

Tourism and Environment

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Annu. Rev. Environ. Resour. 2011. 36:397–416

First published online as a Review in Advance on July 29, 2011

The *Annual Review of Environment and Resources* is online at environ.annualreviews.org

This article's doi:
10.1146/annurev-environ-041210-132637

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1543-5938/11/1121-0397\$20.00

Keywords

recreation, transport, national parks, climate change, management

Abstract

Tourism is a large, diffuse global industry. Environmental aspects are little studied, with ~1,500 publications in total. Impacts range from global contributions to climate change and ocean pollution to localized effects on endangered plant and animal species in protected areas. Environmental management is limited more by lack of adoption than by lack of technology. Government regulation is more effective than industry-based ecocertification. In developing nations, tourism can contribute to conservation by providing political and financial support for public protected area agencies and for conservation on private and communally owned lands. This is important in building resilience to climate change. In developed nations, such effects are outweighed by the impacts of recreational use and by political pressures from tourism property developers. These interactions deserve research in both natural and social sciences. Research priorities include more sophisticated recreation ecology as well as legal and social frameworks for conservation tourism.

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INTRODUCTION

Tourism is both a category of human behavior, and the multitrillion-dollar industry that caters to it. Research on tourism and environment crosses a wide range of social and natural science disciplines, and key contributions are scattered across many fields.

Traditions in tourism research are very different from those in environmental science. Tourism is a large and long-established industry, but tourism research is relatively small, new, insular and inward looking, with competition between cliques and debate between devotees of different methods (1–2). The traditions of tourism research include a strong emphasis on books, as a complement to journal articles, to present primary research data as well as reviews. With rather few exceptions (3), environmental aspects get a somewhat short shrift in the highest-impact tourism journals. This applies even for issues such as climate change, which

are critical to the future shape and survival of the tourism industry. Much of the most significant and relevant research in tourism and environment has been published in journals of conservation and economics.

There are ~1,500 individual academic publications on various aspects of tourism and environment (3, 4), most of them published within the past 25 years. Indeed, there are over 600 articles analyzing recreational disturbances to birds and other terrestrial wildlife (5). There are several volumes on ecotourism, differing considerably in approach and technical detail (4, 6, 7). Related to these are texts on recreation ecology (5, 8, 9), adventure tourism (10, 11), and park and wilderness management (12, 13). There are books on sustainable tourism and responsible tourism (14), oriented largely toward social and economic considerations. There is limited research on environmental planning and impact assessment for large-scale or mainstream fixed-site tourism development (15). There are several books on tourism and climate change (16, 17).

Tourism uses nature as part of its products (7, 18); it creates environmental impacts (5, 9); and it can sometimes contribute to conservation (6, 19). This review considers these three interactions in turn. Thus, it starts with considerations of most concern in tourism research and ends with those of greater interest in environmental research. It cites about one-tenth of relevant literature directly, emphasizing large-scale reviews, classic contributions, the most recent articles in each subtopic, and, where possible, the highest-ranked journals.

NATURE-BASED PRODUCTS

Mainstream, Adventure, Consumptive, and Nonconsumptive Subsectors

People travel to visit other people and other places, and icon attractions include nature as well as culture: national parks as well as famous buildings. About a fifth of the global tourism and travel industry, worth around a trillion U.S. dollars a year, depends heavily on outdoor

natural environments (4). In countries such as Kenya, Costa Rica, and New Zealand, without a large urban tourism subsector, the proportion is up to four-fifths. Many tourist activities need natural environments (18, 20). Tour operators combine components into purchasable products, packaging them to appeal to particular market segments. The components include travel and transport, accommodation and catering, and activities and entertainment; and each has environmental aspects (4). Tourism also includes independent travelers, notably families on holiday in their own cars, and these travelers may also select a mixture of nature-based and urban components.

There is thus an extensive research literature on tourist demographics and motivations (21, 22), on tourism marketing (23), and on the economic scale of various activity subsectors either locally or globally (4). There is also a rather more limited literature on the details of product design and competitive fine-tuning (11). Environmental components of these, however, are rather limited both in practice and in analysis.

As measured by economic expenditure, the largest nature-based subsectors are those that include extensive accommodation and activity infrastructure as well as associated amenity migration and residential property development (24). In these cases, the natural environment is used principally as an outdoor playground. The main examples are the ski industry, the marina industry, and the beach tourism sector. In research terms, these are considered as mass or mainstream tourism. Ski resorts rely on retail shopping precincts and residential land sales as well as on lift ticket sales, but their position and layout is dictated by terrain and climate, and many are on public land originally allocated for forestry or conservation. In developed nations, beach and marina tourism are largely integrated into coastal cities. In developing nations, the main model is the enclave resort, which sometimes grow to resort towns. Although most tourism enterprises are privately owned, in some countries they are owned directly by government agencies. In others, they

are owned privately by government officials through systems of patronage (25).

