinarski and Mackey, 'Evaluating the Status of Species'; Turvey et al., 'Interview-Based Sighting Histories'.
16. Nunn and Reid, 'Aboriginal Memories of Inundation'.
17. Rudwick, *The Meaning of Fossils*.
18. Jochelson, 'Some Notes on the Traditions'.
19. Berkes, *Sacred Ecology*.
20. Godfrey and Jungers, 'The Extinct Sloth Lemurs'.
21. Beck, 'The Giant Beaver'.
22. Cheke, 'Establishing Extinction Dates'.
23. Berkes, Colding and Folke, 'Rediscovery of Traditional Ecological Knowledge'.
24. Reyes-García et al., 'Evidence of Traditional Knowledge Loss'; Tang and McGavin, 'A Classification of Threats'.
25. Papworth et al., 'Evidence for Shifting Baseline Syndrome'.
26. Xie et al., *Living Planet Report*.
27. Shapiro, *Mao's War against Nature*; Shapiro, *China's Environmental Challenges*; Marks, *China*.
28. Xu et al., 'Strengthening Protected Areas'.
29. Turvey et al., 'First Human-Caused Extinction'; Turvey, Crees and Di Fonzo, 'Historical Data as a Baseline'.
30. Xie et al., *Living Planet Report*.
31. Sterckx, *Chinese Thought*.
32. Lander and Brunson, 'Wild Mammals of Ancient North China', 232.
33. Wen, *The Distributions and Changes*; Turvey, Crees and Di Fonzo, 'Historical Data as a Baseline'.
34. Hathaway, 'Global Environmentalism'; Zhang et al., 'Influence of Traditional Ecological Knowledge'.
35. Wang, Liu and Wang, 'The Yangtze River Floodplain'.
36. Turvey et al., 'First Human-Caused Extinction'.
37. Zhang et al., 'Extinction'.
38. Pilleri, 'The Chinese River Dolphin'.
39. Zhou and Zhang, *Baiji*.
40. Pope, *China's Animal Frontier*.
41. Zhang et al., 'Extinction'.
42. Turvey et al., 'Rapidly Shifting Baselines in Yangtze'.
43. *Ibid.*
44. Turvey et al., 'Complementarity, Completeness and Quality'.
45. Van Gulik, *The Gibbon in China*; Turvey, Bryant and McClune, 'Differential Loss'.
46. Zhou et al., 'Hainan Black-Crested Gibbon'; Turvey et al., 'How Many Remnant Gibbon Populations'.
47. Turvey et al., 'How Many Remnant Gibbon Populations'.
48. *Ibid.*
49. Turvey, Bryant and McClune, 'Differential Loss'.
50. Coggins, *The Tiger and the Pangolin*.
51. Marks, *China*.
52. Turvey et al., 'Complementarity, Completeness and Quality'.

53. Turvey, Bryant and McClune, 'Differential Loss'.
54. Turvey et al., 'Rapidly Shifting Baselines in Yangtze', 785.
55. Shapiro, *Mao's War against Nature*; Coggins, *The Tiger and the Pangolin*; Hathaway, 'Global Environmentalism'.
56. Mu, 'Music Loss among Ethnic Minorities'; Netting, 'The Deer Turned Her Head'.
57. Nunn and Reid, 'Aboriginal Memories of Inundation'.
58. Nettle and Romaine, *Vanishing Voices*; Eberhard, Simons and Fennig, *Ethnologue*.

