Journal of Hospitality and Tourism Management 45 (2020) 295–308

Contents lists available at ScienceDirect

Journal of Hospitality and Tourism Management

journal homepage: www.elsevier.com/locate/jhtm

Think globally, act locally: Current understanding and future directions for nature-based tourism research in Sri Lanka☆

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ARTICLE INFO

Keywords:
Recreational ecology
Outdoor recreation
Recreation impacts
Tourism impacts
Vegetation
Protected areas

ABSTRACT

For nearly a century, researchers have observed the ecological impacts arising from increased numbers of visitors using natural areas for tourism and recreational activities. This study reviews the recreational ecology literature as it is relevant to Sri Lanka providing a rare linkage between global research and local applications of this research. The likely ecological impacts of recreational activities undertaken in natural areas in Sri Lanka are identified with a particular focus on walking/hiking, camping, wildlife watching and motorized activities. We conclude by establishing a research agenda that is relevant for developing countries from the Global South and South Asia that aspire to develop their nature-based tourism industry in a sustainable manner. A particular focus should be on fundamental visitor data collection and relating such data to environmental impacts of specific recreation activities, the establishment of research networks, experimental cause-effect studies, and inter-disciplinary studies. We embed this research agenda in a novel conceptual model of the factors and relationships relevant for managing impacts of nature-based tourism as a theoretical contribution to the field of recreational ecology.

1. Introduction

Of the various forms of tourism, nature-based tourism especially with wildlife is popular and has become an important business enterprise and employer across the world (Balmford et al., 2009; Buckley, 2000; Newsome, Moore, & Dowling, 2012). In protected areas and other nature-based destinations, where the natural environment is a vital tourist asset, visitors engage in a broad spectrum of nature-based activities (Mantymaa, Tyrvainen, Juutinen, & Kurttila, 2019; Spenceley, Snyman, & Eagles, 2019).

Tourism staged in the natural environment has been denoted as 'natural area tourism', 'nature tourism' or 'nature-based tourism' (Table 1). However, little consensus exists on the meaning or differences between these terms, which appears to be a problem intrinsic to the tourism taxonomy in general (HaySmith & Hunt, 1995); some people draw distinctions between the terms, others use them interchangeably. Newsome, Dowling, and Moore (2005: 13) described natural area tourism as tourism in the natural environment and recognized three dimensions (a) tourism in the environment (e.g., adventure tourism): (b) tourism about the environment (e.g., nature-based tourism), and (c) tourism for the environment (e.g., ecotourism). HaySmith and Hunt (1995: 203) utilized the term 'nature tourism' and defined it as "domestic or foreign travel activities that are associated with viewing or enjoying natural ecosystems and wildlife for educational or recreational purposes". However, they acknowledged that this term has been applied to many different contexts where recreational activities take place in a natural setting. This resembles Ingram and Durst's (1987: in Weaver, 2001) definition of 'nature-based tourism' as leisure travel that involves the utilization of the natural resources of an area, with ecotourism and adventure tourism seen as partially overlapping sub-categories of nature-based tourism (Weaver, 2001). Whilst ecotourism also centres around the natural (non-human) environment as the main attraction for tourists, it is distinct in that (a) the basis for this attraction is an inherent appreciation/educational interest in the natural environment and (b) an effort is taken to conserve or use that natural environment in a sustainable manner (Orams, 2001). Thus ecotourism is subsumed by the concept of sustainable tourism (Weaver, 2001), which encompasses all activities that do not threaten the

☆ This way, we establish a rare linkage between global research and local applications of this research.

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https://doi.org/10.1016/j.jhtm.2020.08.009
Received 28 March 2020; Received in revised form 23 June 2020; Accepted 22 August 2020

Table 1
Overview and definitions of nature related tourism terminology.

Terminology	Definition	References
Nature tourism	The enjoyment of natural areas and the observation of nature that has low impact environmentally, is labor intensive and contributes socially and economically to the nation	Chiu, Chan, and Marafa (2016)
Natural area tourism	Visiting of wilderness and sensitive areas and other public lands involving non-adventure recreational activities	Newsome (2013)
Nature-based tourism	All forms of tourism where natural environments form the primary attraction or setting. Simultaneously promotes conservation, management of natural resources and provides long-term benefits for local economic development	Gossling, 1999; Newsome, 2013

economic, social, cultural or environmental integrity of the tourist destination in the long term (Butler, 1993). This study concentrates on nature-based tourism activities, following the above-given definition by Newsome et al. (2005), and investigates how current knowledge largely gained from research in the developed countries, on making them sustainable from an ecological point of view (resource sustainability) and from a tourism perspective (sustainability of the tourism experience), can be applied in a case study country from the Global South where little research into this field exists. Notwithstanding the focus, many of the results will be applicable to natural area tourism (Newsome et al., 2005) in general.

Nature-based tourism that is managed sustainably can have various positive effects on wildlife and their habitat; for instance, when tourists participate in practical conservation work (Green & Higginbottom, 2001). Tourists that assist in environmental work or have a positive experience with the natural environment and appreciate the benefits accrued during their travels (Wolf, Ainsworth, & Crowley, 2017; Wolf, Stricker, & Hagenloh, 2015) may develop a closer emotional relationship with nature or particular species (Oberbillig, 2000). This personal bond/appreciation together with an increased conservation awareness (Duff, 1993) perhaps as a result of environmental education through the tourism operator—can have a lasting impetus on people's future behaviour towards the environment (Vickery, 1995). Subsequently, tourists may be more inclined to politically support or donate towards conservation projects or behave in an environmentally responsible manner (e.g., Tisdell & Wilson, 2002). In fact, conservationists may use the charisma of iconic species to promote the protection of whole ecosystems (Eckert & Hemphill, 2005). Thus, the potential of nature-based tourism needs to be explored for developing countries many of which have become strongly reliant on this as a source of income and livelihood for local communities (Steven, 2018).

However, a substantive body of research evidences the varied detrimental effects of nature-based tourism on the environment and the natural resources that are at the core of this industry, exacerbated by the fact that nature-based tourism is largely staged in protected or ecologically sensitive areas (Buckley, 2004). Ecological impacts accrued from visitor use of natural areas include for instance: disturbance to wildlife, introduction and spread of exotic species, pollution of water, soil erosion, and damage to natural environment settings, and fauna and flora (Castley, Hill, & Pickering, 2009; Hein et al., 2019; Newsome et al., 2012). Research into the detrimental effects of nature-based tourism has spawned the discipline of 'recreational ecology' that investigates a wide range of impacts and management techniques (Kidd et al., 2018; Newsome & Davies, 2009; Pickering & Growcock, 2009; Torn, Tolvanen, Norokorpi, Tervo, & Siikamaki, 2009; Spenceley et al., 2019). Therefore, Buckley (2012) explicated recreational ecology as a vital subject in the development of sustainable tourism practises as demonstrated in numerous studies to date (e.g. Steven, Pickering, & Castle, 2011; Zhong, Deng, Song, & Ding, 2011).

While recreational ecology generally encompasses scientific studies on visitor impacts on the natural environment and their effective management (Leung, 2012) suggested conducting research to develop a better understanding of activity- and ecosystem-specific impacts (Liddle, 1997; Sun & Walsh, 1998). These were found to be diverse (Buckley, 2004; Magro & Amanda de Barros, 2004; Weaver, 2001), and scholars have produced an array of reviews and summaries, especially for North America and Australia (Cole, 2004; Hill & Pickering, 2006; Leung, 2012; Leung & Marion, 1996; Monz, 2010a; Pickering et al., 2010a, 2010b; Sato, Wood, & Lindenmayer, 2013; Steven et al., 2011). Previous research has focussed for instance on the impacts of horse riding, tracking, trampling, diving, hiking, walking, camping, bird watching, cetacean watching, and off-road vehicle use (Buckley, 2005; Pickering & Mount, 2010). Since then similar studies have emerged in China, home to one of the largest tourism industries in the region (Liu, Yin & Hung, 2018; Zhong et al., 2011).

Apart from that, however, recreational ecology studies are largely

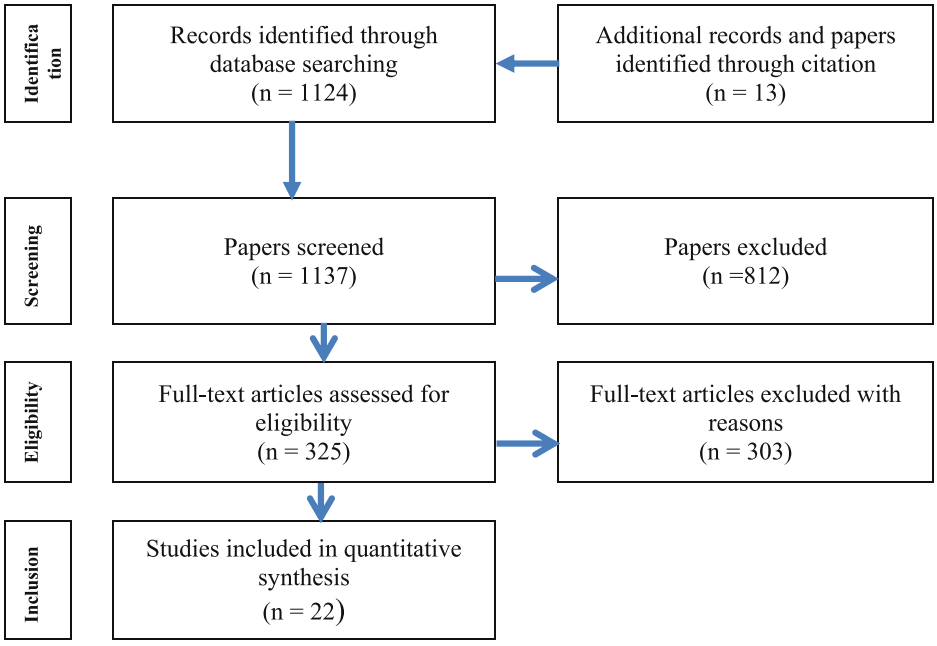

Fig. 1. PRISMA flowchart diagram for the systematic quantitative literature review, $n = 22$ number of research papers selected for review.

missing for Asia and adjoining regions such as Sri Lanka (Leung, 2012; Sumanapala & Wolf, 2019; Leung & Lee, 2003). They are only emerging recently in Sri Lanka in response to increases in recreational activity in natural areas across the country (SLTDA, 2018). Although recreational impact studies have largely been conducted in developed countries gleaning insights gained internationally will be an important first step in identifying priorities for a recreational ecology research agenda for Sri Lanka. Thus, the aim in our paper was to review existing international recreational ecology research and discuss its potential application by establishing a research agenda for Sri Lanka as a case study country located in South Asia where nature-based tourism is booming.