Many outdoor tourism activities also involve large numbers of participants, but less infrastructure and associated expenditure. Most are available either as independent self-supported recreation or as commercial tourism products. They may be considered in three categories, commonly labeled as consumptive, adventure, and (nonconsumptive) nature based. All of these may have marine as well as terrestrial components (26). Consumptive nature-based tourism refers to recreational hunting and fishing (10, 11, 27).

Adventure tourism uses outdoor natural environments as a setting for excitement-based recreation rather than appreciation of nature (10, 11). There is, however, considerable overlap both in individual motivations and in the design of commercial products, which often include nature-based, adventurous, and cultural components in a single product (4, 28). Watching wildlife can be exciting as well as educational (10, 11, 29), and many adventure activities take place in spectacular landscapes. At least 45 different outdoor activities are offered as adventure tourism products. Risk management and participant motivations for these have been examined in particular detail. The structure and packaging of individual products, including the role of individual participant skills and remote icon destinations, are less well studied (11).

Nonconsumptive nature-based tourism includes all activities based on watching animals or plants or enjoying scenery (18, 20). Worldwide, this subsector relies largely on national parks, wilderness areas, and other public lands and oceans (12, 18, 26). These are visited by local residents, independent travelers, and commercial tour clients. There is considerable research on visitor numbers (30, 31) and on the economic scale, economic impacts, and social economic value of tourism reliant on particular protected areas or wildlife populations (32–37). There is more limited research on economic loss to tourism through damage to the natural environment (38). Nature-based tourism provides one immediately visible cash component

in economic valuations of ecosystems and biodiversity (19, 37, 39).

The relative attractiveness of different tourism destinations, for different activities at different times of year, is already being altered by climate change (40). Skiing seasons are already shorter, and snow quality poorer, in many heavily frequented ski resort destinations in a number of countries (41). Beach tourism destinations may be affected by increasing storminess in some coastal areas, and dive tourism destinations are being affected by damage to coral reefs associated with increasing ocean temperatures and acidity. National parks and wilderness zones in forest and woodland areas may suffer higher risks of fire and consequent closure, preventing recreational access. Destinations that are currently free from particular human diseases, pathogens, parasites, or venomous animals and plants may no longer enjoy such advantages in future. Native ecosystems that currently act as tourist attractions may be invaded by weeds, feral animals, or plant and animal pathogens (some of them dispersed by the tourists themselves) and may become less attractive as a consequence. Various sectors of the tourism industry can be affected in different ways (40, 42).

Geography and Land Tenure

Countries have various systems and types of land tenure, each with an associated bundle of rights and constraints. The geography and structure of nature-based tourism depend on these differences, in addition to their attractions and access (4, 11, 42). Legal distinctions at fine scales can have major implications for the design of nature-based tourism products, management of their impacts, and their contributions to conservation. From a tourism perspective, land tenure can be considered in four main categories: national parks and similar protected areas; public lands allocated for primary production or multiple use; private freehold or long-term leasehold; and communal titles and community-owned lands, including Indigenous reserves of various types. Each has different

advantages and disadvantages for design and operation of commercial tourism products.

In most countries, private commercial tourism operations in public protected areas are restricted. Many parks routinely grant operating permits to small-scale mobile guided tours conducting low-impact activities (43). Very few allow development of large-scale private accommodation or infrastructure, and usually only when there is some historical legal issue or modern political negotiation affecting tenure (44). Tourism enterprises gain considerable commercial advantages from operating in parks (4, 31). They have immediate access to publicly maintained natural attractions and visitor infrastructure, generally without contributing to capital or operating costs. They have a largely captive stream of potential clients and publicly funded marketing. They have limited competition because park permit systems provide barriers to entry, and they are protected from encroachment by other primary industries to a greater degree than on other land tenures (4).

Tourism operations on other public forest or rangeland have fewer restrictions but weaker attractions, less publicly funded infrastructure and marketing, and greater risks of encroachment (45, 46). Those on private lands have fewer restrictions but commonly involve much higher costs, generally including the capital cost of the land itself as well as capital and maintenance costs of infrastructure (19, 47). As a result, larger tourism operators may operate preferentially on private land so as to minimize restrictions, and small operators on public lands where they can minimize costs (4). These patterns, however, differ between nations (14, 19, 25, 28).

Communally owned lands are also important for tourism in some regions, notably in southern Africa and parts of South America (14, 19, 25, 28). The types of tourist product that can be offered on community lands depend on (*a*) the type of government tenure that overlies community ownership rights, (*b*) the conditions of the agreements between community owners and private tour operators, and (*c*) the ways that the community uses the rights they have retained. Thus, some lodges

on community lands can offer wildlife watching under relatively undisturbed conditions, with no human habitation and a full complement of native wildlife. Some tour operators offer trophy hunting on communal lands, generally from mobile safari camps. And some areas offer lower-key wildlife watching on lands that are also used by local villagers either for livestock grazing, bush meat hunting, or both.

