1 Extinction and the Challenge of Conservation Reliance

Let's begin with a story, a true story, about toads.

> *The toads were there, just where the people in the village had told them they would be. The scientists and their guide struggled up a muddy trail to a ridgeline. And then they saw them. First one, then a few, then hundreds, shining like amber amid the dark humus of the forest floor. Golden toads. A species new to science.*
>
> *This was in 1964. It turned out that the golden toad occurred only in a tiny, high-elevation area in the Monteverde cloud forest in Costa Rica. A reserve was established to protect the species within its known range. Surveys over the following years indicated a stable population of 1,000–2,000 toads. Then, suddenly, there were fewer than a dozen in 1988, and only one solitary male a year later. The species has not been seen since.*
>
> *Why did the toad disappear so suddenly? Perhaps it was a drying of breeding sites accompanying El Niño, or a shift of the cloud layer to higher elevations (both perhaps related to climate change), or fatal fungal infections. Regardless of the cause, the golden toad was extinct.*[1]

It didn't have to be that way. Conservation's agenda is to avoid such extinctions, to reverse the trends that bring plants and animals to the brink of extinction and return them to secure self-reliance. In this book, we will share stories and case studies to demonstrate how such outcomes can be achieved and the consequences if they are not.

[1] The saga of the golden toad and the controversy over what led to its disappearance are recounted in McMenamin and Hannah (2012). The golden toad is shown in Figure 1.1.

FIGURE 1.1. The golden toad, discovered in Costa Rica in 1964, was briefly conservation reliant. It is now extinct. (A black and white version of this figure will appear in some formats. For the color version, please refer to the plate section.)
Photo: Charles H. Smith, US Fish and Wildlife Service.

There have been some real conservation successes. Peregrine falcons, once endangered in the United States, now soar through the skyscraper canyons of New York and other cities, picking off pigeons as they go. Although the Guadalupe fur seal was twice thought to be extinct and remains threatened, it is now abundant on Guadalupe Island off the coast of Baja California. With intensive management, populations of the giant panda are no longer endangered (although they are still considered vulnerable). Garnett et al. (2018) tell the stories of multiple Australian taxa that are well along the road to recovery, including the spiny rice-flower and the Lord Howe Island stick insect.

For most imperiled species, however, success is elusive.[2] We humans are largely responsible. We have hunted and harvested them; destroyed their natural habitats; altered the physical environment; introduced alien predators, competitors, and pathogens; created novel ecosystems to which they are not adapted; and accelerated climate change. For many species, the threats are so pervasive and immutable that the best we can hope for is to mitigate the effects. We must care for and watch over these species. We must shepherd nature.

Because the threats persist, management to conserve many vulnerable and imperiled species must continue. We call such species *conservation reliant*. *A species is conservation reliant if it is vulnerable to threats that persist and requires continued management intervention to prevent a decline toward extinction or to maintain a population.* The golden toad was fleetingly conservation reliant, dependent on the protection provided by a reserve. But when new threats emerged, the protection was no longer adequate and the species disappeared.

We should clarify several nuances of this definition:

- The threats persist. They cannot be completely eliminated, at least over the short term. Consequently, conservation and management actions must be ongoing, recurrent, or take a long time to complete, even if a species' population is otherwise considered to be secure.
- The management actions are intended to increase or stabilize population size and distribution or reduce the rate of decline; without intervention, the species would decline more rapidly.
- The concept applies to imperiled species: species that are at risk of extinction or are declining rapidly in distribution and abundance. If a species is not vulnerable to extinction in the first place, then simply being managed to sustain recreationally or commercially viable populations does not make it conservation reliant.[3]

[2] In *Wild Hope*, Andrew Balmford (2012) chronicles how difficult it can be to achieve conservation success.

[3] If such species become imperiled, however, management could shift from exploitation to conservation, and they would become conservation reliant. Chinook salmon, Atlantic cod, and Columbian white-tailed deer are examples.

