Daniel T. Blumstein · Benjamin Geffroy
Diogo S. M. Samia · Eduardo Bessa *Editors*

Ecotourism's Promise and Peril

A Biological Evaluation

Springer

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Foreword

I have seen the idea of tourism as a conservation tool blossom across the world since I undertook the role of founding of The International Ecotourism Society (TIES) in 1990. When the first TIES board members and advisors discussed the mission of TIES, we understood that a broad range of experts would be required to measure and manage tourism's impacts. To attract the right expertise, TIES established itself as a membership organization with representatives from dozens of disciplines in well over 50 countries. To reach them in this pre-Internet era, we produced bimonthly paper newsletters, two early textbooks in the field, and printed guidelines to advise tour operators, marine and scuba outfitters, and ecolodge developers. TIES brought together a community of committed souls who developed creative, ethical businesses, managed important reserves and wildlife resources, studied impacts of tourism in a wide range of ecosystems, and were devoted to creating sustainable development outcomes together with their own local communities.

There was never any question among the founders or the many who worked on TIES' board of directors that ecotourism has impacts and that only planning and management can lead to positive outcomes. As a wildlife biologist with a background in animal behavior, I personally was very interested in the question of how well ecotourism could be managed around both terrestrial and marine wildlife. I believe most of the experts in the ecotourism field would agree that specific indicators and management tools for managing tourism in wildlife habitats are essential.

For this reason, I am very glad to see the publication of the book *Ecotourism's Promise and Peril*: *A Biological Evaluation*. The authors offer up-to-date research on the impacts travelers have on wildlife, with results which definitively record that our growing human presence in the wild is not always benign. Wildlife responds to visitors in many different ways, but stress levels are frequently raised by human visits, and repeated visits undermine wildlife species' natural ability to rest and recover, according to the research in this text. In worst-case scenarios, constant invasion of ecosystems and the wildlife that depend on these areas can even cause ecological collapse. Tourists often interrupt the natural feeding patterns of wildlife, or they create dependency on human food sources. For this reason, *Ecotourism's Promise and Peril* offers a wide range of suggested guidelines for tourism managers, which are much needed as the growth of tourism worldwide attracts more and more visitors to important ecological refuges.

Ecotourism once attracted a relatively small, well-educated population of professionals interested in a nature numbering approximately 21 million international travelers in 1990, or 5% of the total tourism market as researched in the International Year of Ecotourism [1]. By 2015, ecotourist numbers might be estimated to be roughly 5% of 1.18 billion international travelers or nearly 60 million people, triple the numbers being managed 25 years ago. And these numbers do not include domestic tourism that is estimated to triple visitor numbers, nor do they give an indication of where pressures are greatest. Because travel in the Asia Pacific region has grown an eye popping 400% in total tourism numbers between 1990 and 2015, the challenges are particularly acute in that region [2].

New efforts to understand our human ancestors have revealed that we are a species which migrated across the planet and rapidly changed the flora and fauna of regions where we lived, including the megafauna found in Siberia, the Americas, and Australia, all of which disappeared not long after *Homo sapiens* arrived [3]. In modern times, our species has flocked to large cities to accommodate our growing numbers, requiring massive conversions of our landscapes and marine environments to feed us, and ever more rapid changes in the CO_2 composition of our atmosphere which has caused a growing climate crisis.

Travel is an accelerator of these trends, putting every human on the fast track to globalized commerce and leisure. It is a carbon heavy sector, which has entered into a period of exponential growth in the consumption of water, energy, food, demand for land, and emissions of CO2 which will exceed all efforts at efficiencies and are likely to more than double the travel and tourism industries' current impacts between 2010 and 2050 [4].

In my book, *Sustainable Tourism on a Finite Planet* [5], I argue that the travel and tourism industry is placing terrestrial landscapes, marine areas, and heritage sites across the world under unprecedented pressure without adequate governmental or international systems to guide the process. I conclude that tourism is essentially a transport, real estate, and service sector, which harvests human commercial value from destinations without adequate recompense, even though ecosystem services are required to preserve destinations and protect human well-being. While ecotourism has offered a beneficial model for tourism management, it is not separate from the larger question of how to manage the ballooning commercial services, transport, and real estate investment that is part and parcel of all tourism development [6].

The volume of travelers is not declining and in fact is escalating rapidly. Industries such as cruise lines, often decried in ecotourism circles, will become omnipresent in ports worldwide, and large-scale coastal development will continue unabated. For this reason, it is crucial that global land managers use science-based indicators, which can provide strong feedback loops to ensure valuable wildlife species, such as whales, dolphins, polar bears, and penguins, are not subject to ever more commercial visitation patterns. The complex and cumulative impacts of tourism on wildlife require an evidence-based approach to review impacts, discuss limits of acceptable change, and redirect visitation when necessary. Larger patterns of tourism development must also be carefully monitored, avoiding patterns of fragmentation and sprawl development. Instead local authorities need to invest in protecting valuable pools of biodiversity by protecting green corridors and designing green infrastructure, which will be worth their weight in gold in the urbanized future of the twenty-first century. This will enrich lives and build value for all citizens and protect the very heritage ecotourism seeks to provide access to.

It is likely that two billion travelers a year or more will be traveling annually by the end of the twenty-first century. In the future, the ecotourism movement will provide access to some of the most important biological heritage that remains on the planet. Wildlife lands, green zones, and marine areas will become ever more valuable, and ecotourism will play an increasingly important role in providing access to these areas. But a positive role for ecotourism can only be forecasted if the protection of wildlife and wildlife habitats are carefully managed as is amply demonstrated in this volume.

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It all started on a Brazilian beach. Dan, Benji, and Diogo argued for days about the behavioral and biological impacts of ecotourism and urbanization. Primed by a previous conversation with Eduardo, we debated a conceptual framework. The framework was eventually published (Geffroy B, Samia DSM, Bessa E, Blumstein DT (2015) How nature-based tourism might increase prey vulnerability to predator. *Trends in Ecology and Evolution* 30:755–765). Verena Penning, of Springer DE, then invited us to turn these ideas into a book and, for that, we are very grateful.

We thank Verena for supporting us in our desire to bring together a diverse and exciting cast of expert contributors. We are indebted to these international contributors from whom we have learned so much during the drafting of the book. By bringing together people from around the world, and specialists who work on many species, we believe we have provided a balanced view of the potential biological impacts of ecotourism and some suggestions on how to reduce them.

Chapters were peer-reviewed by internal and external reviewers and the authors worked to address their comments. For this we especially thank our external reviewers that included William E. Cooper Jr., Peter Dann, Alejandro Frid, Marco Milazzo, Sally Thode, and Pierre Walter.

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Contents

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Daniel T. Blumstein is a professor in the University of California Los Angeles' Department of Ecology and Evolutionary Biology and in the UCLA Institute of the Environment and Sustainability. He conducts integrated studies of animal social behavior, animal communication, and antipredator behavior and has helped develop the field of wildlife conservation behavior. He is the author of over 350 scientific publications and has written or edited six books, including *An Ecotourist's Guide to Khunjerab National Park.*

Benjamin Geffroy is a researcher at the French Research Institute for Exploitation of the Sea (Ifremer). He received his Ph.D. in behavioral ecology and physiology. After postdoctoral work in Brazil studying the effects of ecotourism on fish, he joined Ifremer to work on fish reproduction and behavior. His research deciphers the various physiological and behavioral mechanisms that underlie population changes.

Diogo S.M. Samia received his Ph.D. studying ecology and evolution. He is currently a postdoctoral researcher at the University of São Paulo, Brazil, where he investigates the evolutionary mechanisms promoting sexual dimorphism in animals. Much of his work has examined antipredator behavior and he has focused on applying knowledge of animal behavior to wildlife conservation.

Eduardo Bessa is a zoology professor and an advisor in the graduate program in ecology in the University of Brasília. His research focuses in two main areas: to understand reproductive behavior in a plethora of animal models, especially fish, and to apply basic behavioral knowledge to conservation and ecotourism.

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Introduction: Ecotourism's Promise and Peril

1

Daniel T. Blumstein, Benjamin Geffroy, Diogo S.M. Samia, and Eduardo Bessa

Fig. 1.0 Northern elephant seals (*Mirounga angustirostris*) hauled out along the Pacific Coast Highway in Central California. Photo credit Daniel T. Blumstein

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This is a book that desires to improve the positive impacts of ecotourism and nature-based tourism by properly identifying potential biological impacts so as to help develop effective mitigations and management. We focus mostly on impacts on wildlife. We, the editors, are avid eco- and nature-based tourists. We travel to natural areas to appreciate their wonder. We watch animals, botanize, and enjoy beautiful natural landscapes. We also recreate (bike, hike, climb, surf, ski, snorkel, and dive) in natural areas around the world. Professionally, we are behavioral biologists who study the natural behavior of animals to reveal general trends and understand behavioral diversity. We study animals in the wilderness and in areas with eco- and nature-based tourists. We recreate in the places that we work and we care deeply about managing negative consequences of recreation in these and other places. We also appreciate the value of natural areas in urban places and study the effects of urbanization on wildlife in our ever-urbanizing world.

Nature-based tourism is huge. Globally, a recent study suggested that there are over eight billion visitors per year to terrestrial natural areas [1]. Stated bluntly: more people visit natural areas than there are people on Earth! Alarmingly, this estimate does not include small reserves so the real extent of people interacting with wildlife and recreating in natural areas is even larger. Such high visitor numbers cannot occur without creating ecological impacts. Thus, given the tremendous potential impact of human visitation on natural areas, what can be done to reduce or manage impacts while enjoying the potential economic and conservation benefits of eco- and nature-based tourism?

There has been much written on managing wildlife-, eco-, and nature-based tourism, and we refer all to the outstanding volume, *Natural Area Tourism: Ecology, Impacts and Management*, now in its second edition [2]. Newsome et al. wonderfully review the scope of natural area tourism and discuss ways of identifying and managing impacts. It is an authoritative and comprehensive volume. It contains overviews of the sorts of impacts that natural area tourists create and strategies to minimize them. There are of course a number of textbooks that discuss, in part, impacts of ecotourists (e.g. [3, 4]), and Buckley [5] outlined a number of environmental impacts of ecotourism. In addition, Ballantyne and Packer's [6] *International Handbook on Ecotourism* is another volume that addresses many challenges associated with ecotourism, which begins with its definition. Indeed, the first 20% of Ballantyne and Packer's book is dedicated to discussing the definition of ecotourism! We, however, follow Buckley [7] in being necessarily vague: ecotourism includes the intention to minimize impacts in a nature-based setting, where ecotourists learn about nature and may contribute to conservation and there may be benefits to the local community. Given these wonderful books, why is another book on impacts of ecotourism warranted?

We believe that we, as well as many of the chapter authors, bring a unique animal behavior-centered approach to potential impacts of eco- and nature-based tourism. Changes in behavior are usually the first reaction of animals to environmental challenges, and ecotourism can be viewed as an environmental challenge. This behavioral perspective focuses on mechanisms of how animals respond to threats and challenges. A mechanistic approach is essential if we are to develop better tools to manage impacts [8]. However, since ecotourism is expected to benefit humans as well, we have a separate chapter that discusses the implications of ecotourism to local community and to visitors.

A conflict between what is good for nature and the societal benefits that may emerge from ecotourism is more or less expected given the desire to both reduce impacts on nature while benefiting people and promoting conservation. We will focus, primarily, on impacts on animals; the variety of impacts of ecotourism on vegetation are not our primary focus. In fact, our animal-centered focus is timely since nowadays scientists are concerned with the under-recognized effects of defaunation—the loss of animal species—on ecosystem health [9, 10]. But we also recognize that in many places, ecotourism provides a vital role in community development and indeed in preserving biodiversity. On a recent trip to the Galápagos, Dan had a long and fascinating discussion with a local guide about the disconnect (as he perceived it) between what's good for nature and what's good for the local people. In a place where he said that 80% of the jobs are tied to tourism (also see [4]), his concerns about the constraints on residents (and he was a multigenerational resident of Isabella) illustrate the constant tension that may exist in many places between wildlife and development, between conservation and preservation, and between animal and human welfare.

We believe that unless environmental conservation is at the core of nature-based tourism, its long-term sustainability is ultimately at risk. Dan wrote *An Ecotourist's Guide to Khunjerab National Park* [11], in part because local shepherds wished to develop a trekking industry following the government takeover and protection of the land that they had grazed and hunted on for hundreds of generations. Yet such industries are fragile and susceptible to changes in perceptions of safety and uncontrollable international events. Relatively, few people trek in Northern Pakistan these days compared with Northern India or Nepal.

So why is a biological focus important? We, the editors, share a keen interest in understanding antipredator behavior. Since virtually all animals face some risk of predation at some point of their life, the field of antipredator behavior provides numerous examples of strategies that animals employ to reduce their risk of being killed. These strategies start by simply avoiding areas where there are predators, extend to strategies to detect predators using various senses (which may differ from humans' senses), and include a variety of evolved escape mechanisms.

As behavioral ecologists, we are interested in explaining this behavioral variation by thinking about both the costs and benefits of adopting a particular antipredator strategy. A striking insight from this economic approach is that we can't simply assume that animals will leave a risky or disturbed area. Animals may suffer negative consequences from disturbances because they have no other options. This means that an individual may seemingly appear to tolerate a threat because it's too expensive for them to respond to it, but the threat may, nonetheless, take a toll on its ability to survive or reproduce [12].

Because animals often perceive humans as predators [13], our expertise positions us nicely to address questions of ecotourism's impacts in a novel and essential way. Novel, because this book summarizes recent results in a way that is designed to be accessible to both ecotourists and to operators. Essential, because by thinking deeply about how animals perceive and manage predation risk, we identify potential unrecognized threats to the biodiversity that we all seek to enjoy when we travel to natural areas. And, once identified, we make novel suggestions to reduce the myriad of potential impacts in biodiversity-friendly ways [12].

We have engaged a diverse set of contributors, and together, we believe that we have created a novel perspective on potentially negative effects of ecotourism on wildlife while making a great effort to figure out the ways to reduce them. As you will see, there is some redundancy in the following chapters. We believe this is acceptable and indeed necessary. First, each chapter has a different focus, but together they illustrate the myriad of human impacts on wildlife that may result from ecotourism, and this web of impacts is interconnected. Second, readers are able to acquire isolated chapters instead of the entire book. For this reason, the chapters should be stand-alone, containing the key concepts and conclusions so that readers can have the proper perspective should they only read a single chapter.

You will also see that we provide extensive references. We argue for an evidence-based approach and the references are the evidence supporting authors' conclusions. We believe that access to this evidence is essential for scientists, nonscientists, and managers. All may wish to dig deeper into the evidence. Many of these sources, and certainly most of their abstracts, are available online and without charge. For those without access to a university library, we suggest that you search for the paper's title; many authors make PDFs of their paper freely available.

In Chap. 2, Geffroy et al. [14] review a set of physiological and behavioral consequences of nature-based tourism on wildlife. Behavioral responses are often, but not always, indicators of underlying physiological stress responses. These stress responses are part of a series of homeostatic mechanisms by which animals manage stressors in their environment. Stress responses, themselves, are not bad, but chronic stressors can affect the health and well-being of animals or lead them to change their activity pattern; all these may reduce survival and reproduction. Thus, by understanding how human activities may lead to chronic stress, operators and informed ecotourists can reduce activities that may inadvertently stress animals.

In Chap. 3, Shannon et al. [15] focus on the ecological effects and describe the various and sundry ecological consequences of nature-based tourism on wildlife and the biotic communities in which they live. A growing literature shows that when the behavior of individuals is altered by ecotourists, there may also be ecological consequences to the community as a whole. For instance, tourism-related activities can directly harm animals. For instance, an increase in vehicular collisions can reduce population sizes in specific locations. And, by providing supplemental food by tourists and ecotourism operators, animals will use different areas. Changes in the distribution and abundance of animals modify the relationships between them (e.g., competition and predation) and may have consequences that cascade down to impact vegetation. By recognizing the potential drivers that result in ecological impacts, operators and informed ecotourists can reduce or modify the activities that inadvertently cause them.

In Chap. 4, Møller [16] summarizes what is known about the impacts of ecotourism that span generations. Cross-generational changes in behavior and in other life history trait, such as the age at first reproduction, the number of eggs or young produced, or the offspring sex ratio, may be driven by the experiences animals have with people (i.e., they learn to avoid or tolerate certain activities) but also by natural selection acting by the differential survival and reproduction of certain types of tolerant and intolerant individuals. Møller notes that these are relatively understudied fields and that we should expect both processes to occur. Long-term operators may play an important role in citizen-science-driven projects that allow us to gain more insights into long-term changes in behavior as a function of tourist-related activities.

The next chapters focus on specific taxa and summarize the state of our knowledge about ecotourism's effects on them.

In Chap. 5, Bessa et al. [17] focus on the effects of fish tourism—both in marine and freshwater environments. Diving and fish watching are magical experiences that turned into a huge industry, which often uses food provisioning to attract fishes. The chapter deals with the impacts of human presence and artificial feeding on the physiology, behavior, and ecology of the fish and their environment.

In Chap. 6, Bearzi [18] focuses on marine mammal tourism. Because of a history of widespread exploitation, marine mammal populations throughout the world are recovering from all-time lows. People love to go whale watching and this highly regulated, but also extensive, industry affects whale behavior. But marine mammal tourism is not restricted to whales; people travel to see dolphins, seals and sea lions, manatees, and polar bears. All tourist activities have potential deleterious impacts. By understanding potential negative effects, operators can ensure successful mitigation and thereby create a truly sustainable marine mammal tourism industry.

In Chap. 7, Tablado and D'Amico [19] focus on the huge terrestrial animal tourism industry that includes bird watching—the world's most popular wildlife activity—as well as traveling to see large carnivores, charismatic ungulates, and primate tourism. While not all of those eight billion people visiting terrestrial protected areas annually do so to interact with animals, the mere presence of visitors nevertheless affects resident animals. Here too, by understanding potential negative effects, operators can ensure successful mitigation and thereby create a truly sustainable tourist industry.

In Chap. 8, Ellenberg [20] focuses on penguin tourism. This industry, while relatively small given penguins' rather restricted locations, is also remarkably fragile. Many species live in highly vulnerable and extreme environments that can be easily harmed by well-meaning ecotourists. Moreover, given the harsh environments in which many penguins live, anything that influences their ability to forage or conserve energy may challenge their very existence. Minor disturbances may thus have profound effects on penguins. With growing economic prosperity and more visits to Antarctica and temperate regions, penguin tourism is booming. Both tourists and operators will benefit from understanding how to create best practices to reduce harmful impacts.

In Chap. 9, Zacarias and Loyola [21] bring humans back to the forefront of our discussion on impacts and prime us for thinking about how to evaluate biological impacts in a more integrated way. Ultimately, potentially deleterious impacts of tourism must be traded-off against the benefits to the communities that ultimately manage their natural resources. There are no simple conclusions to draw from this chapter aside from context is everything and the options that local communities have will influence both the costs and the benefits from ecotourism regulations. Well-meaning ecotourists must recognize these conflicts exist and may be able, through their actions, to further reduce their impacts in areas where potentially detrimental activities provide meaningful and documented benefits to local communities and incentives to protect natural resources. Armed with these ideas, it may be possible to work toward the elusive "triple bottom line"—whereby it supports economic, environmental, and social sustainability [22].

In Chap. 10, Samia, along with the authors of the book [23], create a behavioral and biologically based perspective on ecotourism best practices. We hope that this will add to the discussion on how we can reduce impacts while maximizing our enjoyment of nature's wonders. We hope that by working to adopt these suggestions, we will create a more sustainable ecotourism industry that help local communities profit from the natural resources they protect. And we hope that by creating a more sustainable industry, our children, and theirs, may experience some of the magical moments in nature that we have been fortunate to have.

In Chap. 11, we identify underexplored research and open questions regarding the impacts of ecotourism on wildlife with the goals of creating more sustainable ecotourism. We develop a research agenda that will ultimately create a culture of evidence-based ecotourism. It is through evidence-based ecotourism research that we will make ecotourism more sustainable for both the natural resources that we seek to explore and the communities that are charged with their stewardship.

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Physiological and Behavioral Consequences of Human Visitation

2

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Fig 2.0 A mother lion (*Panthera leo*) taking care of her offspring and facing ecotourists at Phinda Private Game Reserve, South Africa. Photo credit Graeme Shannon

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2.1 Introduction

Imagine you are coming home after a successful foraging trip to the local grocery store and you find your front porch occupied by a pack of lions. Sightseeing lions, that is, apparently well fed and lazily dosing in the sun, but, well, with lions you never know! Would you get out of your car and just walk across that pack of lions to feed your hungry kids? Or would you rather stay in the car, lock yourself in where you feel safe? Maybe you feel a bit bolder after a little while and try to sneak into your house through the backdoor. Probably you will make this attempt with your heart in your throat and just bring in the bare essentials. When one of the lions notices you, and gets up to get a better look, you'd probably drop your bags and run for cover.

Just like you may be struggling to trust those front porch lions, many animals are suspicious of us. Wildlife generally perceives humans as potential predators. Not surprisingly so, really, since we've been hunting animals for food and for their products for thousands of years. Today, well fed by modern food production technologies, we now use some of these animals for pleasure and entertainment. But how should they know that we might mean no harm? We still smell like predators, and even a pleasant bouquet of rose perfume won't mask this from the sensitive nostrils of some animals. We are often noisy and colorful and thus very detectable. And we behave oddly too. Today, we hunt with cameras leveled chasing after a good shot to share with our friends via social networks. Not so long ago, we were out there with spears, guns, nets, and harpoons to feed ourselves and the world (indeed, we still do this in many places).

No wonder many animals respond in a strongly negative way to human presence. And even if you only observe subtle behavioral changes—such as increased vigilance—their heart rate is probably going through the roof. Increasing heart rate is a simple, yet important, physiological response that keeps animals prepared so that they can rapidly flee in case we changed our mind and spontaneously decided to pick them up for a nice family feed. The fact is that these normally adaptive behavioral and physiological responses are energetically costly. While a one-off visit may have limited impact, frequent human visitation may deplete energy reserves and reduce the likelihood that an individual survives or has sufficient energy to reproduce. This is mainly driven by physiological and behavioral modifications, and the long-term success of ecotourism ventures will thus depend on a sound understanding of these processes that could be used to inform management action. In the remainder of this chapter, we will examine such often unintentional and avoidable impacts of human disturbance on wildlife in more detail.

2.2 Physiological Responses to Human Visitation

2.2.1 Humans Are Perceived as Stressors

Facing a stressful event, we all respond using the same physiological mechanisms that are triggered at various intensities. Looking down a canyon, making an important presentation, or facing a dangerous predator will make your heartbeat increase and your face will flush with blood. These are the consequences of physiological mechanisms that are very similar among many species [1]. These responses help animals adaptively respond to the stressor and eventually to reset their physiology to a more normal physiological state. This process is called homeostasis. The first physiological response is linked to an increase in "stress hormones" such as catecholamines released within seconds to few minutes after the stressor and followed by the secretion of glucocorticoids in the plasma after several minutes [2, 3]. Secondary responses are related to a change in energy allocation, by inhibiting systems that channel energetic resources to growth or reproduction [4], in order to provide energy for (1) the cellular responses to the stressor, such as the production of protective molecules and the initiation of defensive mechanisms [5], (2) the increase of immune functions [6, 7], or (3) as a source of energy for a new energy-demanding behavior (e.g., an escape) [8]. Thus, during stressful events, energy is transferred from stored reserves and is released in the blood. At the same time, the cardiovascular and ventilatory systems are stimulated and transport oxygen to the organs to prepare them for escape.

Any situation that triggers these physiological responses can be considered a stressor, and therefore, many of these endpoints can be used as indicators to identify a stressful situation. Human visitation has been shown to trigger the stress response cascade in many species leading to higher levels of stress hormones after human encounters [9–11] (but see Tables 2.1 and 2.2). Stress hormones, more specifically corticosterone or cortisol, depending on the species, are frequently used as markers of physiological stress. They are easy to measure from blood plasma samples, and their levels are generally considered to provide an estimate of the intensity of anthropogenic disturbance (higher levels indicate higher disturbance) [12]. They can be estimated using noninvasive tools, since their levels or the levels of their metabolites in hair, feathers, feces, or even in the water for fish are reliable indicators of the overall secretion of stress hormones [13–17]. However, data resulting from these noninvasive techniques need to be interpreted with caution since they are the result of an accumulation over some period of time, making it difficult to disentangle the effects of different potential sources of stress. Studying other parameters of stress can validate hormonal results, and heart rate has been proven to be a reliable and precise measure of human disturbance [18]. Measuring heart rate during and after human presence allows quantification of the relative severity of different disturbance events [19–21].

Overall, human visitation can be considered a stressor for many wildlife species, eliciting physiological modifications such as the production of stress hormones and an increase in cardiovascular activity. These effects are, on their own, not harmful for the animal but part of the normal stress response. However, repeated exposure to a stressor, such as human visitation, can lead to long-term elevated stress levels, described as chronic stress, with eventually deleterious effects compromising an animal's homeostasis. Animals in a state of chronic stress can be expected to show impaired growth, reduced resistance to disease, and ultimately lower survival [22].

2.2.2 Effects of Prolonged Human Visitation on Basal Stress Hormone Levels

Under-regulated nature-based tourism often results in frequent and lasting disturbance impacts that may create chronic stress for wildlife. There have been a number of studies that compared basal glucocorticoid levels in populations living in tourist areas with those outside tourist areas. Interestingly, many studies did not find significant differences in baseline stress hormone levels in visited compared to non-visited zones (Table 2.1), and one study even showed decreased baseline levels in animals from visited zones [9]. On the contrary, other studies found increased glucocorticoid baseline values in animals exposed to frequent visitation [23–27]. This inconsistency between studies is partly linked to the diversity of species studied, highlighting that some species are more sensitive to human presence than others, but also to differences in tourism intensity and practices. Additionally, the methods by which stress hormones are measured may also account for differences between studies. Measurements in feathers or feces integrate stress hormones over a longer

Table 2.1 Ratio of stress levels as inferred from measures of basal glucocorticoid (GC) levels in animals from human-visited and nonhuman-visited areas

Common name	Species	Basal GC (visited/unvisited ratio)	Measured in	References
Marine iguanas	*Amblyrhynchus cristatus*	NS	Plasma	[32]
Marine iguanas	*Amblyrhynchus cristatus*	NS	Plasma	[33]
Northern pintails	*Anas acuta*	NS	Plasma	[34]
Northern Bahamian rock iguanas	*Cyclura cychlura*	NS	Plasma	[35]
European storm petrel	*Hydrobates pelagicus melitensis*	NS	Plasma	[36]
Yellow-eyed penguins	*Megadyptes antipodes*	NS	Plasma	[37]
Hoatzin chicks	*Opisthocomus hoazin*	NS	Plasma	[38]
Magellanic penguins	*Spheniscus magellanicus*	NS	Plasma	[39]
Magellanic penguins	*Spheniscus magellanicus*	NS	Plasma	[40]
Magellanic penguins	*Spheniscus magellanicus*	NS	Plasma	[10]
Magellanic penguins	*Spheniscus magellanicus*	0.57	Plasma	[9]
Gentoo penguins	*Pygoscelis papua*	1.5	Feathers	[24]
African lions	*Panthera leo*	1.7	Feces	[25]
Barbary macaques	*Macaca sylvanus*	1.18	Feces	[26]
Capercaillie	*Tetrao urogallus*	1.28	Feces	[23]
Gorillas	*Gorilla gorilla gorilla*	1.14	Feces	[27]

The values indicate how many times greater the basal GC of animals from visited areas is from the basal GC of animals from non-visited areas. In studies showing no significant differences, a ratio is not provided and replaced by NS time than those measured in the blood, and these feather and fecal measures often show increased stress hormone levels in visited areas.

It is, however, important to treat these baseline levels of stress hormones with some caution. Although high baseline stress hormone levels are reliable indicators of prolonged exposure to a stressor [28, 29], low baseline values can be misleading. Chronically stressed animals sometimes show low stress hormone levels as a result of the exhaustion or downregulation of their stress response system [30, 31]. In order to evaluate the actual physiological effects of human visitation, additional measures need to be considered. A common approach relies on the capacity to respond to a second stressor or a hormonal challenge, enabling to evaluate coping abilities of the animals.

2.2.3 Frequent Human Visitation Disrupts Coping Abilities

The capacity of animals to respond appropriately to stressors is an important ability that affects survival and reproductive success [41], since it involves a process of coping and restoring homeostasis. Investigating whether human visitation impacts these stress-coping abilities is essential for effective conservation management, and there have been a number of studies that contrasted tourist and non-tourist areas in animals' response to stressors.

Overall, studies have shown that the response to a stressor differs significantly in animals from tourist compared to control, unvisited areas (Table 2.2). Several of these studies identified a hypersensitivity of the stress response in animals repeatedly disturbed by human visitation, resulting in a significant stronger glucocorticoid response (GC ratio > 1 in Table 2.2). Thus, repeated human visitation can sensitize animals. Most of these results were obtained using the standardized stressor of capture and restraint, where previous experience with humans can significantly affect an animal's response. Consequently, the differences in glucocorticoid responses detected in these studies can partly reflect the changing perception of humans from a nonthreatening to a threatening stimulus. To test directly for physiological disruptions, researchers have used a technique that directly activates the stress axis (also called "HPA axis"), which is the set of glands involved in the production and degradation of stress-related enzymes by the hypothalamus, the pituitary, and the adrenal glands. This can be done by injecting adrenocorticotropic hormone (ACTH). Following this protocol, stronger stress responses were recorded in a bird (*Hydrobates pelagicus melitensis* [36]) and fish species (*Moenkhausia bonita* [42]) from tourist areas. This suggests that the change in stress sensitivity is not only the result of a change in the perception of humans as a threat but also an actual change in the physiology of the stress and coping response.

Conversely, other studies showed that repeated human exposure may lead to reduced stress responses to human visitation. But it is still uncertain if reduced stress responses are the result of habituation to humans, a change in the ability to physiologically respond to disturbance, or reflect differential sorting where more sensitive individuals leave the disturbed area (see Sect. 2.3.4 on animal personality).

Table 2.2 Ratio of glucocorticoid (GC) levels of animals from human-visited and non-visited areas

Common name	Species	Stressor	GC levels (visited/unvisited) after stressor	Measured in	Comment	References
Magellanic penguins	*Spheniscus magellanicus*	Capture and restraint	NS	Plasma		[10]
Northern Bahamian rock iguanas	*Cyclura cychlura*	Capture and restraint	NS	Plasma		[35]
European storm petrel	*Hydrobates pelagicus melitensis*	Human disturbance	NS	Plasma		[36]
Magellanic penguins	*Spheniscus magellanicus*	Human visitation	0.34	Plasma		[10]
Magellanic penguins	*Spheniscus magellanicus*	Human visitation	0.50	Plasma		[9]
Marine iguanas	*Amblyrhynchus cristatus*	Capture and restraint	0.54	Plasma		[32]
Magellanic penguins	*Spheniscus magellanicus*	Capture and restraint	0.65	Plasma		[40]
Magellanic penguins	*Spheniscus magellanicus*	ACTH injection	0.74	Plasma		[40]
Yellow-eyed penguins	*Megadyptes antipodes*	Capture and restraint	1.43	Plasma		[37]
European storm petrel	*Hydrobates pelagicus melitensis*	ACTH injection	1.47	Plasma	No statistics	[36]
A small fish	*Moenkhausia bonita*	Capture restraint and ACTH	1.85	Water		[42]
Marine iguanas	*Amblyrhynchus cristatus*	Capture and restraint	1.92	Plasma	In non-breeding animals	[33]
Hoatzin chicks	*Opisthocomus hoazin*	Capture and restraint	2.01	Plasma	In juveniles	[38]
Magellanic Penguins	*Spheniscus magellanicus*	Capture and restraint	3.57	Plasma	At hatch	[39]

GC levels were measured soon after a stressful stimulus. The values indicate how many times the GC of animals from visited areas is larger than GC of animals from non-visited areas. *NS* nonsignificant

Reduced physiological capacity to respond to a stressor, as found in Magellanic penguins (*Spheniscus magellanicus* [40]), can cause catastrophic ecological consequences, leading to decreased abilities of animals to efficiently respond to life-threatening stressors, such as a sudden change in the environment or the presence of a predator [43]. More studies using nonhuman-related stressors are required to investigate if differences in stress responses are the result of habituation or modification of individual's abilities to mount an appropriate physiological stress response.

In conclusion, prolonged or repeated exposure to human presence can lead to physiological modifications. Some studies suggest that under-regulated tourism can increase the anxiety of animals toward humans and thus result in sensitization to human visits. In this case, animals perceive human visitation as stressful stimuli, and the accumulating impacts of repeated visitation can increase energy expenditure and ultimately affect individual growth, reproduction, and survival. Other studies described a decreased responsiveness of individuals caused by repeated exposure to humans: habituation. When habituation occurs, the impact of ecotourism seems less important. However, habituation is sometimes accelerated by feeding wild animals [44], leading to quantitative and qualitative modifications of their diet, illustrated by changes in their body condition. Investigating the effects of ecotourism on body condition is therefore part of an important area of research for studying the long-term effects of ecotourism.

2.2.4 Effect of Ecotourism on Body Condition

Where wildlife is fed to increase visibility, animals might be heavier compared to those not fed [26]. However, wildlife provisioning might also have long-term negative effects. For example, southern stingrays (*Dasyatis americana*) regularly provisioned with squids, a nonnatural diet, show a strikingly different blood fatty acid profile when compared with unfed animals, mainly characterized by a higher n–3 by n–6 polyunsaturated fatty acid ratio [45]. Since fatty acids are the main constituents of cellular membranes, such a change in fatty acids ratio can be expected to change cellular membrane permeability possibly impacting the proper functioning of cells [46].

The mere exposure to frequent human visitation might also lead to a decrease in body weight, through an increase of stress. For example, in the common wall lizards (*Podarcis muralis*), animals from tourist-exposed areas had relatively lower body masses in summer—the season with most human–animal interactions—compared to animals not exposed to tourists [47]. Similarly, juvenile hoatzin chicks (*Opisthocomus hoazin*) in tourist-exposed areas are smaller than undisturbed juveniles [38]. Yellow-eyed penguins (*Megadyptes antipodes*) exposed to under-regulated tourism fledged at significantly lighter body weights and, as a result, were less likely to survive their first year at sea [37]. Hence, an increase in energetic expenditure toward stress response mechanisms is often traded-off with the energy available for other essential functions, such as growth [48] and reproduction [4]. This is particularly concerning when animals are already working at their physiological limits, such as during migration or breeding. Indeed, lower body weight can reduce breeding success [49, 50] and the ability to survive predation or environmental challenges [51, 52]. Additionally, effects on body weight or body condition can be the results of a shift in the fine balance of the behavioral time budget, as described in the next sections. Disturbed animals in visited areas may spend more time being vigilant and less time foraging for food (see Sect. 2.3.2 on behavioral time budgets).

2.3 Behavioral Responses

2.3.1 Avoidance: Flight and Displacement

As highlighted in the previous physiological section, animals may perceive an approaching human as an immediate threat to their survival and react by fleeing the area. Animals might also simply avoid valuable areas when humans are present. Such areas were presumably chosen for good reasons, such as providing them with high-quality food and shelter. As a result, animals are displaced to areas of lower quality, foraging in patches with less food and possibly more predators. Furthermore, when animals flee from humans, they use up their limited energy stores while being unable to continue with activities such as feeding or grooming that are crucially important for their survival.

Thus, measuring the flight initiation distance (FID) is a common approach to assess the degree to which individuals are prone or averse to risks. In recent years, considerable research has quantified the FID of animals exposed to apparently non-threatening human visitation. Studies found that FID depends on many factors, including animal group size, individual size, age, experience, sex, starting distance of the intruder, and distance of the closest refuge [53, 54]. Furthermore, FID is species-specific. In some fish species, such as parrot fishes, FID to human approach is 0.5–2 m [55]. In some lizard species, FID varies between 2 and 10 m [56]. In South American fur seals (*Arctocephalus australis*), FID elicited by tourist approaches was 10 m [57], which is similar to that reported for northern elephant seals (*Mirounga angustirostris*) [58]. In birds of Eastern Australia, FID ranged between 2 and 150 m [59], and in Humboldt penguins (*Spheniscus humboldti*), FIDs of more than 200 m were observed [Ellenberg pers. obs.]. This highlights variable sensitivities to disturbance.

The intensity of flight response could also depend on the historical nature of the relationship between the focal species and humans, especially in a context of historic hunting as seen in penguins [60]. Fish from highly fished areas also tend to flee at longer distance than individuals of the same species in protected areas [61]. Hence, the optimal FID for a given species depends on disturbance history, but also on the cost/benefits balance, where readily leaving a “valuable place” increases energy expenditure but also reduces perceived predation risks.