The dynamics of tourism and conservation on community lands are endlessly complex and contested (25). They include overlapping traditional and modernized land tenure systems and social structures (48); relationships between different ethnic groups in postcolonial territories (25); family structures and political patronage at local and larger scales (25); as well as the pressures of subsistence hunting and harvesting (49), agricultural and industrial encroachment (50–52), and poaching (53–54). Many of the world's remaining areas of highest value for biodiversity conservation are occupied by Indigenous or impoverished peoples (55–57). This applies, for example, to many of the rainforest areas of Central and West Africa, Central and South America, Southeast Asia, and, indeed, tropical Australia. These issues thus cannot be ignored, either for conservation or community development. Irrespective of legalities, in countries with limited resources and political support to patrol parks directly, local involvement seems to be critical (19, 25, 58–59).

ENVIRONMENTAL IMPACTS AND MANAGEMENT

Accommodation, Resorts, and Ecocertification

Various types and components of tourism produce very different environmental impacts, requiring very different environmental management tools (4, 15). There are broad distinctions between transport, accommodation, and activity components; between wilderness, rural, and urban levels of land development; and between different climates, terrain types, and ecosystems. City hotels are connected to

municipal utilities, such as power and water supplies, garbage disposal and sewage treatment systems, and contribute proportionally to their impacts. Stand-alone tourist resorts, e.g., on islands, coastlines, or mountains, commonly have their own generators, water supplies, sewage treatment, and waste management systems, and these differ greatly in scale and sophistication.

For tourism in towns, development planning and environmental regulation are largely integrated into local government law and planning for residential and commercial premises more generally. These differ greatly between countries in both scope and effectiveness. Examples include minimum standards for water quality parameters in final outflow from sewage treatment systems, requirements for energy-saving insulation in buildings, and manufacturing standards for energy efficiency in refrigerators and chiller units.

In nonurban areas, large-scale tourism resorts and resort-residential developments can have very significant environmental impacts (5). Local direct impacts include vegetation clearance and loss of wildlife habitat (49, 60, 61); air and water pollution; and noise, light, and visual disturbance to native fauna (62, 63). Roads create barriers to local and long-distance movements (64) and generate noise disturbance and roadkill (65, 66). They also provide access for illegal activities. Off-road and maintenance vehicles crush animals and their burrows (4, 5, 67). There are also many less obvious impacts, such as the introduction of weeds, pathogens, and feral animals, which are at least equally significant ecologically (4, 5).

In most developed nations, large-scale non-urban tourism developments are subject to formal environmental impact assessment (EIA) (15). More stringent standards of evaluation may sometimes, but not always, be applied for developments with impacts on areas of high conservation status, especially those listed under international conservation agreements (15). Many modern tourism resort-residential developments are built in stages, and developers may avoid EIAs by obtaining separate approvals

for each individual stage, with each stage small enough to avoid EIA triggers in planning legislation (68). Equally, however, later stages may never be constructed. An initial development may also catalyze subsequent developments, which take advantage of the first developer's infrastructure and marketing but are owned separately. Cumulative impact assessment is thus particularly important in the tourism sector (15). There are cases in many countries where environmental planning frameworks, including those related to protected areas, have been overridden by political maneuvers executed either by tourism industry associations or by individual entrepreneurs.

At a smaller scale, there are now many low-impact lodges, catering principally to wildlife watching and outdoor recreation, in both public and private lands worldwide. Most of these necessarily have their own power and water supplies and their own waste treatment facilities. Environmental management measures differ considerably from place to place, but some at least have successfully reduced their environmental footprints through best-practice technologies and operational procedures (6).

As in other sectors, the tourism industry promotes self-regulation and corporate responsibility as an alternative to enforceable government regulation. There are ~100 different ecocertification and ecoaward schemes in tourism at various spatial scales and levels of stringency (69, 70). There is little evidence, however, that these have reduced the environmental impacts of the tourism industry. Ecolabels are promoted as mechanisms for consumer choice (69), but it seems that tourists ignore labels referring to the environmental performance of tour operators, and use only those that certify environmental quality at destinations, or service quality in hotels (4).

Ecocertification is thus used more in political negotiation with regulatory agencies than in commercial marketing to retail consumers. Some parks agencies routinely grant much longer multiyear operating permits to certified enterprises (70). There is one case where a Canadian company gave an ecolabel to an

internal program started by staff volunteers, and then used it successfully to claim environmental credentials in a court cases over an environmentally sensitive development application (71). This application was to construct a seven-story conference center inside a national park, against strong opposition from local conservation organizations (71). The environmental impacts from this one development alone would far outweigh the entire gains from minor energy and resources savings in urban hotels, which formed the basis for the ecolabel.

Travel, Climate Change, and Indirect Implications

Travel is a key component of tourism, and one of its principal sources of environmental impacts. Scales range from local hiking or cycle tours to long-haul air travel and even space tourism. There are local impacts from air and water pollution, from noise and visual disturbances to animals, and from physical disturbances to plants and soil (4, 5, 9). There are global impacts from fuel consumption and associated greenhouse gas emissions.