Bibliography

- Anadón, José Daniel, Andrés Gimenez and Rubén Ballestar. 'Linking Local Ecological Knowledge and Habitat Modelling to Predict Absolute Species Abundance on Large Scales'. *Biodiversity and Conservation* 19(5) (2009): 1443–54.
- Balmford, Andrew. 'Extinction Filters and Current Resilience: The Significance of Past Selection Pressures for Conservation Biology'. *Trends in Ecology and Evolution* 11(5) (1996): 193–96.
- Beck, Jane C. 'The Giant Beaver: A Prehistoric Memory?' *Ethnohistory* 19(2) (1972): 109–22.
- Berkes, Fikret. *Sacred Ecology*. Fourth edition. New York: Routledge, 2018.
- Berkes, Fikret, Johan Colding and Carl Folke. 'Rediscovery of Traditional Ecological Knowledge as Adaptive Management'. *Ecological Applications* 10(5) (2000): 1251–62.
- Boakes, Elizabeth H., Tracy M. Rout and Ben Collen. 'Inferring Species Extinction: The Use of Sighting Records'. *Methods in Ecology and Evolution* 6(6) (2015): 678–87.
- Boakes, Elizabeth H., et al. 'Distorted Views of Biodiversity: Spatial and Temporal Bias in Species Occurrence Data'. *PLoS Biology* 8(6) (2010): e1000385.
- Bonebrake, Timothy C., et al. 'Population Decline Assessment, Historical Baselines, and Conservation'. *Conservation Letters* 3(6) (2010): 371–78.
- Burbidge, Andrew A., et al. 'Aboriginal Knowledge of the Mammals of the Central Deserts of Australia'. *Australian Wildlife Research* 15(1) (1988): 9–39.
- Cheke, Anthony S. 'Establishing Extinction Dates: The Curious Case of the Dodo *Raphus cucullatus* and the Red Hen *Aphanapteryx bonasia*'. *Ibis* 148(1) (2006): 155–58.
- Coggins, Christopher. *The Tiger and the Pangolin: Nature, Culture, and Conservation in China*. Honolulu: University of Hawai'i Press, 2003.
- Colding, Johan, and Carl Folke. 'Social Taboos: "Invisible" Systems of Local Resource Management and Biological Conservation'. *Ecological Applications* 11(2) (2001): 584–600.
- Dietl, Gregory P., and Karl W. Flessa. 'Conservation Paleobiology: Putting the Dead to Work'. *Trends in Ecology and Evolution* 26(1) (2011): 30–37.
- Eberhard, David M., Gary F. Simons and Charles D. Fennig (eds). *Ethnologue: Languages of the World*. Twenty-third edition. Dallas: SIL International, 2020.
- Godfrey, Laurie R., and William L. Jungers. 'The Extinct Sloth Lemurs of Madagascar'. *Evolutionary Anthropology* 12(6) (2003): 252–63.
- Gómez-Baggethun, Erik, Esteve Corbera and Victoria Reyes-García. 'Traditional Ecological Knowledge and Global Environmental Change: Research Findings and Policy Implications'. *Ecology and Society* 18(4) (2013): 72.
- Hall, Marcus (ed.). *Restoration and History: The Search for a Usable Environmental Past*. New York: Routledge, 2010.
- Hathaway, Michael. 'Global Environmentalism and the Emergence of Identity: The Politics of Cultural and Biological Diversity in China', in Genese M. Sodikoff (ed.), *The*

- Anthropology of Extinction: Essays on Culture and Species Death* (Bloomington: Indiana University Press, 2011), 103–23.
- Hoy, Charles M. 'The "White-Flag" Dolphin of the Tung Ting Lake'. *The China Journal of Science & Arts* 1 (1923): 154–57.
- Jochelson, Waldemar. 'Some Notes on the Traditions of the Natives of Northeastern Siberia about the Mammoth'. *The American Naturalist* 43(505) (1909): 48–50.
- Lander, Brian, and Katherine Brunson. 'Wild Mammals of Ancient North China'. *Journal of Chinese History* 2(2) (2018): 291–312.
- Marks, Robert B. *China: An Environmental History*. Second edition. Lanham, MD: Rowman & Littlefield, 2017.
- Mistry, Jayalaxshmi, and Andrea Berardi. 'Bridging Indigenous and Scientific Knowledge'. *Science* 352(6291) (2016): 1274–75.
- Mu, Yang. 'Music Loss among Ethnic Minorities in China: A Comparison of the Liu and Hui Peoples'. *Asian Music* 27(1) (1995): 103–31.
- Netting, Nancy S. 'The Deer Turned Her Head: Ethnic Options for the Hainan Li'. *Bulletin of Concerned Asian Scholars* 29(2) (1997): 3–17.
- Nettle, Daniel, and Suzanne Romaine. *Vanishing Voices: The Extinction of the World's Languages*. New York: Oxford University Press, 2000.
- Nunn, Patrick D., and Nicholas J. Reid. 'Aboriginal Memories of Inundation of the Australian Coast Dating from More Than 7000 Years Ago'. *Australian Geographer* 47(1) (2015): 11–47.
- Papworth, Sarah K., et al. 'Evidence for Shifting Baseline Syndrome in Conservation'. *Conservation Letters* 2(2) (2009): 93–100.
- Pilleri, Giorgio. 'The Chinese River Dolphin (*Lipotes vexillifer*) in Poetry, Literature and Legend'. *Investigations on Cetacea* 10 (1979): 335–49.
- Pocock, Reginald Innes. 'Observations Upon a Female Specimen of the Hainan Gibbon (*Hylobates hainanus*), Now Living in the Society's Gardens'. *Proceedings of the Zoological Society of London* 75(3) (1905): 169–80.
- Pope, Clifford H. *China's Animal Frontier*. New York: Viking Press, 1940.
- Reyes-García, Victoria, et al. 'Evidence of Traditional Knowledge Loss among a Contemporary Indigenous Society'. *Evolution and Human Behavior* 34(4) (2013): 249–57.
- Rick, Torben C., and Rowan Lockwood. 'Integrating Paleobiology, Archeology, and History to Inform Biological Conservation'. *Conservation Biology* 27(1) (2013): 45–54.
- Rudwick, Martin J.S. *The Meaning of Fossils: Episodes in the History of Palaeontology*. Chicago: University of Chicago Press, 1972.
- Shapiro, Judith. *China's Environmental Challenges*. Second edition. Cambridge: Polity Press, 2016.
- . *Mao's War against Nature: Politics and the Environment in Revolutionary China*. Cambridge: Cambridge University Press, 2001.
- Shen, Xiaoli, et al. 'Viable Contribution of Tibetan Sacred Mountains in Southwestern China to Forest Conservation'. *Conservation Biology* 29(6) (2015): 1518–26.
- Sterckx, Roel. *Chinese Thought: From Confucius to Cook Ding*. London: Pelican, 2019.
- Tang, Ruifei, and Michael C. McGavin. 'A Classification of Threats to Traditional Ecological Knowledge and Conservation Responses'. *Conservation & Society* 14(1) (2016): 57–70.
- Turvey, Samuel T., Jessica V. Bryant and Katherine A. McClune. 'Differential Loss of Components of Traditional Ecological Knowledge Following a Primate Extinction Event'. *Royal Society Open Science* 5(6) (2018): 172352.
- Turvey, Samuel T., Jennifer J. Crees and Martina M.I. Di Fonzo. 'Historical Data as a Baseline for Conservation: Reconstructing Long-Term Faunal Extinction Dynamics in Late Imperial-Modern China'. *Proceedings of the Royal Society B* 282(1813) 20151299.