Sometimes, avoidance is so pronounced that it becomes difficult to determine whether animals are even present. A very simple tool to circumvent this issue is quantifying animal footprints along tourist trails (Fig. 2.1). Fewer footprints mean

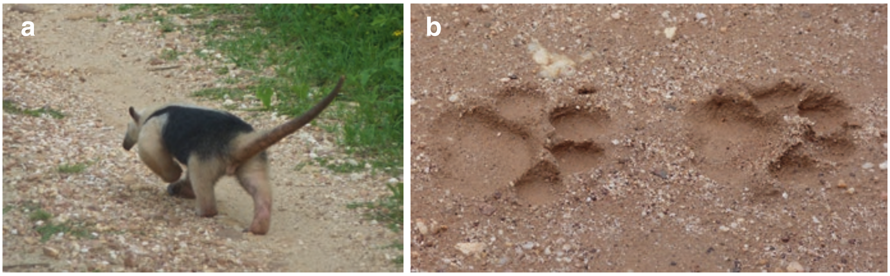

Fig. 2.1 (**a**) Collared anteater (*Tamandua tetradactyla*) leaving delicate footprints and (**b**) footprints of a jaguar (*Panthera onca*) in the "Transpantaneira" tourist trail in Pantanal, Mato Grosso, Brazil. Photo credit Benjamin Geffroy

lower abundance of animals. This is an effective way to measure displacement of animals due to human presence, which is particularly useful for large mammals that are difficult to observe [62]. Remotely triggered infrared cameras are also often used to attest the presence of a given species. This was done in California, where a study detected that bobcats (*Lynx rufus*) and coyotes (*Canis latrans*) avoid trails that are frequented by hikers and mountain bikers [63].

2.3.2 Behavioral Time Budgets

Being able to multitask is a gift that few possess. Thus, the time spent on one activity has consequence on the time available for other activities. The resulting "behavioral time budget" reflects these trade-offs between different activities. There are a number of studies that have shown that tourist presence modifies animal's time budgets, which then affects their energy budget.

Dolphins are good models for studying activity budgets. As flagship species, they attract many tourists and, depending on species, may interact directly with tourists. It was found that Australian bottlenose dolphins (*Tursiops australis*) might not perceive visitors as a threat, as long as swimmers approached from the side [64]. The time spent interacting with humans will nevertheless compromise the time available to forage and rest. This has been observed in many dolphin species (common dolphins *Delphinus* sp., dusky dolphins *Lagenorynchus obscurus*, and bottlenose dolphins), where individuals were shown to compensate by increasing feeding activities following human visitation [64–66], and is discussed more in Chap. 6. Hence, the exact timing of human activities need to be managed carefully to avoid lasting effects on dolphin behavior and ultimately body condition. Disruption of behavioral budgets is also the most consistent finding of studies that quantify whale-watching impacts [67]. In terrestrial mammals, such as elk (*Cervus canadensis*), an increase in travel time during the day has been observed in response to avoidance of humans [68]. Interestingly, travel time increased according to the noise produced by tourist activity, with all-terrain vehicle noise having the most negative effects [68].

Mediterranean mouflon (*Ovis* sp.) also shifts their circadian activity by becoming active nocturnal foragers, but only when tourism pressure is high [69]. In brown bear (*Ursus arctos*) not habituated to humans, a shift in activity patterns has been detected; unhabituated bears become almost exclusively nocturnal [70]. Interestingly, those habituated to humans do not shift their activity, allowing them to maximize foraging opportunities [70].

Similarly to activity, vigilance levels are affected by human presence. Animals look up both to monitor both members of their own species and to look for potential predators. Thus, changes in vigilance behavior can have negative consequences. By studying the behavior of Gentoo penguins (*Pygoscelis papua*) on Subantarctic Macquarie Island, researchers found that vigilance levels were lower in less disturbed areas [71]. As a result, frequently disturbed animals may be more vulnerable to predation [43] or poaching [70, 72]. A change in vigilance and activity patterns was also seen in samango monkeys (*Cercopithecus mitis erythrarcus*) that spend more time foraging near ground level when humans were present than in the absence of visitors, suggesting an artificially created human refuge where the monkeys "feel" safer around humans [73].

Overall, the modification of activity budgets strongly depends on visitor numbers. In some primates, the threshold number of tourists triggering a change in activity was 15 [74], while no differences are detected when only a few visitors (researchers in this case) are present [74, 75]. In Gentoo penguins, the time spent resting was similar on and off a research station although the number of people present was greater inside than outside the station [71]. In comparison, higher frequencies of visitation can lead to decreased resting behavior in marine mammals [76]. Time spent resting also decreased in elk, when both biking and hiking disturbances were intense [68]. These changes in behavior are usually reported when humans are noisy and are a source of disturbance. However, habituation to humans might reduce these effects, as observed in bears [70]. This habituation may be speeded up by providing food. However, provisioning can have negative consequences.

2.3.3 Behavioral Responses to Provisioning

Provisioning animals is commonly used to make them more easily observable, ultimately increasing their tameness [44]. This practice is often accompanied by behavioral changes in activity and aggressiveness. Activity budgets of bottlenose dolphin calves are indirectly impacted by the provisioning of their mother [77]. Calves born from provisioned mothers spend significantly more time foraging and less time resting than calves from non-provisioned mothers. The authors proposed that it could result from lower milk intake, reduced foraging abilities, or increased energy expenditures during the journey to reach the provisioning site.

In most provisioned sharks studied to date (tiger shark *Galeocerdo cuvier*, bull shark *Carcharhinus leucas*, and nurse shark *Ginglymostoma cirratum*), provisioning appeared to have only minimal effects on long movements, such as migration [77]. Indeed, for tiger sharks [74] and bull sharks [75], the time spent in tourist areas does not significantly differ from time spent in other areas. Both species engage in long-range movements to forage and reproduce, and both species visit reef regardless of feeding occurrence. However, other shark species that do not perform such large-scale migrations might instead become more sedentary due to provisioning [78]. There is an increase in daytime activity when tourism operators are diurnally present in fed whitetip reef sharks (*Triaenodon obesus*) that are, otherwise, nocturnally active [79]. Feeding has similar effects on other aquatic species (Fig. 2.2; see also Chap. 5). Some damselfish (e.g., *Chromis chromis*) reduce their home range when artificially fed by humans [80, 81]. In terrestrial animals such as African elephants (*Loxodonta africana*), the installation of artificial water points for conservation purposes allows ecotourists to observe large elephant aggregations, but it also modifies migration patterns and the location of resting places [82]. This appeared to have cascading effects on the vegetation, since elephants selected new places to rest and foraged on endemic plant species [82]. Artificial water holes also have consequences on sexual selection. For instance, female springbok preferentially (*Antidorcas marsupialis*) aggregate around novel water resources such as only strong males surround these artificially created areas [83].

Providing food to animals has been shown to increase aggressiveness and modify social structure in a variety of species [84, 85]. For example, pink river dolphins (*Inia geoffrensis*) become more aggressive when food is provisioned [86]. Aggression between conspecifics also occurred when food was delivered ad libitum

Fig. 2.2 A tourist guide provisioning different fish species with corn, to satisfy snorkelers in a tributary river of Rio Cuiabá, Mato Grosso, Brazil. Photo credit Benjamin Geffroy

to southern stingrays. This was probably linked to overcrowding in a normally solitary species [87]. At the interspecific level, artificial aggregations at feeding practices were shown to lead to an increase in bites and chases between eagle rays (*Myliobatis australis*) and some stingrays [88]. This food provisioning attracts bolder animals [44, 87, 89] that may (un)intentionally target humans as potential prey or competitors. Not surprisingly, feeding operators delivering food to sharks have an increased risk of bite injuries [90].

Similar to pets receiving food every day at the same hour, provisioned wild animals associate humans with food. Some rays and sharks learn quickly to anticipate a food reward and arrive early and wait for food to be provisioned [78]. Changes in behavior associated with shark feeding have also been observed in whale sharks that progressively display vertical feeding behavior below tourist boats. These continuous contacts with humans lead to the progressive conditioning of animals to expect food from humans [91]. Food conditioning is also the main hypothesis explaining the presence of bears around human settlements [92]. Nevertheless, these are only proximate mechanisms, since food conditioning implies that a given bear was previously exposed to an accessible food source from anthropogenic origin. More generally, an individual's social status may also explain which bears will become associated with humans. Subadult and females with offspring will tend to avoid large dominant males by using areas surrounding humans as refuges [92]. Variation in personality also may help explain the differential distribution of bears [92] and other species (see Chap. 4). This has been shown in sharks, where some individuals are highly sedentary when food is provided, whereas others are less affected by provisioning practices [78]. Such individual variability is also observed for learning capacities [85], probably as a result of differences in personality traits.

2.3.4 Animal Personality

The recognition that individuals vary in consistent ways has generated considerable research interest [93, 94]. Statistically, individuality or "personality" is seen when the within-individual variation is less than the between-individual variation [93]. For example, a bold individual will remain relatively bold across different contexts and throughout time. Boldness, exploration, aggressiveness, and sociability/gregariousness are among the best studied personality traits [95, 96]. The response of a community to nonthreatening human exposure will differ according to the species and the type of disturbance but will furthermore depend on the degree of a species' personality types.

Current research often does not distinguish between whether individuals are tolerant toward humans due to individual habituation or because shyer individuals moved away from frequently disturbed areas [97]. It is quite likely that prolonged contact with humans would affect the composition of personality types in a population, selecting for either bolder or shyer individuals [43]. Changing personality types may have long-term consequences since different personality types vary in their reproductive success. For instance, bold and aggressive male zebra fish fertilize a greater number/proportion of eggs than shy fish [98]. Overall, it has been shown in a meta-analysis (including different taxa) that bolder individuals had higher reproductive success than shy individuals [99]. However, bold and aggressive individuals only do well under stable environmental conditions. When the situation becomes more challenging, it is often the shyer ones that are better able to adapt and find a way to survive, whereas bold individuals suffer higher mortality [99]. In the face of current rapid environmental change, it is essential to maintain diverse personalities to enhance adaptive capabilities of wild populations. Favoring one type of personality (e.g., bold over shy), either intentionally or unintentionally, will be risky for the long-term sustainability of populations exposed to ecotourism and thus the industry itself.

Conclusions

In this chapter, we have shown how interactions with humans can systematically change the physiology and behavior of wildlife species. While some changes are transient, others may have long-term consequences. It is essential to realize that these effects are highly dependent on the species, the animal's life stage, the frequency and duration of visits, as well as the degree of human-wildlife interaction (Fig. 2.3). Hence, the "tipping point" where an animal will

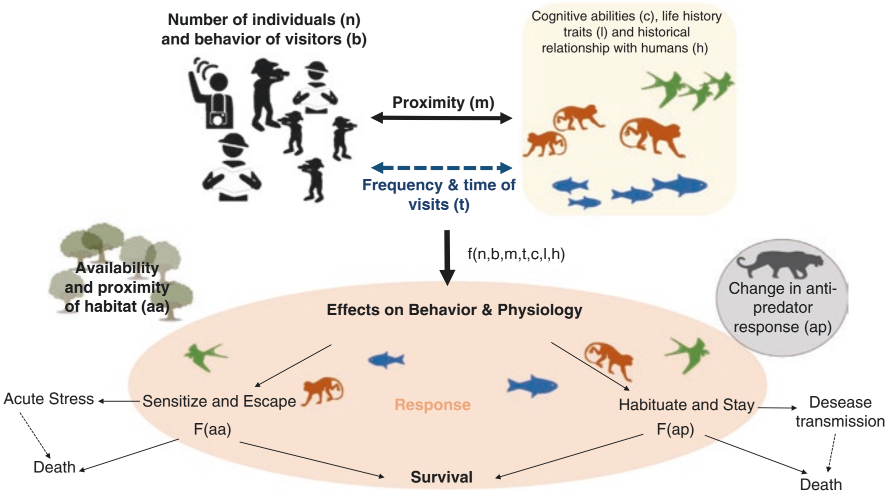

Fig. 2.3 Human visitation can change the behavior and physiology of wildlife leading to sensitization or habituation. The impact of human visitation on wildlife is a function "f" of the number of humans; the proximity to the observed animals; the timing, frequency, and duration of the visits; and the escape capacity and behavior of the animals. Full arrows indicate very likely situations, while dashed arrows indicate possible outcomes. "F" relates to the *function*, such as effects on behavior and physiology are modulated as a function of the intensity of the different variables identified (*n*, *b*, *m*, *t*, *c*, *l*, *h*). Infographic developed by Benjamin Geffroy, Bastien Sadoul, and Ursula Ellenberg

suddenly change its physiological/behavioral state is difficult to estimate, even within a species. However, our global analysis reveals that, overall, when human visitation is an intermittent or rare event, an encounter with a visitor leads to physiological responses similar to those observed when facing an acute stressor, such as the presence of a predator. However, if visitor numbers reach a certain threshold, it can either lead to a state of chronic stress, with deleterious consequences for individual fitness, or to habituation of exposed individuals that results in a decreased stress response over time. However, increasing habituation to humans could have long-term negative effects if translated into higher tolerance around genuine predators [43]. The paucity of information on the effect of ecotourism on animal personality is a call for more research on individual responses. Although nature-based tourism undoubtedly has positive socioeconomic effects for some people, accumulating pressures of frequent visitation needs to be considered and managed carefully. It is essential, for both ecological and economical sustainability, to avoid or reduce any negative human impacts.

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Ecological Consequences of Ecotourism for Wildlife Populations and Communities

3

Graeme Shannon, Courtney L. Larson, Sarah E. Reed, Kevin R. Crooks, and Lisa M. Angeloni

Fig. 3.0 African elephants (*Loxodonta africana*), Amboseli National Park, Kenya. Photo credit Graeme Shannon

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3.1 Introduction

The individual ecotourist will probably only spend a comparatively short amount of time visiting a particular natural area, refuge, game reserve, or national park, with even less time in close proximity to wildlife. The temporary nature of these visits coupled with the spatial extent and apparent pristine environment of many natural areas can make it difficult to appreciate that tourism alone can drive discernible impacts on resident wildlife populations, particularly when these impacts are compared with seemingly more pressing threats such as habitat fragmentation, climate change, and illegal hunting. Indeed, ecotourism is based on the premise that the visitor values the chance to explore the natural world, to gain an appreciation and understanding of diverse habitats and native species, while also lending financial and political support for their continued protection [1]. Ecotourism is therefore commonly viewed as highly compatible with conservation objectives, and indeed it contributes a number of important benefits, including revenue generation, support for conservation, and educational opportunities for visitors and local communities [1].

Nevertheless, there is increasing evidence that human visitation to natural areas can have significant effects on the environment and the wildlife therein, especially when we consider the scale of visitation. A recent study estimated that globally, terrestrial protected areas receive eight billion visits per annum and generate approximately US$ 600 billion for local economies [2]. Visitation can also be highly concentrated; the busiest national park in the USA (Great Smoky Mountains National Park) attracts more than ten million visitors per year. This represents a significant source of potential disturbance to native wildlife, particularly as a result of the impacts associated with providing tourist infrastructure and access for large numbers of people to experience natural areas firsthand (e.g., extensive road networks).

Chapter 2 has highlighted a number of pathways by which the behavior and physiology of wild animals can be altered by the presence of humans. Though

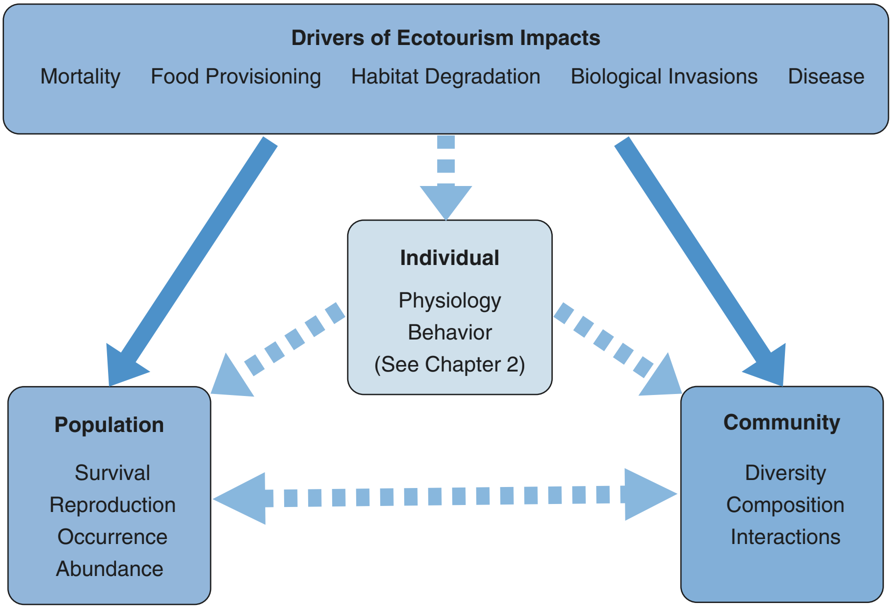

Fig. 3.1 A conceptual model demonstrating the drivers of ecotourism impacts and the effects that these can have at the individual, population, and community level. The solid arrows indicate how populations and communities can be directly affected by ecotourism, while the dashed lines represent indirect effects via changes in physiology and behavior (see Chap. 2), and interactions between the population and community levels

these shifts in behavior are often measured at comparatively short temporal scales, they may also have long-term effects with consequences for wildlife populations and entire ecological communities (see the conceptual diagram in Fig. 3.1 and a glossary of terms in Text Box 3.1). For example, the displacement of a red deer (*Cervus elaphus*) from a grazing site by hikers [3] may seem like a minimal impact if it is assumed that the animal will return to its natural behavior once the disturbance has passed. However, this brief disturbance may have long-term consequences if it occurs frequently, reducing the amount of time the animal spends foraging for important nutritional resources, or if the animal avoids the area, reducing the habitat available to the red deer population. Indeed, exploring these impacts over longer periods and broader scales can be challenging due to the multitude of interacting factors that dictate the reproductive success and survival of individual animals. However, there is a growing body of scientific literature on the effects of ecotourism on wildlife, which is beginning to reveal that behavioral shifts can accumulate over time and have the potential to adversely impact animal populations in the long term.

Box 3.1: Glossary of key terms in the conceptual model

Drivers of Ecotourism Impacts

Mortality: death of an individual animal as a result of ecotourist activity

- Examples: vehicle collisions; trampling; intentional killing of dangerous animals or pests

Food Provisioning: providing food to wildlife as a result of ecotourist activity

- Examples: attracting charismatic animals for viewing (e.g., bears, sharks); unintentional feeding (e.g., garbage)

Habitat Degradation: reduction of the amount and quality of wildlife habitat as a result of ecotourist activity

- Examples: use of limited resources (e.g., water); construction of infrastructure; fragmentation of habitat; human waste and litter; chemical, light, and noise pollution

Biological Invasions: introduction of non-native species as a result of ecotourist activity

- Examples: introduced weeds, domestic animals (e.g., cats, dogs), other animals (e.g., zebra mussels)

Disease: introduction of diseases via ecotourist activity that may infect native plants and animals

- Examples: primates, coral, sudden oak death

Population: a group of organisms in the same species in a given locality

Survival: the probability of survival of an individual animal, a critical determinant of population dynamics

- Examples: mortality; survival rate

Reproduction: the probability of having offspring, a critical determinant of population dynamics

- Examples: mating success; nest success; number of offspring produced

Occurrence: the probability that an animal will occupy a given area

- Examples: geographic range; population distribution; habitat use

Abundance: the number of animals in a population

- Examples: population size (number of individuals); population density (number of individuals per unit area)

Community: assemblage of interacting species in the same locality
Diversity: the number of species in a given area

- Examples: species richness (number of species); species diversity (number and relative abundance of species)

Composition: the identity of species in an ecological community

- Example: catalogue of species

Interactions: interactions between species

- Examples: predator-prey interactions; competition between species; food web dynamics

A recent systematic review documented 274 scientific papers published between 1981 and 2015 on the effects of recreational activities (including ecotourism) on wildlife. Fifty-two percent of the results reported from these studies focused at the individual level in terms of behavior and physiology [4], whereas 48% of the results focused on effects at the population (e.g., survival, reproduction, occurrence, and abundance) and community level (e.g., species diversity, composition, and interactions, Fig. 3.2a). Of these studies investigating the population- and community-level effects of recreation, 35% detected negative effects (i.e., decreased species diversity, survival, reproduction, occurrence, or abundance), while only 6% found positive effects; 59% found no effect or unclear effects (Fig. 3.2b). More than 68% of these studies were conducted in Europe and North America, while South America, Asia, and Africa accounted for only 20%. Birds and mammals represented almost 80% of the research effort, with the majority of work conducted in terrestrial environments (71%). The growing interest in the effects of ecotourism on wildlife, including the ecological effects at the population and community levels, is also highlighted by a number of other recent reviews [5–8].

In this chapter we will delve further into the larger-scale and longer-term ecological effects that can be driven by human visitation. We focus on how human presence itself can have behavioral and physiological impacts (reviewed in Chap. 2) that scale up to affect wildlife population dynamics and community structure. We

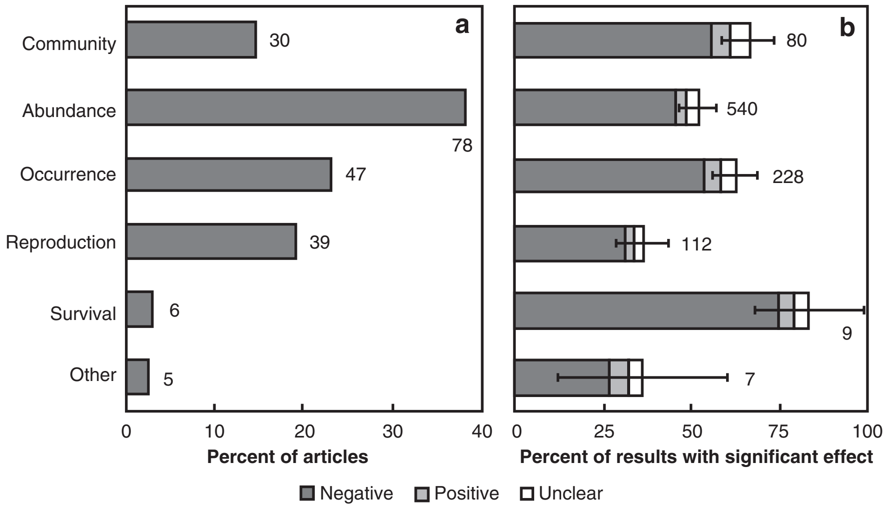

Fig. 3.2 (**a**) The number of scientific papers exploring population and community-level effects of recreation (including ecotourism) on wildlife from 1981 to 2015 [4]; the number of articles is given next to the bars and (**b**) the percentage of results from these studies that indicated a significant effect (the number of results is given next to the bars). Error bars show standard error for the sum of all effects. Unclear responses are those that were unable to be classified as positive or negative effects of recreation (e.g., a change in species dominance index) or results with nonlinear responses (e.g., highest reproductive success at an intermediate level of human recreation)

also explore several impacts of ecotourism, including mortality, food provisioning, habitat degradation, introduction of non-native species, and transmission of disease (Figs. 3.1 and 3.3, Text Box 3.1). A greater understanding and appreciation for how visitation and human activity can affect wildlife will help managers to identify areas of conflict and mitigate potential impacts, while still providing access for visitors.

3.2 Scaling Up the Behavioral and Physiological Effects of Human Presence

In Chap. 2, Geffroy et al. outlined a number of key behavioral and physiological responses of wildlife to the presence of ecotourists. These behavioral and physiological effects can, in turn, influence population and community level metrics through their effects on reproductive success, survival, abundance, species diversity, and the interactions among species.

Research on cetaceans offers some of the best evidence for the scaling up of short-term behavioral impacts of ecotourism to longer-term population level effects. Watching marine mammals has been one of the most successful sectors of the ecotourism industry over recent decades, with an estimated US$ 2.1 billion of income generated in 2008 by tour operators across 119 countries ([9]; and see Chap. 6). While there is no doubt that many cetaceans are faring better since the ban on commercial whaling in 1986 and the shift toward nonconsumptive use, there is growing

Fig. 3.3 Impacts on wildlife associated with ecotourism that can result in population and community-level effects: (**a**) long-term behavioral shifts driven by human presence that may include avoidance or increased vigilance (photo credit Graeme Shannon); (**b**) direct mortality, for example, as a result of vehicle strike (photo credit fishermansdaughter CC BY); (**c**) food provisioning, which is particularly popular for attracting top predators such as sharks (photo credit Joi Ito, CC BY); (**d**) habitat degradation associated with tourist infrastructure and access to protected areas (photo credit Grand Canyon National Park, CC BY); (**e**) biological invasion of non-native species, such as the zebra mussel (photo credit Tom Britt, CC BY), (**d**); (**f**) transmission of human diseases to vulnerable populations, including the mountain gorillas of central Africa (photo credit Henrik Palm, CC BY)

concern about the potential impacts of whale watching [10]. Research on dolphins in Shark Bay, Australia and Fjordland, New Zealand have demonstrated that repeated visitation causes not only short-term shifts in behavior but also long-term changes in social structure and a decline in local abundance [11, 12].

Behavioral avoidance of recreationists that translates to changes in population distribution and abundance has also been documented for many bird species [5]. Winter recreational activities drive significant impacts on population abundance and species diversity in sensitive alpine species [13]. For example, black grouse (*Tetrao tetrix*) in the Swiss Alps experienced a 12% reduction in available wintering habitat and a 36% decline in abundance as a result of activity associated with winter recreation [14, 15]. Nesting shorebirds and seabirds are also particularly vulnerable to disturbance by human tourist activity in coastal areas with effects on their distribution, particularly for species that nest on the ground in the open. However, even nocturnal storm petrels (*Hydrobates pelagicus*) that nest out of sight in cavities experienced higher nestling mortality with greater visitation, implying that noise and odors associated with human presence may drive population-level responses [16]. Likewise, juvenile hoatzin (*Opisthocomus hoazin*) in the Amazonian rainforest exposed to tourists experienced significantly altered stress responses and lower survival compared to those on undisturbed nests, even though adults appeared tolerant of ecotourists [17]. Tourist presence was linked to reduced body mass, a key indicator of survival in fledgling yellow-eyed penguins (*Megadyptes antipodes*) in New Zealand [18]. However, it is important to highlight that human presence does not always impact distribution and abundance, even for shorebirds such as the black-tailed godwit (*Limosa limosa*) that are thought to be easily disturbed [19].

It is well known that the decline of top predators can have cascading effects on lower trophic levels [20]. Similarly, the disproportionate effects of ecotourists on a particular species may impact other taxa in the ecological community. In some cases, disturbance-sensitive predators may simply avoid areas with human activity, thereby creating what is known as a predator shelter or human shield for prey species [21, 22]. This pattern has been seen in large herbivores in Yellowstone and Grand Teton National Parks, where moose (*Alces alces*) selected calving sites close to paved roads [23], while elk (*Cervus canadensis*) and pronghorn (*Antilocapra americana*) behaved as though they perceived reduced predation risk near a major road [24]. Indeed, comparatively benign activities (e.g., cycling, hiking) in prime habitat may well tip the balance in favor of the more tolerant herbivore species, while driving the displacement of predators that require extensive ranges and are often already compromised by habitat fragmentation [21, 22].

In addition to providing a potential predator shelter for prey species, a recent paper suggests that the habituation (or reduced responsiveness over time) of prey to human activity may lead to reduced responses to predators, causing increased boldness, decreased vigilance (or watchfulness), and greater vulnerability to predators over time [25]. Although there has been only limited empirical exploration of this hypothesis, urban foxes (*Vulpes vulpes*), blackbirds (*Turdus merula*), and pigeons (*Columba livia*) that were habituated to humans were less responsive to predators [26–28]. Ultimately, this greater susceptibility to predators (and also human hunters) could impact individual reproduction, survival, population dynamics, and community structure. Indeed, a study on captive-bred swift foxes (*Vulpes velox*) demonstrated that bold behavior was a good predictor of mortality after release into the wild [29].

Though the presence of ecotourists can negatively affect disturbance-sensitive predators, these predator shelters can have a positive effect on the survival of endangered prey species. For example, the presence of tourists on beaches benefits hawksbill sea turtles (*Eretmochelys imbricata*) in the Caribbean by reducing the activity of introduced mongooses that predate on hatchlings [30]. Thus, the challenge is to identify the optimal level of beach use that maximizes turtle survival, while avoiding negative disturbance to this critical habitat. Interestingly, the benefits of human presence can also extend to large predators, such as grizzly bears (*Ursus arctos horribilis*) that are generally considered sensitive to human disturbance. The presence of tourists increased the feeding of female bears and cubs on salmon by displacing aggressive males that tend to dominate the best feeding sites [31]. This sex difference in tolerance of human activity results in important nutritional benefits for the survival of female bears and their young in hibernation.

The presence of humans can also benefit some wildlife populations and their habitat by deterring illegal hunting/harvesting and logging [32]. Sea turtles, in particular, have benefitted from ecotourism, which has enabled greater offspring survival because of the presence of humans, intent on viewing, and protecting turtles. However, the role of ecotourism and the presence of humans have been shown to play only a secondary role in the successful protection of threatened great apes, which rely on effective law enforcement first and foremost [33].

3.3 Mortality

The death of an individual animal as a result of tourist activity is perhaps the most direct way human visitation can negatively impact wildlife populations. Though definitions of ecotourism generally exclude forms of consumptive recreation, such as hunting and fishing [1], inadvertent killing of animals has the potential to be severely detrimental to populations of rare species. One of the most common methods by which animals are killed by tourists is through vehicle collision. For example, the upgrading of a road entering the Cradle Mountain—Lake St Clair National Park in Tasmania led to a dramatic rise in the numbers of eastern quoll (*Dasyurus viverrinus*) and Tasmanian devils (*Sarcophilus harrisii*) killed by cars. In fact, the quoll population became locally extinct and had to be reintroduced following successful efforts to reduce vehicle collisions [34]. Meanwhile, the mortality of nocturnal birds such as nightjars and spotted eagle owls (*Bubo africanus*) due to vehicles traveling at night through Kruger National Park in South Africa has been of concern for a number of decades [35].

In many coastal marine habitats, a rapid increase in the numbers of recreational boats has resulted in greater numbers of animals injured or killed by boat strikes [36]. Sea turtles and dugongs (*Dugong dugon*) appear to be particularly vulnerable due to their comparatively slow movement and preference for swimming close to the surface [37]. Legislation and awareness campaigns can be successful in reducing wildlife-vehicle collisions [38], but the effectiveness of these approaches outside of protected areas is less clear, particularly given the challenge of enforcement.

Apart from vehicle collisions, direct trampling can also inadvertently lead to animals being killed. There is strong evidence to suggest that the disturbance associated with ecotourism on beaches, which provide key habitat for nesting bird species, can result in reduced survival of young, particularly as a result of mortality due to trampling [39]. In addition, studies have also shown that tourists walking in the intertidal zone can drive significant declines in mussels and barnacles, while delicate corals on tropical shores can be even more vulnerable, suffering major damage as a result of trampling [37].

There are also cases of deliberate killing of wildlife connected to ecotourism. Such incidents generally occur around hotels and resorts and concern the presence of potentially dangerous animals, such as venomous snakes or mosquitos [40]. However, the widespread use of pesticides can have a negative impact on the populations of nontarget species, including popular taxa such as butterflies that ecotourists are keen to observe [40]. Finally, the habituation of animals to ecotourist activities can result in animals becoming vulnerable to persecution from other non-tourists that consider the animals either a nuisance or a highly prized resource. For example, fishermen in a number of countries were reported to have killed dolphins that learned to associate with humans and ultimately became a tourist attraction [41]. Similarly, there is evidence that primates habituated for tourist viewing are at greater risk from poaching than non-habituated individuals [42, 43].

3.4 Consequences of Food Provisioning

Attracting charismatic species, such as large carnivores, for ecotourists to view at relatively close quarters is a popular and highly lucrative industry. For example, nightly bear shows at the garbage dumps in Yellowstone National Park were very popular with tourists during the early twentieth century. Indeed, the grizzly bear population in Yellowstone declined significantly after the closure of these dumps in 1970 and 1971 [44], while a number of habituated animals reportedly moved into campgrounds and tourist areas, increasing the risk of human-bear conflicts. Food provisioning is still used occasionally for tourists to observe black bears (*Ursus americanus*) in North America [45] but remains controversial due to the potential impacts on the target species and possible risks for tourists seeking close encounters with dangerous animals. A black bear feeding station in Quebec, Canada, altered the long-term movement, habitat selection, and densities of animals, which could result in greater human-bear conflict [45]. Elevated densities of animals due to food provisioning can also have implications for the transmission of disease, such as tuberculosis in white-tailed deer (*Odocoileus virginianus*) [46]. At tourist-fed sites, southern stingrays (*Dasyatis americana*), usually solitary foragers, had artificially high densities and experienced greater parasitism, lower body condition, and more injuries, potentially impacting survival and reproductive success in the long term [47].

Although active food provisioning of large mammals in natural areas is now less common and often discouraged (although see [42]), the situation is quite different in marine habitats. Shark diving, for example, has become particularly popular over the past few decades, generating hundreds of millions of dollars in revenue every year [48]. Cage diving operations can alter the long-term use of specific sites by great white sharks (*Carcharodon carcharias*), which may alter predator-prey dynamics [49], while also potentially increasing the chance of divers, beachgoers, and swimmers being attacked [50].

Food provisioning can also occur in an uncontrolled or unintentional manner, when for example, ecotourists feed wild animals directly (e.g., primates [50, 51]) or when waste is disposed of inadequately [44]. Animals can become reliant on this readily available resource, such that they no longer search for their own food, which can have population consequences (e.g., as seen with the decline in Yellowstone's grizzly bears once the food source was removed; [44]). The health of Barbary macaques (*Macaca sylvanus*) fed by tourists was negatively impacted in the long term [51], while the unregulated feeding of sea lions (*Zalophus californianus*) at haul-out sites in the USA has led to a number of attacks on tourists, likely driven by an increase in boldness and aggression at the population level [50].

While the majority of the literature focuses on the negative aspects of food provisioning, it is important to note that there have been a number of positive examples, in terms of benefits to the species and conservation more generally. A recent review outlined the conservation benefits associated with the popularity of shark diving [48]. Supplemental feeding has also been successfully used to promote the recovery of the endangered Mauritius kestrel (*Falco punctatus*) [52] and dwindling vulture populations that benefitted from widely used "vulture restaurants" [53]. Nevertheless, there can be unintended consequences of supplemental feeding that have the potential to alter population and community dynamics through increased competition (e.g., the endangered blackbuck *Antilope cervicapra* was negatively impacted as a result of elevated densities of other herbivore species after provisioning), altering predator-prey relationships (e.g., sharks were attracted to food leading to greater number of attacks on dolphins) and advancing the timing of reproduction (e.g., a range of fed-bird species laid their eggs earlier) [50].

3.5 Habitat Degradation

Although one of the goals of ecotourism is to protect natural habitat, there are a range of environmental costs associated with providing large numbers of visitors with access to natural areas, which include the use of limited resources (e.g., water), construction of infrastructure, fragmentation of habitat, human waste and litter, and chemical, light, and noise pollution. All of these can reduce habitat quality, with negative impacts on wildlife, especially in close proximity to tourist infrastructure. Indeed, habitat loss and degradation has been identified as the primary threat to biological diversity worldwide [54].

Successful ecotourism efforts draw high numbers of tourists that can lead to concerns over physical and chemical habitat degradation. Direct physical impacts like trampling can alter vegetative cover, leaf litter, and soil composition, thereby degrading habitat and, for some animals, destroying physical shelter from high temperature, desiccation, and predation [55]. The infrastructure associated with ecotourism, including roads, recreational trails, and resort development, is another source of physical habitat degradation, as it reduces and fragments wildlife habitat [13, 56, 57]. Indeed, in endangered urban forests in Australia, the level of fragmentation caused by recreational trails was similar to that caused by urban development itself [57]. Such habitat fragmentation is known to have negative consequences for wildlife by restricting animal movement and severing landscape connectivity, critical to the persistence of wildlife populations and a vital component of biodiversity conservation [54, 58]. Solid waste and chemical pollution in air and water also pose a serious threat to wildlife [59]. Though little is known about the relative contribution of ecotourism to these forms of pollution, it is likely relatively minor compared to urban and industrial sources of pollution [55]. That said, it is estimated that tourism (transport and activities) accounted for 5% of global anthropogenic CO_2 emissions in 2005 [60].

The infrastructure and activities associated with ecotourism also introduce light pollution into habitats, with effects on wildlife that are just beginning to be explored. Artificial light can negatively affect populations by disorienting animals (e.g., hatchling sea turtles on natal beaches), by "trapping" nocturnally migrating birds that only travel in the dark, and by reducing the reproduction of nocturnally mating animals (e.g., frogs; [61]). Some animals are repelled by light pollution thereby reducing the habitat available to them, while others are attracted to it, sometimes fatally, as documented in nocturnal seabirds [62]. Artificial lighting can also alter predator-prey relationships by increasing the foraging of diurnal animals at night, reducing the foraging of nocturnal animals, and in some cases concentrating predation in localized areas by attracting prey (e.g., moths) to light sources [61]. Lighting can also affect the vertical distribution of aquatic invertebrates in the water column, which may have ecosystem effects by increasing algal abundance and reducing water quality [61].

Noise is a form of pollution that has received increasing attention over the past two decades for its impacts on a wide range of terrestrial and aquatic wildlife [63]. Ecotourism can generate substantial amounts of noise, particularly as a consequence of vehicle use. There are also disturbances associated with subtler noise sources, such as the conversation of tourists who are in close proximity to wildlife [64] and mobile phone ringtones. Introduced anthropogenic noise can mask important sounds that animals rely on for finding mates, locating prey, avoiding predators, parent-offspring interactions, and territorial defense; it can also startle or threaten animals, distract attention away from approaching danger, and cause physiological stress. Although the most well-documented responses to noise are behavioral, several studies have also demonstrated that continued exposure can affect survival and reproduction [63]. For example, chronic road noise can lead to reduced pairing success, fewer eggs, and smaller young among birds [65–68]. Noise in prime stopover habitat reduced the ability of migratory birds to gain body condition, which is vital for survival during the next stage of their journey [69]. On the other hand, noisy conditions can improve the reproductive success of prey species, by providing a shelter from disturbance-sensitive predators, which has the potential to alter dynamics of ecological communities [70].