Sri Lanka is an island situated in the Indian Ocean that is being promoted as a prime destination for nature-based tourism in South Asia. Sri Lanka encompasses 65 000 km^2 abound with many natural tourism attractions such as national parks featuring a rich native fauna and flora, along with 1562 km of marine parks (Ashton & Gunatilleke, 1987; Gunatilleke, Gunatilleke, & Dilhan, 2005; Sumanapala et al., 2017). The country's diverse landscapes are ideally suited for a range of nature-based tourism experiences including hiking and wildlife watching, diving, climbing, and vehicle and boat safaris. The recreational impacts in Sri Lanka's various nature-based tourism destinations particularly in light of increasing visitor numbers to ecologically sensitive areas remains largely unstudied (Sumanapala, 2018). Insights gained from researching these will be vital for a viable long-term development of the country as a sustainable nature-based tourism destination.

Our research therefore aims to present a summary of the field of recreational ecology as relevant to the Sri Lankan context with a focus on four key domains: walking/hiking, wildlife watching, camping, and motorized tourism and recreation activities. We conducted a systematic quantitative review of review papers in the field to draw conclusions across a broad variety of topics all relevant to the local context and the nature-based tourism experiences on offer (Winter, Selin, Cerveny, & Bricker, 2019). We added insights through a narrative review of the limited recreational ecology research conducted in Sri Lanka and supporting grey literature. The study then discusses how this global knowledge can aid the mastering of local challenges by shaping a research agenda for minimizing the environmental impacts of nature-based tourism activities in Sri Lanka, within the broader context of a novel conceptual model of the factors and relationships relevant for managing impacts of nature-based tourism.

2. Methods

We performed a systematic quantitative assessment of review articles in the field of recreational ecology conducted over the past decade (2007–2019). A quantitative review of individual papers was not practical due to the broad scope of this review and the large number of papers published in this field (> 800). Using review papers in addition to a narration of individual empirical research papers focused on Sri Lanka, synthesizes ideas from the larger scholarly community and allows to reflect more broadly on past studies (Pickering & Byrne, 2013). Keywords and various combinations thereof to source literature included 'recreation(al) ecology', 'visitor impacts', 'wilderness recreation', 'outdoor recreation', 'recreation impacts', 'tourism impacts', 'recreation', 'ecology', 'nature-based tourism', 'environmental impacts', 'wildlife viewing', 'walking', 'hiking', 'mountain biking', 'non-motorized', and 'sustainable tourism'.

Our systematic quantitative review follows the approach described by Pickering and Byrne (2013) which was effectively applied in numerous studies (e.g, Barros, Monz, and Pickering (2015), Ballantyne and Pickering (2015), Sato et al. (2013), Pickering and Byrne (2013), Sumanapala & Wolf (2020). The selected peer-reviewed papers published in English language journals were located using Google Scholar, Web of Science, Scopus, and Google Scholar Citation.

After the initial search using the keywords listed above, studies were excluded independently by two researchers if they were deemed irrelevant (Fig. 1). Also in the screening stage, books chapters, policy analysis, non-peer-reviewed articles, industry reports, and other grey literature was excluded, and peer-reviewed publications if the study area, methodology, and the nature of the impact were not clearly articulated, or did not align with the objective of this review. Excluded also were case studies, studies on recreation impacts caused by horse riding, and recreational activities not available or of little importance in Sri Lanka. Finally included were original research papers published in English language journals with a focus on recreational impacts.

Paper selection proceeded in accordance with the Preferred Reporting Items for Systematic Review Recommendations (PRISMA) (Ballantyne & Pickering, 2015; Barros et al., 2015) as summarised in a flowchart (Fig. 1): After the initial 'identification' stage of the literature in a keyword search which identified 1124 papers and another 13 papers through citations, in the 'screening' stage 1137 papers were

Table 2
Summary of selected review papers (n = 22) of recreational ecology studies published between 2007 and 2019.

Author	Study focus	Journal	Publication theme
Abraín et al. (2010)	Bird	Basic and Applied Ecology	Natural Resource Management
Barros et al. (2015)	Vegetation, Birds, Mammals, Soils, Aquatic	AMBIO	Human/Environment
Ballantyne and Pickering (2015)	Trampling	Environmental Management	Natural Science/Environment
Bateman and Fleming (2017)	Wildlife	Biological conservation	Natural Science/Conservation
Buckley, Robinson, Carmody, and King (2008)	Wildlife	Biodiversity Conserve	Natural Science/Conservation
Buckley (2005)	Trampling, Vegetation, Wildlife	Tourism Recreation Research	Tourism
Garthe (2019)	Overall field of recreational ecology	Conservation	Natural Science/Conservation
Hardiman and Burgin (2010)	Coastal ecosystem	Environmental Management	Natural Science/Environment
Larson, Reed, Merenlender, and Crooks (2016)	Wildlife	PLoS ONE	Natural Science
Leung (2012)	Vegetation, Wildlife	Journal for Nature Conservation	Natural Science/Conservation
Marzano and Dandy (2012)	Wildlife	Biodiversity and Conservation	Natural Science/Conservation
Monz, Pickering, and Hadwen (2013)	Vegetation, Aquatic, Wildlife,	Frontiers in Ecology and the Environment	Natural Resource Management
Monz, Cole, Leung, and Marion (2010)	Vegetation and Soil	Environmental Management	Natural Science/Environment
Monz, Marion, et al. (2010)	Vegetation, Wildlife, Soil, Air, Water quality	Mountain Research Development	Natural Science/Environment
Marion, Leung, Eagleston, and Burroughs (2016)	Vegetation, Soil, Water, Wildlife	Journal of Forestry	Natural Resource Management
Monz, D'Antonio, Lawson, Barber, and Newman (2016)	Soil, Vegetation, Wildlife, Water, Air	Journal of Transport Geography	Geography
Pickering and Hill (2007)	Plant biodiversity, Vegetation	Environmental Management	Natural Science/Environment
Pickering, Hill, et al. (2010)	Vegetation, Soils	Environmental Management	Natural Science/Environment
Sato et al. (2013)	Wildlife (Mammals, Birds, Reptile, Arthropods, Protozoan)	PLoS ONE	Natural Science
Steven et al. (2011)	Birds	Environmental Management	Natural Science/Environment
Sumanapala and Wolf (2019)	Overall field of recreational ecology	Environments	Natural Science/Conservation
Wolf, Croft, and Green (2019)	Wildlife, environment	Environments	Natural Science/Conservation

screened from which 812 were excluded. In the 'eligibility' stage 325 papers were studied yielding a total of 22 papers deemed relevant for the final reviewing stage, all published between 2007 and 2019 (Table 2). The selected articles review an approximate total of 800 articles in the field of recreational ecology. For example, the paper by Pickering, Hill, et al. (2010) reviewed a total of 152 articles on hiking published between 1979 and 2009. We were interested in the conclusions drawn from these reviews such as key focus and management recommendations as relevant for Sri Lanka.

For each selected review paper the following variables were recorded: Author, year of publication, geographical focus, recreational activities, the time frame covered by the review article, and any proposed recommendations and strategies to minimize the impact of nature-based tourism.

Additionally, we performed a keyword search using the above terms to source articles for a narrative review of Sri Lankan recreational ecology research focussed on the years 2007–2019. Here, we selected peer-reviewed literature (n = 22) but also bolstered that review with additional information from selected Sri Lankan government reports (n = 10), annual reports (n = 4), tourism master plans (n = 2), conference papers (n = 5), survey reports (n = 2) and unpublished reports (n = 4).

3. Recreational ecology subject focus and geographic bias

Reviewing activity in recreational ecology peaked in 2010, with seven articles published in the *Journal of Environmental Management*, followed by two papers each in *PLoS ONE,* and in *Biodiversity Conservation*. Most of the review papers focussed on impact on vegetation and soil, especially relating to trampling, and impacts caused by wildlife watching.

Studies discussed in the review papers were dated between 1927 and 2019. The majority of review papers however covered the timeframe between 1990 and 2010. Only three articles covered the early stages of recreational ecology in the period between 1960 and 1970. The review papers provided a clear picture of the drastic increase in recreational ecology research globally in the past decade.

Reviews originated mainly in the developed and English-speaking countries including Australia (11), followed by the USA (6), UK (1), Scotland (1) and non-English speaking countries such as Germany (1), East Asia (1) and Spain (1). Fig. 2 shows the geographic bias in review

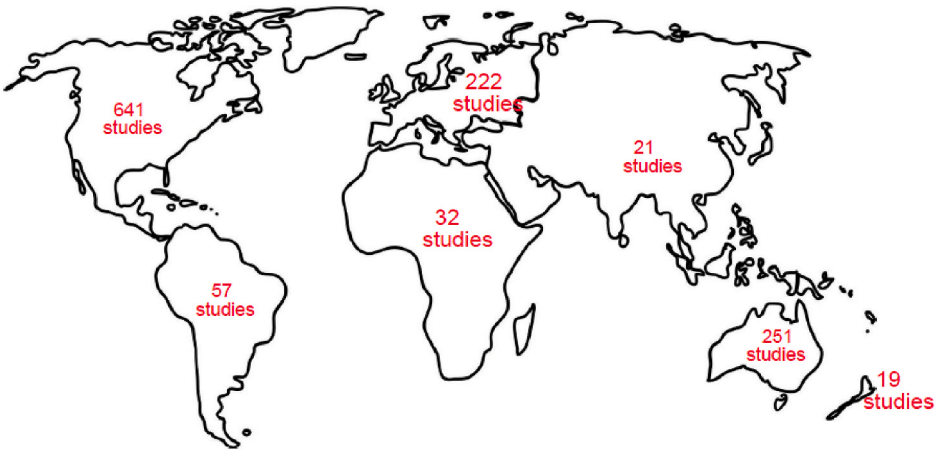

Fig. 2. Global distribution of studies in selected review papers (n = 22) of recreational ecology. Most reviews reported on walking and hiking activities (n = 11 papers), followed by activities facilitated by land-based transport (n = 9) such as wildlife safari vehicles, off-road vehicles, four-wheel driving, and transportation provided by parks both inside and outside of the park (Fig. 3). Aquatic and terrestrial wildlife watching studies were afforded considerable attention, while only a few papers discussed impacts of mountain biking and water-based recreation relating to boat-based wildlife watching and boat-safari-style activities. Numbers on the map refer to (1) the number of *review* papers on recreational ecology included in this study, (2) Numbers on the map refer to the number of empirical recreational ecology papers, by continent or country, respectively, that were reviewed in the review articles that we selected to include in our study.