All forms of motorized transport consume energy and contribute to climate change. The tourism industry is involved in both mitigation measures and adaptation attempts, and greenhouse gas emissions from various subsectors have been calculated either per person, per kilometer traveled, or in aggregate (16, 17, 40, 72, 73).

The principal contribution (~80%) is from air transport of tourists and service items (17, 74). The climate change impacts of tourism thus depend largely on patterns in air travel, which are influenced by factors such as fuel prices and carbon taxes; wars, terrorism, disease, and political instability; currency exchange rates and the relative wealth of different nations; telecommunications technologies; changing work and leisure patterns; differentials in price, marketing, and fashionability between competing countries, destinations, and airlines; and social attitudes to holiday travel (75). Currently, it appears that public knowledge of climate impacts

is not influencing holiday travel, even to destinations highly susceptible to climate change (76–78).

Road transport is also a significant contributor, but holiday and domestic use of cars are tightly linked. Holiday use thus depends on public transport options, urban design, vehicle technologies, and fuel prices, as well as tourism products. A few destinations have tested low-impact local transport, known as soft mobility, but with low take-up. Best known of these are the so-called Alpine Pearls, a set of 24 individual towns in six countries in Europe, which claim to offer “no-car” mobility options such as public transport and bicycle loans. On-site evaluation by S. Gossling (unpublished), however, indicates that these claims are rarely met.

Many travel agents, airlines, and car rental companies now sell carbon offsets, but only about 1% of travelers buy them, even though prices are very low (72, 74, 75). Offset programs claim to fund physical measures to reduce atmospheric concentrations of greenhouse gases, but there is little evidence that they actually do so, and it seems that travelers do not trust them (75).

Mobile tour operations have a range of tools and techniques to reduce environmental impacts, depending on the type of activity and the ecosystems involved. There are broad distinctions between activities involving motorized vehicles on land, water, and air; those that involve livestock; and those that rely entirely on human-powered travel. Within any one activity type, impacts depend on factors such as group size, specific locations and seasons, and individual behavior. Where mobile tours operate on public lands, especially in protected areas, the land management agencies incorporate a range of environmental requirements in the conditions of operating permits. Some individual enterprises also follow their own specialized environmental codes of practice.

There are similar differences in scale and impact for boat-based tourism. At the larger end of the scale, there are cruise liners that carry as many people as a small town and generate corresponding impacts. At the smallest scale,

there are remote-area river and sea kayak tours, which leave little or no sign of their passage. At the intermediate scale, there are, firstly, a large semicommercial recreational boating industry, principally in more heavily populated coastlines, and secondly, a much smaller expedition cruise industry, which visits remote areas of the Arctic, Antarctic, Oceanic islands, and large river systems in less-developed nations.

If either the social attitudes or financial costs of long-haul air travel change significantly as a result of climate change responses, there are likely to be indirect environmental effects in many developing-country destinations where international tourism has become an economic mainstay. Income from tourism has contributed to community well-being and sometimes also to nature conservation (6, 14, 19, 28). There are well-known examples in sub-Saharan Africa, especially in Namibia, Botswana, and South Africa itself, where companies, such as &Beyond and Wilderness Safaris, have successfully funded community conservation through commercial tourism (19).

At the same time, income from tourism has sometimes caused decay in communal resource management systems and accelerated environmental degradation as local residents switch from subsistence to cash livelihoods. This pattern has occurred, for example, for a number of Indigenous peoples in the western Amazon region (28). Increased cash wealth allows locals to buy motorized boats and vehicles, guns, and chainsaws and to make commercial arrangements with international extractive industry enterprises, such as logging and mining companies (28, 79). If international tourism shrinks, these communities may turn to short-term exploitation of natural resources to provide continued access to cash, and they now have modern tools to do so.

Impacts of Outdoor Tourism in Areas of High Conservation Value

Outdoor tourism activities are smaller in scale than tourist towns and global air travel but are concentrated in areas where there are

immediate risks to threatened species and ecosystems. There is thus an extensive literature in the fields of park management (13), recreation ecology (9), and ecotourism impact (5). This literature sets out to analyze and control the impacts of tourism in areas of high conservation value. Impact on birds and terrestrial wildlife have been examined in most detail, with several hundred individual studies (4, 5). This section necessarily presents only the broad patterns revealed by those reviews, selected key studies, and the most recent research.

Most recreation ecology research has focused on direct, immediate, localized, and easily visible types of impact, such as trampling of tracks or disturbing birds. There is much less research on indirect, delayed, diffuse impacts, which are not immediately visible to the naked eye and require sophisticated equipment and experimental design for reliable detection (4, 5). Impacts depend not only on the ecosystem and the type of activity, but also on factors such as time of year, equipment, group size and dynamics, and individual skill and behavior, as well as any management measures that may be in place (4, 5).