3.6 Biological Invasions

People visit natural areas from diverse locations, presenting a significant opportunity for non-native organisms to be transferred from one environment to another. A recent meta-analysis demonstrated that the abundance and species richness of non-native species are significantly higher in tourist areas compared with control sites, a relationship that holds for both terrestrial and aquatic habitats [71]. The majority of invasive species transferred via tourism are plants that have been moved inadvertently as seeds on belongings, shoes, or clothing. For example, Arctic species such as chickweed (*Stellaria media*) and yellow bog sedge (*Carex* sp.) were found on the clothing of tourists and researchers visiting Antarctica [72]. The zebra mussel (*Dreissena polymorpha*) is a prime example of an animal introduced as a result of ecotourism. Originally native to Russia, this species has spread rapidly through waterways in US and Western European protected areas, with recreational boating being implicated as a key vector [71]. Their voracious feeding reduces the amount of microorganisms available to other aquatic species that rely on this food source, and they attach themselves to other native mussel species (i.e., biofouling), which exacerbates susceptibility to environmental stressors and extirpation. The ease with which boats can transfer non-native species (e.g., the stalked benthic diatom *Didymosphenia geminata* in New Zealand [73]), coupled with the high visitation rates in many marine protected areas, presents a major risk to effective conservation at these sites [71].

Tourism can also indirectly lead to the introduction of non-native species through infrastructure (e.g., hotels and lodges) that is staffed by people who bring domestic animals with them, such as cats and dogs. Domestic cats are highly effective predators, and their release into the environment can have potentially catastrophic impacts on native prey species [74]. Likewise, dogs are considered a threat to biodiversity by directly killing, transmitting disease to, and outcompeting native wildlife [75]. Although the role of ecotourism in the spread of domestic animals is small compared to the number of free-ranging cats and dogs living in local communities, it can exacerbate the problem and increase exposure of wildlife to non-native species within natural areas.

3.7 Disease

Just as ecotourists can present a major route for the introduction of non-native species, they can also serve as vectors of potentially deadly microorganisms and parasites. The desire for interactions with wild primates has generated a profitable ecotourism industry, which many believe is crucial in securing funding for conservation efforts and protection for primates from poaching. Nonetheless, these benefits must be balanced against the increased risk of disease transmission that could have catastrophic impacts on remaining wild populations when primates are in close proximity to humans [76]. Humans are direct vectors for a number of diseases that can be harmful to wildlife, particularly primates, which are susceptible to similar diseases because they are closely related in evolutionary terms. There is now considerable evidence to suggest that a range of respiratory diseases (e.g., influenza, common cold, pneumonia), measles, and stomach parasites have been transmitted from humans to chimpanzees (*Pan troglodytes*) and gorillas (*Gorilla gorilla*) on multiple occasions, particularly affecting individuals that are habituated to human presence [76, 77]. For example, the Taï chimpanzee research project in Ivory Coast experienced five distinct outbreaks of human respiratory diseases over a period of 7 years with mortality rates of the affected groups reaching 19% [77]. Strict hygiene protocols and vaccination requirements must be enforced to reduce the risk of disease transmission, while field methods are urgently required to treat and vaccinate wild apes [77].

Outside of primates, there has been limited research on the spread of disease from tourists to wildlife. A study conducted in Thailand demonstrated that coral species exhibit elevated levels of disease near highly used dive sites, likely because tourism drives stressors, such as increased sediment, nutrient enrichment, and physical damage that increase the incidence of coral disease [78]. Additionally, the dramatic rise in human visitation to Antarctica has been identified as a potential threat to penguins, because limited previous exposure to pathogens due to geographical isolation and the extreme climatic conditions of the Antarctic have likely made penguin species immunologically naïve to diseases such as influenza and salmonella [79]. Evidence from zoos supports this, with captive penguins being highly susceptible to a number of infections. Thus, ecotourism combined with other stressors, like a changing climate and increased pollution, may further exacerbate the vulnerability of penguins to a potential disease outbreak.

Given that rare and endangered species are often confined to protected areas and exist in comparatively small, isolated populations, the threat of disease to their long-term existence is very real. Ecotourists may also inadvertently introduce a deadly pathogen indirectly on boots or clothing. In such cases, bacteria or viruses released into an environment where there is no natural resistance can quickly spread through naïve populations. For example, heavily used trails in central California had much higher numbers of *Phytophthora ramorum*—a pathogen that causes sudden oak death—in the soil compared with areas that were off the trail, suggesting that the dispersal of the pathogen was driven by human activity [80].

Conclusions

We have outlined how ecotourism and associated activities can have a variety of ecological consequences for wildlife. In summary, there is substantial evidence to indicate that ecotourism is not a benign activity with negligible disturbance but can in fact have major implications for the reproductive success, survival, and long-term viability of a number of populations of species, particularly those that are rare, geographically isolated, and/or sensitive to disturbance. These impacts are driven by the indirect effects of human presence on the abundance, distribution, reproductive success and survival of species that are disturbance sensitive. Visitors can also have direct effects, which include causing mortality, providing artificial food resources to encourage sightings of elusive species, contributing to habitat degradation and fragmentation, introducing non-native species, and being vectors for disease. Ultimately, this can have far-reaching impacts across the ecosystem, generating cascades that ripple throughout the food web. Despite the potential impacts we have reviewed, tourism remains a key source of revenue for conservation and provides important experiences for people to become advocates for wildlife, while educating them about threats to biodiversity. There is no doubt that tourism can be a vital tool in successful conversation, but the potential negative impacts associated with human presence need to be understood and managed sustainably in concert with the myriad of other factors that threaten the long-term persistence of wildlife.

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Transgenerational Consequences of Human Visitation

4

Anders Pape Møller

Fig. 4.0 Ecotourist at hippo (*Hippopotamus amphibius*) pool, Laikipia District, Kenya. Photo credit Daniel T. Blumstein

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4.1 Introduction

Nature is rapidly changing as a consequence of human exploitation of natural resources, occupation of increasingly large areas for farming, industrial-scale forestry, and the huge worldwide fisheries industry, and the construction and growth of cities. Furthermore, humans reach even the most remote parts of the world in their quest for distant tourist attractions that include rare and pristine habitats that provide novel experiences for visitors. Ecotourism, defined as tourism specifically associated with natural resources, constitutes one such important source of change in how we exploit natural resources. Ecotourism has potentially profound consequences for the behavior of animals.

While ecotourism may benefit local communities economically, it may also have significant costs for such communities [1] and for the wild animals that are the focus of ecotourism [1]. The proximity of humans and their domesticated animals imposes strong natural selection on the behavior of wild organisms because some behaviors and some species are able to adapt to human exposure while others do not. Thus, animals in anthropogenically impacted habitats have only three options: adapt to human proximity, disperse to suitable areas away from humans (if available and suitable), or perish (e.g., [2, 3]). Numerous rare and undisturbed animal and plant populations on even the most remote islands around the world have gone extinct during the last century due to the presence of humans and their domesticated followers, such as dogs, cats, goats, and pigs, and also from the impact of wild species such as mice, rats, and numerous others (e.g., [4]).

In this chapter, I review the scarce and scattered literature dealing with changes in animal behavior across generations as a result of human contact, as well as critically assess the relative importance of their potentially underlying mechanisms.

4.2 Changes in Animal Behavior as a Result of Human Proximity

Animals have repeatedly been shown to change their behavior in response to humans. Human proximity may result in reduced fear responses because animals experience reduced risks of predation around humans (e.g., [5, 6]). A classic example is the tameness of animals in urban environments, where individuals often stay put rather than fleeing when a human approaches them, which is the opposite of the ancestral behavior in natural or rural habitats [6]. Bird species that are the target of ecotourist activity or species that occur in areas frequented by tourists likewise show reduced flight-initiation distance (which is the distance at which animals flee when approached by a human) and flee shorter distances when disturbed [7–10] (but see also [11]) and reduced vigilance [12] (Fig. 4.1).

Numerous animals are adapted to human-impacted environments, but FID still varies with cost of fleeing related to food supply, and human-induced climate change affects perching behavior. Here I review such factors showing effects of humans on behavior thereby indirectly suggesting effects of ecotourism on behavior. In other

Fig. 4.1 Tolerant Galápagos sea lion (*Zalophus wollebaeki*) resting on a bench near the main public pier, Isabela Island. Photo credit Daniel T. Blumstein

words, this provides a review of the underlying mechanisms and thus the evidence for effects of human contact, including ecotourism, on animal behavior (see also Chap. 2). A classic example has to do with barn swallows (*Hirundo rustica*), one of a number of species that have adapted to human proximity and now almost exclusively breed in association with humans and their habitation. Hence, it is surprising when such species still show dramatic changes in behavior across just a few generations. Barn swallows in a Danish breeding population showed a dramatic increase in flight-initiation distance from a mean of 5.1 m in 1984 to a mean of 15.9 m in 2013 [13]. This change was positively linked to increased spring temperatures that produced an earlier and larger peak in insect food availability.

Rapid changes should be generally expected. For instance, another example of rapid change in behavior across generations is a study of positions in the vegetation used by birds for singing. I investigated the position in the vegetation where a community of breeding birds was singing in 1986–1989 and again in 2010 [14], some 20 years after initial effects of climate warming. The choice of sites where animals display constitutes a compromise between transfer efficiency of the display to recipients and the costs of display in terms of exposure to predators. Singing birds' songs are best transmitted when they sing high up on exposed perches, the same position that may increase their vulnerability to predation. The change in where birds sang followed a period of climate change during which temperatures in spring increased on average by 20% and precipitation had increased by 30%. Song post height chosen by singing male birds increased in species that had increasing population trends showing an effect of higher population density on the height at which males of different bird species sing [14]. There were additional effects of habitat and intensity of sexual selection on song post height in this study [14].

There are also examples of changes in fear response across generations. For example, large mammals within the Chernobyl Exclusion Zone have increased in abundance since 1986, when humans evacuated this large area due to radioactive contamination [15]. However, the behavior of animals has also changed. For example, two bird species, great tits (*Parus major*) and blackbirds (*Turdus merula*), showed reduced flight-initiation distance at sites in the Chernobyl Exclusion Zone with higher levels of radioactive contamination during the last 30 years [16]. In great tits, flight-initiation distance decreased from a mean estimate of 16.5 m to 2.2 m across a radiation gradient. Flight-initiation distance of blackbirds in the same area changed on average from 18.1 m to 1.4 m across the radiation gradient during the same period [16]. These examples provide evidence of rapidly changing antipredator behavior when the selective pressure changes.

4.3 Mechanisms of Transgenerational Change in Behavior

Four possible mechanisms can explain why some animals are able to live in close proximity to humans, while others are not: microevolutionary changes, epigenetic changes, habituation, and phenotypic sorting (Table 4.1; [5]). I will define each below and note that while these theoretical alternatives are all viable possibilities, there are few documented cases that permit us to discriminate among them.

4.3.1 Microevolutionary Changes in Behavior

Microevolutionary change is a modification in the genes responsible for a given behavioral or physiological trait (Table 4.1). Microevolutionary change in behavior implies directional selection on individuals with a specific allele (i.e., the variant located at a specific gene that expresses a specific behavior) with superior survival or reproduction and heritability (for which there is empirical evidence [13]), which results in a change in behavior over time due to the increase in frequency of specific genes conferring these advantages [13].

Two examples of reduction in flight-initiation distance may be attributed to microevolutionary change. First, animals on islands have lost or greatly reduced their fear of humans after divergence from their mainland ancestors that reacted to humans by fleeing [17–20]. Second, domesticated animals have likewise reduced their fear of humans in the process of domestication because animals that became associated with humans were more likely to survive and/or reproduce successfully [17, 21, 22].

Table 4.1 Four different kinds of mechanisms underlying transgenerational changes in escape behavior and other types of antipredator behavior

Mechanism of change	Characteristics	Transgenerational change	Example	Suggestions for research
Microevolutionary change	Heritability, selection, and response to selection and temporal trends in change in antipredator behavior	Transgenerational change should be feasible but only reflect response to selection as predicted from the breeder's equation	Divergence in behavior between island and mainland populations	Selection experiments and experimental evolution experiments should change antipredator behavior in a predictable way
Epigenetic change	Change in antipredator behavior linked to structural change in DNA conformation or other change in transcription of genes (e.g., noncoding RNA)	Transgenerational change should be a consequence of change in epigenetic mechanisms	Divergence in behavior between urban and rural habitats	Experimental alteration of stress level and other factors inducing epigenetic changes should affect antipredator behavior
Habituation	Decrease in intensity of antipredator behavior as a consequence of repeated exposure to a nonlethal stimulus over time	Transgenerational change should only occur as a consequence of temporal trends in the number of repeated stimuli	Change in antipredator behavior over time	Tests for decrease in intensity of antipredator behavior of an individual following repeated exposure to stimuli
Phenotypic sorting	Nonrandom distribution of individuals based on their personality (e.g., bold and shy individuals)	Transgenerational change should only occur if the perceived risk in a given habitat changes over time	Systematic spatial differences in antipredator behavior	Experimental differences in perceived risk of different habitats should result in change in distribution of phenotypes

4.3.2 Epigenetic Changes in Behavior

Epigenetic changes are produced by modifications of genes, but these changes are not transmitted across generations in exactly the same way genes are (Table 4.1). Rather, epigenetic changes of the genome work by modifying how genes are copied by interfering with the process of DNA expression called transcription. Certain stressors, including environmental stressors, can lead to methylation (the addition of a methyl group to DNA) of specific genes, which prevents these genes from being copied [23]. In some cases, these nongenetic modifications can persist for several generations. Regardless, these epigenetically modified genes may have behavioral consequences.

A recent study showed that DNA methylation affected exploration and novelty-seeking behavior in urban individuals of great tits but not among individuals living in nearby rural habitats [24]. The addition of methyl groups to DNA increased by 1–4% in urban compared to rural birds for all loci and tissues investigated [24]. Similarly, another study [25] showed that wariness of black swans (*Cygnus atratus*) was partly determined by a specific genotype associated with novelty seeking [26] and that individuals with warier behavior settled in less disturbed aquatic habitats than individuals seeking novel habitats. The DRD4 genotype that was modified is responsible for the gene involved in the dopamine receptor D_4, which affects production of the neurotransmitter dopamine [26].

Rapid changes in antipredatory behavior in captive-bred birds have been documented to occur over just a couple of generations [27]. It is unlikely that these changes in captive-bred birds are the result of habituation, phenotypic sorting, or other phenotypically plastic responses because they have no known mechanisms of cross generational effects. Given the velocity at which these changes in antipredator behavior occurred, it was also unlikely caused by microevolutionary responses to selection, which leaves epigenetic changes in DNA transcription as the likely mechanism. And, if such changes in captivity occur in the wild, it is likely that ecotourists drive such epigenetic changes.

4.3.3 Changes in Behavior Caused by Habituation to Humans

Habituation arises as a consequence of repeated exposure to a stimulus, such as the close proximity of humans giving rise to ever-weaker responses over time in the absence of predation attempts (Table 4.1). Groves and Thompson [28], in their classical review of habituation, presented the dual-process theory of phenotypically plastic responses to repeated stimulation. Plasticity of behavior implies that the same individual may differ in behavior depending on its history of exposure to stimuli (e.g., the degree of repeated encounters with humans in the past). When animals are repeatedly exposed to a novel stimulus (such as well-meaning ecotourists in a pristine location), they may first respond aversively, but with repeated exposures, they may reduce the magnitude of their response and habituate. Neurophysiological experiments indicate that these two processes involved in habituation have separate and specific neuronal substrates implying that the two components of habituation are truly independent [28]. Blumstein [29] recently reviewed the habituation concept and concluded that intensive research has led to well-supported generalizations about mechanisms of habituation. A true "natural history" of habituation and tolerance that explains why some individuals, populations, and species become habituated and tolerant, while others do not, would help us predict how species respond to humans and anthropogenic stimuli. However, such a natural history has so far eluded scientific inquiry [29].

While habituation may result in a change in behavior, including fear responses of animals to humans, there is little evidence of habituation affecting fear response in standardized stimulus presentations in marked individuals ([5]; but see [30]). From an ecotourism perspective, habituation-like processes can allow animals to better tolerate humans, but it cannot be responsible for animal behavior changing across generations.

4.3.4 Changes in Behavior Caused by Phenotypic Sorting

Phenotypic sorting occurs when individual animals that differ in their behavior (for instance, some individuals may be bold, while others are shy) are distributed non-randomly across habitats with different levels of human disturbance ([13]; Table 4.1). A large literature has documented the so-called temperamental [31] or personality [32] differences in a wide variety of species. These differences may lead to individuals differentially tolerating ecotourists (see also Chap. 2).

A classic example of phenotypic sorting is the distribution of gulls (*Larus occidentalis*) in the proximity of humans in California. Tame gulls are found near humans, whereas warier gulls are found at greater distance from humans [33]. Perhaps differences in behavior across generations due to phenotypic sorting could also explain differences in behavior of urban and rural animals [6].

While phenotypic sorting represents, at least theoretically, a feasible explanation for differences in behavior of individuals among sites, there are, to the best of my knowledge, no examples of phenotypic sorting changing the behavior of related individuals across generations. However, if certain types of individuals are more likely to be associated with humans, and these animals differentially survive or reproduce because of their tolerance to humans, there could be genetic changes in the larger population over time.

4.3.5 The Biological Effects of Human Contact on Wild Animals

Many wild animals have become associated with humans to the detriment of animals and humans alike. As stressed above, frequent human exposure often results in a reduction or loss of fear responses of wildlife to humans, which can constitute a dangerous "ecological trap" [34, 35]. While reduction or loss of fear of humans may be beneficial for ecotourists whom usually seek close experiences with wild animals, it may be detrimental if these animals become more easily hunted for bush meat [1]. Human predation and exploitation of fishes and other marine species may explain increased fear in coral reef fishes, which are otherwise important resources for ecotourism [36].

Several of these species frequently exposed to humans are now known to be vectors of pathogenic parasites, such as rodents carrying hantavirus [37], bats carrying MERS virus [38], and Asian palm civets (*Paradoxurus hermaphroditus*) being the vector of SARS virus [39], all of which infect humans and have serious and even lethal effects [40]. Such animals can be dangerous to humans because of their vector activity but potentially also to other animals that may constitute reservoirs of virus or because animals transmit viruses to novel hosts [38, 39].

A well-known example is the presence of antelopes, rhinos, giraffes, and numerous other species at waterholes in dry parts of Africa, which sustain a high population density at sites where density usually was consistently low [41]. Such a change in behavior can cause significant changes in habitat structure, such as change in density and composition of the vegetation, which previously only to a small extent was exploited by herbivores in the presence of artificial water bodies alone [41].

Another example is attraction to feeders or supplemental food, which occurs throughout the world [42] (Fig. 4.2). Because animals become aggregated at feeders, feeders may facilitate the spread of pathogens [42]. Feeders can also advance the timing of annual events such as migration, reproduction, and dispersal because such events are affected by body condition, which in turn is determined by food intake [42]. Feeders may also increase the rate of reproduction and the rate of survival with consequences for population density [42]. A particularly striking example of attraction to feeders is the feeding of great white sharks (*Carcharodon carcharias*) in South Africa, Australia, and Baja California as a means of attracting "extreme" tourists. Such attraction may prove fatal if shark feeding also results in the attraction of sharks to humans at nearby beaches.

Fig. 4.2 Caribbean hermit crabs (*Coenobita clypeatus*) attracted to a garbage dump. St. John, Virgin Islands. Photo credit Daniel T. Blumstein

While effects of tourism on wildlife are well recognized in temperate countries (reviews in [43–45]), very little is known about whether visitors have any influence on rainforest animals, which constitute the majority of terrestrial animal diversity. The rare empirical evidence available indicates that even low numbers of visitors can change activity patterns of animals or cause rainforest animals to flee from potential foraging or breeding sites (e.g., [46–49]). Birds in tropical habitats are known to have much longer flight-initiation distances than conspecific or congeneric populations in the temperate zone [50]. Such dramatic differences in behavior between tropical and temperate zones are expected from life history theory (the theory dealing with the optimal timing of reproduction, clutch size, number of reproductive events, and the timing and rate of senescence) because animals in the tropics have low reproductive rates and high annual adult survival rates, while this is the opposite in the temperate climatic zones [50]. Such effects can reduce reproductive success and therefore hamper conservation goals in protected areas, even when ecotourism is supposed to protect such vulnerable species from human disturbance. Such antagonistic responses to human exposure provide the basis for potential conflicts between conservationists and the ecotourism industry. This may create trade-offs between conservation, on the one hand, and income from ecotourism on the other. That is because negative impacts on wildlife reduce both the value to ecotourists and the economic value of the visited area.

Despite several examples of human tolerance documented here, it is imperative to highlight that numerous animals living in the proximity of humans do not show reduced fear responses to humans. Many animals never managed to adapt to humans because they were all killed before they were able to change their behavior. The solitaire (*Pezophaps solitaria*), the dodo (*Raphus cucullatus*), the moas (Dinornithiformes), and numerous other animals on oceanic islands in the Pacific and the Indian Oceans belong to this category of species that were insufficiently afraid for their own good. Hence, there are clear limits to the ability for some species to adapt to rapidly changing environments when humans first arrive. Most such extinct species had large body sizes, which implies long generation times and little prospect for adaptation to rapidly changing human-impacted environments [51].

4.4 Future Directions

There are several examples of how animal behavior may reveal some of the intricacies of behavior to a recently altered human-impacted environment. A recent study showed that elephants (*Loxodonta africana*) can make subtle distinctions between language and voice characteristics of humans to correctly identify the most threatening individuals on the basis of their ethnicity, gender, and age [52]. In this study elephants were frightened by exposure to the language of one tribe that commonly kills or wounds elephants, while they reacted without fear when the scientists played back recordings of the language of another tribe that does not impose damage or death on elephants [52]. This study provided the first detailed assessment of human voice discrimination in a wild population of a large-brained, long-lived mammal, and it highlighted the potential benefits of sophisticated mechanisms for distinction between different subcategories that differ in fear response within a single predator species. Given that humans have imposed strong selection pressures on animals, we can expect many other examples of animal antipredator behavior being influenced by interactions with specific groups of humans, such as different ethnicities, professions (farmers vs. pastorals), and humans engaged in different activities (hunters vs. birdwatchers).

Future prospects for research include the study of changes across generations in behavior in the tropics where most biodiversity is located and where the importance of habitat change and exploitation is likely to be the most dramatic during coming decades. Indeed, I urge biologists involved in ecotourism projects to monitor changes in fear responses of animals to humans over time before ecotourism begins and also after initiation of ecotourism activity. I also emphasize the importance of documenting not only the benefits of ecotourism but also the changes in associated costs, such as increased risks of hunting and the risks of disease transmission among animals and between animals and humans. Finally, I suggest that the exposure of rare animals to humans in an ecotourism context may result in increased levels of habituation over time that eventually may further endanger such species. Ecotourists may inadvertently transmit pathogens from domestic or pet animals to rare species in environments where such pathogens are otherwise absent. Likewise, habituation of rare animals to humans may result in loss or reductions of fear responses that would in turn result in an increase in risk of mortality due to hunting or poaching or capture for the pet trade.

Conclusions

I have reviewed a small but diverse literature on transgenerational changes in behavior with significant importance for assessment of the impacts of ecotourism and other kinds of human exploitation of wild animals. Such changes in behavior may be better documented in coming decades as more studies of behavior enter the stage with sufficiently long-time series to allow rigorous analyses of underlying mechanisms. Finally, ecotourism may, despite creating benefits for local communities, have a number of costly side effects for animals due to habituation to human exposure and proximity, eventually increasing the risk of transmission of pathogens and the risk of hunting, poaching, and capturing of wild animals for the pet trade. Some of these potential dangers can be mitigated if carefully monitored as a part of ecotourism.

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Impacts of Fish Tourism

5

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Fig. 5.0 Snorkeling along the Rio Olho d'água, Bonito, Brazil. Photo credit Daniel De Granville

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5.1 Introduction

Diving and snorkeling are magical experiences that expose us to a diversity of life that we do not typically encounter on land. Thus, there is a growing nature-based tourism market for snorkeling and diving trips ([1], Fig. 5.1). Indeed, by protecting aquatic resources, dive tourism has been shown to be substantially more profitable than fishing. For instance, a Hawaiian study showed that tourism could produce 20 times the revenue of extractive fishing [2]. And, while sharks are hunted globally, the growing market for shark watching already produces half as much profit as the fin and flesh market [3]. Nevertheless, there are a variety of environmental threats caused by tourism that include resource consumption, the creation of waste, the need for the construction of infrastructure, and, by its very nature, tourism brings more people to natural areas [4]. Thus, it is fundamentally important to develop strategies to monitor and reduce the impacts caused by tourism in aquatic environments if we wish to create a genuinely sustainable ecotourism industry.

Fish tourism is big! In Australia, fish-related tourism brings in US$ 440–770 million annually [5], while in Indonesia's Bunaken Marine Protected Area, it brings in US$ 30 million annually [6]. As long as visitation is sustainable, the contact with fish during aquatic nature tourism helps support non-extractive economies that help protect fish and their environments.

While there has been considerable effort into quantifying the effects of humans and tourists on the physiology and behavior of terrestrial animals, much less work has focused on quantifying the effects on aquatic animals such as fish. Yet, divers enjoy viewing relatively large fish [7, 8], and this focus may create pressures on their populations. We should care about such pressures because in addition to providing food and, more recently, pharmaceutical molecules [9], fish also provide environmental services by regulating food chains, controlling pests, and helping to cycle nutrients.

In this chapter, we aim to synthesize information on fish watching and fish feeding, the two main non-consumptive forms of fish-related tourism. We evaluated these activities by exploring how fish behavior and population dynamics may be influenced by established tourism.

5.2 Impacts of Humans Observing Fish

We can view the tourism's impacts along a cascade of effects that go from physiology to behavior (Chap. 2) and finally to ecology ([10–12], Chap. 3). The immediate response to encountering a person is physiological and behavioral. Ecological impacts may only be detected later and define overuse (Fig. 5.2).

5.2.1 Physiology

Fish may view humans as potential predators and this leads to an immediate physiological response to tourism (also see Chap. 2). Upon interacting with a potentially threatening human, fish increase the production of corticosteroids, their main stress hormone, by activating their hypothalamo-pituitary-interrenal (HPI) axis—which is analogous to the

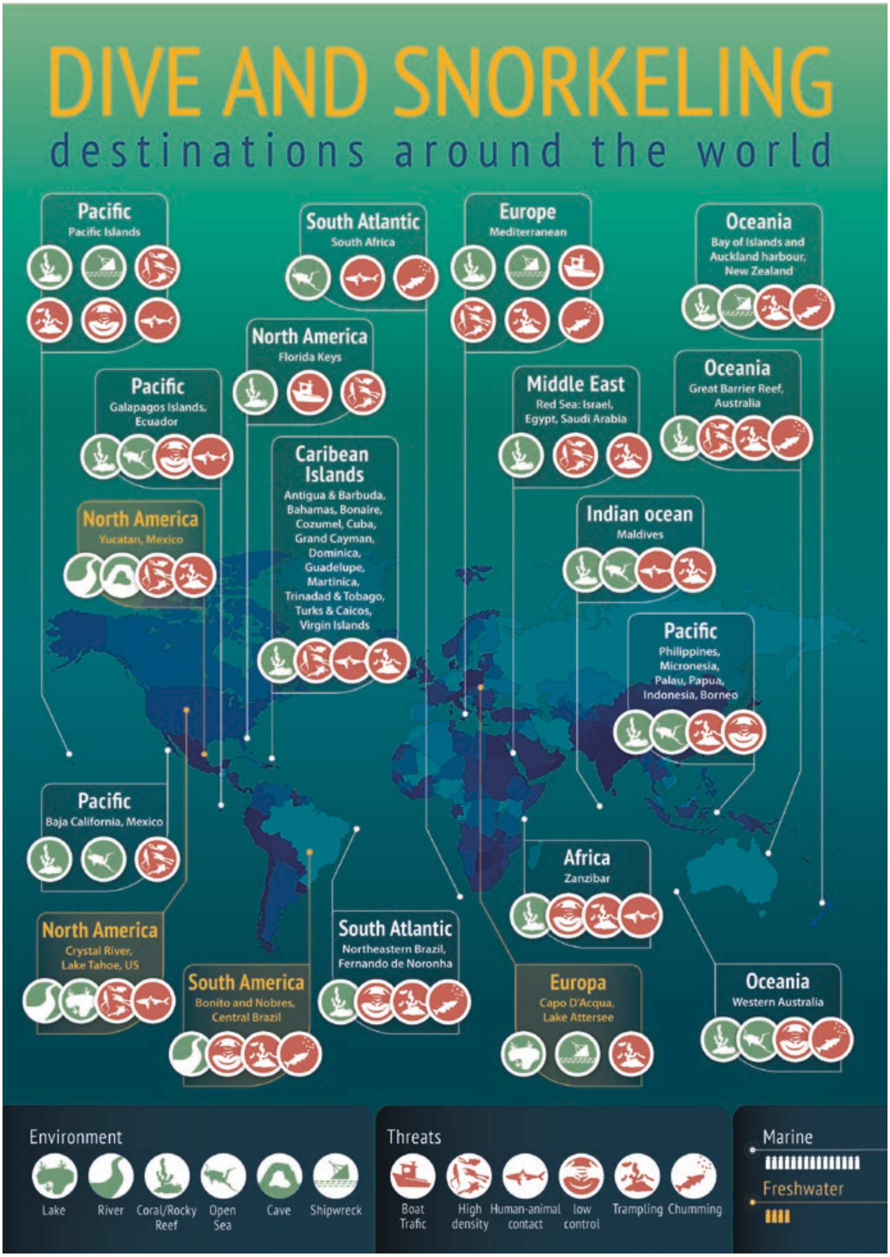

Fig. 5.1 Main fish-watching destinations around the world in marine (*white*) and freshwater (*yellow*). Infographic by André Morato

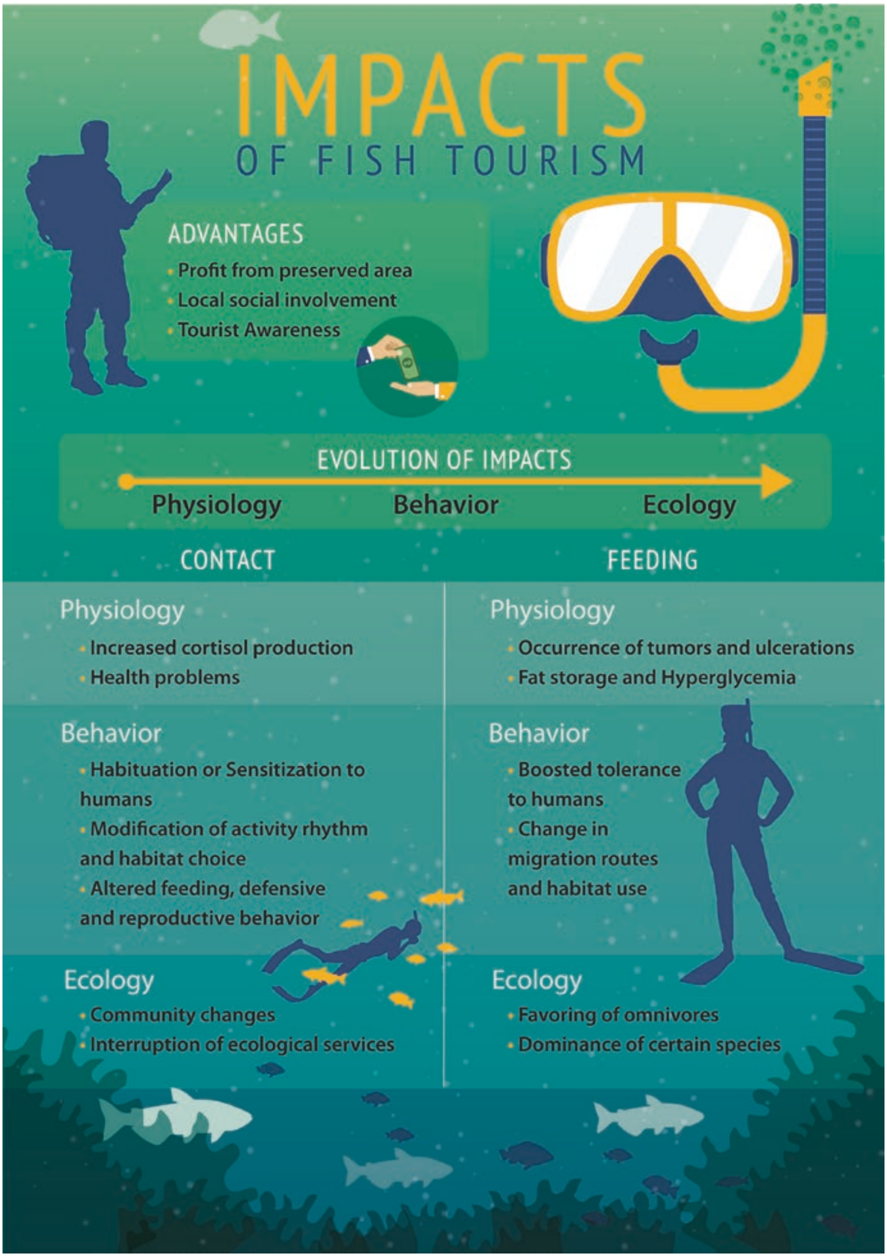

Fig. 5.2 Although nature-based tourism may be beneficial for some fish, both human–animal contact and food provisioning bring impacts that escalate from physiology to behavior and then to ecology. Infographic by André Morato

HPA axis in mammals—the set of glands and the feedback loops between them that respond to stressors (Chap. 2, [13]). Tourism exposure has been shown to modulate stress hormone production (Chap. 2), and fishes are no exception [14]. For instance, Lima et al. [11] demonstrated that tourism increases stress hormone production in head-water stream fish. Both divers and recreational boat noise increases stress hormone level in fish [15], as well as metabolic rate, another indicator of stress [16]. Sharks have been shown to suffer from stress from tourist encounters. Some shark-dive operators impress tourists by inducing tonic immobility in the sharks. However, this procedure has been documented to create stress and physiological/biochemical disruptions [17]. While stress responses are well documented, these are not the only physiological reactions.

A variety of other measures of health and energy balance are negatively influenced by fish tourism. Stingrays (*Dasyatis americana*) have reduced hematocrit, plasma proteins, leukocyte counts, and antioxidant capacity, while they also have increased measures of oxidative stress at dive sites. These are all indicative of chronic stress and directly impact the rays' health. Indeed, rays at tourist sites have more injuries and more intestinal parasites than animals studied at non-dive sites [18]. The presence of scuba divers momentarily disrupts cleaning behavior at cleaning stations, causing client fish to forgo cleaning services. This possibly reduces their survival and reproductive success, because parasites are not removed [19]. Great white sharks (*Carcharodon carcharias*) expend energy by striking the decoy seals that are used to bring them closer to dive cages [17]. Contaminants introduced by tourists, such as sunscreen, have been shown to stimulate egg hatching and reduce digestive enzyme action [20], as well as to interfere with gonad functioning [21]. Thus, tourism can affect fish homeostasis and health.

5.2.2 Behavior

The impacts described above often lead to quantifiable changes in behavior. For instance, around people, fish may habituate or sensitize to repeated disturbance. They may select different habitats to avoid people; they may modify their periods of activity to avoid people, finally affecting both feeding behavior and social behavior. Habituation occurs when an animal's reaction is reduced after repeated stimulus presentation. By contrast, sensitization is seen when there is an increased response to repeated stimulation. It is not always clear when or why fish may sensitize or habituate. A long-term study [22] showed that encountering divers did not reduce, and in fact increased, the chance of whale sharks (*Rhincodon typus*) returning to a dive site in the future, a finding consistent with them being attracted to tourists. Alternatively, Quiros [23] described how whale sharks avoided tourists by frequent changes in direction (23%), occasional shudders (10%), and diving movements (15%). While divers often blocked the shark's route and approached them, when humans touched the sharks, the sharks rapidly responded in what appeared to be an aversive way [23]. Sharks can learn to anticipate human encounters in tourism areas and have been shown to habituate to diving boats and divers [17]. Nevertheless, it is still unclear how fish cope with tourism. Sensitization to human presence in different contexts occurred in seven cases and habituation in other two [14] showing that tourists may affect each fish species differently [24].

Disturbance caused by tourism is likely to affect circadian activity and fish distribution. Sharks change their circadian activity and vertical distribution in the water column in reaction to the presence of diving boats [25]. Snorkelers, but not scuba divers, caused fish to shelter in crevices [24]. Eleven species of headwater stream fish, unable to change microhabitats, delayed their activity to avoid tourists (Eduardo Bessa, unpublished results), something that Lima et al. [11] also reported.