- A species is conservation reliant if it *requires* continuing management to slow or reverse population declines, whether or not actions are actually taken to reduce the threats.
- If the threats are eliminated or reduced so that specific conservation actions targeted on a species are no longer required, then the species is no longer conservation reliant.

The key elements of conservation reliance, then, are the extinction risk and population trajectory of a species, whether the threats can be eliminated or mitigated, and the duration and intensity of the necessary management. Although many species that are listed under various statutes or categorizations are conservation reliant, so also are many species that meet these conditions but have not been afforded special legal protection. The New England cottontail rabbit, Georgia aster, and western pond turtle in the United States are examples. All are conservation reliant. Needed management efforts are supported by a diverse coalition of citizens, non-governmental institutions, zoos, botanical gardens, and government agencies. For many such species, a desire to keep species from being listed under the US Endangered Species Act is a motivating factor.

The elements that characterize conservation reliance vary, so it is not a fixed either/or condition for a species or population. Conservation reliance is dynamic. Consequently, there are degrees of conservation reliance, which we consider in the following chapter.

Conservationists recognized some time ago that some at-risk species might require ongoing management. In 1994, Version 2.3 of the International Union for the Conservation of Nature (IUCN) Red List used a designation of "Conservation Dependent" for species that were of Lower Risk of extinction but depended on conservation efforts to prevent them from becoming Threatened. IUCN dropped this designation in Version 3.1 of the Red List in 2001, primarily to avoid confounding the status of a species with its need for management.[4] Others have used a "conservation dependent" designation to include

[4] www.iucnredlist.org/resources/comparingredlistversion

species that may require some form of management but generally have self-sustaining populations. They are typified by species that have significant commercial value and will remain threatened by overexploitation for the foreseeable future (Redford et al. 2011). Instead, we use "conservation reliance" more broadly to apply to species covering a range of conservation statuses and degrees of management intervention required.

The implications of conservation reliance are sobering. There are some 8–9 million species of plants and animals on Earth, perhaps more. Of these, a quarter of the assessed species may be at risk of extinction, many within decades. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) projects that around 1 million species may already face extinction unless rapid actions are taken (IPBES 2019). Many of these species will likely be conservation reliant. In the United States, some four-fifths of the species listed as Threatened or Endangered under the Endangered Species Act are conservation reliant (Scott et al. 2010). Species in other parts of the world are similarly challenged. The funding and social will needed to support continued management for so many species are unlikely to be available. In the absence of such support, tough decisions will need to be made about how best to prioritize the allocation of resources. We—society as a whole—will need to decide which species are at the most immediate risk of extinction, which have the best chance of survival, and which to leave on their own.

The magnitude of the challenge of conservation reliance requires fresh thinking and new approaches to conservation. This is the challenge we address in this book. Our overriding purpose is to make the tradeoffs and factors underlying prioritization more transparent so that choices can be made in an informed and rational context. Because commitments to the management of conservation-reliant species are generally long term, we aim to shed light on the factors that drive the costs, benefits, and risks that go along with supporting conservation-reliant species.

To do this, we will first develop the concept of conservation reliance (Chapters 1–3) and discuss the threats that drive species toward extinction (Chapters 4–5). Then we consider the legal and policy contexts of conservation reliance (Chapter 6) and the tools that can be used to manage conservation-reliant species (Chapters 7 and 8). We follow with a discussion of some of the socioeconomic forces that affect actions to reduce conservation reliance (Chapter 9) and the problem of how to prioritize conservation efforts (Chapter 10). Finally, we close by considering some components of a way forward and placing conservation reliance in a broader philosophical and ethical context (Chapter 11).

THE SPECTER OF EXTINCTION

Extinction is forever. It is the dying gasp of a species that will be no more. Extinction tears at the fabric of ecological communities and ecosystems, permanently altering the world we share.

Nearly all extinctions since the Industrial Revolution have been direct or indirect consequences of human actions. In some cases, species that were once abundant, such as the passenger pigeon, were hunted or harvested until, almost without warning, too few were left and the species disappeared. The same fate nearly befell the American bison in North America and Père David's deer in China. More often, species that were already rare or restricted to one or a few places, such as the golden toad, suddenly went missing.