Even outdoor tourism uses roads and tracks, leading to habitat fragmentation (4), and this reduces populations of a wide range of wildlife species (41, 66) from butterflies in Bavaria (80) to caribou in Canada (81), with differential effects even on related species (82) and loss in intraspecific genetic diversity (83, 84). Tourists transport invasive pathogens, plants, and animals (4, 5, 85, 86).

Noise, visual, and olfactory disturbances disrupt animal communication and affect courtship, territorial, and predation behavior (4, 5, 87, 88). Some species seem unaffected (89), and some adapt (4, 90–91a), but some endangered species are greatly affected (4, 8, 81, 91–93). Different species have varying sensitivities to disturbance. Penguins approached by Antarctic tourists, for example, show various behavioral and physiological symptoms of stress, and the human approach distance that triggers such symptoms differs between penguin species (94, 95).

A few studies have examined the effects of disturbance to feeding patterns on the energetics of overwintering ungulates or migrating birds, and one or two have examined the role of tourists in transmitting disease, especially to primates (91, 91a, 96). There is as yet very little research on indirect effects, either positive or negative. In one case, introduced nonnative trout provided a new food source for a native predator, an aquatic garter snake, increasing snake populations. The snakes, however, also eat native frogs, so more snakes mean fewer frogs. Introducing the trout thus indirectly reduced the frog population (97). Tourists watching turtles in the Caribbean, however, scare away introduced mongooses, which eat turtle eggs (98).

For wildlife, impacts depend on the history and habituation of individual animals. In areas without hunting, an experienced guide, who can recognize individual animals and interpret their behavior, can lead a well-behaved group of clients very close to wildlife without disturbing animal behavior. Animals that are hunted, however, generally flee at the first inkling of human presence. Even in areas without hunting, individual animals become more wary, or experience raised heart rates or stress hormone levels, if approached by humans on foot. This applies especially if people approach closely, or from an unexpected direction, or are accompanied by dogs (99).

Even for the most heavily studied types of impact, there is little research on the effects of timing and seasonality or of the precise patterns in repetitive disturbance regimes. For example, although the distances at which various bird species take flight have been measured crudely, few studies have examined how repeated disturbances affect the foraging efficiency and energetics of birds undertaking or preparing for long-distance migrations (91a). Timing and seasonality can also be critical even for a single disturbance. There are many recorded instances where even low-intensity or single disturbances have caused heavy and ecologically significant impacts on breeding birds, where eggs and chicks are vulnerable to heat,

cold, predators, or direct damage (91a). This includes a number of threatened bird species.

A similar range of impacts occur for plant species and for sessile animals, such as corals. Trampling is the most heavily studied impact (5, 9, 100–103). Even for trampling, however, most comparisons between vegetation types have been made experimentally in a single episode. This includes comparisons between different trampling agents, such as hikers, horses, or mountain bikes (102). There seem to be few, if any, cases where the effects of intense bursts of trampling have been compared between different seasons or between dry and wet periods. Parks agencies, however, are often asked to approve short-term intense use for multisport competitions and similar events, whose impacts depend strongly on soil moisture content.

There is more limited research on more complex and indirect types of impact (4). For example, plant reproduction can be disrupted through loss of pollinators (104), pollinator competition with introduced plant species (105), increased seed parasitism, and disruption of dispersal agents (106).

For some impacts and ecosystems, considerable recovery can occur between successive disturbances. In other cases, impacts continue to grow even after the initial human disturbance ends. This can occur, for example, for heavily used trails on steep erodible soils in areas of heavy rainfall. Similarly, if nonnative plant or animal species are introduced by tourists into areas where they cannot survive or reproduce, they will die out, but if they are introduced into areas where they thrive, the very small initial impact associated with the introduction of a single plant seed, pathogen propagule, or gravid female insect can then expand into a major threat to native ecosystems without any further direct disturbance (4, 86, 102, 105).

Managing Tourist Impacts in Protected Areas

Protected area managers have a routine tool kit of responses to regulate or reduce the

environmental impacts of tourists and other visitors (4, 12, 107). Broadly, these fall into four categories: rules, fees, education, and hardening the environment.

Regulatory measures include a wide range of different strategies. There are overall restrictions on activities or equipment, such as bans on motorized vehicles, livestock, pets, guns, and/or fires. There are spatially defined restrictions, such as zoning for different activities, and temporally defined restrictions, such as seasonal or diurnal closures or maximum lengths of stay at particular sites. There are restrictions on the behavior of individuals or groups, such as quotas, group size limits, and predefined daily itineraries. There are mandatory requirements for particular equipment or behavior, which can be quite detailed in some cases. For example, both private and commercial groups rafting the Grand Canyon of the Colorado are required to carry and use portable toilets, cooking stoves, firepits and firewood if they want campfires, and large fine-mesh cloths to catch scraps under cooking and eating areas.