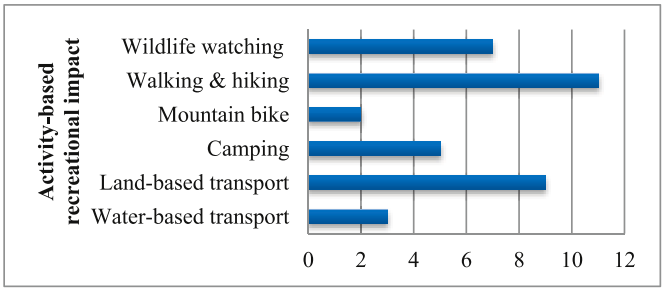

Fig. 3. Activity focus of selected review papers (n = 22) of recreational ecology.

studies of recreational ecology with South Asia largely under-represented in spite of the high demand for nature-based tourism in this destination.

The recommendations of review articles in many studies have highlighted that changing and improving management approaches are most suitable for minimizing recreational impacts. The studies have also recommended visitor education, limiting visitation, staff training, and awareness on recreational impacts for minimizing the ecological impact.

Tourism (and recreation) has undeniable impacts on the visitor experience and natural resources. Ecological impacts were noted for soils, water, fauna, and flora (e.g., changes in vegetation cover, and composition), pollution of waterways, and the spread of exotic species and dispersal of weeds (Liddle, 1997; Hammitt & Cole, 1998; Hill & Pickering, 2006; Newsome et al., 2012; Smith & Newsome, 2002; Mount & Pickering, 2009; Monz, Cole, et al., 2010; Cole, 2004; Pickering, Castley, et al., 2010,b; Steven et al., 2011). Protected and natural areas that are profoundly impacted on by visitors or those that hold an iconic status as a tourist attraction have warranted particular attention by recreational ecologists such as world heritage sites, biosphere reserves and protected parks that host specific endangered species.

The existing research literature is predominantly focussed on North America, Europe, and more recently, Australia and New Zealand (Cole, 2009; Monz, Marion, et al., 2010). Hammitt and Cole (1998), Monz, Cole, et al. (2010), and Newsome et al. (2012) reported that for the past 30 years, North America and Australia have been the epicentres of recreational ecology research that revealed an array of impacts (Table 3). More specifically, Pickering, Castley, Hill, and Newsome (2010) reported that North America and Australia had published 80% of recreational ecology studies, and Buckley (2005) reported that the USA and Canada published 429 out of 768 studies compared to 69 published in Australia and New Zealand. Research completed in these geographic realms that quantifies undesirable consequences of nature-based tourism has been shown to result in actions to mitigate impacts which underpins their value (Cole & Monz, 2002; Liddle, 1997; Newsome & Davies, 2009; Phillips & Newsome, 2002; Pickering & Growcock, 2009; Torn et al., 2009).

4. Current understanding and future directions for nature-based tourism research in Sri Lanka

In the following we provide an overview of what is known in regards to recreational impacts of walking/hiking, wildlife watching, camping, and motorized tourism and recreation activities. These tourism domains are most relevant for the Sri Lankan context, and our review will inform scholars, researchers, and policymakers to prioritise future research areas.

4.1. Walking and hiking

Walking and hiking and are some of the most popular activities in natural areas worldwide, and have received much attention in recreational ecology. These activities are typically facilitated along recreational infrastructure such as 'trails'. Trails are made up of different

Table 3
International recreational research vs. locally studies recreational research.

Likely ecological impact	Recreational activity							Key References
	Cam	D & S	W & H	SB	SV	MWW	TWW	
Terrestrial impacts on soil, vegetation, water								
Change in trail/road width and soil erosion	–	–	X	–	X	–	–	Pickering, Castley, et al., 2010; Newsome, Smith, & Moore, 2008, 2012; Buckley, 2004
Presence of human waste	X*	X	X	–	–	X	–	Bridle & Kirkpatrick, 2003, 2005; Bridle, Von Platen, Leeming, & Kirkpatrick, 2007;Mallikage & Perera, 2017
Tree damage and root exposure	X*	–	X	–	X	–	–	Pickering, Castley, et al., 2010; Newsome et al., 2008; Mallikage & Perera, 2017
Change of vegetation type	X	X	X	–	X	–	X	Cole, 1987; Barros et al., 2015; Marion et al., 2016;
Littering and unburnt matter	X	–	X	–	–	–	–	Cole & David, 1990; Liddle, 1997; Smith & Newsome, 2002; Monz, Cole, et al., 2010
Spread of weeds	X	–	X	–	X	–	X	Turton, 2005; Smith & Newsome, 2002; Pickering & Hill, 2007
Reduced water quality and Soil pollution	X	–	X	X	X	X	–	Bridle et al., 2007; Newsome et al., 2012; Ongerth, Hunter, & DeWalle, 1995; Smith & Newsome, 2002; Turton, 2005; Growcock, 2006
Terrestrial/Aquatic impacts on wildlife behaviour								
Disturbance & Displacement of wildlife	–	X	X	X	X	X	X*[b,c]	Kays et al., 2017; Muhly, Semeniuk, Massolo, Hickman, & Musian, 2011; Ranaweerage et al., 2015[b]; Alwis et al., 2016[c]
Noise disturbance	–	–	–	X	X	X	X	Newsome & Lacroix, 2011; Hadwen, Hill, & Pickering, 2008; Mosisch & Arthington, 1998, 2004
Changes in behaviour	–	X	X	X	X*[b,c]	X	X*[b,c]	Beaumont, 2001; Higham & Carr, 2002; Orams, 1997; Orams, 2002; Newsome et al., 2005; Ranaweerage et al., 2015[b]; Alwis et al. 2016[c]
Aggressive responses from wildlife	–	–	–	X	X*[b,c]	X	X*[b,c]	Boyle & Samson, 1985; Knight & Gutzwiller, 1995; Taylor & Knight, 2003; Steidl & Powell, 2006; Ranaweerage et al., 2015[b]; Alwis et al., 2016[c]
Other aquatic impacts								
Reduced fish hatching	–	X	–	X	–	X	–	Hadwen et al., 2008; Mosisch & Arthington, 1998; Murphy, Willby, & Eaton, 1995.
Reduced feeding success	–	X	–	X	–	X	X	Hadwen et al., 2008; Mosisch & Arthington, 1998; Murphy et al., 1995; Orams, 2002
Changes in benthic cover	–	X*[a]	–	–	–	–	–	Hawkins & Roberts, 1993; Rouphael & Inglis, 1997
Breakage or crushed tips of branching corals	–	X*[a]	–	–	–	–	–	Liddle & Kay, 1987; Rajasuriya, 2000[a], Hawkins and Roberts (1993)

Cam-Camping; D&S-Diving and Snorkeling; W&H-Walking and hiking; SB-Safari boat; SV-Safari vehicle; MWW-Marine wildlife watching; TWW-Terrestrial wildlife watching.
X –Impacts are likely to occur in locally; *a, b, c -Existing Recreational ecology research in Sri Lanka.

materials (rubber, steel, mesh, gravel, natural rock, and soil) depending on the activities and purposes.

According to Pickering, Castley, et al. (2010) walking and hiking mainly degrade the actual tracks, soil and vegetation. While many such impacts can be buffered through intelligent trail design and material choices, impacts are still common, in particular multiple treading, track widening, root exposure, and soil erosion/track deepening (Leung & Marion, 1999; Newsome, 2013; Pickering, Hill, et al., 2010). A very common impact is trail degradation. Weaver and Dale (1978) and Leung and Marion (1996) revealed that trail degradation depended on the following: (1) the amount and type of recreational activity, (2) the steepness and roughness of slope, (3) the physical properties and moisture conditions of the soil, and (4) the climate (rainfall characteristics) and vegetation type. Newsome et al. (2012) highlighted the broad impact of soil erosion, while Garland (1990) revealed that rainfall, soil type, and slope constitute parameters for trail erosion and therefore trail degradation. Monz, Marion, et al. (2010) emphasized the aggravating effects of slope areas and other detrimental factors (as researched by Cole, 2004; Buckley, 2004; Hill & Pickering, 2006, 2009; Pickering & Mount, 2010; Pickering, Hill, et al., 2010; Steven et al., 2011).

Informal trails can also have significant environmental impacts. Defined as illegal, unapproved, and user-created trails (Newsome & Davies, 2009; Newsome et al., 2012; Pickering, Castley, et al., 2010), they can damage the local environment by changing the hydrology, or by degrading visual amenity, while increasing the disturbance of wildlife, ultimately requiring potentially expensive management actions such as site restoration (Monz, Marion, et al., 2010; Newsome & Davies, 2009; Wimpey & Marion, 2011).

Trampling is another common impact on vegetation and soil that has been well researched (Newsome et al., 2012). It can cause a reduction in vegetation height, soil compaction, soil loss, reduced soil moisture, loss of organic matter, loss of groundcover vegetation, loss of native plant species, change in the composition of vegetation, and the introduction of weeds and pathogens (Wolf & Croft, 2014)Newsome & Davies, 2009; Pickering, Castley, et al., 2010; Newsome, Milewski, Phillips, & Anne, 2002; Pickering, Hill, et al., 2010, 2011; Wimpey & Marion, 2011). Newsome (2003) and Cushman and Meentemeyer (2008), for instance, identified a strong relationship between the use of hiking trails and the spread of *Phytophthora* in Australia and in the USA, with an imminent threat of spreading into adjoining natural areas (Boon, Fluker, & Wilson, 2008; Daniel, Taylor, & Guest, 2006; Newsome, 2003; Turton, 2005). Pathogens were found in 40% of the shoes of school children during hiking on a short trail in a natural area (Davidson, Wickland, Patterson, Falk, & Rizzo, 2005).

Conversely in local Sri Lankan studies, the impact of walking and hiking is hardly researched. This is an important gap considering the large and vulnerable forest reserves such as the Sinharaja, Kanneliya, Horton Plains, Knuckles Range, the iconic Little Adams's Peak and Ella Rock which are extensively used for walking and hiking as they are accessible only afoot. A steep topography and ample rainfall renders these areas prone to trail degradation and thus makes ecological impacts highly likely.

The Knuckles Range (UNESCO heritage) and Sinharaja (Biosphere Reserve and World Heritage Site) are the most popular places for walking and hiking (Humke, 2018; UNESCO, 2017). Baret and Strasberg (2005) noted that walking and hiking are in high demand also in other developing countries but especially in Sri Lanka in regional biodiversity hot spots such as these two protected areas. Due to the high visitor numbers there, environmental impacts have been reported of spreading weeds/invasive plants, pathogens, increased plant collection and informal roads/trails (Ballantyne & Pickering, 2015; Pickering, 2010). The relevant management organizations in the country have not yet implemented any monitoring activities and even the most basic information on visitor numbers; distributions and level of usage for walking and hiking are missing.