Perhaps more worrying is that some fish use sound to guide themselves toward preferred habitat during settlement. Boat noise has been shown to disrupt this behavior, causing fish to settle in inappropriate places [26]. Sharks' response to tourists, in terms of migration route and habitat use, depended on the species, how tourism was managed, and the duration and scale of tourism [17]. Teresa et al. [27] described how habitat simplification, by the loss of underwater vegetation caused by snorkeler's trampling the vegetation, changes the behavior of substrate feeders in headwater streams. For instance, the headstander (*Leporinus macrocephalus*) changed its feeding behavior in response to tourism. Instead of suspending large amounts of substrate while feeding, it fed by gently lunging the sand with its mouth. Because of this change, the headstander attracted fewer follower fishes. Tourism increased the feeding frequency of streaked prochilods (*Prochilodus lineatus*) [10], reduced the foraging performance in sticklebacks (*Gasterosteus aculeatus*) [28], and reduced feeding, fighting, and vigilance in pike cichlids (*Crenicichla lepidota*) [12].

The presence of tourists may be associated with an increased predation rate if prey species reduce their vigilance behavior around humans due to a false sense of protection [29]. Fish living in marine protected areas that permitted humans to swim, snorkel, and dive in the water tolerate closer approaches from humans [30], while in non-visited protected areas, fish fled at greater distances. The main problem is that those less wary fish belonging to the no-entry zone sometimes cross the artificial boundary and are thus more likely fished [31].

Boat noise also indirectly increases predation on Ambon damselfish (*Pomacentrus amboinensis*); they are six times less likely to respond to a predator when boats were passing by [16]. This may either be caused by an increased stress response or it could be explained by the boat motor noise distracting the fish. The presence of tourist boats was associated with increased attacks and an increased death rate in this damselfish [16], similar results were observed for eels (*Anguilla anguilla*) [32]. Nevertheless, a long-term exposure (2–12 weeks) caused the European seabass (*Dicentrarchus labrax*) [33] and another coral damselfish (*Dascyllus trimaculatus*) to tolerate boat noise [34].

The one behavior that could have the most profound population and community effects is tourism-driven changes in reproductive behavior. Some fish form large spawning aggregations that are essential for successful reproduction. Tourists have been shown to disrupt such aggregations by approaching the spawning fish, which would abandon the group and resume their nonreproductive behaviors [35]. Tourism also depresses pike cichlid (*Crenicichla lepidota*) reproductive behavior [10]. Although pike males nest in areas with and without tourism, female mating frequency was higher at sites without tourists or with strictly regulated tourism. This regulated tourism was characterized by a controlled number and duration of visits and by the presence of a local guide and floatation equipment ([12], Fig. 5.3a). Similarly, males engaged in less territorial aggression at sites with unregulated tourism ([12], Fig. 5.3b). This territorial aggression is essential to protect nests from egg predators.

Fig. 5.3 (**a**) Tourists watch fish in a clear headwater stream under the control of a tourism guide that enforces floatation device use and forbids stepping on the river bed in Nobres, Mato Grosso, Brazil. (**b**) Limited control of tourists' behavior in a headwater stream in Nobres, Mato Grosso, Brazil. Without the presence of a guide, tourists step on the riverbed, feed the fish, and spend as much time in contact with the fish as they wish. Photo credit Benjamin Geffroy

Recreational boat noise affects territoriality and drives nest abandonment. It also influences communication and reduces shoaling behavior in a number of fish species [15]. When fish refrain from reproducing because of tourism, its impact will escalate to the next level in the disturbance cascade, which are ecological impacts (see also Chap. 3).

5.2.3 Ecology

Tourism potentially impacts fish reproduction and larval settlement. Aquatic tourism is often highest during the hottest months of the year. Although many tropical fishes reproduce year-round, numerous other species are summer spawners [36], being subject to tourist impacts that coincide with their reproductive period (e.g., [37]). As long as tourists are few and adhere to a code of conduct, significant changes in reproductive aggregations are less likely to be seen [35]. Nevertheless, more data are required to properly confirm this. The impact caused by tourism on endangered fish populations in the Pacific islands is poorly understood due to the lack of knowledge on such fishes, but it has already been reported that tourism affects the population of two critically endangered species and three vulnerable reef fish [38]. The mechanism by which tourism impacts these threatened fishes is still unclear, but boat noise is a possibility. Recreational boat noise may have population-level effects by increasing predation [16] disrupting larvae settlement [26], as well as affecting other life stages (reviewed by [15]). If reproduction and early life history traits are impacted by tourism, then we can expect population size to decline in tourist areas, but tourism can also produce community-level changes.

Communities are made up of aggregations of species and the interactions between them. Although tourism's effect on community structure was documented, it was not as important a factor as macroalgae abundance or fishing in affecting the Brazilian fish fauna at Tamandaré's coral reefs [39]. Rather, tourism has a relatively large effect. Indeed, the ichthyofauna of some visited sites differed from similar pristine areas in adjacent headwater streams [10, 11] and in coral reefs [40]. Teresa et al. [27] showed how tourism causes habitat simplification, which modifies substrate composition and food availability; this impact, in turn, has feedbacks on fish behavior and fish diversity. Habitat simplification reduces the availability of crevices and shelters [41–43], as well as reduces the number of headwater stream fish [14]. These reductions in fish species richness and diversity impacts ecosystem functioning and environmental services.

In addition to changes in taxonomic composition, the ecological roles of the remaining species may be impacted by tourism. A single generalist omnivore, the sergeant major (*Abudefduf saxatilis*), became dominant (75% of the ichthyofauna) in tourism sites in Brazil [44]. Gil et al. [40] described a reduction of 70% in herbivores, while no change in reef fish abundance and a number of families were reported in Mexico. Overall, tourism seems to reduce fish abundance, reduce specialists, and favors generalists. These changes in fish composition may have profound influences on ecosystem services and, in the long term, evolution (see also Chap. 4).

5.3 Impacts of Food Provisioning

Fishes are often artificially fed by divers and snorkelers with the aim of attracting them to facilitate interactions [45]. We define fish feeding, or provisioning, as the offering of food (natural or, more often, novel foods) to attract and habituate fish. This is also known as "chumming" (Fig. 5.1 indicates some of the sites where it is performed).

The issue of wildlife feeding as a tourist attraction is a complex topic that requires considering both the social and economic benefits and contrasting them with the negative environmental impacts on the fed animals' biology. Food provisioning offers the chance of interacting with rare or timid fish [46–48]. It can also provide economic benefits [49], social benefits from increased environmental consciousness [50–52], and environmental benefits by helping to raise funds and awareness for the maintenance of protected areas [46, 53–55]. Positive impacts include assisting the conservation of vulnerable and threatened species or attracting tourists that can be then educated about the importance of protecting nature [56]. Besides that, artificial food provisioning by tourists may also result in increased reproduction and survival of certain species during periods of natural food shortage [57].

Feeding is controversial [58] and restricted or banned in some marine protected areas [46]. Nevertheless, food provisioning is a growing practice in tropical and subtropical areas [50, 59], sometimes in a regulated way by tourism agencies, sometimes freely offered to satiation by tourists. The provision of food has negative effects (Fig. 5.2) that include changes in physiology, natural behavior, fish abundance, and ecological structure [25, 53, 60, 61].

When food offered by tourists differs from their natural diet, there may be physiological changes that will affect fish health [51]. Fish frequently fed by tourists often habituate to humans, with a reduction of defense behavior and approach toward humans to increase the chance of being fed [47]. In amberjacks (*Seriola lalandi*), feeding results in nonnatural aggregations of individuals, habituation, and increased interspecific aggression, besides physical signals like fin erosion, tissue ulcerations, and lesions [53]. A study on the rainbow trout (*Oncorhynchus mykiss*) revealed an association between liver tumors and food offered by tourists contaminated with aflatoxins [62]. Aflatoxins are toxic and carcinogenic metabolites produced by fungi of the genus *Aspergillus*, frequently associated with moldy bread [63], a common food offered to fish.

Bread, in fact, is the most offered food item given to fish, although it is not part of their natural diet [64]. Its high carbohydrate load is transformed into glucose, which, despite being a central molecule in many species of vertebrate's metabolism, does not play the same role in fish metabolism [65]. Carnivorous fish are unable to regulate the high concentrations of blood glucose they get from eating bread and display signs of hyperglycemia [66, 67]. Omnivorous fishes are slightly more tolerant, regulating their blood glucose levels within 5 h from its ingestion [68]. The glucose levels in fish return to basal threshold around 90–120 min after food intake [69]. Ilarri et al. [64] suggest that tourists offering carbohydrate-rich food to the fish were potentially related to the dominance of omnivorous species in their study site, functioning as selective factors on the trophic niche of the fish species. Hilton et al. [70] defined optimal and tolerated levels of carbohydrates in a fish's diet. They defined the tolerated amount as the quantity of food that would not result in mortality or growth reduction, while the optimal level was defined as the amount that could be totally oxidized to produce energy. In provisioned sites, even the tolerated amount of carbohydrates in a fish diet is surpassed, resulting in the abovementioned metabolic problems.

The intestinal microbiome is also modified as a function of what an animal eats [71]. Items ingested act like a selective culture medium for different bacterial species, reflecting in metabolic changes of the microorganisms, including the induction of virulence mechanisms [65]. Yeasts can reach the stomach mucosa together with *Ascaris* worms, leading to changes in normal individuals' microbiota and abnormal host-parasite interactions [53]. This will have a great impact on fish health.

Food offered by tourists might also result in unnatural aggregations of fish species, increasing the contact between individuals and contributing to the transmission of infectious diseases and parasites. In this way, infected fish may reduce the health of wild individuals in the fish community [46, 53]. Unnatural aggregations may also interfere directly with the populations of prey, predators, invertebrates, and other fish [72]. The increase in predator density, in the long term, for example, can reduce the number of other species, resulting in direct competition for food. More consumers also reduce the number of certain prey species [73] and increase fecal volume, possibly modifying the structure, energy flow, and composition of the habitat [74].

Cascading effects from the individual level to the community level have also been reported. Brena and collaborators [75] listed the following responses to elasmobranch food provisioning that included changes in fat storage and health problems, changed migration patterns, changes in their distribution and aggregation, the creation of dietary dependencies on the baits, and finally changes in the community of other organisms. In another Mediterranean study [76], some fish species habituated to human presence and feeding suffered physiological effects, while others avoided tourists and/or were excluded by food competitors, which resulted in ecological changes to the aquatic community.

5.4 Future Studies and Open Questions

There are a number of open questions that, when answered, will help us better manage fish tourism. First, one of the most important open questions is explaining why tourism sometimes results in fish avoidance, while in other cases fish are able to tolerate tourists. Developing more predictive models of tolerance are required. Second, while there are a number of behavioral studies that focus on antipredator behavior, more studies should focus on social and reproductive behavior, other important activities that are tightly linked to an individual's fitness and, hence, population biology. Third, coral reefs are better studied than streams and temperate oceanic waters. This may be because these environments are more appealing to tourists and because the fish are relatively easy to access. Nevertheless, the lessons from them may differ because reefs are often more open environments where fish may be able to avoid tourists, compared to streams. Thus, further studies on stream fish are needed. Fourth, despite the growing interest in food provisioning [53], there are relatively few studies that quantify the impacts of this practice on the behavior and ecology of fish. Studies on how artificial food provisioning changes the natural diet of fish species and increases fat deposition are required, because of its effects on fish fecundity [77]. Therefore, food provisioning will probably, at the population level, accelerate sexual maturity and increase fecundity of targeted species, while changing species composition and diversity in the community level. Nevertheless, to our knowledge, there is no empirical data supporting this hypothesis.

In conclusion, while fish tourism has many merits, managing the negative impacts requires work. Reducing or eliminating fish provisioning is probably a good thing given its potential for widespread effects. With proper management, humans can escape into an amazing and different world and, by doing so, help conserve these precious aquatic resources.

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Impacts of Marine Mammal Tourism

6

Maddalena Bearzi

Fig. 6.0 Bottlenose dolphin (*Tursiops truncatus*) in the wild. Published with kind permission of ©maddalenabearzi/oceanconservationsociety 2016

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6.1 Introduction

Since the late 1990s, the waters off Southern California have been the stage for my research on marine mammals. Recently, however, things have drastically changed in my ocean "backyard" off Los Angeles: a high diversity of cetacean species has moved into this area. In the last few years, sperm (*Physeter macrocephalus*), blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*), minke (*Balaenoptera acutorostrata*), and humpback (*Megaptera novaeangliae*) whales, along with new members of the dolphin family, have chosen these waters as their interim "home." Killer whales (*Orcinus orca*), a rare sighting until 5, 6 years ago, have now been spotted foraging just off the LA coastline. Perched on the deck of my research boat, I have recorded how critically endangered blue whales and others of these magnificent leviathans have now adopted nearshore areas to consume their daily buffets during the summertime (Fig. 6.1).

The cause of this unexpected and high occurrence of cetaceans in this stretch of California coast is not related to a population boom. It's more likely a combination of factors, including changes in oceanographic conditions and, consequently, prey abundance. The astonishing richness in marine mammals, especially large whales, is of course drawing attention from the general public. As soon as these cetaceans began frequenting this area, the media was quick to spread the news, and people

Fig. 6.1 A critically endangered blue whale (*Balaenoptera musculus*) off my study area of Santa Monica Bay, California. In recent years, blue whales and other endangered and threatened cetacean species have been frequently observed just off Los Angeles during the summertime. Published with kind permission of ©maddalenabearzi/oceanconservationsociety 2016

started taking to the water in large numbers to have up-close and personal encounters with these creatures.

Both locals and tourists want to see and know more about these complex, large-brained animals. This could be great because seeing marine mammals in the wild might lead to a better understanding of these species in their own habitat, which could perhaps translate in better protection. Regrettably, though, not many Los Angelinos or tourists are aware that marine mammals are strictly protected (under the Marine Mammal Protection Act). They also don't know that close encounters can potentially be detrimental to these animals or even to people observing them. This is not a small problem considering that over 50 million tourists visit these shores each year, many to partake in recreational activities including powerboating, jet skiing, swimming, surfing, kayaking, and stand-up paddleboarding [1, 2] (Fig. 6.2).

Spending time year-round with dolphins and whales at sea, I have seen a recent drastic increase in tourism near these animals. I have watched Jet Skis literally gliding over large whales, recreational and occasionally whale-watching boats approaching so close to these animals as to nearly hit them, and kayakers and paddleboarders crowding near their feeding grounds. And I have seen lesions due to boat strikes on their bodies.

Generally speaking, there is no doubt that people are well intentioned. The consequences for marine mammals, though, can be harmful, even if this is not something that one can observe on the spot.

Fig. 6.2 A surfer paddles close to a bottlenose dolphin off the Malibu Coast, California. Published with kind permission of ©maddalenabearzi/oceanconservationsociety 2015

This is what's happening with marine mammal-based tourism in my study area off California. The situation in other places around the world is, on the other hand, far worse.

6.2 Economic Impact of Marine Tourism

Marine tourism is now considered a "new frontier of late-capitalist transformation" [3], producing more revenue than aquaculture and fisheries put together. For many coastal communities, this industry is becoming the most significant economic activity [4, 5].

Marine tourism spans from simple operations run by one or few people to medium-size operations and large operations [4, 6]. Some examples are (from [4]; Table 4, pg. 146; adapted from [6]):

- One-person operations:
  - Charter fishing boat operators
  - Sea kayak tour guides
  - Scuba diving instructors
  - Land-based whale-watching guides
- Medium-size operations:
  - Whale-watching fleets
  - Marine nature watching boats
  - Charter-yacht companies
- Large and multinational corporations:
  - Cruise ship companies
- Supporting businesses:
  - Coastal resorts
  - Scuba tank-fill shops
  - Windsurfer rental shops
  - Fishing equipment suppliers
  - Island ferry services
  - Souvenir shops
  - Boat maintenance shops
  - Artists
  - Rubbish collectors
- Government agencies:
  - Marine park management authorities
  - Fisheries control officers
  - Tourism marketing and promotion boards
  - Law enforcement agencies
  - Marine safety organizations (coast guard, navies, etc.)
- Nongovernmental organizations (NGOs):
  - Clubs for scuba diving
  - Surf clubs (e.g., engaged in lifesaving)
  - Yachting

  - Windsurfing
  - Surfing
  - Fishing
  - Conservation groups involved in ecosystem or wildlife protection
- Researchers:
  - Wildlife biologists
  - Tourism researchers

As part of this large industry, marine mammal-based ecotourism, especially whale watching,[1] has risen as a novel form of commercial and nonconsumptive[2] wildlife activity [3]. Other forms of this kind of "green" tourism involving marine mammals comprise, among others, swim-with-wild-dolphin programs (occasionally combined with whale-watching tours), dolphin provisional feeding programs, watching polar bears, or visiting pinniped rookeries.

The rapid growth of this business is linked to the broad appeal that these charismatic and large animals have on many people and to coastal habitats that make some of them readily accessible. Nearly half of the human population on our planet lives near water and uses the oceans as recreational playgrounds on a regular basis.

Whale-watching, the pillar of marine mammal-based ecotourism and currently the greatest economic activity reliant upon cetaceans [7], is not a new thing, as it has been ongoing as a commercial endeavor for more than 60 years [8]. Its origin seems to coincide with a whale-watching trip that took place off California back in 1955. Here, a solo entrepreneur charged $1 a person for a ride on his fishing boat to observe migratory gray whales (*Eschrichtius robustus*; [9]; Fig. 6.3).

Based on the definition of the International Whaling Commission (IWC; [10]), whale-watching represents "*any commercial enterprise which provides for the public to see cetaceans in their natural habitat.*" Whale-watching, although mostly conducted aboard boats, also includes land-based or even aerial observations. In 2005, the IWC corrected the definition to include not only commercial businesses but also the public going to sea with their own vessels to observe cetaceans and/or research trips with paying guests [7].

In the last two decades, this marine tourism has increased substantially, becoming a worldwide profitable industry and affecting many nearshore populations of cetaceans [11]. Since the 1990s, the number of people participating in boat-based whale-watching worldwide has expanded considerably, from 4 million in 31 countries in 1991 to 13 million in 119 countries in 2008[3] [12]. The International Fund for Animal Welfare estimated the value of this business at $2.1 billion back in 2008 [11]. Recently, the development of this eco-business has been increasing exponentially in Europe, Asia, the Caribbean, and South America.[4]

[1] While not all cetaceans are whales, cetacean-watching trips are often referred to as "whale watching."

[2] Nonlethal.

[3] 2008 is the most recent year where full data on the whale-watching industry is available.

[4] http://us.whales.org/issues/responsible-whale-watching

Fig. 6.3 Gray whales (*Eschrichtius robustus*) traveling near shore during their migration from Alaska to Baja California. Published with kind permission of ©maddalenabearzi/oceanconservationsociety 2016

Swim-with-wild-dolphin programs, considered a subset of the whale-watching industry, are also operated in different parts of the world becoming exceptionally popular in the Caribbean. These types of programs are considered *active* or *passive*, depending on whether humans are interacting with cetaceans (usually dolphins) or cetaceans are allowed to approach swimmers of their own will [13]. Another subset of whale-watching includes marine mammal "provisioning" activities, which usually involve feeding wild dolphins in shallow waters. Monkey Mia, in Australia, is one of the most popular spots for this type of tourism.

Cetaceans are not the only marine mammals affected by tourism. Weighing up to 1200 pounds, manatees (*Trichechus* sp.) have been the focus of ecotourism and swim-with programs for several decades. The Crystal River Refuge in Florida, for instance, is a mecca for people looking to swim with or kayak near these animals, hosting more than 327,000 visitors in 2014.[5]

Pinnipeds also appeal to tourists due to their behavioral traits that make them easily accessible by boat and/or on foot [14, 15]. Often, whale-watching trips include some type of "pinniped viewing" in their on-the-water tours. Watching seals, sea lions, and other pinnipeds has become more popular in the last couple of decades, involving a wide range of species in various locations worldwide. Kirkwood

[5] https://www.washingtonpost.com/news/energy-environment/wp/2015/03/17/are-floridatourists-loving-manatees-to-death-when-swimming-looks-like-harassment/

Fig. 6.4 "Pinniped viewing" is quite popular because species such as sea lions are easily accessible by boat and/or on foot. Published with kind permission of ©maddalenabearzi/oceanconservationsociety 2016

et al. [14] reported approximately 80 pinniped tourism sites in the Southern Hemisphere alone, with an economic value of around US $12 million; the Australian component included 53 operators visiting 23 sites and involving around 400,000 tourists. Pinnipeds also attract tourism in several locations in North America, the Galápagos Islands, and Europe [15]. An important breeding site in North America is located on San Miguel Island, in the Channel Islands National Park and Marine Sanctuary, California. Here, there are approximately 70,000 California sea lions (*Zalophus californianus*), 50,000 northern elephant seals (*Mirounga angustirostris*), 5000 northern fur seals (*Callorhinus ursinus*), and 1000 harbor seals (*Phoca vitulina*).[6] In 2012, about 265,000 tourists visited these islands.[7] Usually, seals and sea lions are observed at their breeding colonies and/or at the haul-out sites, but some pinnipeds—such as sea lions—can also be observed near urban centers [15] (Fig. 6.4).

Even the cold polar regions are not immune to the masses brought by marine mammal-based tourism. Visitors in the Arctic now exceed the host population at several destinations, and local communities are increasingly dependent on the jobs,

[6] https://www.nps.gov/chis/planyourvisit/seal-and-sea-lion-viewing.htm

[7] https://www.nps.gov/chis/learn/management/statistics.htm

income, and business revenues generated by this type of tourism [16]. On the opposite pole, things are not much different. Tourism in Antarctica has expanded greatly in the last decades, with shipborne tourists increasing by 430% in 14 years and land-based tourists by 757% in 10 years [17].

Going out to sea to observe dolphins, whales, and other marine mammals has gained even more momentum in the last few years, due to the crisis in the captivity industry. Anti-captivity campaigns and documentaries such as *The Cove* and *Blackfish* have helped to raise public awareness about the status of dolphins and whales kept in tanks. Inside academic circles, scientists have begun to recognize these animals as cognitive beings with personalities and emotions [18]. As a result of this deepening "animal-human bond," the number of people feeling empathy and compassion toward these and other animals is growing and so has the interest in experiencing wildlife away from bars or glass.

Whale-watching, either boat-based from land or atop a paddleboard, seems the obvious and right alternative to visiting animals in captivity.

The benefits of marine mammal-based ecotourism span from a better appreciation of the marine environment to bolstering local economies [4, 19], particularly in developing countries in which ecotourism represents an alternative way of "using" natural resources. Hoyt [4] summarizes potential values, benefits, and services provided by the whale-watching industry as follows (modified from [4]; Table 6, pg. 148–149; original source: [20]; Fig. 6.5):

Fig. 6.5 A researcher studies dolphins from a sailboat in the Pacific Ocean. Published with kind permission of ©maddalenabearzi/oceanconservationsociety 2016

- Recreation
- Scientific
- Education
- Financial
- Cultural
- Heritage
- Social
- Aesthetic
- Spiritual/psychological
- Political
- Vicarious experience
- Remote viewing
- Environmental quality (amenity)
- Ecological services
- Environmental disturbance quality
- Combination value

For animal lovers, whale-watching and other types of marine mammal viewing in natural habitats are an incredible and often once-in-a-lifetime experience. For conservationists, it's a chance of educating the public, raising awareness and interest in conservation issues facing cetaceans and other marine mammals, finding sustainable alternatives to fishing, and ending captivity in marine parks. For instance, in places like Japan, where the whaling industry still seems unstoppable, whale-watching could represent a lucrative alternative to the hunting of cetaceans [21] and a response to the country's recent cultural shifts.

6.3 A Biological Evaluation of Ecotourism Impacts on Marine Mammals

Marine mammal-based ecotourism may be a solution to important ocean conservation problems. However, something odd is going on in the wilderness. Dolphins are becoming restless, large whales spend more time at depth, polar bears are stressed, and baby belugas (*Delphinapterus leucas*) are dying [22]. And "eco"-tourism, at least in part, appears to be the culprit.

The great popularity of this form of marine tourism has recently put in doubt its sustainability (e.g., [3, 23, 24]). Many species of marine mammals, at sea and on land, do not react as well to our presence as we wish they would. In the last decade or so, scientists began looking closer into the effects of boat-based and whale-watching activities on target animals [3]. Some of these results show that, in several cases, whale-watching has become an additional threat to the survival of marine mammals. There are emerging studies raising concerns about the viability of some populations and emphasizing the behavioral disturbance on these animals, potentially leading to long-term consequences such as the decrease in female reproductive success and, thus, in population size [25–29]. Several investigations indicate short-term effects on cetaceans such as killer whales, Risso's dolphins (*Grampus griseus*), dusky dolphins (*Lagenorhynchus obscurus*), bottlenose dolphins, and minke whales in response to whale-watching activities [30–34]. Minke whales swimming in the Faxaflói Bay in Iceland, for instance, respond to approaching whale-watching boats as if they were their natural predators: these whales increase their speed and display "heavier" respiration patterns [34]. In another study, Lusseau et al. [28] point out that bottlenose dolphins in Doubtful Sound, New Zealand, could be driven to extinction in just decades due to the high number of whale-watching boats. The large number of vessels, in this case, pushes the dolphins away from favorite foraging areas. Small, resident populations of dolphins, such as bottlenose, are usually those that tend to be more exposed to repeated and extended year-round interactions with whale-watching activities [23], and negative consequences for their populations have been recorded [27–29]. Increases in whale-watching traffic in the St. Lawrence now appear to be contributing to the death of baby belugas because vessel noise affects the calves' ability to communicate with their mothers [22]. Things don't get any better along the Mekong River, between Cambodia and Laos, where about 70 endangered Irrawaddy dolphins (*Orcaella brevirostris*) are harassed by boat-based tourism [12]. For large baleen whales, the low-frequency noise coming from large vessels in areas of heavy shipping traffic "overlaps" with the acoustic signals used by different species.[8] As a consequence, whales tend to respond to this disturbance with behavioral changes, habitat displacement, alterations of calls, and, as recently discovered, physiological responses, such as increase in chronic stress [35]. Rolland et al. [35] demonstrated that reduced ship traffic in the Bay of Fundy, Canada, was associated with decreased baseline levels of stress-related fecal hormone metabolites (glucocorticoids) in North Atlantic right whales (*Eubalaena glacialis*). And these examples are just a taste of the effects of human disturbance on marine mammals (for a more complete list of effects: [4]).

Then, there are swim-with-dolphin programs and food-provisioned encounters at sea. These usually occur in areas where dolphins are found in shallow or limpid waters, and, consequently, encounters with swimmers appear to be more likely. Here, the problems do not only concern cetaceans. Increased exposure to humans, for instance, intensifies the risk of disease transfer in both directions, including parasites [36]. When disturbed, dolphins can also pose threat to swimmers, injuring, and, in one documented case, even killing, humans [37]. Constantine [38] observed sensitization and increased levels of avoidance with long-term exposure to swimmers off New Zealand, and the same author [39] also recorded a decrease in bottlenose dolphin resting behavior during swimmer's approach. In Hawaii, where swim-with-wild-dolphin programs are not well regulated, increased swimmer and kayak presence led to decreased resting behaviors in spinner dolphins (*Stenella longirostris*; [40, 41]). These and other kinds of disturbance by ocean recreational users on different species of cetaceans have been recorded in many areas worldwide [2], and even encounters that appear positive (i.e., dolphins voluntarily approaching swimmers) can still cause a reduction in crucial behavior such as feeding [42].

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[8] Baleen whales (Mysticeti) communicate using low-frequency acoustic signals.

These short- and long-term behavioral effects on cetaceans vary in magnitude and type depending on the target species and the locations in which they occur [24]. Behavioral responses to whale-watching by different species can span from changes in their activity budgets [32, 43, 44], respiration patterns [45], and vocalizations [46, 47] and can include avoidance [48] and several other major and minor effects (for a more complete list: [24, 49]). For instance, as highlighted by Houghton et al. [19], more maritime activity can lead to vessel collisions with marine mammals and noise pollution. Cetaceans are particularly vulnerable to these types of disruptions due to their life history, behavior, large size, etc. and, above all, because they rely on sound to communicate with each other, find food, and survive in their environment. It's also important to point out that whales tend to come close to shore when they are breeding, feeding, or giving birth [50], making them even more susceptible to human disturbance, including swim-with-wild-dolphin programs and whale-watching.

Other marine mammals such as polar bears (*Ursus maritimus*) that spend more time on land are not impervious to the impacts of ecotourism. Since the early 1980s, people have traveled to Manitoba, in Canada, to observe these large mammals up-close. Most of this viewing happens during October and November, the period when polar bears should be resting just before they start hunting their main prey: seals. The problem is that these animals can't rest because of the continued presence of specialized ecotourism vehicles on site, as reported by Dyck and Baydack [51]. Signs of vigilance among male bears increase nearly sevenfold when vehicles are around, and just one vehicle can disrupt the normal behavior of an individual bear. Variations in behavior and decreased resting and feeding activities in polar bears, as well as other marine mammals, may cause changes in energetic demand, leading to changes in the lifetime fitness of these animals [52, 53].

Manatees in Florida, the best-studied taxon, have also been affected by tourism for many decades. As reported by Reynolds III and Powell [54], collisions with vessels accounted for about 25% of these animals' mortality from 1974 to 1998. Three Sisters Springs, the most important natural habitat for overwintering Florida manatees throughout this subspecies' range, has been increasingly used by swimmers and boaters in the past few years. On December 27, 2014, "2258 human passages were recorded, or one passage every 15.9 seconds. The maximum number of manatees in the Springs at one time this day was 20 at sunrise."[9] These tourists approached resting manatees, sometimes next to nursing mother-calf pairs, often triggering these animals to move to other areas or to flee the Springs entirely through the narrow spring run that is usually clogged with boaters.[10] In addition to severely injuring these animals with their propellers, boats create noise and other types of disruption, potentially affecting their habitats, distribution, and energetics [54] (Fig. 6.6).

Although actions have been taken to mitigate some of these human-induced effects and positive results are now evident, the recovery from their depleted state has been slow due to the low fecundity and reproductive rate of the species [54, 55]. Things are

[9] https://www.fws.gov/uploadedFiles/Final%2028%20pages.pdf

[10] http://www.mmc.gov/wp-content/uploads/manatees_three-_sisters_springs_090415.pdf

Fig. 6.6 A yacht moving at high speed near dolphins in the Mediterranean Sea. Published with kind permission of ©silviabonizzoni/dolphinbiologyandconservation 2016

worse for the Antillean manatee (*T. manatus manatus*), occurring from northern Mexico to the northeastern coast of Brazil. For this species, considered endangered on the IUCN Red List of Threatened Species, the cumulative actions of natural catastrophes, anthropogenic disruptions, and low recovery rates appear to be responsible for the progressive decrease in the population throughout their distribution range [56].

In her literature review paper entitled "The impact of human disturbance at seal haul-outs,"[11] Susan C. Wilson discusses the types of human disturbance at pinniped colonies worldwide and summarizes the scientific literature assessing the impact of such disturbance. Many studies dating from the 1970s have focused on phocids, mainly harbor seals, but since the year 2000, disturbance has stretched to other phocid species as well as otariids (fur seals and sea lions). Human disturbance usually spans from tour boats to paddle boats, speedboats, Jet Skis activities and also "swim-with" programs and also comprises aircraft overflight, icebreaking vessels, and snowmobile activity. The response of pinnipeds to human disruption includes; increased alertness, threat displays, movements toward or into the water, temporary or permanent pup separation, disturbance during suckling, physiological stress, energetic deficit to pups, loss of resting, etc. Physical trauma has also been recorded, especially in the presence of powerboats. As previously mentioned, some pinnipeds—such as sea lions—can also be easily seen near urban centers, making them particularly susceptible to human harassment [15].

[11] http://www.pinnipeds.org/attachments/article/199/Disturbance%20for%20SCS%20-%20text.pdf

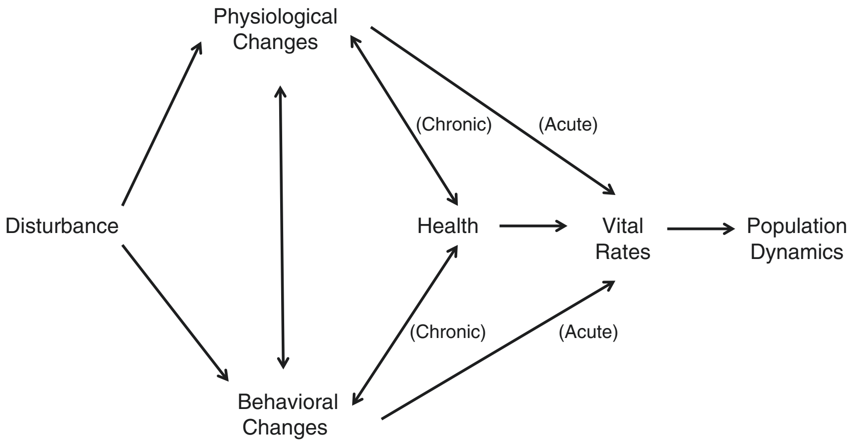

Fig. 6.7 A diagram of the Population Consequences of Disturbance (PCoD) framework that links disturbance to changes in behavior and physiology, health, vital rates, and population dynamics (from [58])

The high diversity of behavioral and physiological disturbance recorded for different species in many parts of the world makes it hard to evaluate the overall impact of whale-watching and other forms of marine mammal viewing on these animals. We have just begun to scratch the surface of what can be known about the long- and short-term effects of our actions on marine mammals in the wild [25]. For instance, we don't have sufficient data on the impact of noise on these animals or the effect of high vessel traffic in proximity to a target individual.

We still don't know enough about the effects of swimmers, kayakers, and Jet Skis in water and of disturbance that is continual versus sporadic or how various species—or specific individuals—react to different types of disruption based on age classes, sexes, etc. [25]. The long-term effects based on short-term behavioral changes are certainly the most difficult to assess, as pointed out by other authors [27, 57]. The diagram in Fig. 6.7 shows the Population Consequences of Disturbance (PCoD) framework [58]. This framework has been developed to attempt to link short-term changes in individual behavior and physiology to the potential long-term effects on population dynamics due to whale-watching activities. The PCoD framework can distinguish "between disturbances that have an acute, immediate effect on vital rates, such as a collision with a vessel, and chronic effects, such as whale-watching, that affect vital rates through an individual's health" [49].

Concerned about the issue of long-term effects, the whale-watching subcommittee of the IWC issued a statement stating, "… there is new compelling evidence that the fitness of individual odontocetes repeatedly exposed to whale-watching vessel traffic can be compromised and that this can lead to population-level effects" (page 54 in [59]).

Another difficulty is that most of marine mammal-based activities, such as whale-watching and swim-with-wild-dolphin programs, are unaudited, unaccredited, unregulated, and uncontrolled worldwide, causing harm to these species [7].

Even the word *eco* itself—that often precedes "tourism" while talking about marine mammal viewing activities to make them more appealing to the public—"has cachet suggesting special quality, high-value and exclusivity." Thus, as suggested by Orams [6], "abuse of the label is not surprising."

6.4 Positive Impacts, What We Don't Know, and How We Can Mitigate Negative Impacts

Surely, different forms of whale- and other marine mammal-watching can bring many advantages to local communities and help in providing sustainable habitats for these animals [8, 60]. Many communities have been literally "transformed" by the presence of whale-watching activities in their areas, showing a "sense of identity" and "pride" [8]. Whale-watching has not only been helpful to nurture a better appreciation of the critical importance of ocean conservation but has also provided a study platform for scientists involved in marine mammal or other ocean-related investigations [8] (Fig. 6.8).

But it's clear that more research is critically important to evaluate the effects of tourism on marine mammals and maximize its sustainability. This type of tourism must be a nonconsumptive wildlife activity and, to do so, it's key to study and assess its costs and benefits. An attempt to rank benefits and costs by constructing an evaluation matrix has been discussed by Hoyt [4]. An evaluation matrix is basically a method for easily visualizing cost-benefit analysis (CBA). The matrix can show, for

Fig. 6.8 A volunteer observes dolphins during a well-managed marine mammal research program in the Greek waters. Published with kind permission of ©giovannibearzi/dolphinbiologyandconservation 2016

instance, a comparison between mass tourism and ecotourism whale-watching options. These types of analyses are important in determining a "sustainability index" for whale-watching as well as other forms of ecotourism [4].

Land-based watching from a safe, regulated distance is, generally speaking, a better choice than being on a whale-watching boat or in the water with marine mammals, as there is less risk to the target animals. It is crucial, though, to conduct preliminary research wherever possible, before these types of programs are implemented so that they are developed thoughtfully, without harassing or harming marine mammals. Data on population size, home range, use of habitat, and behavior of the target species should always be collected prior to the beginning of and during any ecotourism program. Unfortunately, these data are still lacking for most projects worldwide.

There is also a need for more comparative investigations that take into consideration response patterns among different species and locations [24]. It's necessary to plug short-term observational data into longer-term population models to see whether changes in activities by different species are only temporary or represent more serious threats to these animals [12, 28].

Further revision or implementation of current local, national, and international regulations is needed to minimize the effects of this industry on marine mammals before things get worse, and it becomes just another form of harmful exploitation. Regulations must always include, among other things, minimum distances between animals and human observers, areas to avoid, restriction in speed limits in the case of vessels, and observation time limits.