Confirming the absence of something—that a species is in fact extinct—is more problematic than determining its presence. There are enough rediscoveries of species long thought to be extinct—so-called "Lazarus" species[5]—to give one pause. The Banggai crow, which had not been seen since 1900, was rediscovered in Indonesia in 2007. Since 1889, over 350 species of amphibians, birds, and

[5] After the Gospel of John, in which Jesus raised Lazarus of Bethany from the dead. The term was originally applied to species in the fossil record that were long thought to be extinct only to be "rediscovered" in more recent deposits (Flessa and Jablonski 1983) but is now applied to the rediscovery of recently extinct species.

mammals that were thought extinct have been rediscovered (Scheffers et al. 2011). Most of these species are tropical, have small geographic ranges and population sizes, and remain highly threatened.

Species may be overlooked for a variety of reasons: they are secretive or occur in remote locations, the locations in which they were formerly found were poorly recorded so we don't know where to look for them, they occur in areas of armed conflict that cannot easily be searched or on private property to which access is denied, they are difficult to distinguish from other species, or there are simply so few individuals remaining that they are unlikely to be encountered. Baumsteiger and Moyle (2017) have addressed this problem by recognizing several levels of extinction, ranging from species that no longer occur in portions of their range ("regional extinction"), to those maintained only in captivity ("wild extinction"), to those that have not been observed over a defined waiting period ("global extinction"). Before declaring a species globally extinct, they suggest waiting for a period of one generation (i.e. longer for a long-lived mammal or tree than for a short-lived fish or annual plant). Similarly, IUCN declares a species extinct only after exhaustive surveys throughout its historic range over a time period appropriate to the species' life history have failed to record any individuals.

Regardless of the definition, there are clear consequences of declaring a species extinct. Management efforts may diminish or cease, funding to support conservation disappears, and the impetus to maintain habitat set aside for the species wanes. If the species still survives, the curtailment of conservation efforts may doom it to eventual extinction. Understandably, many conservationists prefer to hold out hope.

Such hope fueled the excitement that accompanied reports of a sighting of the ivory-billed woodpecker in the Big Woods of Arkansas in 2004 (Fitzpatrick et al. 2005). The species was widely believed to be extinct, but then a beguiling but inconclusive video set off a massive search effort. Teams of observers scoured the backwaters of the Big Woods and other places for several years in

search of firm evidence that the species still existed. Federal funds were diverted to support a recovery effort and lands were purchased to preserve potential habitat. There were enough tantalizing hints—fleeting glimpses of a large woodpecker, distant calls reminiscent of old recordings, unusually large woodpecker excavations in trees—to encourage searchers to continue. But no conclusive evidence has been found. If the ivory-billed woodpecker is not extinct, it is extraordinarily elusive.

Extinction is not a new phenomenon, of course. The story of life on Earth is one of species arising, evolving, persisting for some period of time, and then disappearing. Humans have been pushing species across the extinction threshold for millennia. Many large mammals—short-faced bears, saber-tooth cats, wooly mammoths, giant ground sloths, giant beavers, and dozens of other species and genera—became extinct in North America at the end of the Pleistocene. Although several hypotheses have been offered to account for this pulse of extinctions (Koch and Barnosky 2006; Meltzer 2015), a role for humans is suggested by the coincidence of the extinctions with the arrival of humans some 10 000–15 000 years ago.[6] A similar disappearance of many large mammals from Australia occurred as much as 50 000 years ago, again coinciding with the arrival of humans on the continent (Miller et al. 2005).

More recently, the spread of Polynesians across the Pacific over the past four millennia was accompanied by the extinctions of as many as half the bird species on individual islands or archipelagos—collectively, thousands of species (Steadman 2006; Duncan et al. 2013). Europeans also eradicated species as they explored and colonized new lands. The impacts of people were especially great on islands that had no prior human presence. Species living on such islands had no fear of people and were easily killed; this was the fate of the dodo

[6] A recent claim that humans were present in North America 130 000 years ago (Holen et al. 2017) is controversial.

on Mauritius, the moas of New Zealand, and the flightless waterfowl of Hawai'i (e.g. Allentoft et al. 2014).[7] Loehle and Eschenbach (2012) estimated that fully 95% of the extinctions of birds and mammals since 1500 were on islands, largely due to humans and the herbivores and predators they introduced.