An overview of recreational impacts studied by activity group is provided in Table 3, which also marks local research. For example, for terrestrial wildlife watching, studies were conducted in Sri Lanka that noted disturbance and displacement of wildlife, as well as changes in behaviour and aggressive responses from wildlife. Table 3 clearly demonstrates that there is very limited research available locally, especially about the impact of walking and hiking, and marine wildlife watching compared to the internationally well-established body of literature in the field. Urgent investigations focused on the above-mentioned subjects and as per caveats exposed in Table 3 for specific activity groups and impact types such as terrestrial impacts on soil and vegetation are urgently required.

4.2. Camping

Newsome et al. (2012) revealed that camping constitutes one of the most popular tourism and recreation activities, especially in the USA and Australia. Camping areas exposed to an informal and temporary appropriation of space by visitors invariably abound with negative impacts on soils, vegetation, and wildlife (Cole, 1990, 2004; Hammitt & Cole, 1998; Smith & Newsome, 2002; Cole, Foti, & Brown, 2008). In fact, camping produces some of the most significant impacts noted by recreational ecologists (Newsome et al., 2012), which increase in absence of proper management actions (Smith & Newsome, 2002; Cole, 2004; Reid & Marion, 2005). Conversely, impacts and their spatial extent can be reduced where management provides campsites on cleared space with adequately designed facilities meeting demand. Localised impacts identified by scholars include a reduction in biotic ecosystem structure, loss of habitats, reduction in biodiversity due to the collection of wood (Harmon et al., 1986; Freedman et al., 1996; Lindenmayer, Claridge, Gilmore, Michael, & Lindenmayer, 2002; Woldendorp & Keenan, 2005; Smith, Newsome, & Enright, 2012), and a reduction of coarse woody debris (CWD) in surrounding areas (Harmon et al., 1986; Christensen, Herwig, Schindler, & Carpenter, 1996; Hecnar & M'Closkey, 1998; Bowman, Sleep, Forbes, & Edwards, 2000; MacNally, Parkinson, Horrocks, & Conole, 2001; Lindenmayer et al., 2002; Woldendorp & Keenan, 2005), along with some of the trampling effects described above. In addition, Harmon et al. (1986) found wildlife impacts likely and a reduced quality of the visitor experience due to littering and the disposal of human waste as recorded in Australia and Malaysia (Lucas, 1990a, b; Dixit & Narula, 2010; Chin, Moore, Dowling, & Wallington, 2000; Morin, Moore, & Schmidt, 1997; Cochrane, 2006). Cole (1992) and Marion (1995) have expressed concerns about the expansion of formal campsites and degradation of soils and vegetation at informal campsites in natural areas around the world.

In Sri Lanka, selected protected areas including 13 national parks and 51 campsites currently provide camping facilities to visitors. Among these Yala National Parks, Udawalawa, Horton Planes and Wasgamuwa are the most popular campsites located within the 13 national parks. Here the monitoring appears to be better established compared to the situation described above for hiking, simply because of the more concentrated nature of use and the lower number of campsites compared to walking/hiking trails. Sri Lankan park staff at least in protected areas is required to regularly monitor compliance with management guidelines such as the maximum number of visitors allowed per campsite. There are also clear regulations for allocating spaces for demarcated campsites, provision of toileting facilities, and limiting the number of camps and campers per site much in line with international standards (Marion et al., 2016). This helps reduce impacts, and yet more granular observations at each site are completely missing: such as possible impacts of fire rings, seating near vegetation, collection of firewood, changes in vegetation around campsites, or introduced invasive plants, along with loss of tree height, biomass, reduction in forest cover and changes in species composition. (Pickering & Hill, 2007).

Only a few local studies aim to fill the research gaps around

camping impacts in Sri Lankan national parks. Between these Mallikage and Perera (2017) have found that non-biodegradable litter was higher than biodegradable litter at campsites in National Parks. Most of the camping visitors were well educated and had great expectations for high-quality visitor experiences at their campsites. Therefore, to meet visitor expectations and to improve environmental conditions, park managers have to minimize biophysical impacts near campsites (Mallikage & Perera, 2017). Their results also showed that inappropriate visitor behaviour such as vandalism and tree damage occur. Visitor education is essential in this context, and so is long-term monitoring of campsite conditions here and elsewhere in Sri Lanka.

4.3. Wildlife watching

Wildlife watching is a favorite activity of visitors to protected areas in Africa, Australia, Nepal, the USA, and South America (Newsome & Dowling, 2010). Its popularity is increasing and attracts an affluent market (Newsome et al., 2005; Rodger, Moore, & Newsome, 2007).

Hammitt and Cole (1998) warned that an increase in visitor interaction with wildlife may cause an adverse response both in animals and their habitats, including various levels of disturbance and harassment. These impacts are also reported elsewhere (Knight & Gutzwiller, 1995; Steidl & Powell, 2006; Taylor & Knight, 2003). As per Boyle and Samson (1985), most wildlife is affected even by non-consumptive outdoor recreational activities. Wildlife that is subjected to tourism disturbance, initially responds with physiological changes that helps survive during an emergency. During the so-called “fight or flight response” (Cannon, 1929) of higher animal species to disturbance, numerous endocrine mechanisms are activated to cope with the emergency (Munck, Guyre, & Holbrook, 1984), and the body prepares for behavioural defence reactions through increases in heart rate, respiration and body temperature (Mayes, 1979). Such physiological adjustments usually precede overt behavioural responses. For instance, when incubating penguins were approached by humans up to a distance of 15 m, they showed no behavioural changes, but their heart rates were significantly elevated above baseline rates (Giese, 1998). Only closer approaches triggered behavioural reactions. The physiological reaction to disturbance constitutes a stress response which, depending on its duration, frequency and magnitude, may cause adverse side-effects including immuno-deficiencies, developmental delays, weight loss or reduced reproductive success (Hofer & East, 1998; Siegel, 1980). Overtly, disturbed animals will assume vigilance behaviour to evaluate potential danger (e.g., Dyck & Baydack, 2003) or undertake evasive actions (e.g., Cassirer, Freddy, & Ables, 1992; Wolf & Croft, 2010; Wolf & Croft, 2012). Sometimes, aggressive responses occur. As a consequence less time can be spent on feeding (Knight, Anderson, & Marr, 1991; Roe, Leader-Williams, & Dalal-Clayton, 1997), resting and in social interaction (Edington & Edington, 1990). Moreover, off-spring may be abandoned during flight reactions (Stuart-Dick, 1987), and animals may spatially or temporally avoid disturbed habitats even if they sustain better quality resources (Griffiths & Van Schaik, 1993; Olson, Gilbert, & Squibb, 1997; Woodall, Woodall, & Bodero, 1989).

There is no guarantee that short-term behavioural responses of individual animals translate into long-term deficits in reproduction and survival, and therefore into fitness deficits. Notwithstanding, there are obvious implications, given that the individual's current energy levels are depleted by physiological reactions as well as additional vigilance and flight, less new energy can be consumed due to reduced body maintenance activities, and the actual intake will be less efficient if displacement from optimum foraging places and times occurs. For example, elevated heart rates suggested that the energy expended by incubating penguins following close approaches by a human should be significantly higher than that of undisturbed penguins (Giese, 1998). These changes in response to disturbance may explain why hatching success and chick survival of repeatedly disturbed colonies were reduced by 47% and 80%, respectively, compared to that of undisturbed colonies (Giese, 1996). Thus, if tourism disturbance persists or occurs frequently, impacts may extend to populations (e.g., Liley & Sutherland, 2007) and whole communities. Changes in these higher levels of biological organization may involve changes to population abundance and age-sex structure as well as changes in species community composition, species richness and diversity.

Bird watching is the most favored recreational activity among wildlife-watching tourists (Jones & Buckley, 2001; Newsome, 2005; Sekercioglu, 2002). However, Liddle (1997), Newsome et al. (2002), and Buckley (2004) argue that such a recreational activity has negative impacts on birds. Previous studies revealed changes in foraging of birds, vigilance, evasion, reduction in the number of nests built, eggs laid; chicks prematurely hatched or fledged are a further detrimental effect on birds (Banks & Bryant, 2007; Buckley, 2004; Cardoni, Favero, & Isacch, 2008; Liddle, 1997; Liley & Sutherland, 2007; Müllner, Linsenmair, & Wikelski, 2004; Regel & Putz, 1997; Steven et al., 2011; Wolf, Hagenloh, & Croft, 2013). Steven et al. (2011) reviewed the impacts on birds due to nature-based recreation which revealed significant adverse effects of non-motorized recreational activities on birds (Buckley, 2004; Liddle, 1997). Steven et al. (2011), Liddle (1997) and Buckley (2004) acknowledge that most of the previous bird watching studies have been conducted in cool-temperature or temperate climatic zones. Therefore, there is a lack of evidence for other climatic regions such as Australia, Central America, Asia, and Africa. Newsome (2005) warns about the potential impacts on birds in the developing world due to informal guidance and money-targeting tour guides.

Dolphin and Whales (Cetaceans) are also popular targets for wildlife-watching tourists (Beaumont, 2001; Higham & Carr, 2002; Lusseau et al., 2006; Orams, 1997). Developed countries such as Australia, New Zealand, Scotland, and Iceland, as well as some developing countries such as Sri Lanka but also India, Indonesia, Cambodia, Thailand, Malaysia, the Philippines, and many more offer cetacean-watching tourism as a recreation activity. Previous researchers found impacts of cetacean watching to be both short term and long term. Short-term effects include behavioural changes of reduced resting activity, less time spent with feeding and socializing, or diving, and more time spent with milling and traveling. Long-term outcomes result in changes in activity periods, breathing rates, phonation rates, summing direction, “singing” synchronously, and vocalization. Therefore, many developed countries have established codes of conduct to sustain the cetacean watching industry. The challenge is to control and reinforce the distance between boats and cetaceans (Bejder, Samuels, Whitehead, & Gales, 2006). Beasley, Bejde & Marsh (2010) warns though that in some countries earning income from the lucrative cetacean watching industry is a greater priority than conservation. Hence, more research on the impacts of tour vessels in these countries is necessary, because their activities are the cause of significant declines in cetacean numbers in tourist sites.

From a Sri Lankan perspective, the country is famous as a wildlife watching destination in South Asia (Buultjens, Ratnayake, Gnanapala, & Aslam, 2005), especially because it is home to the world biggest land animal (elephant), and water animal (blue whales), along with a highly diverse community of birds, and mammals including large attractive predators such as the normally illusive leopard that can be spotted relatively easily within short traveling distances from major Sri Lankan tourist hubs. Therefore, wildlife tourists have substantially increased in national parks, forest reserves, and marine parks in the country. This is the case, for example, for Yala, Udawalawa, and Kaudulla with respect to elephant watching, the Sinharaja Forest reserve for bird watching, and the Mirrisa reserve for whale watching (IUCN, 2016).