Park fees are well studied, including acceptability (34, 108–111), pricing and efficiency (112, 113), equity (114), structure, and differentials (43, 115). There is less research on the demographics and motivations of nature-based tourists in parks, the structure of commercial tour products operating there, and the reasons why commercial tour operators decide whether to use parks or other lands.

The third category contains two different subsidiary approaches that both rely on persuasive communication. The first such approach consists of marketing or demarketing measures intended to influence where visitors decide to go. Some of these are controlled by parks agencies on Web sites or in maps and brochures. Others are created by tourism marketing organizations or operators. Some parks agencies have assumed control over advertising by tour operators who use their parks under permit either to promote particular features, such as a World Heritage listing, or to avoid misleading visitors by illustrating features or species that are rarely ever seen.

The second subsidiary approach involves interpretation and education to influence how visitors behave once they arrive. Delivery ranges from simple signs to computerized interactive systems and skilled tour guides and park rangers. Most are based on behavioral codes of conduct. Some codes reflect regulations and are enforceable: for example, fire bans; minimum approach distances for particular wildlife species; and site- and activity-specific permit conditions for commercial tours. Others are voluntary (116, 117). Tour operators frequently do not comply with codes (118, 119). There is little research on the effectiveness of interpretation in reducing impacts, although it can be successful under some conditions (120).

The fourth technique for managing visitor impacts in parks is through physical hardening of the environment, i.e., by constructing or upgrading tracks, lookouts, campsites, and toilet facilities in heavily used areas. This is widely employed but has a number of disadvantages. It consumes funds that could otherwise be used for conservation. It is self-perpetuating in that more hardening attracts more tourists, who create more impacts. It creates secondary impacts, such as interruption of waterflow, introduction of weeds (105), or changes to wildlife distribution and movement patterns. It changes visitor perceptions and behavior from wilderness or backcountry to tourist frontcountry. It can also lead tourism property interests to intensify lobbying for development rights inside a park.

Commercial tourism operations within national parks and other public protected areas differ between jurisdictions. Many parks permit small-scale, low-impact mobile tour operations under similar conditions and regulations to independent visitors. Some parks allow tour operators to offer different activities in different places from independent visitors. They may also charge differential fees and set different maximum group sizes and safety and insurance requirements (4, 43). Some parks allow pets, pack stock, riding animals, and motorized vehicles; others do not.

Most parks do not permit the development of fixed-site private tourism accommodation or

infrastructure, except for visitor facilities constructed by the parks agency itself. Large-scale tourist accommodation is restricted to gateways outside the park. There are a few parks that include private facilities. These exist because they are (a) a legacy of colonial pioneer days, (b) on enclaves of private land predating park establishment, (c) where the parks agency wants to offset maintenance costs for heritage structures, (d) rights retained when private land was given to the parks agency, (e) where public land was converted from production to conservation, and (f) land rights granted to Indigenous inhabitants (44). A very small number of parks have granted new leases for exclusive-access areas; small-scale up-market lodges; or pay-per-view infrastructure, such as canopy towers, infrared cameras, or diving pontoons. Other parks agencies, however, have insisted that longstanding tourist accommodation inside protected areas must be moved outside (44).

TOURISM CONTRIBUTING TO CONSERVATION

Under certain circumstances, tourism can make positive contributions to conservation through a combination of political, social, and economic mechanisms (19, 31, 121). These mechanisms differ between countries, depending on their natural environments, relative wealth, social structures, and government institutions (6, 14, 19, 25, 28, 30, 122–124).

The ways in which tourism can contribute to conservation are tightly linked to land tenure, which assigns different bundles of rights and responsibilities to different stakeholders. Examples include rights to use or sell wildlife, water, or other natural resources and to control or exclude access by various people for various purposes. Tourism can influence changes in tenure type or conditions and changes in land ownership and use. These may involve landowners and land management agencies, local tourism operators, global tourism distribution and marketing networks, local residents and communities, nongovernmental organizations and philanthropists, aid

agencies and donors, and commercial financiers (19, 25).

There are now a number of cases where commercial tourism has clearly converted private or communal lands from primary production to conservation (19). There are three essential components. The first component is commercial: an icon attraction, adequate access, and an experienced tour operator to provide, package, and market tourism products, which include logistic and hospitality services as well as the attraction and activities. The second component is social: a local community that supports both tourism and conservation, generally because it receives some immediate or indirect benefits. The third component is legal: a framework to provide formal title and conservation status to the land concerned and to allow the landowner to generate either income or capital gain as a consequence. Rights over wildlife, as well as land, can also be critical. This includes both traditional and modern legal rights. Many attempted conservation tourism ventures have failed because they ignored these basic requirements.

A small but increasing number of commercial tourism corporations, often in conjunction with parks agencies and environmental non-governmental organizations, have made significant contributions to conservation of endangered species, including birds, primates, cats, bears, and large ungulates. These contributions have included cash, equipment, infrastructure, and technical expertise (19). The principal mechanism is through the establishment of private or community reserves with translocation and soft release of small breeding populations of endangered species, actively enforced rules against hunting, and, in some cases, continuous tracking and surveillance of individual animals to guard against poaching. Threats from hunting may be associated with subsistence, traditional, sport, or trophy hunting; control or revenge on predators that take domestic livestock; and concerns over safety or nuisance to humans. Trophy hunting can, however, also contribute to conservation in some cases (4, 6, 14, 25).