- Turvey, Samuel T., et al. 'Complementarity, Completeness and Quality of Long-Term Faunal Archives in an Asian Biodiversity Hotspot'. *Philosophical Transactions of the Royal Society B* 374(1788) 20190217.
- . 'How Many Remnant Gibbon Populations are Left on Hainan? Testing the Use of Local Ecological Knowledge to Detect Cryptic Threatened Primates'. *American Journal of Primatology* 79(2) (2017): e22593.
- . 'First Human-Caused Extinction of a Cetacean Species?' *Biology Letters* 3(5) (2007): 537–40.
- . 'Interview-Based Sighting Histories Can Inform Regional Conservation Prioritization for Highly Threatened Cryptic Species'. *Journal of Applied Ecology* 52(2) (2015): 422–33.
- . 'Rapidly Shifting Baselines in Yangtze Fishing Communities and Local Memory of Extinct Species'. *Conservation Biology* 24(3) (2010): 778–87.
- van Gulik, Robert Hans. *The Gibbon in China: An Essay in Chinese Animal Lore*. Leiden: E.J. Brill, 1967.
- Wang, Hongzhu, Xueqin Liu and Haijun Wang. 'The Yangtze River Floodplain: Threats and Rehabilitation'. *American Fisheries Society Symposium* 84 (2016): 263–91.
- Wen, Rongsheng. *The Distributions and Changes of Rare Wild Animals in China*. Jinan: Shandong Science and Technology Press, 2009.
- Woods, Charles A., José A. Ottenwalder and William L.R. Oliver. 'Lost Mammals of the Greater Antilles: The Summarised Findings of a Ten-Weeks Field Survey in the Dominican Republic, Haiti and Puerto Rico'. *Dodo* 22 (1985): 23–42.
- Xie, Gaodi, et al. *Living Planet Report: China 2015. Development, Species and Ecological Civilization*. Beijing: WWF, 2015.
- Xu, Weihua, et al. 'Strengthening Protected Areas for Biodiversity and Ecosystem Services in China'. *Proceedings of the National Academy of Sciences of the USA* 114(7) (2017): 1601–6.
- Zhang, Hui, et al. 'Extinction of One of the World's Largest Freshwater Fishes: Lessons for Conserving the Endangered Yangtze Fauna'. *Science of the Total Environment* 710 (2020): 136242.
- Zhang, Lu, et al. 'Influence of Traditional Ecological Knowledge on Conservation of the Skywalker Hoolock Gibbon (*Hoolock tianxing*) Outside Nature Reserves'. *Biological Conservation* 241 (2020): 108267.
- Zhou, Jiang, et al. 'Hainan Black-Crested Gibbon is Headed for Extinction'. *International Journal of Primatology* 26(2) (2005): 453–65.
- Zhou, Kaiya, and Xingduan Zhang. *Baiji: The Yangtze River Dolphin and Other Endangered Animals of China*. Washington, DC: Stone Wall Press, 1991.
- Ziembicki, M.R., J.C.Z. Woinarski and B. Mackey. 'Evaluating the Status of Species Using Indigenous Knowledge: Novel Evidence for Major Native Mammal Declines in Northern Australia'. *Biological Conservation* 157 (2013): 78–92.