January to April constitutes peak season for whale watching in Mirrisa, on the south coast of Sri Lanka, from where locals run whale-watching operations for tourists. Because of the high demand at this time of the year and the large number of competing operators, whales are being aggressively pursued by six or more seven-passenger boats at any one time (Fig. 4A & B). This inappropriate practice, results in displacement of individual whales outside into the international shipping

Fig. 4. A Heavy traffic of vessels that transport tourists to watch whales at Mirrisa.
Fig. 4B A whale's fluke (marked in red color) in close proximity to six vessels. . (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

lines. Consequently, each year approximately five whales get killed through collision with ships, contributing to a decline of already vulnerable populations.

In response to this and related issues, the Sri Lankan government has introduced the Sea Mammals Regulation and the Wild Fauna Act through the Wildlife Conservation Department. Unfortunately, the code of conduct and guidelines for whale watching are far more lenient and lack the strict regulations informed by rigorous research as implemented for instance by the Australian Government, for example, pertaining to minimum approach distances and approach angles (Parsons, 2012). Recently at least the Sri Lankan Wildlife Conservation Department has introduced a whale watching rotation system for boat operators to limit the number boats per whale which underpins the increased awareness of impacts and the need to act. However, such efforts are impeded by the limited research available despite increased level and distribution of activities (DWL, 2018; Sumanapala, 2018).

An exceptional Sri Lankan study on feeding activity of elephants in the presence versus absence of tourists in national parks revealed significant changes in the behaviour of elephants while tourists were present (Ranaweerage, Ranjeewa, & Sugimotoa, 2015; WNPSSL, 2019). Moreover, Rathnayake (2015) argued that without appropriate nature-based tourism planning, there is a low likelihood of achieving tourists' satisfaction while minimizing recreational impacts. Also, Alwis, Perera, and Dayawansa (2016) investigated the impact of human recreational disturbances on the distribution of birds along a popular nature trail in Sri Lanka's Sinharaja World Heritage Forest (IUCN, 2016). Accordingly, high levels of disturbance caused birds to avoid edge habitat. As per previous findings (Steven et al., 2011), negative impacts on bird diversity were noted, even in response to seemingly harmless, non-motorized bird watching activities. Although the relevant authority has educated visitors about their general visitation guidelines and appropriate behaviour inside the park it did not focus specifically on bird watching activities. This is an important gap as guidelines for reducing impacts need to be as specific as possible to be effective (Wolf & Croft, 2012). Here and elsewhere in Sri Lanka, guidelines need to be structured by activities inside the specific parks, yet again requiring research to inform and educate visitors, and to help park managers decide upon specific acceptable forms of visitor use and behaviour (Kandasamy, Weerakoon, Sivaruban, & Jayasiri, 2019; "Asian Development Bank Protected area management and wildlife conservation project," 2000; DWL, 2017, 2018).

The cited investigations reveal that impacts arise because of outdoor recreational tourism activities in Sri Lanka, much in line with international findings that highlight the likely ecological impacts of wildlife tourism (Table 3). While the few local studies provided important results, they are too sparse to properly cover the range of impacts experienced by the diverse fauna in their varied Sri Lankan habitats and clearly more research is needed at different national parks and in different seasons.

4.4. Motorized tourism activities

The number of power-boating activities has increased as freshwater leisure endeavours such as water skiing, and power boating are on the rise (Jackson, 1986; McCall, 1977; Mosisch & Arthington, 2004). Also, viewing of mangrove habitats has become a popular activity. Tours are typically organized on non-motorized boats (rowing boats or traditional boats); however lately, the increased demand for such activities compels service providers to operate motorized boats, motivated more by financial interests than conservation concerns. This poses a primary challenge especially in developing countries, and consequently many scholars have analyzed power boating impacts on the ecology of inland water bodies (Murphy et al., 1995; Warrington, 1999). Mosisch and Arthington (2004) identified three main effects of power boating: (a) physical impacts, (b) chemical impacts, and (c) ecological impacts. They conducted sound studies on the effects of power boats on freshwater bodies (Warrington, 1999). As per Jackson (1986), the level of impact from power boats depends on the size, shape, and speed of the boat (Jackson, 1986; Murphy et al., 1995). Both direct and indirect impacts, and more obscure impacts on water birds, and the effects of settled sediments on aquatic flora and fauna have also been studied (Mosisch & Arthington, 2004).

Terrestrial tourism activities facilitated by conventional passenger vehicles, four-wheel drives and other off-road vehicles, and in the specific context of safari touring are also known to affect wild animals and their habitat in protected areas. Vehicles used on park tracks for instance have been reported to create physical damage to the environment (Hall, 1994). Wolf et al. (2013) showed that bird communities inhabiting ecosystems adjacent to roads may be adversely affected by disturbance from passing tourism traffic, vehicle-related mortality, habitat alteration and modified biotic relationships such as the increase of strong competitors. Vegetation communities along roads suffered from substantial edge-effects through the impacts of trampling, modified environmental conditions and competition with species that benefit from disturbance as noted by Wolf and Croft (2014). Importantly in this study, roadside effects were greater and more pervasive than trailside effects, and certain impacts, such as the increase of non-native species, self-perpetuated from their points of introduction to disjointed sites with a predisposition to disturbance. The latter largely increased the overall spatial extent of roadside impacts far beyond the road verge. An experimental study by Wolf and Croft (2010) in the Australian Outback demonstrated that kangaroos exposed to driving tourists reacted with flight that varied with the type of approach and various environmental conditions. Also, night-time observations of various Australian wildlife (mammals, birds, reptiles) were affected by driving tourists (Wolf & Croft, 2012). Simulations used in this (Wolf & Croft, 2012) and a previous study (Wolf & Croft, 2010), for the case of driving tourists, teased out specific disturbance factors influencing flight response and observation distances. Other studies addressed road impacts in protected areas in the Western world (i.e., the USA, Canada, Australia, and New Zealand) (Hall, 1994; Liddle & Kay, 1987). However, the nature of impacts varied between countries according to the diversity in species, ecosystem, management region, and human behavior (Buckley, 2005). Altogether experimental studies to drill down to cause-effect relationships as conducted by Wolf and Croft (2010, 2012) remain the exception.

In Sri Lanka almost all of the national parks allow vehicle access,

although activities are limited to daylight hours (6am to 5pm). Therefore, there is no nighttime safari activity at the park and no related night time disturbance as reported elsewhere (e.g., Wolf & Croft, 2012). However, the increasing demand for visiting popular parks such as Yala Park has caused traffic congestion and visitor crowding both outside and inside of the park especially on weekends and public holidays.

Because motorized activities in Sri Lanka are largely unplanned and appear to operate haphazardly at times, substantive impacts have been noted especially for bird watching in wetlands (Shashikala & Perera, 2018). Sri Lanka boasts many wetlands included Ramsa-categorized wetlands which are in high demand among visitors for water bird vising such as in the Bundala, Anawilundawa, and Madu ganga area. One of the few existing studies has reported such negative effects, and emphasized the great importance of maintaining minimum-approach distances and vehicle speed limits to minimize the impact on bird behaviour such as foraging, resting and breeding (Goonatilake et al., 2020; Shashikala & Perera, 2018).

Apart from motorized bird watching activities, private stakeholders have developed a segment of park tourism that is focussed on elephant and leopard safaris. Tourists participating in these activities are known to do so multiple times to increase their chances of spotting these elusive animals, especially the leopard (IUCN, 2016). Hence between 450 and 500 vehicles enter the most popular parks on a daily basis during peak times and holidays. This has increased the disturbance of not only the targeted wildlife species but any wildlife present, along with destruction of habitat resulting in loss of plant diversity. Recently this has also resulted in the loss of three leopards due to collisions with vehicles within just five consective months. Similarly, free-ranging elephants have been exposed to the same issues. Ranaweerage et al. (2015) concluded that vehicle noise, a close approach distance and specific timing of a safari are closely associated with behavioural changes of elephants. In the Sri Lankan Udawalawe National Park elephants were especially disturbed while feeding.

Clearly, here one of the key issues that needs to be addressed is whether such a significant amount of tourism traffic causes a level of disturbance to the habitat that renders it unusable by wildlife and therefore decreases the probability of habitat occupancy, and whether this then has an impact on different wildlife species populations; along with research that investigates whether immediate reactions to disturbance such as flight or behavioural changes translate in long-term impacts of animal fitness and population viabilities. However, not only is no research conducted in this realm, but currently the Sri Lankan Department of Wildlife Conservation does not have any management tool in place to control daily visitor flows nor has it established (let alone reinforced) a code of conduct for vehicle use inside parks (Prakash, Perera, Newsome, Kusuminda, & Walker, 2019).

5. Conclusions and implications for a future recreational research agenda

Mitigating and managing the diverse recreational impacts as discussed above will be critical for the viability of the nature-based tourism trade in Sri Lanka and other developing countries of the Global South or more specifically in South Asia. Yet, as we have shown above this research is virtually non-existent in the peer-reviewed literature. If it is at all addressed, then mainly in less accessible grey literature and other informal government and consultant reports or via online channels. Our review captured the current understanding of recreational ecology internationally, and placed it in context with the Sri Lankan situation. Thereby we established linkages between local research and global knowledge as a means to 'think globally' and encourage to 'act locally' by informing research design (measurement variables, methods, etc.), policies and strategies for nature-based tourism (Fig. 5).

In line with the impact management strategies proposed in the reviewed papers, we have developed a conceptual model that shows the factors and interrelationships to be considered for managing impacts of nature-based tourism. In the following we discuss these components along with the specific recommendations given in Table 4 that contains a summary of suggestions for a recreational ecology research agenda. Although the focus was on Sri Lanka the conceptual model and specific recommendations are of broad theoretical value to other countries where recreational ecology research is lacking, and that are in the initial stages of developing research and management initiatives to support, guide and inform tourism trade and planning initiatives.