Native wildlife may also be threatened by habitat loss, competition or predation from invasive species, poisoning, pollution, and disease. In each of these cases, reducing the threat generally requires changes to social structures so as to establish and enforce systems of conservation rather than consumption or destruction (25, 125). These social structures change in response to changed net incentives, which may involve a number of different factors. Commonly, the most important contribution from commercial tourism is a significant source of local income, which continues only so long as the animals remain alive (19, 126).

For publicly owned lands, tourism can contribute to conservation politically, financially, or both (19, 31, 127). In some cases, tourism can displace higher-impact industries and land uses so that even though tourism itself creates impacts, a change to tourism may represent a reduction in impacts otherwise occurring from farming, forestry, fisheries, or, occasionally, the oil or mining industries. The principal mechanism is through reallocation, rezoning, and rededication of public lands from primary production to protected areas. Such changes have indeed taken place on occasion, but rather rarely as yet. One example occurred when the Australian government declared the Wet Tropics of Queensland as a World Heritage Area, replacing a destructive rainforest logging industry with a profitable rainforest tourism industry many times larger in economic scale.

In most countries, operational funds for parks agencies are derived largely from central government budgets. In a few states and countries, however, the bulk of park funding is derived directly from tourism. This revenue is received principally from fees charged directly to individual visitors. License fees from commercial tour operators provide less than one-twentieth of total annual income for any parks agency (44). Where individual visitors are themselves international tourists to the country concerned, tourism can thus be critical in keeping parks agencies operational.

In both developed and developing nations, the extent of the protected area estate is

determined essentially by political processes, with economic considerations playing a contributory rather than a controlling role (25). This also applies for the allocation of public funds to protected area management agencies. Historically, countries established protected areas as part of domestic policy or international obligations under the International Biodiversity Convention. Some countries have established protected area systems specifically as an attraction for international tourists. Others have converted areas of public lands from primary production to conservation, at least partly to boost regional employment and economic opportunities through tourism.

Although tourism gains from political decisions to protect areas of high conservation value, it rarely contributes to those decisions. Pressure for conservation is created mostly by voluntary conservation organizations. Small tourism enterprises play a significant part in some cases (4, 6). Tourism industry associations and government portfolios, however, remain mute. The same applies for World Heritage designation. The World Heritage brand increases tourism arrivals by an order of magnitude (128), and commercial tourism enterprises and regional economies gain correspondingly, but it is conservation groups, not their tourism counterparts, which press for listing.

The role of tourism in providing funds, and hence political support for conservation tourism, is becoming increasingly critical as population growth and climate change put additional pressure on existing conservation reserves and mechanisms. Existing parks alone are not enough to conserve global biodiversity because they are too small, do not include all species and ecosystems, and are themselves under many threats (18, 125, 129). Lands outside parks, which have historically contributed to conservation, are continually shrinking in conservation value (130).

Conservation advocates worldwide, including multilateral institutions such as the IUCN and the most recent (tenth) Conference of the Parties to the International Biodiversity Convention, are calling both for growth in the

total extent of global protected areas and for landscape-scale connectivity (121, 131). These are required both as one response to climate change and to withstand pressures from human population growth and the associated expansion and intensification of land and water use. Growth in the conservation estate, whether on public or private land, needs a portfolio of funding approaches (121), and tourism is one of these. Conservation tourism has limitations (47), but also a number of successes (19, 132–136). It therefore seems likely that the role of tourism in supporting conservation will become increasingly critical in future.

DISCUSSION AND CONCLUSIONS

Tourism makes up about a tenth of the global human economy and has more environmental impact than a medium-sized country, but these impacts are much less studied, managed, and regulated than for other industry sectors of comparable size. There are a number of possible reasons for this.

From an industry perspective, tourism is diffuse and heavily cross-linked with the building, aviation, and automobile industries. Its growth has been recent relative to primary production and manufacturing. There are no materials, major tools, or technologies that are exclusive to tourism. The international System of National Accounts does not distinguish tourism as a separate sector. Government tourism ministries are seen as second-tier portfolios, and tourism industry associations do not have significant political lobbying power. Government tourism budgets are spent mainly on international marketing to attract more visitors, without concern about what impacts visitors produce once they arrive. The commercial tourism industry contributes very little to tourism research funding. The tourism industry still presents itself in political forums as an environmentally benign sector with little need for environmental research.