There are over 50 countries around the world that have produced national guidelines or regulations for whale-watching. Issues can—and do—vary between species and locations, but there are some common elements for establishing the best whale-watching practices. In 2012, the IWC put together a review of these worldwide whale-watching guidelines and regulations from 103 different documents.[12] The US Fish and Wildlife Service has also compiled information for polar bear viewing in Alaska.[13] These guidelines span from general activities allowed near bears to safety guidelines and best practices. In Florida, where manatees are found in shallow waterways and boat-related mortalities have been high for many years, the Florida Fish and Wildlife Conservation Commission now has viewing guidelines[14] that include specific restrictions in speed near these animals for powerboats, personal watercrafts, paddle-sport operators, divers, and snorkelers.

Particular attention should be paid to the issue of proximity, as the animals are susceptible to disturbance, especially during feeding, breeding, birthing, and

[12] "A Review of Whale Watch Guidelines and Regulations Around the World": https://iwc.int/private/downloads/ZIGknj3zwgPmvixnuykJqw/WWREGS%202013.pdf. There is also a workshop report entitled "Viewing and Interacting with Wild Marine Mammals" that includes a compilation of guidelines and regulations for viewing or interacting with marine wildlife in the United States: http://www.nmfs.noaa.gov/pr/pdfs/education/viewing_interacting_wild_marine_mammals2011.pdf

[13] http://www.adfg.alaska.gov/static/viewing/pdfs/polar_bear_viewing_information_2013_usfws.pdf

[14] http://myfwc.com/education/wildlife/manatee/viewing-guidelines/andhttp://myfwc.com/media/3411428/protectnativewildlife-manatee.pdf

nursing [7]. Well-regulated operators must always conduct whale-watching and other forms of marine mammal viewing at sea or on land, to the highest industry standards. Scarpaci et al. [61] proposed that guidelines for marine mammal viewing should be simple, accurate, easy to understand, achievable in the field, and enforceable without a great effort. Parsons [7] pushed this proposal one step further by adding that guidelines need also to be created in a way that can be altered quickly, if necessary, depending on specific programs. This type of adaptive management[15] approach should always be considered as part of the process because it allows to make well-informed decisions and address ecosystem issues before a catastrophe might occur. One of the many advantages of using such approach is "to encourage managers to monitor using carefully chosen indicators and learn from the results about how their particular system works and react to change" [63].

Guidelines, however, need to be more than just guidelines; they need to be respected and, above all, enforceable and enforced. The IWC has developed general guidelines (Box 6.1) to reduce potential disturbance on marine mammals that can affect their conservation status.

Box 6.1: General Principles for whale-watching. Agreed general principles to minimize the risks of adverse impacts of whale-watching on cetaceans (from IWC, http://iwc.int/wwguidelines#manage)

1. Manage the Development of Whale-Watching to Minimize the Risk of Adverse Impacts:
   - 1.1. Implement as appropriate measures to regulate platform[1] numbers and size, activity, frequency, and length of exposure in encounters with individuals and groups of whales.
     - 1.1.1. Management measures may include closed seasons or areas where required to provide additional protection.
     - 1.1.2. Ideally, undertake an early assessment of the numbers, distribution, and other characteristics of the target population/s in an area.
   - 1.2. Monitor the effectiveness of management provisions and modify them as required to accommodate new information.
   - 1.3. Where new whale-watching operations are evolving, start cautiously, moderating activity until sufficient information is available on which to base any further development.
   - 1.4. Implement scientific research and population monitoring and collection of information on operations, target cetaceans and possible

[1] Any vessel (with or without engine), aircraft, or person in the water.

[15] Adaptive management is about "incorporating an ongoing process of experimentation, monitoring, and revision as an ongoing social learning process" [62].

impacts, including those on the acoustic environment, as an early and integral component of management.

- 1.5. Develop training programs for operators and crew on the biology and behavior of target species, whale-watching operations, and the management provisions in effect.
- 1.6. Encourage the provision of accurate and informative material to whale-watchers, to:
  - 1.6.1. Develop an informed and supportive public.
  - 1.6.2. Encourage development of realistic expectations of encounters and avoid disappointment and pressure for increasingly risky behavior.

2. Design, Maintain, and Operate Platforms to Minimize the Risk of Adverse Effects on Cetaceans, Including Disturbance from Noise:
   - 2.1. Vessels, engines, and other equipment should be designed, maintained, and operated during whale-watching, to reduce as far as practicable adverse impacts on the target species and their environment.
   - 2.2. Cetacean species may respond differently to low and high frequency sounds, relative sound intensity, or rapid changes in sound.
     - 2.2.1. Vessel operators should be aware of the acoustic characteristics of the target species and of their vessel under operating conditions, particularly of the need to reduce as far as possible production of potentially disturbing sound.
   - 2.3. Vessel design and operation should minimize the risk of injury to cetaceans should contact occur; for example, shrouding of propellers can reduce both noise and risk of injury.
   - 2.4. Operators should be able to keep track of whales during an encounter.
3. Allow the Cetaceans to Control the Nature and Duration of "Interactions":
   - 3.1. Operators should have a sound understanding of the behavior of the cetaceans and be aware of behavioral changes which may indicate disturbance.
   - 3.2. In approaching or accompanying cetaceans, maximum platform speed should be determined relative to that of the cetacean, and should not exceed it once on station.
   - 3.3. Use appropriate angles and distances of approach; species may react differently, and most existing guidelines preclude head-on approaches.
   - 3.4. Friendly whale behavior should be welcomed, but not cultivated; do not instigate direct contact with a platform.
   - 3.5. Avoid sudden changes in speed, direction, or noise.
   - 3.6. Do not alter platform speed or direction to counteract avoidance behavior by cetaceans.

3.7. Do not pursue[2], head off, or encircle cetaceans or cause groups to separate.
3.8. Approaches to mother/calf pairs and solitary calves and juveniles should be undertaken with special care.
    3.8.1. There may be an increased risk of disturbance to these animals, or risk of injury if vessels are approached by calves.
3.9. Cetaceans should be able to detect a platform at all times.
    3.9.1. While quiet operations are desirable, attempts to eliminate all noise may result in cetaceans being startled by a platform which has approached undetected.
    3.9.2. Rough seas may elevate background noise to levels at which vessels are less detectable.

[2] Chase (as opposed to follow), causing the whale to change its course or speed.

These procedures have been "adopted" by over 100 countries as well as commercial whale-watching operators worldwide [49]. Unfortunately, they have not been even close to be effective, mostly because of the general absence of strict and enforced regulations [64]. A 2004 review study comparing international whale-watching guidelines and codes of conduct worldwide established that only one-third of these activities were regulated and two-thirds were totally voluntary [50] (Fig. 6.9).

Fig. 6.9 Tourists in a powerboat watching bottlenose dolphins. Published with kind permission of ©silviabonizzoni/dolphinbiologyandconservation 2016

Without legal support, regrettably, there is little hope for change. Even with regulations in place, it's necessary to monitor that these regulations are actually followed. Enforcement or pressure to comply by other operators and whale-watching tourists had been suggested as a potential and alternative way to go [7]. According to research recently presented to the International Whaling Commission in Cambridge, for instance, whale-watching vessels off Panama killed at least 10 cetaceans in a population of about 250 in 2012 and 2013 [65]. And this was an area with regulations. A similar issue was found in Doubtful Sound, New Zealand, where two-thirds of encounters between whale-watching vessels and dolphins violated the country's Marine Mammal Protection Act [66]. In my own study area off Los Angeles, in California, marine mammals are protected under the Marine Mammal Protection Act of 1972. Based on this act, it's a violation of federal law to harass or harm marine mammals, and penalties can include up to one-year imprisonment and fines of up to $20,000. Most recreational boaters, however, are not aware of these laws and viewing guidelines—despite recent statewide awareness campaigns. This is an example of an area in which enforcement is absent, likely due to the complexity of monitoring these types of activities and determining the degree of harassment and harm to targeted species or individuals. Monitoring of compliance is thus mostly absent or just left to occasional operators or concerned whale-watchers. Even when violations are reported to the right federal office, actions are rarely taken. This is not just an issue close to my own backyard; it is a worldwide problem, as noted by Parsons [7].

One of the most effective ways to promote and manage successful marine mammal-based programs—and at the same time attract tourism—is perhaps through the establishment of Marine Protected Areas (MPAs; [4, 7]), which tend to engage all stakeholders in the process. As an example, several countries in Europe have recognized the Pelagos Sanctuary for Mediterranean Marine Mammals as a Special Protected Area of Mediterranean Interest (SPAMI). This status confers high protection to this large sea area under the Barcelona Convention [4]. Inside this Sanctuary, whale-watching is usually conducted with high standards, and scientific research and education are integral part of this endeavor [67].

Boosting education is another important step in the right direction, also considering that providing accurate educational information to the public should be one of the main goals of marine-mammal-based tourism. Strict regulations aimed to produce a reduction in direct threats and better environmental education to the general public [68], for instance, have helped West Indian manatees in Florida to be potentially reclassified from endangered to threatened species under the Endangered Species Act (ESA) at the beginning of 2016.[16]

If tourists participating in whale-watching and other viewing trips better understand the consequences of their actions and their own impact on the animals they observe, this can have a benefit for wildlife. If tourists tend to avoid whale-watching tours that use unsustainable practices, this can bring about a change in work ethics.

[16] https://www.fws.gov/news/ShowNews.cfm?_ID=35428

Some organizations have already started to create different types of whale-watching certifications to encourage those who are working toward increasing welfare of marine mammals by conducting ethical tourism. Whale SENSE Alaska,[17] for instance, is a voluntary education and recognition program founded by NOAA (National Oceanic and Atmospheric Administration) Fisheries that was recently developed in collaboration with the whale-watching industry in the Juneau area. This program recognizes whale-watching companies that use responsible practices, such as time limits near cetaceans, safe distances from whales, and reduced speed limits. In addition to Whale SENSE, NOAA has also viewing guidelines and regulations for other marine mammal species, such as seal, sea lions, and fur seals, especially in critical habitats. Another example is the "High Quality Whale-Watching® certification",[18] an ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area) trademark jointly developed with the Pelagos Sanctuary in the Mediterranean Sea. The program was established to encourage "reasonable and sustainable" whale-watching activities, guide volunteer operators, and oversee this tourism industry. This certification, among other things, guarantees a whale-watching experience respectful of the code of good conduct for the observation of cetaceans and educational information acquired during a training course that are provided to guests by a certified operator during the entirety of the trip.

These types of certifications are an excellent step in the right directions but are still not widely adopted. In his study of dolphin-swim tours in New Zealand, Lück [69] found that these tours were not providing enough information to the public. In an older study, Hoyt [70] looked into the state of whale-watching for scientific, educational, and conservation benefits and found that 48% had no educational commentary and only 35% of trips had naturalists aboard. Evaluating the educational component of the marine mammal-based industry is essential to better understand if there is, in fact, a change in public attitude toward these animals and an actual improvement in their protection.

It's also important to learn more about the "users" who are experiencing wildlife aboard whale-watching boats, participating in swim-with-wild-dolphin programs and observing polar bears in the Arctic, killer whales in the Antarctic, or elephant seals on the coasts of Central California. What are their motivations and expectations? What's their satisfaction level at the end of a trip? Answering these and other questions is key to achieving more effective management strategies [71]. Addressing both the human and ecological dimension of whale-watching and other marine mammal-based activities can help mitigating the impact of tourism on targeted species and allow a more sustainable approach [71].

Conclusions

Marine mammals are charismatic animals, and many of them represent top predators and iconic species often referred to as *keystone* and *umbrella* species. They are keystone because their disappearance may lead to the loss of other species

[17] https://alaskafisheries.noaa.gov/pr/mm-viewing-guide

[18] http://www.whale-watching-label.com/label

[72, 73], and umbrella because conservation actions that mitigate threats to them are expected to improve the protection of other organisms and the ecosystem itself [74–76]. In many areas around the world, the importance of these animals as keystone and umbrella species is being increasingly recognized and, consequently, so is the need to protect this captivating megafauna [76–78].

Marine mammal-based tourism, if conducted properly and on a sustainable basis, is a "benign" industry [4, 43, 71, 79, 80]. Ecotourism done right cannot only work, but it can work well. Marine mammals' welfare should, however, remain the main objective of this industry because, without these animals, there will be no ecotourism at all.

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Impacts of Terrestrial Animal Tourism

7

Zulima Tablado and Marcello D'Amico

Fig. 7.0 Giraffe (*Giraffa giraffa*) causing a traffic jam with tourist and private vehicles in a South African protected area. Photo credit Manuela González-Suárez

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7.1 Introduction

The human wish to experience nature and view wildlife is not new. For instance, bird watching trips and safaris to observe African mammals were already taking place in the 1800s [1]. Traditionally, terrestrial animal tourism has mainly focused on the observation of vertebrate species, with bird watching being the most popular activity worldwide [2]. Some other examples include observations of bears (*Ursus* spp.), wolves (*Canis lupus*), and lynx (*Lynx* spp.) in Europe and North America; large mammals in Africa (the "Big Five"); koala (*Phascolarctos cinereus*) and kangaroos (*Macropus* spp.) in Australia; and orang-utans (*Pongo* spp.) and Komodo dragon (*Varanus komodoensis*) in Asia [3]. Nowadays, however, the wildlife tourism market is also expanding towards the observation of invertebrates, such as butterflies and glow-worms [3].

Despite the long tradition of terrestrial animal tourism, it has expanded most and fastest in the last decades, and currently many countries, both developed and developing, are investing in these activities to attract visitors [4, 5]. This recent increase has been caused by the economic growth in some countries, accompanied by the development of technology and transportation. This has also led to improved accessibility of remote areas that were previously inaccessible to most people [6, 7]. On the other hand, there has also been an increase in environmental awareness and many countries have recognized the potential of wildlife viewing as a better option, in the long run, when compared to more destructive or consumptive tourism [6, 8]. This was, for example, the case of Kenya, where the government banned sport hunting and trophy trade in the 1970s, while encouraging ecotourism [9].

Terrestrial animal tourism is thus based on positive principles. It may create incentives for area protection and wildlife conservation, and offer more sustainable alternatives to resource exploitation, promote education and pro-environmental attitudes [2, 10–12], and even provide wellness benefits to tourists [13]. However, even though wildlife tourism may originate from good intentions, it is far from innocuous. If misused, it may even be counterproductive, threatening the sustainability of natural areas, wildlife populations, local communities, and even the tourism business itself.

Unfortunately, tourists and tour operators are sometimes unaware of the negative effects that they may cause. That is why the aim of this chapter is to enhance the general awareness about this topic by providing an overview of the main negative biological effects caused by terrestrial animal tourism. Additionally, we will describe some management actions that have been applied to mitigate those negative impacts, and will also examine the positive effects of this tourism. We hope that this information will inspire better practices in the future, maximizing wildlife protection while allowing the continuity of this type of tourism.

7.2 Adverse Effects of Terrestrial Animal Tourism

When first hearing about negative impacts of humans on wildlife, most people think of killing or direct injury of animals, such as that from hunting or the results of vehicular collisions. However, the spectrum of effects triggered by human presence

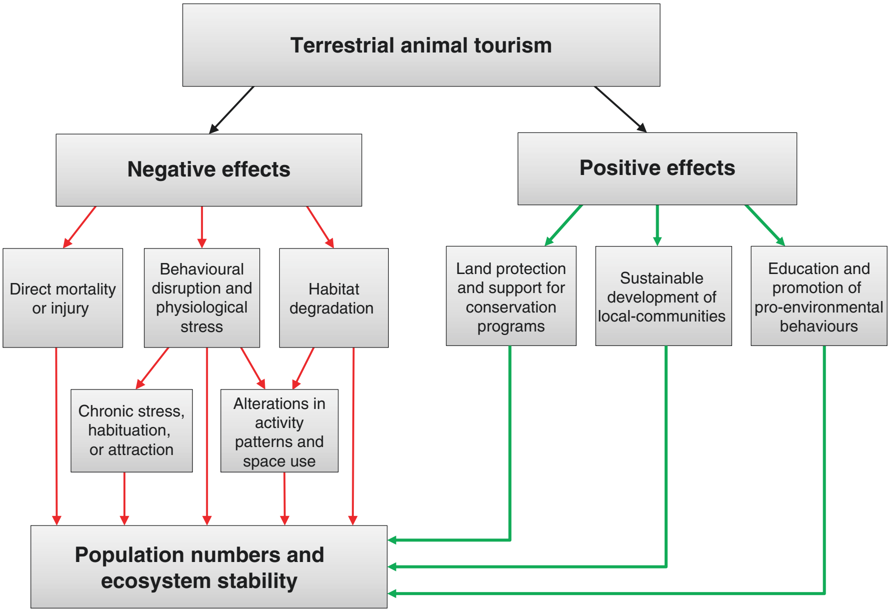

Fig. 7.1 Negative (*red*) and positive (*green*) impacts of terrestrial wildlife tourism

is much larger and not always evident. For instance, there may be changes in behavior, breeding success, or space use (see Fig. 7.1). Below we describe the main impacts of wildlife tourism.

7.2.1 Direct Mortality or Injury

Even when wildlife tourism aims to observe and not to damage animals, it can cause collateral mortality and injury, mainly through vehicular collisions and disease transmission (see also Chap. 3). Much wildlife tourism depends on the use of vehicles to reach and move through natural areas, as well as to directly view wildlife from, as in the case of the observation of elephants (*Loxodonta africana* and *Elephas maximus*), rhinos or large felids in Africa or India (Fig. 7.2) [14, 15]. Consequently, wildlife inhabiting famous national parks with many thousands of visitors per year are susceptible to being struck by cars. For instance, in one year, more than 2000 vertebrates (mostly amphibians) were killed on four roads of the Doñana Biosphere Reserve (Spain) [16]. Similarly, almost 2000 road-killed vertebrates were recorded in 1 year on a single road of Biebrza National Park, Poland [17], and almost 700 birds and mammals were killed by vehicles in Banff National Park (Canada) in about 2 years [18]. In response to these collisions, a variety of mitigation efforts have been instituted including the construction of fences next to roads to reduce the likelihood that black bears (*Ursus americanus*), wolves (*Canis lupus*), or moose (*Alces alces*) are hit by vehicles [19].

Fig. 7.2 Typical wildlife tourism in African savannah protected areas: self-driven safari. (**a**) African elephant (*Loxodonta africana*) on the road, in South African subtropical shrubland. Photo credit Margarita Mulero-Pázmány; (**b**) White rhinoceros (*Ceratotherium simum*) on the road, in South African semi-arid savanna-lowveld. Photo credit Marcello D'Amico

When animals successfully avoid vehicles, there can be additional negative consequences. For instance, tourist vehicles may separate young deer or antelopes from their mothers, and this increases the potential risk of predation or abandonment of the juveniles [20]. Roadkills in natural areas are one of the impacts directly threatening the persistence of some animal populations and subspecies. This is the case for Florida panthers (*Puma concolor coryi*), whose distribution is restricted to a reserve network that includes Big Cypress National Preserve, Everglades National Park, and the Florida Panther National Wildlife Refuge [21, 22] as well as for Iberian lynx (*Lynx pardinus*) in Doñana Biosphere Reserve (Spain) [23].

Furthermore, high numbers of roadkills can also lead to a decrease in the attractiveness of a given area. This is the case in Tasmania, where the roadkill impact is often highlighted by tourists and calls for mitigation measures are common in the popular press [24]. Not less important is the threat that collisions with wildlife pose for tourists' safety, especially in regions inhabited by large mammals such as Canada [25].

Terrestrial wildlife tourism can also unintentionally transmit diseases to wild animal populations. This impact is especially important, although not exclusive, for great apes, since their genetic similarity to humans makes them especially vulnerable to transmission. Disease transmission is considered as a serious threat for endangered ape populations [26]. In some African parks, such as the Uganda's Bwindi Impenetrable National Park or the Democratic Republic of Congo's Virunga National Park, tourists have often been reported closer than two meters from gorillas (*Gorilla* spp.) and sometimes make physical contact with them [27, 28]. Such behavior increases the risk of disease transmission to these highly endangered apes (see also Chap. 3). There have been indeed many cases of illnesses in apes associated with human respiratory and enteric diseases, such as influenza, measles, or *Salmonella* infections [26]. As wildlife tourism expands into previously pristine areas, the threat that "naïve" animals are exposed to human-transmitted pathogens increases.

7.2.2 Behavioral Disruption and Physiological Stress

Some less evident effects of wildlife tourism emerge from the fact that this type of tourism is founded on a basic contradiction, while humans want to see wild animals and go out of their way to encounter them; animals do not usually want to be seen by humans [29]. As discussed in detail in Chap. 2, animals may perceive humans as potential predators [30, 31], and therefore, when detecting human presence, immediately engage in risk-avoidance behaviors and stress responses in the same way as when encountering a predator. Sometimes animals respond to human presence by escaping or attacking [32]. Escape or panic reactions may result in direct self-injuries or damage to offspring, eggs, or other conspecifics [33]. This is especially important in the case of tourists visiting breeding-bird colonies, where the effects are maximized due to the high concentration of individuals [34, 35]. Other times, however, wildlife responses are subtle and include freezing or hiding [32, 36, 37]. Freezing is a reaction in which animals stay immobile and even may reduce some of their vital physiological activities to avoid being detected by predators [36, 38]. These subtle reactions are sometimes misinterpreted by ecotourists as tameness or lack of reaction, because they allow for closer approach.

By responding to tourists, animals may interrupt crucial activities such as foraging, resting, communicating, watching for predators, mating, and incubating or feeding their young [11, 34]. For example, in the national reserves and parks of Kenya, tourists have been reported to prevent lions (*Panthera leo*) from catching their prey [39] and to alter the cheetah (*Acinonyx jubatus*) feeding behavior [40]. Human disturbance has also been related to nest desertion in birds and crocodiles (*Crocodylus* spp.), with the consequent predation or chilling or overheating of the unattended eggs/offspring [41–43]. For instance, in the Murchison Falls National Park (Uganda), the approach of tourists caused Nile crocodile (*C. niloticus*) females to retreat into the water, leaving their nests unattended, which were then more likely to be preyed upon by predatory lizards and baboons (*Papio* spp.) [41]. In fact, researchers have found that some predators might specialize on attacking unattended prey, and may learn to follow humans around to take advantage of the disturbance they cause [44, 45].

Vehicles used both on roads and off-roads may disturb animals or otherwise disrupt their natural behavior. In Monfragüe Biosphere Reserve, in western Spain, the breeding success of cinereous vultures (*Aegypius monachus*) is lower in nests located near roads and unpaved tracks, due to the direct disturbance of vehicles on adults while they are brooding or feeding their nestlings [46]. In the Californian deserts, vehicles driving off-roads have been reported to induce the emergence of the western American spade-foot toads (*Scaphiopus couchii*) from their burrows during the wrong season, probably because the sound and vibrations produced by vehicles are similar to those of heavy rain [47]. The negative consequence of this is that toads are unnecessarily exposed to hot dry weather and to predators [47].

Moreover, the lack of behavioral reaction does not necessarily mean that wildlife is not stressed by the presence of tourists. As described in Chap. 2, encounters with humans may also trigger alterations in the internal physiology of animals, such as increases in heart rates, body temperature, and stress hormones [48–50]. These physiological stresses may go unnoticed by many wildlife tourists, since sometimes-distressed animals do not show external (behavioral) signs. For instance, in the Sheep River Wildlife Sanctuary human disturbances led to increases in bighorn sheep (*Ovis canadensis*) heart rate that was not accompanied by an obvious behavioral reaction [51]. The same occurs in the Galápagos Islands, where colonial breeding birds were thought to be "tame" because of the lack of behavioral response when visitors approached. However, studies monitoring the heart rates found that these animals, thought to be unaffected, were actually physiologically stressed by tourists [52]. Both immediate behavioral and physiological responses of wildlife to tourists are energetic costly and may reduce body condition. If disturbances occur during energetically demanding periods, like during breeding or migration, they may reduce reproductive success or even survival [53].

While these animal immediate reactions to people might seem harmless if they only occurred sporadically, this is rarely the case in terrestrial wildlife tourism. Areas used for wildlife tourism receive up to millions of tourists per year. For example, the total number of tourists visiting the Kruger National Park in the year 2014/2015 exceeded 1.6 million guests. This implies that wildlife is likely constantly exposed to disturbances, which might have more permanent consequences, such as the alteration of activity patterns, changes in the use of the available space, chronic levels of stress, or habituation to humans [34, 53–55].

7.2.3 Alterations in Activity Patterns and Space Use

Animals might avoid areas, either temporarily or permanently, where the presence of visitors is more frequent or intense. By doing so, humans alter animals' natural activity or space use patterns [53]. Changes in daily activity have been reported in Katmai National Park and Preserve (Alaska), where brown bears (*Ursus arctos*) using a stream close to a tourist lodge have become crepuscular, while bears using undisturbed streams are active throughout the day [56]. In Amboseli National Park (Kenya), cheetahs, which are naturally diurnal, also became more crepuscular to try to avoid disturbance by ecotourists [40].

Some studies have also shown that in the presence of humans, some bird species avoid areas that they would normally use for breeding or resting during migration [57]. This was also the case in Punta Suarez (Galápagos Islands), where, as a response to tourism, albatrosses (*Phoebastria irrorata*) have moved their nests away from tourist trails [40]. In the Sumatran Rain Forest, barking deer (*Muntiacus montanus*), sambar (*Rusa unicolor*), and rhino (*Dicerorhinus sumatrensis*) were also found to move away from areas with high human visitation [58]. Vehicle traffic, and related noise, vibrations, light, dust, or pollutants have been reported to have a strong effect on wildlife space use, resulting in animals avoiding areas near roads [59]. This is the case, for example, of a study that experimentally created an acoustic road in an otherwise forest without roads by broadcasting motorized-traffic noise [60]. This study demonstrated that road noise alone caused birds to avoid the areas adjacent to this phantom road.

A strategy often used in terrestrial animal tourism is to concentrate visitors around areas where wildlife aggregate to engage in crucial activities, such as foraging, drinking, breeding, or migrating [61, 62]. The purpose is to maximize tourist-wildlife encounters. For example, in protected areas of Africa, tourist facilities and viewpoints are placed near water holes where large mammals congregate to drink [63]. Similarly, visitation of breeding-bird colonies is also a common activity worldwide [62]. Unfortunately, these methods to maximize wildlife viewing may not be inconsequential. For example, the concentration of tourist facilities along ungulate migration routes in the Masai Mara Ecosystem (Kenya) has been found to alter their migration patterns and cause further habitat deterioration.

By these alterations of space use and activity, wildlife may be pushed into suboptimal habitats or forced to be active at otherwise costly times. This may prevent animals from acquiring needed resources and could reduce their body condition, interfere with reproduction, or reduce survival [53, 64]. Unfortunately, these effects are difficult to perceive by most people, including tourists and tour operators, since it is not always known what the natural spatial or activity patterns of the animals would be if humans were not there.

7.2.4 Chronic Stress, Habituation, or Attraction

If animals are not able or willing to avoid, permanently or temporarily, a tourist-frequented area, they will either suffer from chronically high levels of stress or they may habituate to humans (Chap. 2, [53]). Chronic stress occurs when the organs involved in producing stress hormones are overstimulated, resulting in high levels of stress hormones and a dysfunction of the stress-hormone production system [54, 65, 66]. As in the case of humans, this chronic stress affects animal health, reducing their ability to reproduce, and potentially interfering with survival [67, 68]. In the Amazonian rainforest hoatzin (*Opisthocomus hoazin*) chicks in areas with ecotourism had altered stress-hormone responses, lower body mass, and increased mortality compared to nondisturbed areas [69]. Wildlife tourism has also been shown to alter stress-hormone production and immunological responses to diseases in the Galápagos marine iguana (*Amblyrhynchus cristatus*) [70]. In the same way, a study in the Natural Park Montes do Invernadeiro (Spain) found, through the analyses of fecal samples, that tourism pressure was causing chronic elevation in stress hormones in the European pine marten (*Martes martes*) [71].

On the other hand, terrestrial animal tourism has often been reported to lead to animals reducing their response to humans through habituation. That is, after frequent nonthreatening exposures to humans, animals may learn that tourists are not predators and thus stop reacting to them [72]. Habituation can be accidental, by animals simply getting used to the passage of tourists, or deliberate, as reported in great ape tourism [73], where tour operators need to actively teach apes that humans are not dangerous before this tourism can even take place.

Even though habituation, at first sight, might seem an idyllic scenario for wildlife conservation and tourism, it has negative consequences for both animals and humans. For example, animals without a fear of humans may be more likely to be killed by wildlife poachers [74, 75]. This was seen in the Democratic Republic of Congo, where ex-poachers confirmed that habituated gorillas were more likely to be killed than the nonhabituated ones [76]. Habituated wildlife is also more likely to be hit by cars if they do not avoid roads [11, 77]. Similarly, closer approaches of tourists to habituated animals increase their vulnerability to disease transmission from humans [26, 78]. Moreover, wildlife not afraid of humans may venture outside of parks into neighboring rural areas, where they may cause serious human-wildlife conflicts. For instance, the gorillas of the Bwindi Impenetrable Forest (Uganda) have sometimes ventured outside the park, damaging nearby crops and becoming aggressive towards humans trying to chase them out of the fields [79]. Habituation, when not occurring equally for all species, can also alter ecological relationship among species. For example, in the Yellowstone Ecosystem (USA) female moose habituated to tourists choose to give birth in areas close to roads because of the lower presence of predators, which are warier towards humans [80]. This may lead to disruptions of the predator-prey relationships, with potential negative consequences for predators and imbalances in the ecosystem.

An extreme case of habituation occurs when wildlife not only loose fear to tourists but are attracted to them, mostly, but not exclusively, due to human-provided food resources (Fig. 7.3) [29]. Wildlife attraction to humans can also be unintentional or intentional. Unintentional attraction occurred, for example, in the case of grizzly bears in Yellowstone National Park (USA) that until the 1970s were attracted to the park's waste disposal sites [81]. On the other hand, wildlife are often intentionally attracted either by tourists themselves or by tour operators and park staff, as a tool to ensure predictable and longer-lasting encounters that facilitate photography [29]. Methods to attract wild animals range from providing them with food, establishing salt licks, providing artificial water sources, or broadcasting the calls of conspecifics to lure otherwise secretive birds into view [29, 74, 77, 82].

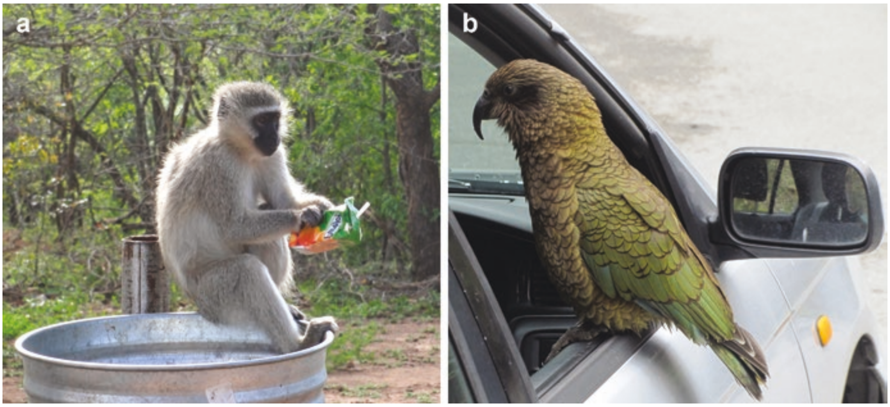

Fig. 7.3 Wildlife attraction towards human-provided food resources. (**a**) Vervet monkey (*Chlorocebus pygerythrus*) attracted to human waste, in a South African protected area. Photo credit Manuela González-Suárez; (**b**) Kea (*Nestor notabilis*) towards intentionally provided food, in a New Zealand National park. Photo credit Marcello D'Amico

In most cases, however, tourists are unaware of the negative consequences of these attraction methods. For instance, broadcasting bird songs or calls simulates a territorial intrusion, which may unnecessarily stress birds, making them waste energy in defending their territory and leave their nests unattended [2, 82]. By providing food or water to attract fauna, such as, for example, the creation of artificial water holes in Hwange National Park (Zimbabwe), unnatural and unsustainable concentrations of some species may be created [40]. This, in turn, has been shown to cause devastating damage to local vegetation, to destabilize animal communities, and to favor or attract relatively more aggressive individuals and species [40, 74]. In Aberdare National Park (Kenya), the use of salt to attract wildlife to a tourist lodge had a negative impact when salt leached into the soil and caused the death of vegetation in a nearby waterhole [40]. The provision of food by humans may also alter the natural feeding patterns of the animals, as observed in the Galápagos Islands, where animals became dependent on food supplied by tourist and lost the capacity to find natural food [83]. Finally, attracting and habituating wildlife can create dangers for both tourists and the animals [74]. For example, tourists have been killed by food-conditioned deer in Yosemite National Park (USA) and by dingoes (*Canis dingo*) on Fraser Island (Australia) [84]. In some cases, wildlife managers, seeking to prevent the spread of aggressive behaviors, shoot animals seen begging for food from visitors, as seen with the baboons in the Umfolozi Game Reserve (South Africa) or the elephants in Mana Pools National Park (Zimbabwe) [40, 85].

7.2.5 Habitat Degradation

In addition to the direct effects we discussed above, terrestrial animal tourism is often associated with habitat alterations [34]. For instance, vegetation clearing to construct accommodations, parking spaces, or picnic areas may lead to the disappearance of wildlife previously inhabiting those areas or the loss of those that depended on those areas during critical periods (e.g., during droughts or migration) [86]. This has been observed in Africa and North America where habitat alterations have disrupted migratory routes of wildebeest (*Connochaetes* spp.) and elk (*Cervus canadensis*), respectively [86]. Another example is the elimination of mature trees in tourist areas, which has had negative consequences for species such as marsupial (possums), owls, and snakes that use tree cavities for shelter and as breeding sites [87, 88]. Firewood collection around campgrounds also causes the loss of many bird nests in Yosemite National Park (USA) [89]. In some areas, such as the Thornybush Game Reserve (South Africa) shrubs are even deliberately cleared to facilitate viewing wildlife [29, 40], negatively affecting birds and mammals that rely on this understory to hide, feed, or breed [86, 90].

Often terrestrial wildlife tourism also depends on the construction of trails and roads to allow tourists to move through natural areas. These linear infrastructures break landscape connectivity and may reduce the likelihood of persistence for species unable to move across fragmented habitats [59, 86]. For example, in the Brazilian Amazon, movements of forest birds were found to be negatively affected by the lack of vegetation along roads, most likely because of the associated increase in exposure to predators [91]. Chemicals found in road pavement have also been shown to further elicit avoidance in some species, such as small mammals in Californian natural reserves [92]. The opposite effect, road attraction, has also been described, with for example scavengers using roads to feed on road-killed animals [93]. However, road attraction does not come without a risk, since it increases the probability of wildlife-vehicle collisions, as seen in Australian cassowaries (*Casuarius casuarius*) and wallabies attracted to human waste around roads [94, 95].

Soil deterioration is also an important impact of terrestrial animal tourism [11]. Vegetation trampling, soil compaction, and increased erosion have been described in roads, trails, and off-road tracks in many protected areas including Golden Gate Highlands National Park (South Africa) and several Kenyan National Parks [40, 96]. These effects lead to decreases in the numbers of invertebrates and young seedlings, land degradation, higher dust pollution, and water turbidity, with potential negative consequences for local biodiversity [59, 86]. Finally, wildlife tourism also has a negative influence through excessive use of local resources (such as water in Africa), garbage production, increases in water and light pollution, and spread of invasive species [40, 86, 97]. For example, mountain lions were seen to avoid artificial lights when moving through the San Ana Mountains in California [98] and increases of invasive plants were observed along roadsides in Wayne National Forest and Glacier National Park (USA) [99, 100].

7.3 Management of Negative Effects

The discussion above suggests that terrestrial animal tourism must be carefully managed to reduce potentially negative impacts of tourism. Mitigation measures mostly focus on managing visitor numbers and spatio-temporal distribution, improving tourist behavior by providing guidelines and education, and physically modifying the environment [40, 86]. For example, in Uganda, Rwanda, and the Democratic Republic of Congo, great ape tourism operates under strict limitations in numbers of visitors allowed per day and per year [40]. In Kruger National Park (South Africa), wildlife management measures also include reducing the size of rest camps and restricting vehicle numbers per road, among others [101]. Unfortunately, limitations on visitor numbers are not easy to enforce, as seen in the case of the Galápagos Islands National Park, where tourist numbers often largely exceed maximum values set by management plans [102]. The spatial and temporal distribution of tourists is also often managed by delimiting areas within parks where visitor access is restricted either permanently, such as wilderness areas in the core of biosphere reserves [103], or temporarily during sensitive periods [40, 86]. For instance, in Monteverde Cloud Forest Reserve (Costa Rica), trails close to quetzal (*Pharomachrus* spp.) nests are closed during breeding period [104]. A well-designed trail and road network is another useful tool to control where tourists go or not [40].

Additionally, guidelines have been established in many areas to improve visitor behavior and reduce their impact on wildlife. One of the main guidelines is the definition of minimum approaching distances. For example, native communities in the Northwest Territories (Canada) established minimum distances at which visitors must stay away from wolf dens and bird nests [40]. Similarly, in African parks, tourists should not approach closer than 5 m to gorillas [26]. Guidelines can also limit vehicle speed (Fig. 7.4a) and off-trail circulation to avoid wildlife-vehicle collisions, and habitat deterioration [86]. Wildlife feeding, both intentional and unintentional, is also often banned or managed (Fig. 7.4b), as in North American National parks, where feeding animals is prohibited, or in the Currumbin Bird Sanctuary (Australia) where trained staff allow feeding under highly controlled conditions [74].