Our model highlights the need to develop a research agenda

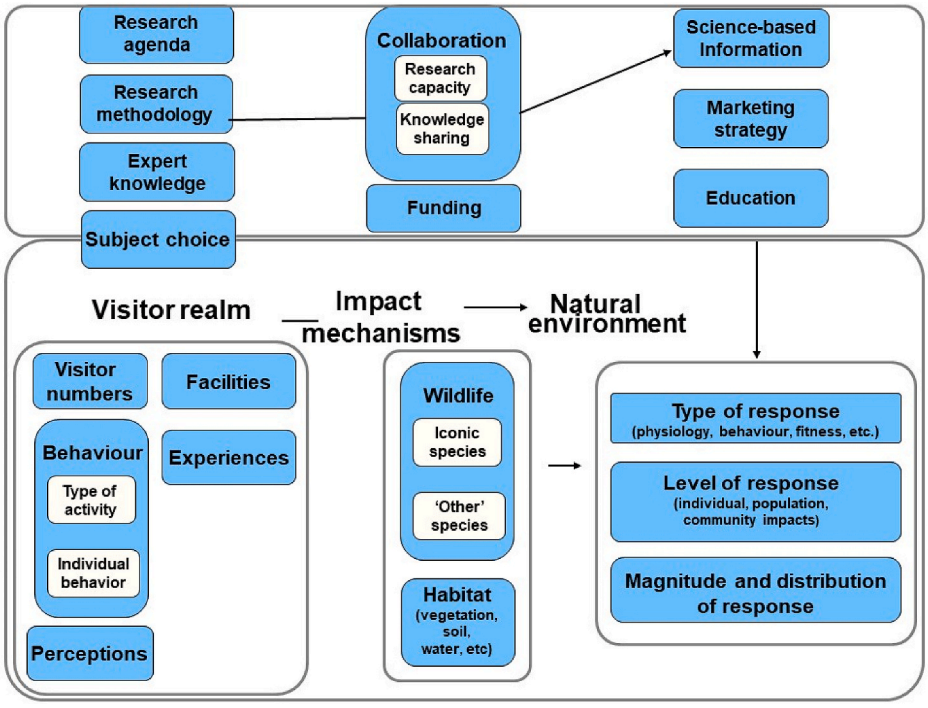

Fig. 5. Conceptual model of the factors and interrelationships relevant for managing impacts of nature-based tourism.

incorporating adequate and novel research methodologies (recommendation 6, 8). To establish the research design or for data collection purposes expert knowledge should be harnessed (rec. 8). A careful choice of study subjects (rec. 2) should consider both the natural environment (rec. 2, 7) and its responses to nature-based tourism as well as the social realm of participants (rec. 4, 6) in nature-based tourism activities, along with a rigorous study of impact mechanisms (rec. 3, 4). Management of nature-based tourism activities is best achieved by capitalising on research collaborations (rec. 1), accessing and planning for funding opportunities and using insights gained from research (rec. 4), along with implementing marketing and education strategies to manage visitor expectations and behaviour (rec. 5).

In line with impact strategies proposed in the reviewed papers, we have developed the following recommendations along with Table 4 containing a summary of suggestions for a recreational ecology research agenda. Although the focus was on Sri Lanka the recommendations are of broad value to other countries where recreational ecology research is lacking, and that are in the initial stages of developing research and management strategies to support and guide tourism planning initiatives.

(1) Establish a strong network among the relevant planning agencies and tourism stakeholders such as the local operators, local and international university researchers and local communities to build research capacity and knowledge-sharing programs. This requires an analysis of the connections and relationships among all the identified parties.
(2) Expand existing empirical research and research paradigms as summarised in Table 4. The review presented above and in Table 4 should help in honing in on the most pressing subjects for research. Future impact studies should be expanded across different activities (Table 4) and ecosystems because Sri Lanka is climatically and geographically diverse. Research on walking and hiking activities and water-based recreation needs to be a top priority.
(3) Conduct experimental cause-effect studies. In the field of recreational ecology, these are lacking both locally and internationally, as noted by Wolf et al. (2019), and Sumanapala and Wolf (2019). Particularly valuable are studies on impacts of specific wildlife watching activities and variables such as minimum approach distances, group sizes, and observation techniques and conditions. Such studies would be highly insightful in creating a better understanding of impacts, their modulating factors and the most effective management approaches.'
(4) Research social impacts of recreational activities such as perceived environmental impacts and crowding (Barros et al., 2015; Monz, Marion, et al., 2010). Recreational ecology is a multi-disciplinary field that spans environmental sciences and social sciences. Although the social aspects of nature-based tourism research were not a main focus of this review we certainly recommend that this forms an integral part of the research agenda for the Sri Lankan case as well as in countries with a similar (non-existing) research base. Environmental impacts and sustainable practices need to be understood in the context of tourist satisfaction as this figures largely into the uptake of sustainable visitor practices. The challenge is to manage visitor expectations while mitigating impacts and at the same time considering the economic implications of reducing visitor flows or specific activities, or altering them in line with stricter policies that may reduce visitor satisfaction (Monz, Cole, et al., 2010; Monz et al., 2013). And yet, there are several experimental studies from Australia that provide an excellent blueprint on how to research tourism experiences that reconcile environmental and visitor needs (Wolf & Croft, 2010, 2012). These should be considered and followed closely when local research is to be designed. For example, a key component of these interdisciplinary studies was to observe the spectrum of tourism behaviour and then simulate this behaviour to test for wildlife response. In addition visitor expectations were determined through questionnaire-based surveys. The studies concluded by recommending low-impact visitor experiences with high potential to satisfy participants. Similarly, studies are needed that ascertain the local communities' perception of tourism and how to manage it so they benefit from it. Findings from these studies need to be translated into guidelines and policies to promote socially and environmentally responsible tourism offers (Azam, Mahmudul & Harron, 2018; SLTSP, 2017).
(5) Communication of benefits of nature-based tourism activities deserves research attention in Sri Lanka. The promotion, market positioning and possible repositioning of natural areas, their management agencies and related tourism offers to participants, tourism operators and nature-based tourism destination managers may constitute an important strategy in the conservation of sensitive ecosystems (Humke, 2018; Torland, Weiler, Moyle, & Wolf, 2015; Weiler et al., 2014, 2017; Wolf et al., 2015b, 2017).
(6) Acquire fundamental visitor data (numbers, behaviour) for tourism destinations and relate them to impacts of recreational activities to formulate policies and guidelines for individual activities. Visitor monitoring efforts are in their infancy in Sri Lanka. Although this is beyond the scope of this review, we recommend that visitor monitoring forms part of an overall recreational ecology research agenda in Sri Lanka. Environmental impacts can only be efficiently researched and managed if they are interpreted in relation to causal factors such as type and intensity of tourism usage (Wolf, Hagenloh, & Croft, 2012; MOSDW, 2017, 2018). In particular, we suggest that participatory approaches are considered that have proven to be effective in protected areas management as they give voice to otherwise silent perspectives of the local community, for instance, to better understand values of protected areas, acceptable forms of use, zones of conflict and management needs (Wolf, Brown, & Wohlfart, 2018; Wolf, Wohlfart, et al., 2015). Public participatory geographic information systems (PPGIS) are known to be of great value for building knowledge on appropriate uses of landscapes, landscape values, visitor conflict and visitor management. This knowledge is critical for the acceptance of management regulations by tourism operators in a country or regions where the subsistence of people may be entirely reliant upon the tourism trade. It should further clarify how potentially conflicting land uses (tourism, agriculture, urbanization, conservation) can be reconciled to the benefit of all stakeholders involved and in line with sustainability considerations.
(7) Indirect impacts on wildlife and their habitat need to be considered. Sri Lanka is a biodiversity hotspot (Weerakoon, 2012). Although iconic wildlife species such as the elephant and leopard are the local attractions that elicit visitation and repeat visitation, other wildlife species and their habitat fulfilling important ecosystem functions are likely to suffer from disturbance by improperly managed visitor flows. This type of research is even lacking by international standards and has received no attention to date in the local research arena. Better developed is international research on habitat impacts through human waste, changed trail conditions, soil erosion and disturbance, and yet locally this research is completely lacking.
(8) Since most research is lacking on recreational impacts and management in Sri Lanka a key challenge will be on how to prioritise research especially in light of funding shortages. For this matter our research recommendations presented in Table 4 can be used as a framework for qualitative research with experts in the field from both industry and academia to solicit their opinions on how to prioritise. This in conjunction with the PPGIS assessments of the public that we mentioned above and the development of maps to visualise a geographic prioritisation of research by region will further help with this type of complex and fuzzy decision making (Ballantyne & Pickering, 2015).

Table 4
Recommendations for a recreational ecology research agenda and supporting activities in Sri Lanka.

Type of recommendation	International recommendation given in 22 selected review papers on recreational ecology	Recommendation for the Sri Lankan context
Expanding existing empirical research	Wildlife-specific research: More research on bird watching due to its general popularity. Activity-specific impact studies e.g., for mountain biking. Urgently needed is more empirical research on threatened ecological communities. Study of long-term impacts on wildlife and their habitat (more than 10 years). Assessing the impacts of informal trail development, comparing trails types and impacts on a threatened ecosystem More attention on recreational impact on water quality and soil quality.	Locally, forest reserves are the most popular destinations for bird watching, both motorized and non-motorized, and therefore, research needs to focus here on recreational activities and their impacts on bird communities. Few studies were available in Sri Lanka on wildlife watching in general. Therefore expand research areas on impacts on terrestrial and aquatic wildlife watching with a focus on iconic species (likely to attract funding) but using research designs that also consider impacts on less attractive species ('side effects'). Establish permanent sampling plots for long-term monitoring of impacts in selected protected areas in the country as they currently do not exist. Although locally there are many types of trails for motorized and non-motorized traffic, limited studies exist on trails and their recreational impacts. In future studies expand the scope of trail studies as they constitute the main pathways of access to recreational areas.
Expanding existing research paradigms	Expand studies based on different geographical and climatic zones. Need more funds for expanding existing studies and supporting future studies. Future research needs more robust and sensitive methods for measuring impacts. Introduce and apply geographical systems to measure and monitor impact. Improve science-based information to make decision on recreational impacts.	Sri Lanka has vastly different climatic zones. Future studies need to extend across different climatic zones. Future research needs new innovative and cost-effective research methods and collaborations to conduct research locally. Build private-public partnerships for accessing research funds. Invest into public participatory geographic information systems (PPGIS) research and solicit expert opinion to establish research priorities by regions and monitor recreational impacts. Science-based information is needed across all subject areas, prioritisation is key to use limited budgets efficiently and address most urgent issues first.
Management approach	Employ professionally trained interpreters and tour guides to minimize recreational impacts. Solicit practitioners' opinions to assess practicability of existing management strategies and implementations. Improve the communication between protected area institutions and universities. Assess visitors' perception of environmental and social impacts and usage patterns in protected areas.	Introduce educational awareness programs for interpreters and tour guides to enhance their knowledge about recreational impacts and methods to minimize impacts. Conduct qualitative studies of community stakeholders, technical experts and park managers about the practicality and acceptability of rules and regulations of park management. Build solid collaborations between government institutions and local universities to conduct research studies and monitoring programs on recreational ecology impacts. Develop a social research agenda that closely monitors visitor perceptions and behaviours. Develop a marketing strategy that positions nature-based tourism activities adequately to manage visitor expectations and to encourage low-impact visitor behaviour.

Lack of funding for research studies remains a vibrant issue in Sri Lanka and in countries 'suspended' in a similar development stage (Barros et al., 2015; Monz, Marion, et al., 2010; Newsome et al., 2012; Sumanapala, 2018). Research that aligns visitor, community and environmental needs is paramount as it likely will attract the necessary financial support. Although the country undoubtedly hosts many local recreational ecology experts, their knowledge needs to be harnessed which requires funding and a concerted systematic effort. This again calls for collaboration with universities as much labour-intensive research nowadays is undertaken through PhD students. It also requires increasing overall research capacity. International collaboration and the establishment of an active communication network between park managers, researchers, and research funding agencies will be critical.