From a tourism research perspective, there are ~50 academic journals about tourism, but these focus on tourism as an aspect of human

social behavior, largely using interview and questionnaire approaches (1, 2). There is an idiosyncratic focus on internally generated theory, no matter how localized in scale and relevance. There is low awareness of tools, techniques, and theories in long-established academic disciplines that could be applied in tourism research. The most-cited theories among tourism researchers, such as the “life-cycle model” for resorts or the “irritation index” for host communities, are entirely familiar in town planning and anthropology (137). Biologists, geographers, psychologists, and economists studying tourism publish principally in the journals of their own disciplines because tourism journals treat such aspects as secondary, require particular writing styles, and prefer approaches that ask opinions rather than make measurements. This divides the research literature on tourism and environment, and limits the penetration of broader academic knowledge into tourism.

From an environmental research perspective, most research on the mechanisms, measurement, and management of tourism’s environmental impacts is still rather crude. There are indeed some very well-designed experimental studies, but to date, these are in the minority. Examples include early work on mountain sheep and more recent studies on various penguin species (91, 91a, 94, 99). There are opportunities to deploy more sophisticated approaches, particularly in testing the more complex but ecologically significant indirect impacts, such as interference in plant pollination, animal communications, and interspecies interactions. There are also opportunities for

ecologists to use tourism, recreation, and park management practices as controlled or natural experiments.

From a policy perspective, the role of tourism in supporting conservation both on and off reserve is becoming increasingly critical as human populations continue to expand, wilderness areas continue to shrink, and it becomes increasingly difficult for national governments to declare further public protected areas of any significant size. The effects of climate change, the need to improve resilience of protected areas, and the importance of landscape-scale connectivity conservation have rendered this area of research increasingly urgent. There are, indeed, some examples worldwide that appear to have generated practical successes, with enterprises such as &Beyond and Wilderness Safaris, mentioned earlier, as leading examples (138). These, however, are as yet few in number, small in area and financial scale, and, with few exceptions, remarkably little studied (6, 14, 19, 28).

In practical terms, this may well be the most important area of research on the interactions between tourism and environment. Although the significance of this approach is determined by the natural sciences and propounded by conservation ecologists, the key research questions relate to human behavior and the dynamics of human social institutions, and these questions thus require social science skills. Effective collaborations between natural and social scientists, while recognized as important, are still relatively uncommon. Where tourism and environment are concerned, these collaborations are critical for future research to be effective.

SUMMARY POINTS

1. The tourism sector now represents over a tenth of the global economy, with correspondingly large environmental impacts. There are ~1,500 publications on tourism and environment, but few of these provide rigor, insight, and significance.
2. Critical impacts include: greenhouse gases for airlines, liquid wastes for cruise ships, water and energy conservation for urban hotels, vegetation clearance and wildlife displacement for rural resorts, and a range of direct and indirect local impacts on plants and animals for nature-based and adventure tourism in parks and wilderness areas.

3. The geography of tourism is influenced by the relative prosperity of nations; currency exchange rates; airfares and taxes; land tenure and wildlife ownership laws; transport infrastructure; police, quarantine, and border security; investment law; public protected-area systems; and a variety of social pressures and fashions.
4. Most environmental technologies used in tourism already exist in other sectors. The most effective means to improve environmental management in tourism is through laws and regulations for development planning, pollution control, and protected areas.
5. The tourism industry's attempts at self-regulation through ecocertification are largely ineffective. Likewise, there is no evidence that taking tourists to areas of high conservation value converts them to conservation advocates.
6. Visitors to public protected areas contribute political and financial capital to parks agencies. A few private tourism operators have converted areas of private and communal land to conservation.
7. In developed nations, tourism is a threat to conservation as property developers push to build private facilities inside public protected areas. In developing nations tourism is a tool to fund conservation both in public parks and on private or communal lands.
8. As tourism increases in importance both as a tool and as a threat to the global environment, it deserves attention from researchers in both natural and social sciences, across borders and languages.

FUTURE ISSUES

1. Identify and track trends in commercial tourism, with a focus on destinations and demographics, activities and product structures, and related environmental management issues.
2. Improve the sophistication of recreation ecology research to test the quantitative dynamics of indirect and complex interactions between particular types and patterns of tourism and particular species responses.
3. Test more carefully how different legal, social, and financial frameworks influence the ability of tourism to contribute to conservation.
4. Investigate the role of changing human social structures and communications, especially across cultures and languages, influence all of the above.
5. Examine how all these factors are responding to climate change and to human measures intended to mitigate or adapt to climate change.

Most of these approaches require a combination of social and natural sciences. There are many opportunities for researchers with expertise in the many primary academic disciplines of natural and social science to turn their attention to tourism and recreation. Tourism is a global but geographically differentiated industry. Research on tourism and environment is more valuable if it transcends countries, cultures, and languages.

DISCLOSURE STATEMENT

The author is not aware of any biases that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

I acknowledge information and insights provided during many valuable discussions and contributions by colleagues both in the International Center for Ecotourism Research and worldwide, most particularly in the chapters in three of the books cited. Drafts were kindly critiqued by Guy Castley and Fernanda Pegas. Our research library is managed by Wendy Smith.

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