Recommending or restricting the use of certain clothing or equipment by visitors is another way of minimizing their effects. For example, the use of surgical and respirator masks are recommended for ape tourism to avoid disease transmission from humans [105]. Some parks and tour operators, such as South African National parks and the International Association of Antarctic Tour Operators, are also now banning the use of drones (unmanned aerial systems), which, when used carelessly, may stress animals ([106, 107], Mulero-Pázmány et al. in press).

Some parks, like the Yankari Game Reserve (Nigeria), only allow guided tours [108]. This is positive because the presence of guides or rangers may control the distribution and inappropriate conducts of tourists [77]. Moreover, guides help educate visitors, which is a key management action to reduce tourism impact. Tourist behaviors and expectations can be modified by informing them about animal needs and threats, the guidelines and recommendations to reduce impacts, and by providing tourists with more realistic expectations about what they will experience [86]. This is sometimes implemented by putting up signs (Fig. 7.4c), through visitor information centers or by well-informed guides [40, 86]. For example, in the Masai Mara National Reserve (Kenya), drivers were trained to provide information about the park as a whole (and not only about the most popular species) in order to encourage tourists to visit different areas of the park and reduce congestion [109]. Likewise,

Fig. 7.4 Mitigation measures associated with wildlife tourism: (**a**) road sign for speed limitation and driver awareness, Doñana biological reserve, Spain, photo credit Nuno Negroes; (**b**) wildlife-proof waste container, especially focused on monkeys, in a South African protected area, photo credit Marcello D'Amico; (**c**) Signpost advising tourists of recommended behavioral conduct in a New Zealand nature reserve, photo credit Marcello D'Amico; (**d**) fencing aiming to prevent wildlife from leaving the protected area and avoid conflicts with humans, South Africa, photo credit Margarita Mulero-Pázmány

in a sanctuary for reintroduced native birds in New Zealand (Kapiti Island Nature Reserve), short talks are given to visitors to prevent harmful tourist behavior [110].

Finally, another way to manage tourism impact is to physically manipulate the environment. For instance, fences can be used to regulate tourist access to vulnerable bird colonies [111] or to prevent wildlife from leaving protected areas and thus avoiding conflicts with humans (Fig. 7.4d) [112]. Fences are also often placed along roads to decrease human risk of collision with large mammals. This measure also protects animal communities, especially when combined with wildlife road-crossing structures, as in Banff National Park (Canada) [16, 19]. Boardwalks and platforms are also sometimes built to reduce vegetation damage and to keep tourist away from sensitive wildlife areas [86]. Hides and visual shields, as used by birdwatchers or next to waterholes in some African parks, prevent animals from seeing tourists, consequently minimize wildlife stress [29, 86]. Sometimes it might be even necessary to perform habitat restoration to mitigate vegetation damages produced by visitors or to create refuge zones for wildlife outside of the tourism-contact zone [86].

7.4 Favorable Effects of Terrestrial Animal Tourism

Despite the above-mentioned negative effects of wildlife tourism, we do not intend to advocate against this recreation activity. Indeed, impacts of terrestrial animal tourism are often preferable to those of alternative land uses, such as logging, agriculture, or urban development [11]. Moreover, wildlife tourism also has positive effects (see Fig. 7.1). It may contribute to protect species and their ecosystems by creating a link between biodiversity conservation and financial benefits for local people in areas where economic opportunities are scarce [11, 113]. One of the most beneficial outcomes of terrestrial wildlife tourism is the creation of protected areas containing desired species and, sometimes, even the promotion of conservation-oriented management practices in privately owned land [2, 114]. Fees paid by tourists are partially meant to fund conservation programs, or at least to manage tourism-related damages [11, 114]. For example, Galápagos National Park contains eight endangered or critically endangered bird species whose persistence clearly depends on the protected status of this area [113]. Ecotourism revenue has also motivated the preservation of elephant habitat in Thailand [6]. Similarly, income from mountain gorilla tourism has been used in the Democratic Republic of Congo and Rwanda to conserve habitat and establish anti-poaching measures, which are essential for the protection of this species [11].

In addition, some operators and tourists contribute positively by participating in management, monitoring, or even research [11, 114]. In addition, ecotourism can have positive impacts on local communities as long as it is conducted with sensitivity towards local cultures and people [114]. For instance, in many cases people have been barred from using their traditional land in traditional ways (subsistence hunting, fishing, etc.) [40, 115, 116]. However, if the involvement of local people is done thoughtfully and with sensitivity to their needs, the involvement of local communities, through education and employment of local guides, may produce socio-economic changes that also support wildlife and nature protection [2, 114]. Finally, terrestrial animal tourism may have additional positive effects through the education and sensitization of visitors that promote pro-environmental and pro-animal welfare attitudes [12].

Conclusions

As we have seen in this chapter, terrestrial animal tourism can have important negative effects on wild animals and ecosystems. At the same time, the positive effects of wildlife tourism might make preferable to other land use alternatives. A positive balance between the cost and benefits will thus depend on the careful management of these activities and the resources they rely on. Future wildlife tourism should improve this management through the following lines of action: (1) establishing guidelines to minimize impacts, (2) encouraging long-term wildlife monitoring and research programs, (3) enhancing visitor education, and (4) controlling and enforcing appropriate conducts (see also Chap. 10 on best practices).

As seen above, guidelines could include limitations in numbers of visitors and vehicles approaching wildlife, especially during sensitive periods, increases in the use of low-impact structures, such as hides, and the maintenance of safe distances from fauna (e.g., by using scopes). Restricting the use of attracting techniques, such as feeding or call playbacks, is also among important guidelines. Wildlife tourism should also minimize habitat deterioration and favor the creation of core wilderness zones within protected areas. In addition, since many impacts go undetected in the absence of long-time series of data, more investment in monitoring and research is warranted. Ideally, this will not be restricted to large, emblematic animals, but also focus on other vulnerable species. Moreover, parks could further benefit local communities by hiring local people to implement these standardized monitoring programs, and even involving tour operators and tourists in data collection programs.

Tourist education is essential. Even though some tourists accept the furtive nature of wild species and appreciate the experience of being out there looking for wildlife, whether they find it or not, many tourists' expectations are too high. Tourists usually expect good, close-up views of wildlife and otherwise they are not satisfied with the experience. This is pushing the wildlife tourism industry into taking more and more measures to increase wildlife-viewing opportunities, with the negative effects mentioned above. These expectations result from a general lack of knowledge about wildlife requirements and behavior, together with past experiences from years of bad practices in wildlife tourism. For instance, people may have been exposed to wildlife feeding or other potentially stressful activities that attracted animals to facilitate observation. More efficient nature-interpretation programs are needed to help shift the expectation of seeing many animals to having more wild and natural experiences. Finally, education can also help promote tourism of other species, beyond charismatic megafauna.

Stronger regulations are, in some cases, needed to control unethical and harmful behaviors by tourists and tour operators. In the era of environmental consciousness, bioproducts, and green labels, there should be room to promote "greener" wildlife tourism according to these lines of action. It is also in operators and park managers best interest to preserve the resources on which their industries and livelihoods depend. Investment in greener services will benefit not only animal welfare and nature conservation, but also the future sustainability of terrestrial animal tourism.

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Impacts of Penguin Tourism

8

Ursula Ellenberg

Fig. 8.0 Penguin encounter on Goudier Island (Port Lockroy, Antarctic Peninsula) where regular, well-managed tourist visitation has led to the habituation of Gentoo penguins (*Pygoscelis papua*, photo credit: Rolf Stange, www.antarctic.eu)

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8.1 Introduction

Suddenly everyone turns around and looks at you. Facing them, your heart starts to race, unable to move, and you notice your body trembling. Hit by stage fright, you are trying to take a deep breath and tell yourself, don't worry. This is completely normal and is part of the natural "fight or flight" response most animals have evolved since it improves the chance of survival in the face of threat (see Chap. 2). But what a Cro-Magnon man needed to fight a cave bear is no longer what a modern person requires to give a good speech. Yet most of us are stuck with this uncomfortable expression of anxiety and fear when facing an audience.

Penguins with their tuxedo-like coloration and general demeanor are often looked upon as little show masters. While they may not be immediately related to humans, penguins have evolved a very similar "fight or flight" response. You could argue they too have stage fright since they often show physiological responses that may be entirely inappropriate when being exposed to a group of well-meaning tourists. But then, they don't really "show" how stressful this encounter is for them. Penguins don't blush. Thus their predicament often remains unnoticed by the excited observer.

It is a common misconception that penguins are little worried by the proximity of people. This is partly driven by close-up encounters with habituated penguins in a zoo setting, although even zoo penguins can perceive visitors as threatening [1]. In part, this misconception is driven by the apparent absence of overt behavioral responses of penguins to human visitation, particularly when they are breeding or molting.

Direct effects of tourism, such as number of roadkills associated with increasing traffic, are obvious. Concerned ecotourism ventures have made significant improvements by placing traffic signs and closing access roads after dark, two activities that have been shown to significantly reduce penguin roadkill (Peter Dann pers. comm., Fig. 8.1c). The Oamaru Blue Penguin Colony recently installed a penguin tunnel to mitigate traffic interactions (Fig. 8.1d–e). More impacting, yet often overlooked, are the subtle and cumulative effects of frequent, low-level human disturbance that can have negative consequences for individual nest-site choice, breeding success, or survival and which may ultimately affect the long-term persistence of breeding colonies [2, 3].

Few people are involved long enough with a given tourism operation to notice a decline in the abundance of the focal species or gradual alteration to habitats. And the tourists themselves will buy what they are sold, generally unaware of their impact. Some 20 years ago, scientists working on Magellanic penguins in Punta Tombo, Argentina, suggested that ecotourism—if well managed—may have negligible impact on penguin populations [4]. About the same time, researchers studying disturbance responses of Adélie penguins in Antarctica concluded that "tourism does adversely affect breeding penguins, almost irrespective of how 'well-behaved' the tourists are" [5].

So which of these positions is correct and where does this leave the responsible tourism manager or well-intentioned ecotourist? Today, we know that the impact of

Fig. 8.1 (**a**) Author recording a Humboldt penguin (*Spheniscus humboldti*) nest, Isla Choros, Chile [9], photo credit Thomas Mattern; (**b**) molting yellow-eyed penguin (*Megadyptes antipodes*), Otago Peninsula, New Zealand, photo credit Thomas Mattern; (**c**) penguin traffic sign, New Zealand, photo credit Oamaru Blue Penguin Colony; (**d**) little penguins (*Eudyptula minor*) using the road tunnel, Oamaru Blue Penguin Colony, New Zealand, photo credit Shelley Ogle; (**e**) road tunnel for little penguins, New Zealand, photo credit Oamaru Blue Penguin Colony; (**f**) prototype of an artificial egg for recording penguin heart rate, photo credit Thomas Mattern; (**g**) yellow-eyed penguin (*Megadyptes antipodes*) incubating an artificial egg during a disturbance experiment [10, 11], photo credit Ursula Ellenberg

human disturbance—including the type of disturbance (e.g., number or behavior of humans) and visibility (habitat and topography)—is species-specific and varies within a species in relation to individual temperament, sex, age, condition, current behavior, time of day, stage of breeding, penguin group size, distance to other penguins, and previous experience with humans. Thus, sustainable visitor management requires detailed site- and species-specific knowledge.

Ecotourism managers generally operate with good intentions, yet often lack the information required for effective visitor management decisions. Fortunately, recent years have seen the development of powerful research techniques to investigate human disturbance effects on penguins. As a result, an increasing number of ecotourism ventures are able to make informed decisions for anticipatory visitor management. The Australian Phillip Island Nature Parks, where applied research and management work hand in hand, can serve as a role model for evidence-informed ecotourism management. Managers increasingly realize that in the face of the current and predicted growth of nature-based tourism, it is important not only for ecological but also for economic sustainability to minimize any associated negative human impacts.

Life isn't easy for penguins these days. Many populations have declined substantially in the past two decades [6]. Currently, 11 of the world's 18 penguin species are listed as threatened [6, 7]. Habitat loss and degradation, fishing, pollution, and climate change perturb previously stable ecosystems and are critical threats to penguins [6] and other wildlife. Ecotourism ventures can be advocates and key communicators of such severe environmental issues. Yet, one has to keep in mind that human disturbance acts on top of the many other human-induced threats penguins must face in their daily struggle for survival. Fortunately, compared to other threats, human disturbance impact is relatively easily minimized, and local efforts will yield local rewards.

In the following, I will summarize the current state of knowledge of how human disturbance affects penguins and provide a general framework on potential disturbance effects. I believe that effective mitigation of the negative effects that may accompany ecotourism activity can arise only from detailed site- and species-specific research.

8.2 Encounters with Wild Penguins

While being based at the Universidad Católica Del Norte's seabird lab in Chile, I had the opportunity to be involved in counts of Humboldt penguins on seabird islands located in the Pacific Ocean off the southern fringes of the Atacama Desert. I had just arrived in Chile and was looking forward to finally seeing the penguins in the wild, which I knew so well from zoo visits.

Every year, penguins molt all their feathers over a 2–3-week period. They fatten up prior to molt by undertaking extensive foraging trips and then remain landlocked while they have "holes" in their plumage. They will shed last year's feathers and regrow a new fancy dive suit while living off their fat reserves and may lose up to half their body weight in the process. They look terrible during this sensitive time in their annual life cycle, a bit like an experiment involving a firecracker and a down pillow gone wrong (Fig. 8.1b).

The uninformed visitor sometimes believes the bird is sick and might require help. In areas where people encounter penguins in the wild, for example, many beaches in New Zealand, well-meaning tourists may pick up the supposedly sick bird to hand it over to rehabilitation centers which then have to deal with a perfectly healthy but completely stressed bird. Other people are more ignorant and take advantage of the penguin's precarious situation. They pose for selfies next to the poor birds so that they can post them on social media oblivious to the harm they are causing.

The annual molt is a particularly challenging time for penguins. Their limited energy reserves mean that any additional stressors, such as human approach, may push birds over the fine line that separates survival from starvation. And every year a number of penguins won't survive their annual molt. Still, in some species, the molt is a good time to monitor population numbers [8], since penguins have to stay on land and thus can be easily counted in open terrain.

My first Humboldt penguin (*Spheniscus humboldti*) encounter in the wild left a lasting impression. For the annual molt census, well aware how vulnerable penguins are during this period, we moved along the coastline on top of a cliff some 50 m above and out of sight of the molting birds. On arrival at our first counting site, my Chilean colleague signaled me to lie down on my belly. Ever so carefully, I poked my head and binoculars over the cliff's edge for my first penguin count. What I saw left me stunned. Although I was still well over 150 m from the first penguin group, some more alert individuals had already spotted me and started running further down the wide pebbly beach drawing more and more birds into their panic run. I quickly retreated, promising myself to be even more careful the next time.

My colleague wasn't surprised. "Yes, Humboldt penguins are extremely timid. Let's hope they quickly settle down. We should try it again from the rocky outcrop over there." For me, this was an eye-opener that ultimately leads to my first published study of penguins [9].

Humboldt penguins have been hunted by coastal communities for more than 11,000 years [12, 13]. No wonder they are among the most timid of all penguin species. Yet, even Humboldt penguins show little behavioral response to human approach when on the nest (1.8.2a). This is often mistaken for habituation. In fact, energy conservation and tending eggs or chicks under often-adverse environmental conditions have absolute priority.

8.3 Behavioral Responses to Human Disturbance

The distance at which human approach is tolerated behaviorally depends not only on species [14] but also on timing during the breeding cycle. For example, Adélie penguins (*Pygoscelis adeliae*) tending older chicks later in the season will flee when approached to within ~6 m, whereas when the chicks are young, parents will tolerate approach to within ~1 m [15], because young chicks are unable to maintain their body heat and require the presence of their parent for survival.

Birds not tied to a nest site show more marked avoidance behavior. A solitary human quietly standing 20 m from an Adélie penguin pathway caused commuting penguins to deviate up to 70 m off this path; and the deviated route was maintained for several hours after the person had left resulting in an estimated extra 840 penguin kilometers covered by the 12,000 birds on the track over a 10 h observation period [16]. Yellow-eyed penguins will delay even coming ashore if people are present at or near landing sites [17]. This disrupts chick feeding and can result in reduced fledging weights at frequently disturbed sites with detrimental consequences for survival and recruitment [18, 19].

There is evidence that chinstrap penguins (*Pygoscelis antarctica*) make risk-based assessments, treating humans as potential predators: thus, different types of human approach and varying proximity to subcolonies will induce different types of responses in nonbreeding birds [20]. In African penguins (*Spheniscus demersus*), a gradual approach (with regular stops) caused less disturbance than a person approaching at a steady pace [21]; and in Humboldt penguins, walking clearly past the bird (tangential approach) was less intrusive than a direct approach [9]. Emperor penguins (*Aptenodytes forsteri*) showed increased vigilance when exposed to helicopter overflights at 1000 m altitude, with 69% of chicks walking or running away from the source of disturbance [22]. Adélie penguins responded behaviorally to an approaching aircraft at up to 1.1 km from their colonies, and flight behavior lasted until the aircraft was more than 2.8 km away [15]. The potential impact of an aircraft varies among bird species and with the type of aircraft, speed and altitude, ambient environment, timing, duration, and frequency of exposure [23].

Visitor approach distances for ecotourism guidelines are often determined via quantification of overt behavioral reactions, such as percent of population fleeing. For sustainable tourism management, it must be taken into account that human disturbance may disrupt vital behaviors and induce freezing. Even without any overt behavioral reaction, human proximity can increase energy demands solely due to physiological stress responses [11, 24]. It is now well recognized that overt behavioral reactions, or lack of them, may be a poor guide to quantifying the impact of human proximity on wild animals.

8.4 Physiological Responses to Human Disturbance

On Macquarie Island, the established guideline of a 5 m minimum approach to penguins was assessed by researchers using dummy eggs to record heart rate responses of royal penguins (*Eudyptes schlegeli*) to human visitation. Without showing overt changes in behavior, the mean increase in heart rate in response to the careful approach of a single human was greater than that during direct overflight of a predatory skua (*Catharacta* sp.). To reduce the potential of cumulative impacts of repeated visitation, it was recommended that the setback distances around penguin colonies be increased from 5 to 30 m [25].

Elevated heart rate is part of the vertebrate stress response to stimuli that an animal perceives as being novel, challenging, or threatening. Heart rate increase can occur independently of any behavioral response. The heart rate of incubating birds is generally recorded using dummy eggs, these being one of the least impacting ways to study human disturbance effects currently available [11, 26] (Fig. 8.1f). Dummy eggs either use an infrared sensor [27] or sound [11] (Fig. 8.1g) to record heartbeat frequency. The egg is placed within a nest and incubated by the attending adult and, once parents swap incubation duties, its essentially undisturbed mate.

Using dummy eggs, researchers found that heart rates may double during human approach of nesting gentoo (*Pygoscelis papua*) [28], royal [25], Magellanic (*Spheniscus magellanicus*) [29], African (Marienne de Villier, pers. comm.), and king penguins (*Aptenodytes patagonicus*) in low disturbance areas [30, 31]. King penguins nesting close to a permanent station on Possession Island showed a significantly lower heart rate response to human approach than conspecifics breeding in less disturbed areas. It is currently unclear whether this is due to penguins having habituated to frequent human presence near the station or due to shyer individuals having left the highly disturbed area [30].

In comparison, Snares penguins (*Eudyptes robustus*) that were naïve to human presence showed little heart rate response to human visitation, and heart rate quickly dropped to pre-disturbance levels even during human stay as long as the person stayed motionless. In contrast, birds that had been exposed to frequent research and filming activities in the previous season appeared sensitized and responded significantly stronger to human approach [32]. Yellow-eyed penguins (*Megadyptes antipodes*) responded even more strongly and needed considerably more time to recover following human approach [10, 11].

Humboldt penguins showed a significant heart rate response to a single person, even when passing the nest at 150 m distance [9], and heart rates may triple during careful direct approach. Once the human had retreated out of sight, Humboldt penguins needed up to 30 min to recover with little evidence of habituation to even minor human disturbance [9]. The closely related Magellanic penguin appears more robust when exposed to human visitation; but even they show a significant physiological stress response to human presence [33–35].

An elevated heart rate response is only one manifestation of the vertebrate stress response, which is mediated by a release of “stress hormones”: corticosterone in birds, from the adrenocortical tissue (see Chap. 2). Short-term increases in circulating stress hormones are often beneficial and enable individuals to escape from, or cope with, challenging situations. However, longer-term elevation of stress hormones or the accumulating effects of frequent disturbance can result in higher susceptibility to disease, lower fertility, and reduced life expectancy [18, 34].

The measurement of stress hormones enables rapid assessment of environmental stress and therefore has become an important tool in conservation physiology [36]. In the first study of its kind, the hormonal stress response of Magellanic penguin chicks was examined, and researchers showed that newly hatched chicks in tourist-visited areas had higher corticosterone responses than newly hatched chicks at a neighboring undisturbed site [34].

The opposite was the case for adult Magellanic penguins, which showed lower hormonal stress responses at tourist-exposed sites compared to an undisturbed control area [35]. This difference may be due to shyer penguins leaving frequently disturbed areas or failing to reproduce [33]. On the other hand, penguins may habituate to repeated, predictable, low-level disturbance [10, 35].

In the case of the Magellanic penguins, the reduced stress response observed in tourist-exposed birds was due to a decreased capability of the adrenocortical tissue to secrete the stress hormone [35]. This may have disadvantages when individual survival depends on the ability to mount an adequate stress response, for instance, when having to escape from a predator or access energy stores in times of need.

Contrary to Magellanic penguins, yellow-eyed penguins exposed to unregulated tourism have been sensitized by human disturbance and overreact; that is, they show stronger stress responses compared to less disturbed conspecifics [11, 18]. Similarly, little penguins (*Eudyptula minor*) that had previously experienced handling at sites exposed to research and tourism activities responded more strongly compared to naïve birds from neighboring breeding areas although sample sizes were low and results not statistically significant [37]. To date, little is known about the factors that drive the habituation or sensitization of wildlife [10, 38]. Yet, this information is crucial for effective management of ecotourism.

Hormonal stress response typically is analyzed by using a standardized capture stress protocol and taking blood samples at certain intervals [39]. More recently, new low-impact methods to quantify levels of stress hormone in feathers or scats are becoming available. Stress hormone metabolites have already been quantified in scats of captive Adelie [40] and little penguins [41], and analyzing stress hormones in feathers has recently been established as a reliable, noninvasive physiological measure of stress in birds [42, 43] (Fig. 8.1b, note the pillow of molted feathers that is readily available for sampling).

Whereas corticosterone levels in blood or scats provide a snapshot of the level of stress at a particular time, corticosterone concentrations in feathers offer an integrated measure of the level of environmental stress over the weeks the feathers are grown. This promising new tool has already been successfully employed in gentoo penguins [44]. Currently, we are validating feather corticosterone levels in little penguins as potential low-impact method of monitoring environmental stress, including tourist visitation.

8.5 So What?

Much innovative science has gone into finding ways to measure the impact of human disturbance without the confounding effects of observer presence or manipulation. Modern technologies offer new tools for measuring penguin responses to disturbance via video surveillance, artificial eggs that act like heart rate monitors, or the assessment of stress hormone metabolites in scat or naturally shed feathers as cumulative measure of environmental stress. However, a critical question remains: So what? So what if the heart rate is elevated? That happens to me all the time. So what if some penguins show an increase in circulating stress hormone levels in response to human visitation? Does this have any consequences for the evolutionary fitness of individuals?

The challenge when measuring the impact of human disturbance is to distinguish between simple responses that, in isolation, may be inconsequential and actual impacts on individual fitness that require management action. Certainly, a single human visit cannot be that much of a problem, can it? Well, the answer is a clear "maybe." One has to keep in mind that nature-based tourism is booming, and it is the cumulative impact of repeated disturbance events that can have far-reaching consequences, including breeding failure and even death of individuals.

Having said this, even a one-off event can be devastating. For example, approximately 7000 king penguins died by asphyxiation on Macquarie Island when a single overflight by a Hercules aircraft caused a stampede [45, 46]. The deaths resulted from large numbers of fleeing penguins piling up on top of each other against a natural barrier at one edge of the colony. Although an extreme event, this illustrates that without any bad intentions much damage can be done.

However, it is the subtle, often overlooked effects of ecotourism activities that can accumulate and reduce the fitness of individual birds that are of greatest concern (Fig. 8.2). If enough individuals are affected, this will ultimately affect the breeding

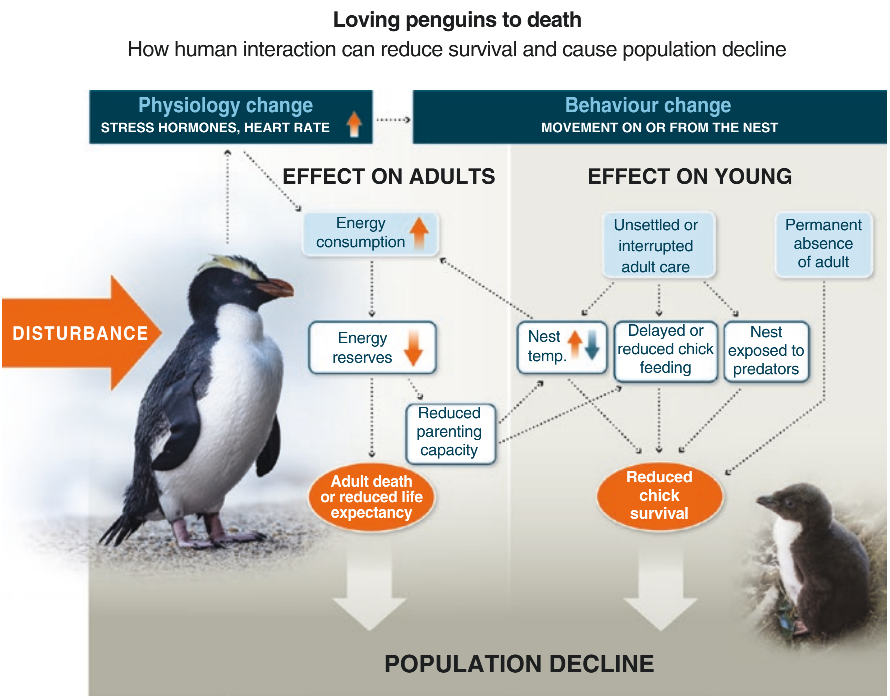

Fig. 8.2 The process through which human disturbance can cause death of individual penguins and ultimately population decline (Infographic developed by Ursula Ellenberg and Heather Kiley, photos supplied by Doug Gimesy and Thomas Mattern

population. Hence, rather than merely documenting stress responses, the challenge for studying human disturbance impacts is to quantify how the measured behavioral or physiological responses cumulatively affect an individual's probability of successful reproduction or survival.

8.6 Disturbance Impact on Distribution, Breeding Success, and Survival

Human disturbance is known to have caused reduced breeding success in a number of penguin species. On the Puñihuil Islands in southern Chile, unregulated tourism activities lead to increased incidence of nesting burrow collapse and a decline in numbers of both Humboldt and Magellanic penguins [47]. In New Zealand, human disturbance that pushes adults off their nests has caused increased predation of Fiordland penguin (*Eudyptes pachyrhynchus*) eggs and chicks by native weka (*Gallirallus australis*), a flightless rail endemic to New Zealand [48]. Further south, skuas or giant petrels (*Macronectes* sp.) take advantage of the distraction caused by human presence at penguin breeding areas [49, 50]. At Cape Crozier, Antarctica, penguin breeding groups that were reduced in size through human disturbance were unable to resist skua attacks and consequently were more vulnerable to predation [51].

Breeding failure may also be caused by more subtle means than destruction of nesting burrows or facilitation of predation. For example, human passage through low-density breeding areas of African penguins caused not only egg loss and the exodus of birds but prevented nest-site prospecting [52]. Similarly, human visits have adversely affected the recruitment of pre-breeding birds to Adélie penguin colonies [53]. In addition, ineffective brooding due to visitor presence may lead to loss of the clutch, retarded development of the embryos, or hypothermia of chicks [49]. Furthermore, greater energy demands on the adults arising from human disturbance may leave less food for the chicks [11, 18, 19].

Adélie penguin colonies exposed to recreational visits hatched only half the number of chicks compared to neighboring undisturbed areas, and chick survival was reduced by up to 80% at tourist sites [49]. Surprisingly, investigator disturbance had significantly less impact than tourist visitation. The investigator entered a colony for regular nest checks, which was thought likely to constitute a more intense disturbance event than tourists moving slowly around at 5 m distance from the colony's edge 2–4 times a day. The main reason for low reproductive success in the disturbed colonies was predation by skuas taking advantage of the distraction caused by human presence. Additional losses were thought to be due to cooling of eggs or chicks as a result of ineffective brooding during disturbance events. The results lead researchers to suggest that frequency of disturbance, rather than type of intrusion, may be the critical factor affecting breeding success [49].

Over the longer term, human disturbance can lead to declines in the number of breeding birds. This is best documented in Antarctica. At Cape Hallet, Adélie penguin numbers declined while the joint NZ-USA Antarctic base was in operation between 1959 and 1968, increasing again after the base was mothballed in 1973 [15]. At Cape Bird, Ross Island, breeding groups of Adélie penguins near a field station declined more than 50% over a 20-year period, even though the total population of the colony markedly increased due to locally favorable foraging conditions [54].

At breeding colonies in Wilkes Land, East Antarctica, Adélie penguin numbers increased by as much as 928%, with the exception of those at Shirley Island, near the Australian Casey Station [55]. Here, changes in distribution and reductions in mean breeding success due to human visitation are believed to have prevented any population increase [53]. Similarly, the drastic decline in numbers of breeding Adélie Penguin at Cape Royds in Antarctica between 1955 and 1963 is attributed to visitor disturbance [56]. Such historic accounts of population-level impacts often don't report on the details of the types and levels of human disturbance and visitor management.

However, it is the detailed species- and site-specific visitor management decisions that will determine the success or failure of an ecotourism venture. At Penguin Place in New Zealand where well-informed visitors watch yellow-eyed penguins at close range from hides and covered trenches, chick feeding rates and breeding success were unaffected [57], whereas under-regulated tourism at neighboring Sandfly Bay was associated with significantly reduced breeding success and lower fledgling weights [18]. At the latter site, penguin numbers have considerably declined over the last 20 years to the extent that penguin sightings can be no longer guaranteed.

Species that are perceived as more robust can also be negatively affected by human visitation. For example, the density of nest sites of the little penguin decreased with proximity to footpaths on Montague Island [58], and areas accessible to the general public in St. Kilda, Australia, sustained only half the number of breeding pairs per 20 m section of breakwater despite similar breeding habitat [59]. On the other hand, tourism impacts can be negligible even for sensitive species if visitors are managed appropriately. Breeding success of gentoo penguins appears unaffected by tourist visitation at Port Lockroy, one of the five most visited sites by tour ships on the Antarctic Peninsula, [60] (see Fig. 8.0).

It is important to note that even closely related species may respond differently to human disturbance [9]. Breeding success of Magellanic penguins was not affected in Punta Tombo, Argentina, where visitors can walk freely among nests and approach penguins to within a few meters of nest sites [61], whereas a Humboldt penguin colony exposed to visitors at close range had virtually no reproductive output [9] and has since ceased to exist.

Penguins will never lose their charm and will continue to attract increasing numbers of visitors. There is pressure from the tourism industry to increase visitor numbers at already established sites and to open up new areas for penguin viewing opportunities. Tourists, in turn, inspired by close-up pictures in wildlife documentaries, expect ever-closer access for penguin photo opportunities. Therefore, it is crucial to recognize any negative consequences of human activities sufficiently early, in order to mitigate their impacts on penguin populations and, thus, to manage tourist expectations.

8.7 Implications

Effective management decisions require information based on detailed site- and species-specific research. What might be an acceptable level of human visitation for one species may be detrimental to another species in a different setting. Consequently, there are no general "rules of thumb" for tourism management. Generic visitor guidelines, particularly those derived from visible reactions to humans, run the risk of allowing harmful impacts at both individual and population levels.

Visitors need to be considerate and avoid any sudden noise or movement that can aggravate their disturbance impact. Although tempting to some, tourists must refrain from touching birds irrespective of penguin behavior, which, as explained, is easily misunderstood.

Importantly, setback distances based on conservative estimates for one species may trigger significant physiological responses with associated fitness costs when applied to another species. In addition, individual stress-coping styles differ markedly even within the same species depending on a range of factors we are just beginning to appreciate. Habituation to human disturbance is not assured. There is still much to learn about the form and magnitude of stimuli that drive individual or interspecific tendencies for habituation or sensitization.

Current gaps in knowledge of human disturbance impacts on wildlife need to be filled urgently, since increasing pressure from ecotourism will not necessarily await the development of better guidelines. Tourism managers, conservation authorities, and researchers need to work hand in hand to develop anticipatory management guidelines that benefit both the penguins and the tourists that come to see them. Effectiveness of management decisions needs to be monitored, assessed, and, if necessary, revised. The long-term sustainability of ecotourism ventures relies on well-informed adaptive management strategies.

Conclusions

We all take an escape into the natural beauty of our wonderful world for granted and dream of energizing experiences in ever more remote locations. But there are a lot of us and ever-smaller numbers of penguins. We now know that even minor low-key human disturbance can accumulate, leading to potentially far-reaching impacts that act on top of other threats. Sustainable ecotourism requires comprehensive research to quantify human disturbance effects and inform the development of effective management guidelines that will enable us to enjoy the great outdoors without negative effects on resident wildlife.

So the next time you find yourself in front of an audience with your heart in your throat, wishing to be somewhere else, far away, spare a thought for the plight of the penguins that call these rugged southern shores their home. And when you are lucky enough to go and visit them, give them space, stay quiet, and try to be invisible. With a bit of effort and empathy, you may observe penguins doing their own thing, completely unaware of your presence (Fig. 8.3). And, trust me, this is an experience you will treasure for the rest of your life.

Fig. 8.3 Pair of Tawaki/Fiordland penguins (*Eudyptes pachyrhynchus*) peacefully preening on the New Zealand West Coast. Photo credit Ursula Ellenberg, www.tawaki-project.org

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How Ecotourism Affects Human Communities

9

Daniel Zacarias and Rafael Loyola

Fig. 9.0 Dining in the street, Puerto Ayora, Santa Cruz Island, Galápagos. About 80% of Galápagos residents are involved in the ecotourism industry that caters to tourists from around the world. Photo: Daniel T. Blumstein

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9.1 Introduction

Tourism has been flagged the new economic force for development [1, 2], especially for areas that are still struggling with poverty but are rich in natural resources that can be used for non-extractive uses. Under this paradigm, emerging and developing countries are willing to promote their wilderness and attract as many tourists as possible [3]. As a result, tourism has exponentially increased with ca. 1.184 billion people crossing international borders for leisure in 2015, 50 million more tourists than in the previous year [4]. Among several segments of tourism, ecotourism is becoming one of the most developed with estimates indicating a share of 10–15% of global tourism growth and more recently 30–40% [5, 6], equivalent to nearly 474 million travelers.

Since its inception in the 1970s, ecotourism has gained extensive interest among the scientific community (see Fig. 9.1), with research being directed toward most dimensions of the activity, such as environmental/ecological, economic, sociocultural, experiential, and policy/planning. Despite this extensive knowledge, little effort has been directed to summarize the potential implications of ecotourism to local communities and either the process or mechanisms of instigating local people to participate in natural resources management for visitation [7].

In this chapter, we aim to summarize existing knowledge on these issues by showing how local communities can benefit from ecotourism activities. However, we view these benefits from different perspectives and describe the different role of incentives as mechanisms to stimulate local people's participation. Apart from this general introduction, the chapter presents a broad literature review on the association between ecotourism and economic development at the community level and discusses the mechanisms of community engagement in conservation activities, with focus on incentives. Ultimately, this background knowledge is essential if we are to properly evaluate the relative costs of different ecotourist activities on the animals and plants that people seek to enjoy.

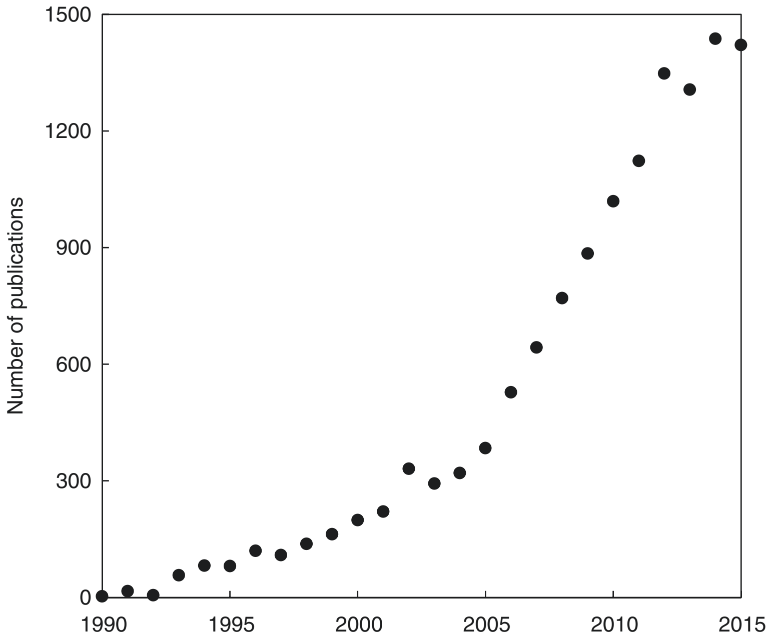

Fig. 9.1 Temporal trend in the number of publications about ecotourism, based on a search at the ISI/Web of Science Core Collection (https://webofknowledge.com) and Scopus (www.scopus.com) using the keyword *ecotourism* for the period 1945–2015. Only publications from 1990 on are shown

9.2 Tourism, Ecotourism, and Community Development

Tourism has been extensively criticized due to the negative effects of its development on the environmental and societal spheres. Most research indicated that despite generating revenue for the destination, tourism development is associated to habitat degradation, increased water and energy use, increased littering, disruption of local social values, social imbalances, and child labor and/or prostitution, among other negative impacts [8].