The history of human expansion and exploration is littered with the memories of extinct species. What is different now is that we humans have so altered the environment that some recognize a new geological epoch, the Anthropocene (Crutzen and Stoermer 2000).[8] Nature and humans are no longer separable, and the growing domination of people over the planet is pushing even more species toward extinction. By some accounts, the rate of extinction of species is now perhaps tens to hundreds of times higher than over the past 10 million years (IPBES 2019). And it is accelerating. Much of this increase may be brought on by the direct and indirect effects of climate change (Urban 2017).

The distribution and abundance of many more species are declining, putting them on the pathway to extinction. IUCN provides the most comprehensive information on the conservation status of the world's species. Of the 105 500 species of plants and animals reviewed by IUCN (as of 2019), over one-quarter are considered to be

[7] In their beautifully illustrated book, *A Gap in Nature*, Flannery and Schouten (2001) describe the fate of 103 mammals, birds, and reptiles that became extinct after 1500, all of them at the hands of humans. IUCN lists 784 well-documented extinctions (over a broad array of taxa) since 1500, but acknowledges that the actual number may be much greater. Lawton and May (1995), Quammen (1997), and Cokinos (2000) provide additional perspectives on extinctions.

[8] Based on markers of human actions that appear in geological strata, Lewis and Maslin (2015) suggest that the Anthropocene began in 1610, coinciding with a global dip in atmospheric carbon dioxide. Noting the sudden appearance of synthetic chemicals and radiocarbon from nuclear bomb tests in the environment, Zalasiewicz et al. (2015) and Waters et al. (2016) suggest a beginning in the mid-twentieth century. One could argue instead that the Anthropocene was set in motion when humans began to modify the environment, as indigenous Australians have been doing by managing fire for tens of thousands of years. The onset, or even the appropriateness, of the Anthropocene as a geological epoch is a matter of continuing debate (Finney and Edwards 2016).

currently threatened with extinction.[9] The percentage of threatened species varies widely among taxa for which sufficient information is available: 25% of mammals, 14% of birds, 40% of amphibians, 34% of conifers, 31% of sharks and rays, and 30% of reef corals are at risk of extinction.[10] The magnitude of endangerment also varies among countries. Based only on the numbers of taxa formally listed by government agencies, there are over 1800 taxa of native plants and animals and 774 ecological communities at risk of extinction in Australia;[11] the Endangered Species Act in the United States lists 1662 plant and animal taxa;[12] the Species at Risk Act (SARA) in Canada lists 769 taxa;[13] and the Threat Classification System in New Zealand lists 799 taxa as Nationally Threatened (Hitchmough 2013). What is truly sobering is that these tallies do not include the many taxa that have not been assigned a specific legal status, so they substantially underestimate the actual number of at-risk species (Wilcove and Masters 2005).

Many conservationists regard extinction as the most alarming manifestation of a broader erosion of global biodiversity. They argue that species teetering on the brink of extinction most urgently need our help. But not everyone considers extinction to be a crisis. Stewart Brand has argued that a preoccupation with extinction may be counterproductive, diverting attention from the widespread decline of much of the Earth's biological diversity (Brand 2015; see Wiens 2016a). Populations of even once-common species are dwindling and their ranges shrinking (Ceballos et al. 2017). This, and the extent of conservation reliance among imperiled species, suggests that the demand on limited resources for conservation may be much greater than we thought.

[9] See www.iucn.org/theme/species. Potential future extinctions due to global changes are not included in these figures.
[10] www.iucnredlist.org/ [11] soe.environment.gov.au/frameworks/state-and-trends
[12] ecos.fws.gov/ecp0/reports/box-score-report
[13] www.registrelep-sararegistry.gc.ca/species/schedules_e.cfm?id=1