Acknowledgments

We, an especially lead author would like to thank Associate Professor David Newsome of Murdoch university, western Australia for initially showing the existing research gaps on nature-based tourism in Sri Lanka and directing to do a review paper to fulfill the research gaps in the country and also our thanks go to anonymous reviewers for their valuable comments on this paper.

References

Abraína, A., Oroa, D., Jiménezb, J., Stewartc, G., & Pullinc, A. (2010). A systematic review of the effects of recreational activities on nesting birds of prey. *Basic and Applied Ecology, 11*(4), 312–319.

Alwis, N., Perera, P., & Dayawansa, N. (2016). Response of tropical avifauna tovisitor recreational disturbances: A case study from the Sinharaja World Heritage Forest, SriLanka. *Avian Research, 7*(15), 1–13.

Ashton, P., & Gunatilleke, C. (1987). New light on the plant geography of Ceylon . Historical plant geography. *Journal of Biogeography, 14*(3), 249–285.

Asian Development Bank. (2000). Asian Development Bank Protected area management and wildlife conservation project. *Sri Lanka,* (September), 1–13.

Azam, M., Alam, M. M., & Hafeez, M. H. (2018). Effect of tourism on environmental pollution: Further evidence from Malaysia, Singapore and Thailand. *Journal of Cleaner Production, 190*, 330–338.

Ballantyne, M., & Pickering, C. M. (2015). The impacts of trail infrastructure on vegetationand soils: Current literature and future directions. *Journal of Environmental Management, 164*, 53–64.

Balmford, A., Beresford, J, Green, j, Naidoo, R, Walpole, M, & Manica, A (2009). A global perspective on trends in nature-based tourism. *PLoS Biology, 7*(6), e1000144.

Banks, P., & Bryant, J. (2007). Four-legged friend or foe? Dog walking displaces native birds from natural areas. *Biology Letters, 3*(6), 611–613.

Baret, S., & Strasberg (2005). The effects of opening trails on exotic plant invasion in protected areas on Reunion island (Mascarene archipelago) Indian Ocean. *Review Ecology, 60*, 325–332.

Barros, A., Monz, C., & Pickering, C. (2015). Is tourism damaging ecosystems in theAndes? Current knowledge and an agenda for future researc. *Ambio, 44*, 82–98.

Bateman, P. W., & Fleming, P. A. (2017). Are negative effects of tourist activties on wildlife over-reported? A review of assessment methods and empirical results. *Biological Conservation, 211*, 10–19.

Beasley, I., Bejder, L., & Marsh, H. (2010). Dolphinwatching tourism in the Mekong River, Cambodia: A case study of economic interests influencing conservation. *Paper presented to the scientific committee at the 62nd meeting of the international whaling commission* May 30–June 11, Agadir, Morocco.

Beaumont, N. (2001). Ecotourism and the conservation ethic: Recruiting the uninitiated or preaching to the converted? *Journal of Sustainable Tourism, 9*(4), 317–341.

Bejder, L., Samuels, A., Whitehead, H., & Gales, N. (2006). Interpreting short-term behavioural responses to disturbance within a longitudinal perspective. *Animal Behaviour, 72*(5), 1149–1158.

Boon, P., Fluker, M., & Wilson, N. (2008). A ten-year study of the effectiveness of an educative programme in ensuring the ecological sustainability of recreational activities in the Brisbane Ranges National Park, south-eastern Australia. *Journal of Sustainable Tourism, 16*, 681–697.

Bowman, J. C., Sleep, D., Forbes, G. J., & Edwards (2000). The association of small

mammals with coarse woody debris at log and stand scales. *Forest Ecology and Management, 129*(1–3), 119–124.
Boyle, S. A., & Samson, F. B. (1985). Effects of non-consumptive recreation on wildlife: A review. *Wildlife Society Bulletin, 13*(2), 110–116.
Bridle, K. L., & Kirkpatrick, J. B. (2003). Impacts of nutrient additions and digging for human waste disposal in natural environments Tasmania, Australia. *Journal of Environmental Management, 69*(3), 299–306.
Bridle, K. L., & Kirkpatrick, J. B. (2005). An analysis of the breakdown of paper products (toilet, tissues and tampons paper) in natural environments, Tasmania, Australia. *Journal of Environmental Management, 74*(1), 21–30.
Bridle, K. L., Von Platen, J., Leeming, R., & Kirkpatrick, J. (2007). Inadequate faeces disposal in back-country areas, Tasmania Environmental impacts and potential solutions. *Australasian Journal of Environmental Management, 14*(1), 58–67.
Buckley, R. (2000). Tourism in the most fragile environments. *Tourism Recreation Research, 25*(1), 31–40.
Buckley, R. (2004). Impacts of ecotourism on birds. In R. Buckley (Ed.). *Environmental impacts of ecotourism* (pp. 187–289). Cambridge: CAB Internationa.
Buckley, R. (2005). Recreation ecology research effort: An international comparison. *Tourism Recreation Research, 30*(1), 99–101.
Buckley, R. (2012). Sustainable tourism: Research and reality. *Annals of Tourism Research, 39*(2), 528–546.
Buckley, R., Robinson, J., Carmody, J., & King, N. (2008). Monitoring for management of conservation and recreation in Australian protected areas. *Biodiversity & Conservation, 17*(14), 3589.
Butler, R. W. (1993). Tourism: An evolutionary perspective. In J. G. Nelson, R. W. Butler, & G. Wall (Vol. Eds.), *Tourism and sustainable development: Monitoring, planning, managing: Vol. 37*, (pp. 29–43). Waterloo: Department of Geography Publication Series.
Buultjens, J., Ratnayake, I., Gnanapala, A., & Aslam, M. (2005). Tourism and its implications for management in Ruhuna national park (Yala), Sri Lanka. *Tourism Management, 26*(5), 733–742.
Cannon, W. B. (1929). *Bodily changes in pain, hunger, fear and rage.* New York: Appleton Press.
Cardoni, D. A., Favero, M., & Isacch, J. P. (2008). Recreational activities affecting the habitat use by birds in Pampa's wetlands, Argentina: Implications for waterbird conservation. *Biological Conservation, 141*, 797–806.
Cassirer, E. F., Freddy, D. J., & Ables, E. D. (1992). Elk responses to disturbance by cross-country skiers in Yellowstone National Park. *Wildlife Society Bulletin, 20*(4), 375–381.
Castley, J. G., Hill, W., & Pickering, C. M. (2009). Developing ecological indicators of visitor use of protected areas: A new integrated framework from Australia. *Australasian Journal of Environmental Management, 16*(4), 196–207.
Chin, C., Moore, S., Dowling, R., & Wallington, T. (2000). Ecotourism in Bako national Park,Borneo: Visitors' perspectives on environmental impacts and their management. *Journal of Sustainable Tourism, 8*(1), 20–35.
Chiu, H. Y., Chan, C. S., & Marafa, L. M. (2016). Local perception and preferences in nature tourism in Hong Kong. *Tourism Management Perspective, 20*, 87–97.
Christensen, N. A., Herwig, B. R., Schindler, D. E., & Carpenter, S. R. (1996). Impacts of lakeshore residential development on coarse woody debris in north temperate lakes. *Ecological Applications, 6*(4), 1143–1149.
Cochrane, J. (2006). Indonesian national parks: Understanding leisure users. *Annals of Tourism Research, 33*(4), 979–997.
Cole, D. N. (1987). Effects of three seasons of experimental trampling on five montage forest communities and a grassland in Western Montana, USA. *Biological Conservation, 40*(3), 219–244.
Cole, D. N. (1990). *Ecological impacts of wilderness recreation and their managementR.C* (2nd Eds.),Wilderness). North American Press425–466.
Cole, D. N. (1992). Modelling wilderness campsites: Factors that influence amount of impact. *Environmental Management, 16*(2), 255–264.
Cole, D. N. (2004). *Impacts of hiking and camping on soils and vegetation.* Cambridge: CAB International.
Cole, D. N. (2009). Ecological impacts of wilderness recreation and their management. In C. Dawson, & J. Hendee (Eds.). *Wilderness management: Stewardship and protection of resources and values* (pp. 395–438). Fulcrum Press.
Cole, D. N., & David, N. (1990). Wilderness management: Has it come of age? *Journal of Soil and Water Conservation, 45*(3), 360–364.
Cole, D. N., Foti, P., & Brown, M. (2008). Twenty years of change in campsites in the backcountry of grand Canyon national park. *Environmental Management, 41*, 959–970.
Cole, D. N., & Monz, C. A. (2002). Trampling disturbance of highelevation vegetation, wind river mountains, Wyoming. *U.S.A. Arctic, Antarctic, and Alpine Research, 34*(4), 365–376.
Cushman, J. H., & Meentemeyer, R. K. (2008). Multi-scale patterns of human activity and the incidence of an exotic forest pathogen. *Journal of Ecology, 96*(4), 766–776.
Daniel, R., Taylor, J., & Guest, D. (2006). Distribution and occurrence of Phytophthora cinnamomi at middle head and north head, Sydney harbour. *Australasian Plant Pathology, 35*, 569–571.
Davidson, J. M., Wickland, A. C., Patterson, H. A., Falk, K. R., & Rizzo, D. M. (2005). Transmission of Phytophthora ramorum in mixed evergreen forest in California. *Phytopathology, 95*(5), 587–596.
Department of Wildlife (2017). *Performance report of the department of wildlife*Sri Lanka: Department of Wildlife Sri Lanka.
Department of Wildlife (2018). *Performance report of the Department of wildlife (unpublished)*Sri Lanka: Department of Wildlife.
Dixit, S. K., & Narula, V. K. (2010). Ecotourism in madhav national park: Visitors' perspectives on environmental impacts. *South Asian Journal of Tourism and Heritage, 3*(2), 109–115.
Duff, L. (1993). Ecotourism in national parks: Impacts and benefits. *National Parks Journal, 37*, 18–20.
Dyck, M. G., & Baydack, R. K. (2003). Vigilance behaviour of polar bears (*Ursus maritimus*) in the context of wildlife-viewing activities at Churchill, manitoba, Canada. *Biological Conservation, 116*(3), 343–350.
Eckert, K. L., & Hemphill, A. H. (2005). Sea turtles as flagships for protection of the wider Caribbean region. *Mast, 3*(2), 119–143 4(1).
Edington, J. M., & Edington, M. A. (1990). *Ecology, recreation and tourism.* Cambridge: University Press.
Freedman, B., Zelazny, V., Beaudette, D., Fleming, F. G., Gerrow, J., & Woodley, S. (1996). Biodiversity implications of changes in the quantity of dead organic matter in managed forests. *Environmental Review, 4*(3), 238–265.
Garland, G. (1990). Technique for assessing erosion risk from mountain footpaths. *Environmental Management, 14*(6), 793–798.
Garthe, C. J. (2019). Early recreational ecology Research in Europe Disciplinary development and review of German language research results. *Journal of Nature Conservation, 51*, 125718.
Giese, M. (1996). Effects of human activity on Adélie Penguin *Pygoscelis adeliae* breeding success. *Biological Conservation, 75*(1), 157–164.
Giese, M. (1998). Guidelines for people approaching breeding groups of Adélie Penguins (*Pygoscelis adeliae*). *Polar Record, 34*(191), 287–292.
Goonatilake, S. De A., Fernando, M., Kotagama, O., Perera, N., Vidanage, S., Weerakoon, D., et al. (2020). The national red list of Sri Lanka: Assessment of the threat status of the freshwater fishes of Sri Lanka 2020 Colombo: IUCN. *International union for conservation of nature, Sri Lanka and the biodiversity secretariat, ministry of environment and wildlife resources*.
Gossling, S. (1999). Ecotourism: A means to safeguard biodiversity and ecosystem funtions? *Ecological Economics, 29*(2), 303–320.
Green, R., & Higginbottom, K. (2001). *The negative Effects of wildlife Tourism on wildlife. Status assessment of wildlife tourism in Australia series.* Gold Coast: Sustainable Tourism Cooperative Research Centre.
Griffiths, M., & Van Schaik, C. P. (1993). The impact of human traffic on the abundance and activity periods of Sumatran rain forest wildlife. *Conservation Biology, 7*(3), 623–626.
Growcock, A. (2006). *Impacts of camping and trampling on Australian alpine and subalpine vegetation and Soil. PhD thesis.* Griffith University.
Gunatilleke, I. A. U. N., Gunatilleke, C. V. S., & Dilhan, M. A. A. B. (2005). Plant biogeography and conservation of the south-western Hill forest of Sri Lanka. *Raffles Bulletin of Zoology, 12*, 9–22.
Hadwen, L. W., Hill, W., & Pickering, C. M. (2008). Linking visitor impact research to visitor impact monitoring in protected areas. *Journal of Ecotourism, 7*(1), 87–93.
Hall, S. J. (1994). Physical disturbance and marine benthic communities: Life in unconsolidated sediments. *Oceanography and Marine Biology an Annual Review, 32*, 179–239.
Hammitt, W., & Cole, D. (1998). *Wildland recreation: Ecology and management.* John Wiley.
Hardiman, N., & Burgin, S. (2010). Recreational impacts on the fauna of Australian costal marine ecosystems. *Journal of Environmental Management, 91*(11), 2096–2108.
Harmon, M. E., Franklin, J. F., Swanson, F. J., Sollins, P., Gregory, S. V., Lattin, J. D., et al. (1986). Ecology of coarse woody debris in temperate ecosystems. *Advances in Ecological Research, 15*, 133–302.
Hawkins, J. P., & Roberts, C. M. (1993). Effects of recreational scuba diving on coral reefs: Trampling on reef flat communities. *Journal of Applied Ecology, 30*(1), 25–30.
HaySmith, L., & Hunt, J. D. (1995). Nature tourism: Impacts and management. In R. L. Knight, & K. J. Gutzwiller (Eds.). *Wildlife and recreationists: Coexistence through management and research* (pp. 203–219). Washington: Island Press.
Hecnar, S. J., & M'Closkey, R. T. M. (1998). Effects of disturbance on five-lined skink, Eumeces fasciatus, abundance and distribution. *Biological Conservation, 85*(3), 213–222.
Hein, T., Funk, A., Pletterbauer, f., Graf, W., Zsuffa, I., Haidvogl, G., et al. (2019). Management challenges related to long-term ecological impacts, complex stressor interactions, and different assessment approaches in the Danube River Basin. *River Research and Applications, 35*(5), 500–509.
Higham, J., & Carr, A. (2002). Ecotourism visitor experiences in Aotearoa/New Zealand: Challenging the environmental values of visitors in pursuit of proenvironmental behavior. *Journal of Sustainable Tourism, 10*(4), 277–294.
Hill, W., & Pickering, C. M. (2006). Vegetation associated with different walking track types in the Kosciuszko alpine area, Australia. *Journal of Environmental Management, 78*(1), 24–34.
Hill, R., & Pickering, C. (2009). Differences in resistance of three subtropical vegetation types to experimental trampling. *Journal of Environmental Management, 90*(2), 1305–1312.
Hofer, H., & East, M. L. (1998). Biological conservation and stress. *Advances in the Study of Behavior, 27*(1), 405–525.
Humke, M. (2018). *Nature-based tourism plan.* Retrieved from URL https://www.escamp.lk/wp-content/uploads/2018/10/Nature-Based-Tourism-Plan-Sinharaja-FRC.pdf.
Ingram, D. C., & Durst, P. B. (1987). *Nature oriented travel to developing countries. FPEI working paper No. 28: Center for forest economics.* Research Triangle Park, North Carolina.
International Union for Conservation of Nature (2016). *International Union for conservation of nature annual report 2016.* IUCN.
Jackson, I. (1986). Carrying capacity for tourism in small tropical Caribbean islands. *UNEP's Industry and Environment Newsletter, 9*(1), 7–10.
Jones, D. N., & Buckley, R. (2001). *Bird watching in Australia.* Australia: CRC for Sustainable Tourism.
Kandasamy, G., Weerakoon, D., Sivaruban, A., & Jayasiri, H. B. (2019). The value of Community-based Avitourism in a post-conflict rural village, Kavutharimuani. *International conference on biodiversity and management (iConferences) 2019* At Gall