The idea that local human communities are not profiting from tourism, as a result of low economic gains and very high environmental and sociocultural costs, raised concerns over the usefulness of visitation. In addition, most tourism enterprises are developed as small islands in which local people are excluded or integrated as low-pay employees. In remote areas, tourism development also raises concerns over its impacts on protected areas and biodiversity conservation, mainly through road kills and wildlife habituation [9].

Since its inception, ecotourism has become a contradictory concept [10–12], and several definitions have derived from two broad schools of thought, namely, the school concerned with case studies on the impact of ecotourism and the school concerned with thematic studies illustrating issues regarding planning and development [13–15]. Nevertheless, ecotourism has gained enough power to survive in academia and policy-making to the point of being acknowledged as the green or modern version of tourism [11, 16] and a market tool for conservation [17, 18].

When introduced under the scope of pro-poor tourism [19], ecotourism can be understood as a strategy that focuses on increased economic benefits, noneconomic impacts, and policy processes [20] that, to a certain extent, should benefit local communities [11] (Fig. 9.2). Economic benefits of ecotourism include the expansion of business and employment opportunities. The noneconomic benefits include building capacity and the empowerment of poor people, as well as the mitigation of the environmental and sociocultural impacts of tourism on the local community. Finally, policy processes include building more supportive and planned frameworks that enhance participation of the local community in the decision-making process.

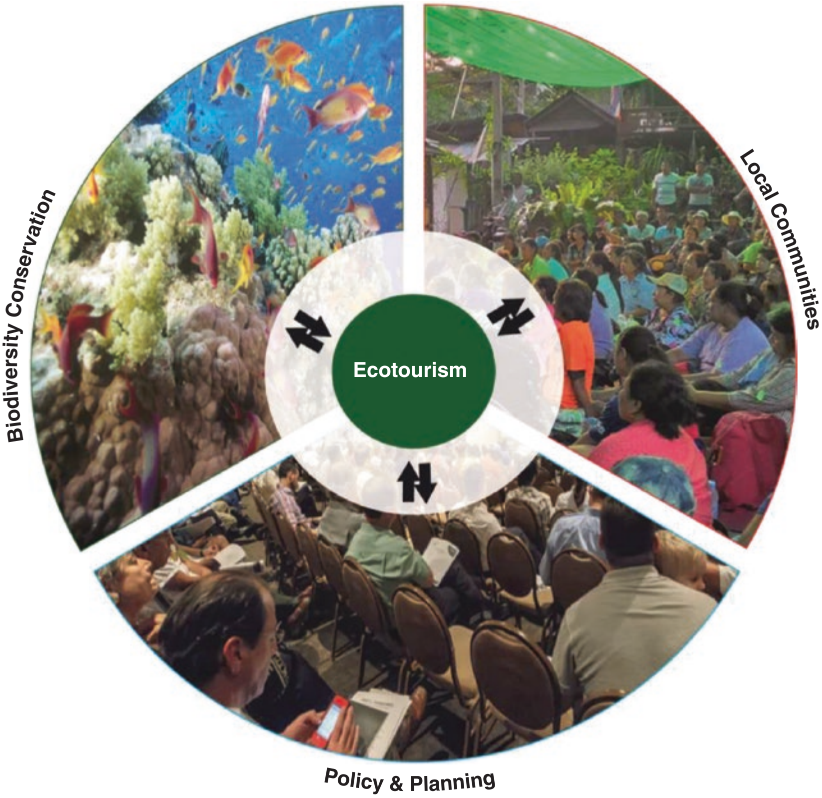

Fig. 9.2 The ecotourism paradigm (adapted from [10]). With appropriate management, ecotourism can help to achieve a balance between conservation and development through the promotion of synergistic relationships between natural areas, local populations, and tourism

The early history of protected areas and landscape management indicates that, in most cases, the government had to bear the costs of implementation, maintenance, and management of protected areas. This approach, based on the philosophy of conservation without people [21, 22], resulted in high social and economic costs and low conservation outcomes [23–25], calling for a new and more integrative approach that could incorporate local people into nature conservation. Despite the attempt to implement this strategy, people living in and around protected areas were still seen as contributors to environmental degradation [26]. In addition, local people's willingness to participate in biodiversity conservation and landscape protection depends, to some extent, on whether their basic needs are satisfied since they rely on natural resources for their survival [6, 10, 12, 16].

To cope with this problem, ecotourism has been suggested as an alternative to accommodate resource needs and resource protection. Many such ecotourism projects have been implemented worldwide, but the willingness of local people to participate in ecotourism is not straightforward because they already have their own practices and, in most cases, do not understand the benefits that may arise from ecotourism. In this regard, incentives are necessary to enhance community participation in conservation [27] and ensure biodiversity preservation in rural and remote areas where the government lacks resources to safeguard biodiversity conservation [28]. A vast array of mechanisms to ensure the success of ecotourism projects exists. Examples include the establishment and enforcement of laws and policies that protect biodiversity and discourage destruction, degradation, and fragmentation; integrated planning and decision-making for tourism development; establishment of incentives for conservation; prevention of loss of biodiversity through management, education, and awareness of local communities; and establishment of protected areas with mixed land-use areas [28].

The purpose of incentives is to change institutional and individual attitudes toward the environment, aiming to achieve conservation and sustainable use of biodiversity. Conservation incentives should aim to address the fundamental underlying causes of biodiversity loss and to encourage and enhance biodiversity conservation [28]. In the context of ecotourism, incentives are of three types: (1) direct payments to natural resource users to conserve natural resources; (2) certification of "eco-friendly products," in which production protects species and habitats and participates to improve the livelihoods of people in the same time; and (3) community-based or benefit-sharing ecotourism that gives local communities responsibility in conserving critical habitats and species [29].

9.3 Impacts of Ecotourism on Community Development

There are several ways to understand and describe the impact of ecotourism on local communities. Here, we describe the contribution of ecotourism to (1) the empowerment of local people, (2) the decision-making process, (3) the direct economic impacts on the local community, and (4) the role of ecotourism on educating people about biodiversity conservation.

9.3.1 The Role of Community-Based Ecotourism

As previously described, ecotourism does not simply imply the establishment of activities to attract visitors but also seeks to establish a productive base that allows local people to enjoy acceptable living standards. In many cases, the simple process of setting aside areas for visitation has created conflicts over resource ownership because local people were evicted from their land or had limited access to the resources that enabled their survival. In addition, there are many examples of communities that, with full access to natural resources, exploited these resources in an unsustainable fashion [30].

A mechanism to mitigate conflicts over the use of natural resources and biodiversity conservation, with the integration of local people, is the so-called community-based ecotourism (CBET), a "practice of tourism where the local community has a significant control over, and participation in its development and management, and a major percentage of the benefits stay within the community" [31]. As indicated by Kiss [32], CBET is "a form of community-based natural resource management … and a common element in integrated conservation and development projects." CBET empowers local people and improves resources stewardship [33, 34]. It was introduced under the premise that local people needed greater interest in the sustainable use of natural resources, have greater knowledge about the local ecological processes, and needed to participate more effectively in the management of local resources [35].

Successful examples of CBET projects that impact local communities' livelihoods exist all over the world. For example, a survey of CBET projects in Thailand indicated that local communities were involved in the process by being allowed to run businesses under the auspices of local institutions, serving as guides, porters, providing food and accommodation, and replacing private operators [36]. The Amadiba Horse and Hiking Trail on the South Africa's Wild Coast is another example of the effectiveness of CBET project. This South African project involved the Amadiba people in all aspects of the project including its planning, implementation, management, and decision-making while extensively contributed to biodiversity conservation and supported local livelihoods [20]. In Mozambique, a misguided allocation of a hunting concession to a foreign company restricted access to wildlife and natural resources for the people of Bawa (central province of Tete), creating a hostile and volatile relationship between local people and the tour operator [37, 38]. Through a CBET and natural resources management named the Tchuma-Tchato project, translated as *Our Wealth*, stakeholders shared the benefits from the use of natural resources. This was achieved by directly sharing the 33% of tax revenues between all stakeholders that was directed to local communities [37]. This experience was successful and resulted in behavioral change and turned local communities from resource users to resource protectors that directly benefited from their protection [37–39].

9.3.2 Ecotourism and Its Influence on Environmental Policy and Decision-Making

If adequately planned and implemented, ecotourism can shape policy and decision-making directly supporting conservation and environmental management and, indirectly, enhancing community livelihoods. Conservation of natural resources is a crucial step in securing long-term sustainability and safeguarding benefits for local people. But conservation is a multidisciplinary science that includes ecological aspects and also the sociopolitical, economic, legal, cultural, aesthetic, and spiritual dimensions [40–43]. As such, a balance between all these dimensions is necessary when planning for conservation and sustainable use of natural resources through ecotourism [44]. Another dimension that also needs to be addressed is that ecotourism can be developed in privately owned areas or community land, in which the costs of its development are usually distributed among those stakeholders. Under these circumstances, ensuring mutual benefits to those involved can be the most viable strategy.

The role of ecotourism in shaping policy and decision-making is widely documented. Sofield and Li [45] described the process of formulating an ecotourism policy for nature reserves in Yunnan, China, and revealed that the process was largely influenced by the need to accommodate competing interests and local cultural values, which negated *imported social values* [46] brought by foreigners. As a result, there was a need to integrate Western paradigms with native values and integrate the access to natural resources for the locals, incorporating ethnic cultural systems and conservation imperatives [45]. In Fiji, the development of a national ecotourism policy was mostly influenced by the need to increase revenue and share these benefits with the rural sector, allowing local people and communities to develop according to their own wishes. National ecotourism policy in Fiji also promoted conservation and environmental awareness by working with rural communities, nongovernmental organizations, and tourism associations [47].

9.3.3 Economic Benefits and Diversification Economies Through Ecotourism

The economic impact of ecotourism can be evaluated in several ways, but it is usually attained through user fees, concession fees, royalties, taxations, and donations. Apart from the direct payment for ecosystem management, other forms of the contribution of ecotourism to local communities are associated with the implementation of development interventions in the peripheral areas of endangered ecosystems. This redirects labor and capital away from activities that have potential for ecosystem degradation or encourages commercial activities that supply ecosystem services as joint products [48]—the Serengeti and Masai Mara ecotourism projects, in Africa, are some examples [49] (Fig. 9.3).

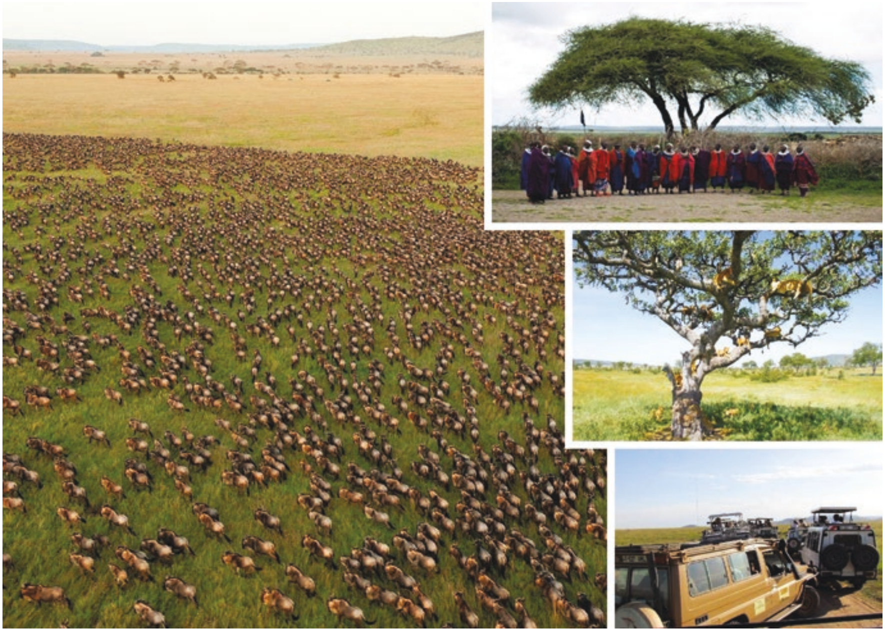

Fig. 9.3 The Serengeti/Masai Mara ecotourism landscape, describing the wealth of the ecosystem and the adoption of local people as tour guides. Direct payments to view wildlife are an important source of income for local people. All figures flagged as publicly available from Google Images

As indicated by the Zimbabwe Trust [50], the optimistic point of view considers that ecotourism presents an opportunity to stimulate local economies as an alternative to extractive industries and environmental degradation, meaning that increased tourism can increase local incomes and, in turn, create incentives for conservation. This framework results in complex economic linkages that transmit impacts from the directly affected agents to others in the local economy, in ways that may be nonlinear and shaped by resource constraints [50] (Fig. 9.4).

The understanding of the contribution of ecotourism to the improvement of local communities' livelihoods is not a straightforward process since most investments are directly felt at the country or ecosystem level and indirectly at the local people' level. Existing studies suggest that, despite the fact that conservation payment initiatives are neither a magic bullet nor an appropriate intervention for every site [48], its contribution in several places of the world should be acknowledged. For example, an analysis of cash flows for the Communal Areas Management Program for Indigenous Resources (CAMPFIRE) in Zimbabwe generated, yearly, revenues of ca. US$ 4000 per household [51], but most of these gains were distributed at the national level [52].

With growing trends toward sustainable or green products all over the world, suggesting that people are increasingly interested in the integration of social and environmental impacts of current patterns of production and consumption [17], another option of ecotourism is the certification of local products. Certification of bio-cultural products ensures that they are produced in a sustainable manner, which

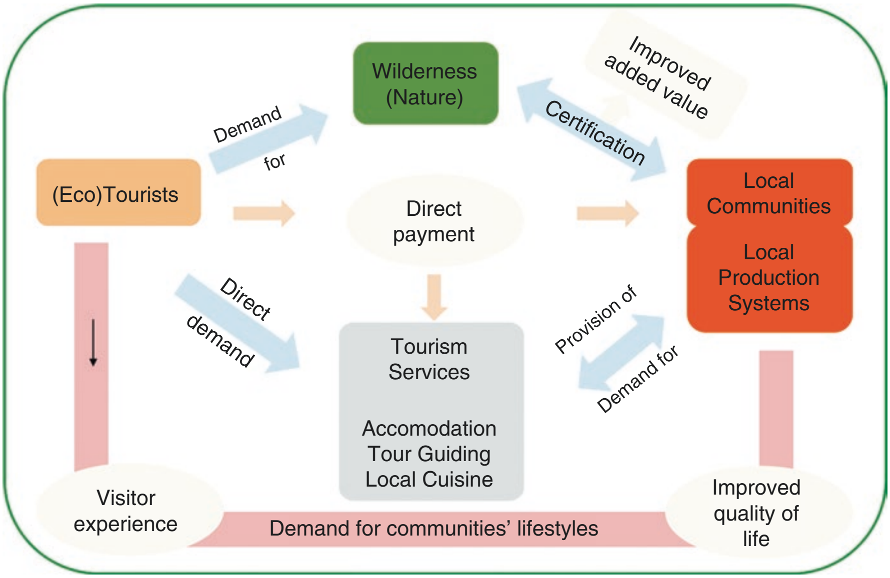

Fig. 9.4 Linkages between ecotourism activities and local economies (adapted from [50]). With a growing consciousness and desire for sustainability, ecotourists are increasingly interested in natural settings with adequate services. In the case of ecotourism, this demand needs to be supplied by local people, and those operations that are properly certified can have increased value, contributing both to visitor's satisfaction and the improvement of local communities' quality of life

raises their quality and price [53, 54]. As a result, local communities with certified bio-cultural products can have greater profits and engage with much power in natural resources conservation [55, 56]. For example, in Southeastern Tanzania, mismanagement and inequitable harvesting of valuable timber stocks penalized local communities. This fact has led to the implementation of a group certificate scheme that yielded more than US$ 100,000 per year and extensive community management against illegal and private loggers [57]. The result was an increase in wildlife sightings and an increase in ecotourism activities. In Indonesia, the certification of forest products has resulted in extensive conservation and protection of forests, at the same time maximizing land use, reducing social conflicts, and creating employment opportunities [58].

Certification is a segment that is growing substantially [59, 60], with over 60 programs already being implemented worldwide [61], the majority of them focused on environmental issues [62, 63] and very few incorporating sociocultural issues [17, 64]. Although certified forms of ecotourism and the income derived from these are minor in comparison to other forms of tourism, it is important to consider that this revenue is often available in peripheral areas with structural problems and can make greater contribution to livelihoods [17]. In addition, certification can enable ecotourism entrepreneurs to capture additional income from value-added products sold directly to consumers [63, 65, 66], at the same time indirectly contributing to the reduction of the CO_2 footprint associated with tourism [67–69].

9.3.4 Ecotourism as a Form of Education and Environmental Awareness

Ecotourism can raise awareness about the environment and educate the public about conservation. Early attempts have institutionalized ecotourism as a panacea for the conservation of natural resources, a view predominantly supported by the aspiration that ecotourism would provide financial gains that could be applied in natural area management. But this argument is difficult to translate into measurable outcomes, and, therefore, new alternatives have been established to understand the benefits of ecotourism.

As suggested by [70, 71], one easy way to elucidate the potential contribution of ecotourism is to understand how it improves awareness and attitudes toward biodiversity conservation, not only on local people but also on visitors. This approach argues that increasing participation in outdoor settings, when associated with adequate interpretation programs, can change behaviors and secure greater support for natural resource conservation. In the context of ecotourism, changing behavior is extremely important because it is often implemented in marginal rural land, in which local communities rely heavily on natural resources for their daily activities and there is a need to convert locals into resource conservationists.

From the visitors' side, several studies have demonstrated that educational programs in outdoor settings have positive impacts in shaping their attitudes and perception of conservation needs and goals [71]. Other authors [72, 73] showed that ecotourism shapes visitors' opinions toward conservation by enabling them to stand eye to eye with species, directly experience natural environments, and witness species engaging in their natural behavior, increasing their support toward wildlife conservation. A study conducted in Tangalooma, Australia, demonstrated that interaction with dolphins invoked in tourists a desire to change their behavior and become more environmentally responsible [72]. This indicated that the association of educational programs and the experience of interacting with species could be instrumental in changing visitors' behavior and enhance support to conservation programs (Fig. 9.5).

From the local community perspective, engagement in ecotourism has also been associated with an improvement of local people's attitudes and behavior toward environmental conservation. However, this was different from the visitors' perspective; behavior changes in local people are mostly a result of direct monetary gains that can compensate the reduction of free access to natural resources [74–77]. In addition, participation in ecotourism can strengthen community bonds [78–80]. This is of particular importance in the sense that social bonding can allow group members to overcome collective action dilemmas and promote cooperation toward common goals [78, 81–83]. Several experiences exist in the world regarding the role of social bonds in supporting collective actions. In Amazonian Brazil, for example, the Puxirum ecotourism project was implemented based on the need to build community integration, with the community members sharing opinions; having the same customs, culture, and identity; and making decisions jointly over small or major themes on a daily basis [78, 82]. Community collaboration in ecotourism occurs when the community is actively involved in the design and

Fig. 9.5 The Tangalooma ecotourism community project in Australia, an example of how ecotourism can be an important tool for promoting environmental and cultural awareness of their visitors. All figures are publicly available from Google Images

development of an ecotourism project, resulting in an increased environmental awareness [84]. By doing so, community leaders develop and support programs for families and children to learn more about environmental conservation and preservation.

9.4 Discussion and Final Remarks

The planet is amidst one of its most worrying environmental crisis, with continuous human population growth, increasing demand for natural resources, and an increasing number of species at risk of extinction. Under these circumstances, the need to save natural areas and species is a must, and many efforts are being undertaken around the world. But, these conservation efforts are still not effective because they are impaired by several factors, including the need to ensure the survival of poor local communities in rural areas (whom rely heavily on natural resources for their survival [16, 18, 27]), because most pristine areas are remote and difficult to maintain through governmentally established protected areas [16], and because most rural lands needing protection are privately owned and often susceptible to be utilized for other purposes rather than conservation [85, 86].

That said, ecotourism has been considered a good alternative, especially when considering the need to balance controversial land uses [44, 87–89]. However, the ecotourism concept has not yet granted consensus in academia or among practitioners, with several views considering this activity ineffective in meeting conservation goals and improving communities' quality of life [7]. Nonetheless, several examples exist around the world illustrating that, with appropriate planning and management, ecotourism can be a multifaceted, beneficial alternative.

The concept of ecotourism has different meanings, and its implementation strategies vary from region to region where it is applied. This is most notable when viewed from the perspective of the North-South debate associated with natural resources management [90, 91]. This debate focuses on the equalities and inequalities associated with power management in natural resources conservation, in which poor countries (Southern) with valuable species of flora and fauna are regarded as the main ones responsible for their conservation. They act as trustees on behalf of their communities [92], while most of the planning, control, and economic benefits are held by actors from developed (Northern) countries [93, 94].

Under this paradigm, ecotourism is constructed as a transnational link between tourism in developed countries and nature in developing countries [93], in most cases connecting networks of private businesses while promoting Western environmentalism that legitimates these businesses. As a result, some authors argue that ecotourism in the South can be seen as a sort of neocolonial system that extirpates local resources in favor of transnational international business [95, 96]. In addition, despite the fact that ecotourism has been created as a strategy to empower local communities [3, 8, 32], its rise, in most cases, creates conditions for the persistence of unequal powers, where small and external groups of stakeholders might marginalize local communities [94].

Throughout this chapter, we have demonstrated that ecotourism can promote conservation, raise environmental awareness, empower local people, and provide economic benefits to local communities. These facts, however, do not mean that ecotourism is completely beneficial. Indeed, not all communities involved in ecotourism benefit from the activity. Several aspects impair this understanding, ranging from misinterpretations of the concept, opposing views and interests across regions, and the inequalities in benefit sharing among people at the community level. As indicated by [97, 98]:

> *the North and South have very different views, need and priorities in respect of the process of globalization, and especially with regard to natural resource use. The close relationship between natural resources use and economic growth makes debates about environmental protection or natural resource use a complex task of reconciling largely opposing positions. Usually rich in natural resources, with growing populations and lagging behind on the road to development and industrialization, the South's priorities lie in eliminating poverty and reducing a taxing international debt. The South zealously guards the principle of sovereignty over its natural resources and is wary of engaging in environmental debates specifies by the North which, in the South's view, seeks to continue its affluent lifestyle while blocking the South's right to develop* [97].

These different views give rise to different interpretations of ecotourism in which developed countries create a belief that "by importing natural resources and exporting sink capacity demand and environmental costs, are more sustainable, as their consumption rates are not tightly linked to domestic environmental conditions" .

Though ecotourism does provide economic benefits to local communities, as we indicated earlier (see Sects. 9.3.1 and 9.3.3), there are concerns associated with this (see Table 9.1). For example, it has been considered that ecotourism might lead to local disempowerment [99] because tourism dollars can create wealth stratification, in which local leaders might receive more benefits than the remaining members of the community in the form of privileges [87, 94]. The alternative is the incorporation of tourism as a community-based enterprise in which all community members are involved in the decision-making process, advised on the structure of the project, and are aware of any possible concerns that might arise [18, 89]. Under the North-South debate, and the different perspectives between rich and poor countries, it is important to acknowledge that ecotourism is still viewed in most poor countries as a policy of eco-imperialism that restrains their sovereignty over natural resources [43, 44, 92]. This view is still dominant in the context of natural resources use and management, and in ecotourism projects, it is maintained by the fact that most tourism enterprises are a result of Western investments that flow their profits back to these countries, but export their impacts on developing countries [18, 94, 100].

From the range of opportunities created by ecotourism, direct payments have been identified as one of the most important. Under this perspective, local residents can be employed by ecotourism projects in the building, maintenance, and operation of hotels and the supply of goods and services [94]. The latter has been advocated in the last years, and several certification programs are already being implemented. Unfortunately, differing perspectives on natural resources use and legislative impairment dictate that ecotourism projects situated in developing and developed countries be of different certification standards [17, 62, 63]. Certified local products are considered to have better value added and can be a source of income directly paid to local producers and have greater conservation value. However, certification programs, especially in developing countries, are value dominated, where the economic-conservation paradigm often overrides the sociocultural paradigm [18]. This is certainly due to the fact that social standards are ambiguous and assessment methods are inconsistent and open to interpretation [61–63].

In conclusion, when properly designed, implemented, and managed, ecotourism can help balance biodiversity conservation and community needs, enabling sustainable utilization of the community resource base, and can empower local communities by improving their sense of ownership over the use of natural resources. And, ecotourism can support funding for conservation and scientific research and promote cooperation between countries. Finally, ecotourism can be a mechanism to improve environmental awareness of visitors and local people, educating the public and contributing to improved social well-being.

Table 9.1 Framework for determining the impacts of ecotourism initiatives on local communities

Typology	Signs of empowerment	Signs of disempowerment
Economic empowerment	Ecotourism brings lasting economic gains to a local community. Cash earned is shared between many households in the community. There are visible signs of improvements from the cash that is earned (e.g., improved water systems and houses made of more permanent materials)	Ecotourism merely results in small, spasmodic cash gains for a local community. Most profits go to local elites, outside operators, government agencies, etc. Only a few individuals or families gain direct financial benefits from ecotourism, while others cannot find a way to share in these economic benefits because they lack capital and/or appropriate skills
Psychological empowerment	Self-esteem of many community members is enhanced because of outside recognition of the uniqueness and value of their culture, their natural resources, and their traditional knowledge. Increasing confidence of community members leads them to seek out further education and training opportunities. Access to employment and cash leads to an increase in status for traditionally low-status sectors of society (e.g., women and youths)	Many people have not shared in the benefits of ecotourism, yet they may face hardships because of reduced access to the resources of a protected area. They are thus confused, frustrated, disinterested, or disillusioned with the initiative
Social empowerment	Ecotourism maintains or enhances the local community's equilibrium. Community cohesion is improved as individuals and families work together to build a successful ecotourism venture. Some funds raised are used for community development purposes (e.g., to build schools or improve roads)	Disharmony and social decay. Many in the community take on outside values and lose respect for traditional culture and for elders. Disadvantaged groups (e.g., women) bear the brunt of problems associated with the ecotourism initiative and fail to share equitably in its benefits. Rather than cooperating, individuals, families, and ethnic or socioeconomic groups compete with each other for the perceived benefits of ecotourism. Resentment and jealousy are commonplace
Political empowerment	The community's political structure, which fairly represents the needs and interests of all community groups, provides a forum through which people can raise questions relating to the ecotourism venture and have their concerns dealt with. Agencies initiating or implementing the ecotourism venture to seek out the opinions of community groups (including special interest groups of women, youths, and other socially disadvantaged groups) and provide opportunities for them to be represented on decision-making bodies (e.g., the Wildlife Park Board)	The community has an autocratic and/or self-interested leadership. Agencies initiating or implementing the ecotourism venture treat communities as passive beneficiaries, failing to involve them in decision-making. Thus, the majority of community members feel they have little or no say over whether the ecotourism initiative operates or the way in which it operates

Source: Adapted from [101]

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Best Practices Toward Sustainable Ecotourism

10

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Fig. 10.0 Burrowing owls (*Athene cunicularia*), found throughout North and South America, are often quite tolerant of humans. Photo credit Diogo S. M. Samia

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10.1 Introduction

When entering a natural environment, ecotourists and wildlife operators must be aware they are entering habitats that are home to millions of individual organisms. Ecotourists are guests in these environments where residents must acquire resources, avoid predation and parasitism, and safely rest and reproduce. Each of these basic activities has been honed to efficiency by generations of natural selection to work well in that specific environment. Changes in the environment, such as those caused by human visitation and tourism activities, can create mismatches between what the organisms are adapted to and the environment, creating novel challenges for the organisms that call it home.

Often when we think about an ecotourist destination, we immediately think of the charismatic species—the large terrestrial and aquatic vertebrates that are commonly featured in photographs and in the public media [1]. However, these species usually represent just a tiny portion of any ecological community [2–4]. Most of the species richness and abundance in an ecosystem is composed of small vertebrates (e.g., small rodents, amphibians, fishes), invertebrates (e.g., arthropods, mollusks, worms), plants, fungi, bacteria, and viruses—all of which play vital roles in ecosystem functioning.

The species in an ecosystem are connected by a complex and dynamic interaction network [5], which includes fundamental ecological processes such as predation (some species eat others), competition (species which compete for access to resources), parasitism (some species benefit at the expense of others), and mutualism (species that work together to create mutual benefits). This interdependence implies that fluctuation in populations of one or more species (e.g., through extinction of a parasite or of a top predator) can trigger a cascade of effects that may compromise other species [6, 7], change the structure and dynamics of the ecological community [8, 9], or even threaten ecosystem functions, processes, and environmental services [10–12].

Importantly, these intricate and interdependent processes are all around us when we are hiking, biking, snorkeling, whale watching, or just sitting on a boulder enjoying the sunset. The uniquely new thing in remote parks and protected areas is often us, humans, along with our set of novel accessories. We bring with us new stimuli (motor noises, lights, etc.) that animals may have no ecological or evolutionary experience with because, unlike the ecosystems that we encounter in our backyards and cities, many of these species and their interactions have not evolved with human activity. Thus, in these places, even seemingly benign activities can have considerable impacts.

For some species, human activities create a sudden disturbance from which animals flee to avoid potentially detrimental effects. Other species may appear unaffected, ignoring or seemingly tolerating human activity. However, it is important to remember that even species that appear tolerant of humans may still experience subtle physiological or ecological changes, as many examples in previous chapters have illustrated. And, while subtle changes in behavior and physiology do not always alter the structure and dynamics of natural populations and communities or ecosystem health, they may indicate that human activity is not entirely benign. Indeed, ecotourism may be the additional stressor that, when combined with other stressors (habitat degradation, climate change, etc.), triggers harmful effects on biodiversity and environments. Thus, we should adopt the precautionary principle, and our goal should be to limit potentially deleterious effects of ecotourism and, by doing so, support population viability and ecological sustainability.

How can we reduce potentially negative effects while maintaining the beneficial outcomes of ecotourism for conservation and human community development? This is a key question. Well-managed ecotourism can prevent destruction of wildlife and their habitats by deterring illegal hunting, illegal logging, and urban development while promoting education and pro-environmental behavior in the tourists. Ecotourism can also benefit human local communities by preserving their cultures and providing revenue and thus incentives for nature conservation. By doing so we may ultimately transform human communities from consumers to stewards of their natural environment. The challenge is getting the balance right, and the key to this is developing and applying best practices that reduce any negative impacts of tourist activities.

In this chapter, most of the book's authors worked together to suggest a number of best practices for ecotourism (Table 10.1). We tried to combine our insights from writing the other chapters to provide scientifically sound recommendations to better meet the three pillars of ecotourism—environmental, economic, and social [13, 14]. Because this book focuses on the evaluation of biological ecotourism impacts, we have placed a greater emphasis on recommendations related to the environmental dimension of ecotourism. However, we also considered the economic and social aspects of ecotourism, as shown by the first category of recommended best practices of our list (see Table 10.1).

This list is clearly not exhaustive. Other lists and other discussions of best practices can be found elsewhere (e.g., [15–20]), and we encourage ecotourists and ecotourism managers and operators to become familiar with them. Here, however, we provide updated recommendations based on the latest scientific knowledge of ecotourism impacts. The list comprises best practices to integrate the local human populations with ecotourism development and maintenance, to advance ecotourism management that draws upon multidisciplinary scientific knowledge, and to design policy and practices that reduce impacts on wildlife while promoting long-term ecosystem sustainability.

Table 10.1 Best practices for ecotourism

Recommended best practice	Reasons for recommendation	Empirical examples of reasons for recommendation
1. Encourage community-based tourism as the preferred form of ecotourism	Integrating local communities in the design and maintenance of an ecotourism project ensures more socially sustainable practices Promotes a more stable and sustainable relationship between local people and tour operators Creates employment opportunities for local communities (e.g., building, maintenance and operation of hotels, and the supply of goods and services) and promotes a sense of belonging in the local population From the range of opportunities created by ecotourism, direct payments to local communities have been identified as one of the most important Reduces the chances of wealth stratification in which local leaders receive more benefits than the remaining members of the community	A survey of community-based ecotourism projects in Thailand indicated that local communities were involved running businesses under the auspices of local institutions, serving as guides and porters, providing food and accommodation, and replacing private operators [21] In the Tchuma-Tchato project of Mozambique, 33% of tax revenue was shared between all stakeholders and was directed to local communities [22]. This changed the perspective of citizens and transformed local communities from resource users to resource protectors [22–24]
2. Reduce the likelihood that local communities become financially overdependent on ecotourism	Fluctuations in climate, currency exchange rate, and political and social conditions can influence ecotourist visitation rates Reduces the economic impact on a local community caused by some industries monopolizing aspects of ecotourism (e.g., hotels and airlines at some destinations) Local communities with certified bio-cultural products can have greater profits and be more effective in natural resource conservation [25, 26]	Human local communities in cold polar regions, an extremely threatened area because of global warming, are increasingly dependent on the jobs, income, and income generated by ecotourism, especially marine mammal tourism. For example, the polar bear tourism industry in Churchill, Canada, has rapidly grown into a $2 million/year industry since the 1970s [27] In Southeastern Tanzania, mismanagement and inequitable harvesting of timber stocks penalized local communities. This led to the implementation of a group certification scheme that yielded more than US$100,000 per year and extensive community management against illegal and private loggers [28], which in turn resulted in an increase in wildlife sightings and an increase in ecotourism activities Beyond creating revenue for a local community, bio-cultural certification has indirectly contributed to the reduction of the CO_2 footprint associated with tourism [29–31]

3. Promote partnerships with a multidisciplinary body of scientists, integrating them in all stages of an ecotourism project	Acquisition of updated and scientifically sound knowledge concerning the environmental, economic, and social impacts of ecotourism and how to mitigate them should help to design low-impact, sustainable practices Monitoring of wildlife and local human populations permits a dynamic decision-making process Minimizes labor costs because scientists and students often have other sources of support Trains students and volunteers and creates skilled labor in the local population Increases the chances of developing public policies to protect the area as new scientific evidence is accumulated	A cost-benefit analysis of a three-way partnership between conservation biologists (the Tambopata Macaw Project, Peru), an ecotourism operator (Rainforest Expeditions), and a volunteer-recruiting NGO (the Earthwatch Institute) was conducted [32]. Researchers provided training, volunteers, and supervision and offered research presentations to ecotourists. In turn, researchers received funding, transportation, food, lodging, and volunteers to help with gathering data. At the end, all partners benefited financially from this association and by protecting the clay lick that provided key resources for macaws [32]. The project enhanced the sustainability of the ecotourism site
4. Promote partnerships between the ecotourism project and eco-friendly and socially responsible companies	Some consider ecotourism as an oxymoron [33, 34] because ecotourists usually have to travel long distances with transportation that contaminates the environments and contributes to global climate change and because ecotourists often have to stay in eco-unfriendly hotels and resorts [35]	It is estimated that tourism (transport and activities) accounted for 5% of global anthropogenic CO_2 emissions in 2005 [36] Only 47% of ecotourism travel companies licensed by Galápagos National Park purchases carbon offsets or engages in carbon neutral policies [37] Many tourist camps in the Okavango Delta depend on borehole water, and their waste water and sewage sludge contaminate the groundwater [38]

(continued)

Table 10.1 (continued)

Recommended best practice	Reasons for recommendation	Empirical examples of reasons for recommendation
5. Promote "ecological network thinking" in all stakeholders, from decision-makers to ecotourists, through environmental education and integrated planning of all ecotourism activities	Organisms in an ecosystem are connected by a complex and dynamic network of ecological interactions (e.g., the trophic relationships between predators and prey and the relationships between pollinators and plants) [39, 40] Many studies show how disturbance of a few species, interactions, or resources can trigger cascading effects across species leading to extinctions of other species. Thus, minor disturbance events may affect the entire community or ecosystem, particularly if such disturbance impacts keystone species or keystone interactions [11, 41, 42]	The eradication of gray wolves (*Canis lupus*) from Yellowstone National Park by the mid-1920s led to an increase in elk (*Cervus elaphus*) which grazed in the open areas close to rivers, an area previously avoided because of the greater vulnerability to wolf attacks [43]. The consequence was that elk overgrazed the vegetation along the rivers, which triggered a cascade of events such as changes in species composition and abundance, which led to visible and biologically important landscape modifications [43, 44]. Consumption of Pacific salmon (*Oncorhynchus* spp.) by brown bears (*Ursus arctos*) is responsible for up to 24% of the nitrogen influx in riparian ecosystems in southwestern Alaska—an iconic example of keystone interaction [45] A theoretical model validated with data of a natural food web found that 80% of the extinctions in a community did not occur in the species in which the mortality rate was manipulated but rather in another species directly or indirectly connected to it [46]
6. Encourage national accreditation of the natural area tourism based on international standards while respecting idiosyncrasies of each region or country	Not all tourism in natural environments is ecotourism Many recreational companies operating in natural places are accused of marketing their tourism as "eco" while not meeting the environmental, economic, and social responsibilities required for an ecotourism activity (this is sometimes referred to as "greenwashing") While many accreditation programs for ecotourism exist worldwide, with at least two attempts to create international standards by consensus [47, 48], ecotourism in many countries still lacks regulation, or participating in certification programs is not mandatory Idiosyncrasies should be respected because, among other reasons, some impactful ecotourism practices might be more acceptable in developing than developed countries	An evaluation of the websites of tour operators from the UK, the USA, and Ecuador selling "ecotourism" to Galápagos Islands reported considerable variation in how ecotourism principles were followed between countries and operators [37] For an enterprise be marketed as ecotourism in the Ngorongoro Conservation Area (NCA; Tanzania), the economic benefits should be culturally appropriate, they should be socially and politically acceptable to the local community, and they must respect the community's land tenure and its ability to make decisions over it [49]

7. Continuously monitor wildlife and the environment, preferably with taxonomic and environment specialists, but always with a holistic view of the ecosystem's functions and processes	Populations, communities, and ecosystems are dynamic entities, and a myriad of known and unknown factors, as well as rare events (e.g., wildfires or oil spills), can change—sometimes dramatically—their structure and stability Early detection of threats, such as proliferation of diseases and the introduction of alien species, increases the chances of a successful mitigation Exposure to chronic stressors will make individuals more susceptible to disease and reduce reproductive success and life expectancy. Thus, stress levels in wildlife must be monitored regularly Idiosyncrasies in a species' biology/ecology or a unique habitat feature may require species-specific or environment-specific mitigation. Identifying these idiosyncrasies may help design more effective management strategies	Only 1% of the extinctions predicted for the forest-dependent vertebrates from the Brazilian Amazonian have so far taken place, and 80% are expected to by 2050 [50]. Knowing the areas that are likely to be vulnerable and the estimated time delay involved offers an opportunity to concentrate management efforts, for example, through habitat restoration or species translocation [50, 51] Elevated stress levels in ring-tailed lemurs (*Lemur catta*) were directly related to increased mortality over a subsequent 2-year period. One of the key reasons for the observed effect was greater susceptibility to infectious disease as a result of suppressed immunity [52]. Early detection may have helped reduce lemur mortality The monitoring, over several months, of water quality and nutrient inputs throughout several Australian lakes allowed the detection of planktonic algae [53]. Such a perturbation, linked to tourism, would have been missed without intensive sampling
8. Rely on multiple biological indicators to monitor stress in wildlife	The lack of behavioral reaction does not necessarily mean that wildlife is not stressed by tourists. Even in the absence of a behavioral response, encounters with humans may trigger physiological responses, such as increases in heart rates, body temperature, and stress hormone production Because exposures to chronic stressors can result in exhaustion or downregulation of the stress response system, a low baseline level of stress hormones may be misleading, thus requiring additional tests of the capacity to respond to a second stressor or a hormonal challenge (e.g., activation of the HPA axis) to evaluate coping abilities	Despite showing no obvious behavioral reaction, heart rates of Bighorn sheep (*Ovis canadensis*) in the Sheep River Wildlife Sanctuary increased when encountering humans [54] The lack of behavioral responses to visitors in colonial birds on the Galápagos Islands was misinterpreted in the past as tameness. However, later studies monitoring heart rates found that internally they were experiencing physiological stress [55] Chronically stressed European starlings (*Sturnus vulgaris*) had low basal corticosteroid levels. By studying the response to a secondary stressor, reduced responses were identified, suggesting that birds had exhausted their ability to respond to stressors [56]

(continued)

Table 10.1 (continued)

Recommended best practice	Reasons for recommendation	Empirical examples of reasons for recommendation
9. Conduct rigorous controlled studies of wildlife physiology, behavior, reproductive success, and survival, before and after the introduction of artificial sources of resources, significant habitat alterations, or when introducing non-native species	Artificial resources (e.g., water holes, salt licks) may increase the abundance or density of local species which, in turn, may affect behavior, increase injury among conspecifics and heterospecifics, and modify habitat structure [57, 58] There is a large literature on the effects of non-native species introduced to control pests on the survivorship and health of native species [59, 60]	The establishment of artificial water holes in Hwange National Park (Zimbabwe) led to extremely high density of some species [58]. These unsustainable densities damaged local vegetation, altered animal communities, and favored especially aggressive individuals and species [58, 61] Animals aggregating at feeders, which occur throughout the world, may facilitate the spread of pathogens and advance the timing of annual events (e.g., migration, reproduction, and dispersal) because such events are affected by body condition, which in turn is determined by food intake [62]. Feeders may also increase the rate of reproduction and survival with consequences for population density [62] Cane toads (*Rhinella marina*) introduced into Australia to control mosquitoes have had a devastating effect on Australian biodiversity [63] as have rats and chickens introduced into Hawaii [64]
10. Apply mechanistic knowledge concerning animal physiology, behavior, ecology, and evolution to mitigate impacts or designing low-impact ecotourism activities	The main senses used to perceive the environment differ among species (e.g., vision for many birds and olfaction for many mammals). By understanding sensory abilities, we can design effective mitigation actions for target species Animals evolved to avoid predation. By identifying how animals assess risk, novel and effective ways to reduce risks can be used to reduce the negative impacts associated with human presence Species have limitations to adapt to human visitation based on their historical experience interacting with humans and other predators	Set vehicle speeds based on a fundamental understanding of mechanisms that animals use to assess approaching risks; species that have not evolved with rapidly approaching vehicles may be unprepared to successfully avoid them [65, 66] The use of hides and visual shields at bird-watching sites and water holes in Africa helps reduce animal stress since they are unable to see tourists and thus do not activate their physiological stress response [67, 68] Elephants (*Loxodonta africana*) are able to discriminate between language and voice characteristics of humans to correctly identify the most threatening individuals based on their ethnicity, gender, and age [69]. This highlights the benefits of identifying the mechanisms underlying patterns because this could be potentially applied to solve specific wildlife management problems (e.g., avoid poaching) The fact of flight initiation distance (FID) of zebras (*Equus quagga*) is substantially larger than the FID of horses (*Equus caballus ferus*)—both from areas with low frequency of interactions with humans—may be partially explained by a long history of humans hunting zebras, compared to a relatively brief period of humans hunting horses (since the last glacial cycle) [70]

11. Stimulate research on "compassionate conservation," animal emotions, and animal cognition for species usually observed in the protected and ecotourism areas	The recognition of animal emotions and cognitive abilities has generated empathy in humans and sensitized people to conservation needs and the well-being of other species [71, 72]	Scientists have begun to recognize animals as cognitive beings with personalities and emotions [73, 74]. As a result of this deepening "animal-human bond," the number of people feeling empathy and compassion toward animals is growing, as is the interest in experiencing wildlife firsthand
12. Collect data on ecotourist visitation to understand current levels of use and as a baseline for future mitigation strategies	Knowledge of the frequency and type of disturbance on a natural area is key to evaluate present impacts as well as to determine targets for future restoration If visitation increases rapidly, new mitigation measures or regulations may have to be implemented	The number and behavior of ecotourists influence the effects of ecotourism and thus must be known to develop effective mitigation plans [75, 76] After an increase in visitor frequency to some areas of the Sinharaja Forest Reserve, Sri Lanka, researchers used a data-informed GIS model to plan new trails to mitigate human-created stresses [77]
13. Conduct social research to understand how different ecotourism activities improve visitors' scientific literacy and increase their engagement in conservation activities	Ecotourist's participation in interpretation programs enhances their understanding of ecological processes [78, 79], because the more senses that are stimulated, the more likely they are to be engaged [78–80] Citizen science is on the rise, but how people are engaged and the associated benefits are still not well understood [81] Help ecotourism providers to design more effective interpretation programs that lead to pro-environmental behavior [82]	A study of tourists visiting the Galápagos Islands found that after a guide-run interpretation program, tourists got 10% more correct answers about biodiversity and evolutionary processes [83] A study conducted in Tangalooma, Australia, found that after interacting with dolphins, tourists increased their desire to change their behavior and act in more environmentally responsible ways [84]
14. Provide environmental education services to the ecotourists, preferentially using guides	Guided interpretation programs can manage tourist behavior to reduce impacts, provide participants with realistic expectations, increase the value of more wild and natural experiences, and promote tourism of less crowded areas and less known wildlife beyond charismatic species [68] Guides improve environmental education of ecotourists, enrich ecotourist's experiences, and enforce regulations designed to protect wildlife and natural resources The use of local guides creates financial incentives for conservation and, by employing locals, may increase satisfaction through the recognition of the value of their resources and knowledge	Evidence has shown that educational programs in outdoor settings have positive impacts in shaping their attitudes and perception of conservation needs and goals [85] Yankari Game Reserve (Nigeria) [86] and the Galápagos National Park [87] only permit guided tours where guides or rangers control the distribution and conduct of tourists Guides in the Masai Mara National Reserve, Kenya, were trained to deliver information, not only about the popular species but also about the entire park to inspire tourists to visit other park areas and reduce high concentration of tourists in specific sites, which would generate impacts [88]

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Table 10.1 (continued)

Recommended best practice	Reasons for recommendation	Empirical examples of reasons for recommendation
15. Establish clear guidelines for human access in the ecotourism area, making it more or less restrictive according to season, conservation status, and sensitivities of species and environments to human disturbance	Human-wildlife contact should be controlled because animals may become more tolerant to human presence, which can increase human-wildlife conflict and disease transmission from humans, increase mortality by vehicular collisions, and increase susceptibility to poaching Reacting behaviorally or physiologically to an encounter with humans is energetically costly for wildlife and may reduce their body condition, reproductive output, and survival. It may be particularly costly when disturbances occur during energetically demanding periods, like breeding or migration seasons Species' sensitiveness to human disturbance is mostly species-specific and also varies according to age, sex, breeding stage, time of the day, number of humans approaching, directness of approach, etc. [89, 90]. Areas with human-limited access should take these variables into account to design effective buffer zones Stresses caused by repeated human disturbance may reduce physiological capacity to respond to a stressor, such as responding to a sudden change in the environment or the presence of real predators Some individuals become bolder as a function of human contact and evidence shows that bold individuals can suffer higher mortality than shy individuals in challenging, unstable environments [91] Escape or panic reactions from encountering ecotourists may lead to self-injury or damage to offspring, eggs, or conspecifics [33]. This impact might be aggravated in tourist visits to breeding-bird colonies due to the high density of individuals Making human behavior predictable, such as by walking and driving on existing trails, helps to reduce animal stress and prevents animals from engaging in costly antipredator behavior [92, 93]	Gorillas (*Gorilla beringei beringei*) habituated to humans in the Bwindi Impenetrable Forest, Uganda, have sometimes ventured outside the park, damaging nearby crops and becoming aggressive toward humans trying to chase them out of the fields [94] Primates habituated for tourist viewing are at greater risk from poaching than non-habituated individuals [95] Tourist presence is associated with reduced body mass, a key indicator of survival in fledgling yellow-eyed penguins (*Megadyptes antipodes*) [96] Common wall lizards (*Podarcis muralis*) from tourist-exposed areas had relatively lower body masses in summer, the season with most human-animal interactions, compared to animals not exposed to tourists [97]. Similarly, juvenile hoatzin chicks (*Opisthocomus hoazin*) in tourist-exposed areas are smaller than undisturbed juveniles [98] Adélie penguins (*Pygoscelis adeliae*) tending older chicks later in the season will flee when approached to within ~6 m, whereas when the chicks are young, parents will tolerate approach to within ~1 m [99], because young chicks are unable to maintain their body heat and require the presence of their parent for survival Stingrays (*Dasyatis americana*) have worse health indicators at dive sites. In addition, rays at tourist sites have more injuries and parasites than animals studied at non-dive sites [100] Polar bears (*Ursus maritimus*) from Manitoba, in Canada, are prevented from resting during a key period of the year when they are unable to hunt because of the continued presence of specialized ecotourism vehicles [101] The approach of tourists to Nile crocodile (*C. niloticus*) in Murchison Falls National Park, Uganda, caused females to escape into the water, leaving their nests unattended and making them likely to be predated by lizards and baboons (*Papio* spp.) [102]. Studies have shown that some predators even specialize on attacking temporarily unattended prey and may follow humans around to profit from their disturbance [103, 104] Western capercaillie grouse (*Tetrao urogallus*) avoid suitable habitat in response to human visitors in a similar way to how they respond to predators [92]

16. Avoid physical contact with and very close approach to wild animals	Physical contact increases boldness, aggressiveness, the likelihood of disease transmission, and injuries in animals and humans Close contact may drive habituation, which in turn can increase human-wildlife conflicts and disease transmission, increase mortality by vehicular collision, and increase susceptibility to poaching Close interaction with wildlife may push shy individuals away. The resulting displacement of certain animals can degrade the tourism experience and will alter species population structure with potential consequences to population viability	Operators delivering food to sharks or stimulating tonic immobility have an increased risk of bite injuries, create stress in animals, and disrupt normal physiological/biochemical process [105] Increased exposure to humans during swim-with-dolphin programs and food-provisioned encounters at sea intensifies the risk of disease transfer in both directions [106] African penguins (*Spheniscus demersus*) had varying levels of tolerance to human presence depending upon the overall level of activity and proximity of tourists. The authors noted that careful management is required to ensure undisturbed areas that can be used by shy individuals [107]
17. Avoid feeding wildlife, particularly with nonnatural and non-native food	Feeding may increase boldness, aggressiveness, disease transmission, and injuries among conspecifics and humans Feeding can promote change in species abundance and distribution, change the social structure of a population, and cause environmental changes Feeding with non-native prey items may facilitate biological invasion (e.g., non-native seeds and non-native prey species) At a physiological level, a shift from a natural to an artificial diet can affect an animals' body condition and other traits essential for population survival Feeding can create an ecological trap in which food-conditioned individuals are easily killed by poachers Animals being fed may become dependent on artificial sources of food and lose the capacity to find natural food [61, 108]	Brown and black bears (*U. arctos and U. americanus*) have habituated to human presence, particularly in situations where they have access to readily available food resources (e.g., garbage). This sometimes results in a serious human-wildlife conflict with associated risks to people, property, and ultimately the animals [109] Unregulated feeding of sea lions (*Zalophus californianus*) at haul-out sites in the USA has led to a number of attacks on tourists, likely driven by an increase in boldness and aggression at the population level [61] The use of salt to attract wildlife in Aberdare National Park, Kenya, caused leaching of salt into the soil and led to vegetation death in a nearby water hole [58] At tourist-fed sites, usually solitary southern stingrays (*Dasyatis americana*) aggregate at high densities where they have more parasites, have reduced body condition, and have more injuries. These aggregation-related problems may impact their survival and long-term reproductive success [110] Regularly provisioned southern stingrays have different blood fatty acid profiles when compared to unfed animals [111]. Similarly, carnivorous fish become hyperglycemic because they could not control the increased blood glucose induced by eating bread [112, 113] Wildlife poachers in the Democratic Republic of the Congo stated that gorillas (*Gorilla gorilla*) that were habituated are more easily killed than non-habituated ones [95]

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Table 10.1 (continued)

Recommended best practice	Reasons for recommendation	Empirical examples of reasons for recommendation
18. Prioritize the use of noninvasive techniques, to the extent possible, when studying or monitoring wildlife populations within ecotourism and protected areas	Contact with humans disturbs animal behavior and physiology (e.g., by increasing stress), which can make individuals either sensitize or habituate to humans Invasive techniques (e.g., toe amputation, handling) can cause stress and infections and can affect chemical cues of recognition among conspecifics Some modern and noninvasive techniques have been shown to be as effective, or more effective, than invasive techniques (e.g., measuring metabolites through animal feces, hair, feathers, etc.)	Human handling influences physiological stress responses in little blue penguins (*Eudyptula minor*) [114] Evidence shows that blood sampling in cliff swallows (*Petrochelidon pyrrhonota*) reduces their survival rate [115], although blood sampling had no effect on survivorship of barn swallows (*Hirundo rustica*; A. P. Møller unpublished data), and surprisingly, there was a positive association between breeding success and disturbance in yellow-eyed penguin (*Megadyptes antipodes*) [116] The stress caused by tourism has been successfully examined by measuring stress hormones in feces of European pine martens (*Martes martes*) in the Natural Park Montes do Invernadero, Spain [71]. This has also been done for emblematic species such as African lions (*Panthera leo*) [117] Avian heart rates can be monitored with noninvasive techniques such as dummy eggs within nests that contain infrared or acoustic sensors [118, 119]

19. Implement rigorous practices to prevent biological invasions and disease transmission	The abundance and richness of non-native species is significantly higher in tourist than non-tourist areas, both in terrestrial and aquatic habitats [120]	Heavily used trails in Central California had much higher numbers of *Phytophthora ramorum*—a pathogen that causes sudden oak death—in the soil compared with areas that were off the trail, suggesting that the dispersal of the pathogen was driven by human activity [122]
	The majority of invasive species transferred via tourism are plants that have been moved inadvertently as seeds in or on belongings, on shoes, or on clothing. Therefore, sanitizing belongings before visiting protected areas is highly recommended	Viable seeds of diverse non-native plants were found in the footwear of tourists visiting Svalbard in the high Arctic [123]. Whereas, Arctic species such as chickweed (*Stellaria media*) and yellow bog sedge (*Carex* sp.) were found on the clothing of tourists and researchers visiting Antarctica [124]. Some tour operators in the Antarctic use “local” footwear to avoid introducing microorganisms on boots
	Detrimental effects of biological invasions and diseases may cause rapid decline in small populations because generally there is insufficient time for effective mitigation	Originally from Russia, the invasive zebra mussel (*Dreissena polymorpha*) spread through waterways in North American and Western European protected areas. Recreational boating was implicated as a key vector of rapid spread [120]. Their voracious feeding reduces the number of microorganisms available to other aquatic species that rely on this food source, and they attach themselves to other native mussel species (i.e., biofouling), exacerbating susceptibility to environmental stressors
	The introduction of domesticated, non-native animals, such as cats and dogs, has impacted native wildlife worldwide because they are highly effective predators and vectors of diseases to a number of species [121]	Feral cats in Australia are implicated in the decline of endemic mammals and birds [125, 126]
	Limited previous exposure to pathogens, due to geographical isolation, makes indigenous tribes and some species immunologically naïve to diseases such as influenza and salmonella	A number of diseases (e.g., influenza, common cold, pneumonia, measles, and intestinal parasites) have been transmitted from humans to chimpanzees (*Pan troglodytes*) and gorillas (*Gorilla gorilla*), especially to those that are habituated to human presence [127, 128]
	Due to their close evolutionary relationships, humans and other primates are susceptible to similar diseases, making the use of surgical or respirator masks, strict hygiene protocols, information on avoiding visitation when sick, and vaccination requirements for humans highly recommended	The chimpanzees studied as part of the Taï research project in the Ivory Coast experienced five distinct outbreaks of human respiratory diseases over a period of 7 years with mortality rates of the affected groups reaching 19% [128]

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Recommended best practice	Reasons for recommendation	Empirical examples of reasons for recommendation
20. Implement rigorous practices to prevent environmental pollution, including light and noise pollution	Beyond those well-known sources of chemical pollution (e.g., oil and heavy metal contamination), there are some nonobvious sources such as those caused by sunscreen in water bodies, which can affect fish homeostasis and health [129] Light and noise pollution can generate what is called ecological or evolutionary traps by attracting animals to suboptimal habitats [130], as well as interfere with intra- and interspecific communication among animals [131] Artificial noise and lights can physiologically stress animals and increases mortality [132, 133]	The presence of sunscreen in water bodies stimulates early egg hatching, reduces digestive enzyme action [129], as well as interferes with gonadal functioning in fishes [134] The sounds and vibrations caused by vehicles driving off-roads have been interpreted by Western American spadefoot toads (*Scaphiopus couchii*) as heavy rain, causing them to emerge from their burrows during the wrong season in the Californian deserts [135], thus exposing them to unnecessarily hot dry weather and to predators [135] Increased whale-watching traffic in the St. Lawrence appears to be contributing to the death of baby belugas (*Delphinapterus leucas*) because vessel noise affects the calves' ability to communicate with their mothers [136] Artificial light can negatively affect populations by disorienting animals, such as hatchling sea turtles that are lured away from the sea by artificial lights on land [137] Light pollution can "trap" nocturnally migrating birds that only travel in the dark and can reduce the reproduction of nocturnally mating animals (e.g., frogs [130, 138])
21. Spatially cluster ecotourism infrastructure in order to maintain larger blocks of contiguous habitat	Roads increase habitat fragmentation, interfere with species dispersion, and affect community structure [139–141] Scattered ecotourism infrastructure associated with electricity, water supply, and waste disposal may increase the extent of human impacts	A meta-analysis shows that mammal and bird population density tends to decline with proximity to infrastructures, affecting the populations within a range of 1 to 5 km radius [141] Both dik-diks (*Madoqua guentheri*) and mule deer (*Odocoileus hemionus*) are more tolerant of humans within 500 m of human buildings and settlements (even temporary ones) than farther away [142, 143]. These results suggest that scattered development further increases the negative impacts of development

22. Plan and manage roads and trail placement to avoid vehicular collisions and habitat fragmentation and to direct tourists to areas where humans are allowed	Vehicular collisions are responsible for the deaths of millions of animals within and outside ecotourism areas annually, both in terrestrial and aquatic environments [144, 145] Roads increase habitat fragmentation, interfere with species dispersion, and affect community structure [139–141] Establishment of speed limits, improvement of signage, and building of fences and wildlife crossing structures have helped to decrease wildlife mortality by vehicular collisions [92, 146] Making human behavior predictable, such as walking and driving in existing trails, helps to reduce animal stress and avoid animals to elicit costly antipredator behavior [92, 93]	Over 2000 road-killed vertebrates were recorded in 1 year on the roads of the Doñana Biosphere Reserve, Spain. Yet, almost 2000 vertebrates were killed in a year on a single road of Biebrza National Park, Poland [147]. In about 2 years, almost 700 birds and mammals were killed by vehicles in Banff National Park, Canada [148] Mortality by vehicle collision in the Lake St. Clair National Park, Tasmania, was so high that eastern quoll (*Dasyurus viverrinus*) became locally extinct and had to be reintroduced following successful efforts to reduce vehicle collisions [149] Collisions with vessels accounted for about 25% of the manatee mortality in Florida from 1974 to 1998 [150] In endangered urban forests in Australia, the level of fragmentation caused by recreational trails was similar to that caused by urban development itself [151] Fences placed along roads, combined with wildlife road-crossing structures, helped to decrease risk of vehicle collision in Banff National Park, Canada [152, 153] After the improvement of a road in Cradle Mountain-Lake St. Sinclair National Park, Australia, the resident population of Tasmanian devils (*Sarcophilus harrisii*) declined by 50%, and the local population of eastern quolls (*Dasyurus viverrinus*) went extinct because of vehicular collisions. By reducing traffic velocity and educating park visitors, vehicular mortality was reduced and populations increased [149]

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Recommended best practice	Reasons for recommendation	Empirical examples of reasons for recommendation
23. Ecotourism best practices should be adaptable to the specific ecological, geographical, and sociological contexts	Ecological and evolutionary patterns and their drivers are not homogeneous across space and time (e.g., species richness decreases as latitude increases [154] and species-area relationships varies according by the ecoregion and other environmental factors [155])	Birds in tropical habitats are less tolerant of human presence than conspecific or congeneric populations from temperate zones [157], a pattern expected from life history theory. This occurs because animals in the tropics have low reproductive rates and high annual adult survival rates, while this is the opposite in the temperate climatic zones [157]
	Trade-offs between conservation and socioeconomic goals usually depend on whether ecotourism occurs in developed or developing countries (e.g., North-South debate [156])	Certification programs, especially in developing countries, are value dominated, where the economic-conservation paradigm often overrides the sociocultural paradigm [158]
	Guidelines for protecting wildlife should certainly be stricter in areas where ecotourism does not benefit a local human community or in places where there are no human residents	Rules for penguin ecotourism in Antarctica should be very strict. By contrast, in places where there may be benefits to human local communities, such as inhabited areas of Australia, New Zealand, South Africa, and South America, there may, at times, be valid reasons to have less strict regulations
24. Ecotourism best practices should be updated based on new scientific evidence and with new environmental problems	New evidence can help us regulate management practices to correct mistaken past practices It is essential to develop a culture of continuous evaluation so that emerging threats can be identified in time for effective mitigation	Recreational fishing was considered a reasonable practice until the amount of fish harvested and population fluctuations showed it is a dangerous practice. This led to a call for the widespread adoption of catch and release fishing. However, recent evidence is showing that catch and release is also deleterious [159]

10.2 The Recommended Best Practices

Below we list 24 recommendations that comprise our suggested best practices for ecotourism. They are divided into four categories, although some recommended best practices could fit perfectly well into more than one category. We emphasize that the order in which the recommended best practices are presented here does not reflect their relative importance. And, as we noted before, there are other previously published lists of best practices for ecotourism. Thus, our list is necessarily incomplete but does focus on many of the issues discussed in previous chapters regarding the biological and social dimensions of ecotourism. Table 10.1 details the reasons for these recommendations and examples of empirical evidence supporting them.

Aspects Related to Socioeconomic Outcomes:

1. Encourage community-based tourism as the preferred form of ecotourism.
2. Reduce the likelihood that local communities become financially overdependent on ecotourism.
3. Promote partnerships with a multidisciplinary body of scientists, integrating them in all stages of an ecotourism project.
4. Promote partnerships between the ecotourism project and eco-friendly and socially responsible companies.
5. Promote "ecological network thinking" in all stakeholders, from decision-makers to ecotourists, through environmental education and integrated planning of all ecotourism activities.
6. Encourage national accreditation of the natural area tourism based on international standards while respecting idiosyncrasies of each region or country.

Improving Knowledge on Conservation Topics Related to Ecotourism:

7. Continuously monitor wildlife and the environment, preferably with taxonomic and environment specialists, but always with a holistic view of the ecosystem's functions and processes.
8. Rely on multiple biological indicators to monitor stress in wildlife.
9. Conduct rigorous controlled studies of wildlife physiology, behavior, reproductive success, and survival, before and after the introduction of artificial sources of resources, significant habitat alterations, or when introducing non-native species.
10. Apply mechanistic knowledge concerning animal physiology, behavior, ecology, and evolution to mitigate impacts or designing low-impact ecotourism activities.
11. Stimulate research on "compassionate conservation," animal emotions, and animal cognition for species usually observed in the protected and ecotourism areas.
12. Collect data on ecotourist visitation to understand current levels of use and as a baseline for future mitigation strategies.
13. Conduct social research to understand how different ecotourism activities improve visitors' scientific literacy and increase their engagement in conservation activities.

Aspects Directly Related to Animal Well-Being and Population Sustainability:

14. Provide environmental education services to the ecotourists, preferentially using guides.
15. Establish clear guidelines for human access in the ecotourism area, making it more or less restrictive according to season, conservation status, and sensitivities of species and environments to human disturbance.
16. Avoid physical contact with and very close approach to wild animals.
17. Avoid feeding wildlife, particularly with nonnatural and non-native food.
18. Prioritize the use of noninvasive techniques, to the extent possible, when studying or monitoring wildlife populations within ecotourism and protected areas.
19. Implement rigorous practices to prevent biological invasions and disease transmission.
20. Implement rigorous practices to prevent environmental pollution, including light and noise pollution.
21. Spatially cluster ecotourism infrastructure in order to maintain larger blocks of contiguous habitat.
22. Plan and manage roads and trail placement to avoid vehicular collisions and habitat fragmentation and to direct tourists to areas where humans are allowed.

Context Dependence of the Best Practices:

23. Ecotourism best practices should be adaptable to the specific ecological, geographical, and sociological contexts.
24. Ecotourism best practices should be updated based on new scientific evidence and with new environmental problems.

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Creating a Research-Based Agenda to Reduce Ecotourism Impacts on Wildlife

11

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Fig. 11.0 Spotted eagle rays (*Aetobatus narinari*) off Isla Isabela, Galápagos. Photo credit Daniel T. Blumstein

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11.1 Understanding Ecotourism Stressors on Wildlife

The chapters in this book illustrate the variety of physiological, behavioral, and ecological consequences of ecotourism on (mostly) animals. We, and our expert group of contributors, have shown that even seemingly benign activities can have profound effects on individuals, their populations, and the communities in which they live. These costs provide the basis for determining whether a given ecotourist activity is acceptable or not.

These costs are based on the best available evidence. We recognize an unavoidable bias in the available evidence: positive results (i.e., those with significant effects) are typically easier to publish than negative results. This publication bias is common in many fields [1] and makes it difficult to know the actual extent of ecotourism's effect on wildlife. Despite a bias against publishing negative results, there could also be a bias against publishing positive results that demonstrate deleterious effects of ecotourism. This is particularly true if ecotourism operators feel threatened by allowing the extent of impacts to be made public. Thus, it is imperative to create a culture where results of impacts associated with ecotourism activities are openly published.

As we discussed in Chap. 10 [2], we recognize that whether or not an impactful activity is considered acceptable is a very context-dependent decision. We have shown that different individual animals, different species, and species at different times of the year and in different years (based on food stresses) may have variable responses to tourists. Such variation makes it difficult to make generalizations about stressors.

We believe that one of the main future challenges for scientists is to work to integrate the suite of potential stressors generated by human presence so as to understand why some species cope well with ecotourism while others do not. The first step toward developing an integrative view of stressors depends on a deep understanding of the natural history and life history traits of a focal species. And this is where ecotourism guides can play a vital role.

Many naturalists have a "field feeling" acquired through many hours of wildlife observations. But, these insights are rarely published. Sharing these insights and producing peer-reviewed literature (because the best science is reviewed by other scientists before it is considered acceptable for publication) will codify this knowledge and allow others to benefit from it. The best information can help refine the needs of each species and ultimately improve both their well-being and the sustainability of a specific ecotourism activity.

Ecotourists themselves also can play an important role by conducing citizen science (scientific research performed by the public) under the supervision of scientists. Not all ecotourism experiences provide these opportunities, but when they do, it seems like a win-win. The tourists are engaged in helping to study the impacts of their presence on wildlife to generate ways that reduce their negative impacts while still preserving the species and habitats that they have traveled to see. New technologies and biodiversity apps such as eBird[1] (an app to record bird sightings), Urubu[2] (a Brazilian app to record road kills), and others can facilitate collecting data. Over time, ecotourists and guides will collect vast amounts of data that will permit formal statistical analyses of how variation in human visitation influences animal behavior, diversity, health, etc.

As we recommended in Chap. 10 [2], we believe it is always desirable to view every ecotourism experience as an opportunity to experiment on reducing stressors on wildlife. Populations are often threatened not by a single stressor but by the sum of many stressors. Thus, population persistence could be threatened not just by animals not responding well to human activities, but rather suffer a death by a thousand cuts of which ecotourism is but one of the cuts. It is essential to identify these stressors and the magnitude of their cumulative effects [3].

As described in Chap. 4 [4], it is crucial to realize that stressors, animals exposed to now, can have both immediate effects and effects that can be transmitted across multiple generations. Epigenetic mechanisms allow the relatively quick transfer of information to offspring since it does not rely on genetic mutations [5]. Maternal stress hormones can be put into eggs or transferred to young via milk. These stress hormones have the potential to alter gene expression and change how animals respond to adverse events [6]. Understanding the role and importance of epigenetic modifications is of particular interest in many other research areas, and insights from these other areas can undoubtedly be applied to understand and mitigate the impacts of ecotourism.

Yet, the goal of creating a beneficial ecotourism industry, rather than one that seeks to narrowly eliminate human stressors, is exacerbated by the challenge of simultaneously optimizing three factors—economic, environmental, and social sustainability [7]. And thus we recognize that social context will influence the relative benefits associated with a particular activity. Ethical norms vary over time and by culture and must be factored into such decisions (Markwell [8] exhaustively explores this topic). Future quantitative models incorporating all these variables could help managers in the

[1] http://ebird.org/content/ebird/

[2] http://cbee.ufla.br/portal/sistema_urubu/index.php

decision-making process of a given ecotourism activity, a lesson from the conservation biogeography discipline applied for selecting priority area for conservation [9].

We also believe that ecotourism research must be conducted in the context of "learning by doing"—what is formally called adaptive management [10]. Adaptive management is an approach that explicitly modifies future management based on the results of ongoing assessment. Importantly, to make the best-informed decisions, we must identify what are called control areas, areas without ecotourism to which areas with ecotourism are compared. And, we often can learn by studying areas with different degrees of ecotourism or human impacts [11]. Both of these comparisons help us isolate the effects of particular tourist activities or particular degrees of tourist presence.

But, as important as these scientific considerations are, it is also essential to have the dynamic regulatory (or self-regulatory) procedures established. And these regulatory procedures must be very sensitive to the site and context-specific responses of wildlife to stressors. Much as personalized medicine uses specific knowledge to generate best medical practice for a particular patient [12]. Context-sensitive ecotourism management realizes that some stressors may be less consequential at some times or places or for some species. As more data become available to help us "personalize" our understanding of ecotourism impacts, best practices must be reevaluated and potentially updated.

11.2 Open Questions About Tourism Impacts

As scientists, we are thrilled by the opportunities to conduct future studies that can produce meaningful insights that will help us reduce ecotourism impacts on wildlife. As we stated above, it is not completely understood how a constant stressor may vary its impact seasonally, on different phases of the life cycle or across diverse taxa. This could give a more complete picture of the environmental effects of human visitation. Future studies should better explain how visitors elicit animals' responses and how consistent they are across different contexts. In this sense, we suggest that progress will be made with comparative studies across related taxa at different tourism sites, as well as studies considering the impacts of tourism on multiple species from a single tourism site. Such an initiative will help to build a more complete scenario for tourism impacts, allowing for more accurate previsions.

A number of topics are ripe for further study. We list some questions below, in no particular order, which will benefit from additional study.

1. Long-term adaptation to stressors, such as tourists, can be achieved by epigenetic modifications, but we lack evidence of how common and long-lasting these effects are.
2. How common is it that tourists or tourism practices transmit pathogens to wildlife.
3. We have written a lot about the potential deleterious effects of food-provisioning, but there is still so much to learn. What is the magnitude of the effects of food provisioning on wildlife compared to the magnitude of other factors?

4. We also do not know a lot about how the chemicals we wear (e.g., sunscreen, repellants, perfumes) and the sounds we make (e.g., motor vehicles, conversation) affects the animals and the environment in which they live. A rapidly growing literature [14] will certainly have implications for future management.
5. Habituation should be better explored to help us understand why some animals tolerate humans, while others avoid us. Developing more predictive models of tolerance is required [13].
6. Further research should target social and reproductive behavior, important activities closely connected to the fitness, and, hence, population biology of target animals.
7. While ecotourism is growing, it is not really known in detail how much of an individual animal's life is exposed to ecotourists? Does this vary by species? Are there lessons about absolute thresholds of exposure that can be deciphered by detailed study of exposure?
8. Individuals are different and variation in individual tolerance to humans could explain many of the effects of ecotourism on wildlife. We need more studies that follow individuals and understand the variation in sensitivity to humans [13].
9. In terms of the tourism activity itself, it is unclear how animals react to continuous or sporadic exposure to tourists. Comparing tourism versus no-tourism sites misses a lot of information on how different types of tourism management, exposure time, tourist activity, tourist number, and their behavior are stressful to animals. Designing studies that explicitly modifies management protocols to evaluate their effects on wildlife will be very useful. Here too, we can learn from medicine which acknowledges that we first have to determine whether a treatment works by comparing it to a placebo but then go on to evaluate the treatment with respect to other treatments. Such comparative effectiveness evaluations will play an important role in future conservation management and ecotourism management [14].
10. Finally, it is important to learn about the expectations and desires of ecotourists themselves (Fig. 11.1). By doing so, operators can provide positive and enjoyable experiences while simultaneously reducing stressors on wildlife.

11.3 Final Thoughts

As we have shown in this book, there is a wealth of knowledge that already can be immediately implemented to reduce impacts on wildlife, but to do so requires ecotourism operators being sufficiently trained. Tropical areas that harbor the greatest biodiversity along with particularly vulnerable areas (e.g., high-latitude tourism) should be prioritized for training because this is where we expect the greatest benefits to be concentrated. Thus, improving staff education at ecotourism destinations in Latin America, Asia, and sub-Saharan Africa should immediately pay dividends in terms of reducing stressors on wildlife.

All resource management decisions must be made with some degree of uncertainty [15], but with an evidence-based research approach, we can reduce that

Fig. 11.1 Two guides and two ecotourists enjoying floodplains in the world's largest tropical wetland: the Pantanal, Poconé Region, Mato Grosso, Brazil. Photo credit Boris Patentreger

uncertainty. Ultimately, we hope that the evidence and information provided in this book will be useful to operators, regulatory agencies, and ecotourists who wish to minimize impacts. We also hope that the overall information provided can help communities benefit from truly sustainable ecotourism. All of this, ultimately, depends on creating an evidence-based process by which new information is used to reduce the impacts and increase the sustainability of ecotourism operations.

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