Face Hotel, Colombo, Sri Lanka.
Kays, R., Parsons, A. W., Baker, M. C., Kalies, E., Forrester, T., Costello, R., et al. (2017). Does hunting or hiking affect wildlife communities in protected areas? *Journal of Applied Ecology, 54*(1), 242–252.
Kidd, A. M., D'Antonio, A., Monz, C., Heaslip, K., Taff, D., & Newman, P. (2018). A GPS-Based classification of visitors' vehicular behavior in a protected area setting. *Journal of Park and Recreation Administration, 6*, 69–89.
Knight, R. L., Anderson, D. P., & Marr, N. V. (1991). Responses of an avian scavenging guild to anglers. *Biological Conservation, 56*(2), 195–205.
Knight, R., & Gutzwiller, K. (1995). *Wildlife and recreationists: Coexistence through management and research.* Washington: Island Press.
Larson, L. R., Reed, S. E., Merenlender, A. M., & Crooks, K. R. (2016). Effects of Recreation on animals revealed as widespread through a global systematic review. *PLoS One, 11*(2).
Leung, Y. F. (2012). Recreation ecology research in East Asia's protected areas: Redefining impacts? *Journal for Nature Conservation, 20*, 349–356.
Leung, Y. F., & Lee, J. H. (2003). Recreation ecology and visitor carrying capacity management implications for protected areas in East Asia. *Korean Journal of Entomology, 26*(2), 53–58.
Leung, Y. F., & Marion, J. L. (1996). Trail degradation as influenced by environmental factors: A state-of-the-knowledge review. *Journal of Soil and Water Conservation, 51*, 130–136.
Leung, Y. F., & Marion, J. L. (1999). Spatial strategies for managing visitor impacts in national parks. *Journal of Park and Recreation Administration, 17*(4), 2–38.
Liddle, M. (1997). *Recreation ecology: The ecological impact of outdoor recreation and ecotourism.* London: Chapman & Hall.
Liddle, M. J., & Kay, A. M. (1987). Resistance, survival and recovery of trampled corals on the Great Barrier Reef. *Biological Conservation, 42*(1), 1–18.
Liley, D., & Sutherland, W. J. (2007). Predicting the population consequences of human disturbance for ringed plovers Charadrius hiaticula: A game theory approach. *Ibis, 149*(1), 82–94.
Lindenmayer, D. B., Claridge, A. W., Gilmore, A. M., Michael, D., & Lindenmayer, B. D. (2002). The ecological roles of logs in Australian forests and the potential impacts of harvesting intensification on log-using biota. *Pacific Conservation Biology, 8*(2), 121–140.
Liu, Z., Yin, J., & Huang, S. (2018). Manging tourism impacts in Chin's wetlands: A total relationship flow management perspective. *Asia Pacific Journal of Tourism Research, 23*(3), 231–244.
Lucas, R. (1990a). The wilderness experience and managing the factors that influence. In G. S. J. C. Hendee (Ed.). *Wilderness management* (pp. 469–499). Golden: North America Press.
Lucas, R. (1990b). Wilderness use and users: Trends and projections and wilderness recreation management: An overview. In J. Hendee, G. Stankey, & R. Lucas (Eds.). *Wilderness management* (pp. 355–398). Golden: North American Press.
Lusseau, D., Wilson, B. E. N., Hammond, P. S., Grellier, K., Durban, J. W., Parsons, K. M., et al. (2006). Quantifying the influence of sociality on population structure in bottlenose dolphins. *Journal of Animal Ecology, 75*(1), 14–24.
MacNally, R., Parkinson, A., Horrocks, G., & Conole (2001). Relationships between terrestrial vertebrate diversity, abundance and availability of coarse woody debris on southeastern Australian floodplains. *Biological Conservation, 99*(2), 191–205.
Magro, T., & Amanda de Barros, M. (2004). Understanding use and users at Itataia national park, Brazil. In R. Buckley (Ed.). *Environmental impacts of ecotourism* (pp. 361–376). (Oxford).
Mallikage, S. T., & Perera, P. K. (2017, August). *Assessment of the environmental impacts of campsite use by visitors in selected national parks of dry zone, SriLanka.* Sri Lanka: WILDLANKA International symposium.
Mantymaa, E., Tyrvainen, L., Juutinen, A., & Kurttila, M. (2019). *Importance of forest landscape quality for companies operating in nature tourism areas.* Land Use Policy 104095.
Marion, J. (1995). Capabilities and management utility of recreation impact monitoring programs. *Environmental Management, 18*(5), 763–771.
Marion, J., Leung, Y.-F., Eagleston, H., & Burroughs, K. (2016). A review and synthesis ofRecreation ecology research findings on visitor impacts to wilderness and protected natural areas. *Journal of Forestry, 114*(3), 352–362.
Marzano, M., & Dandy, N. (2012). Recreationist behaviour in forests and the disturbance of wildlife. *Biodiversity & Conservation, 21*(11), 2967–2986.
Mayes, A. (1979). The physiology of fear and anxiety. In W. Sluckin (Ed.). *Fear in animals and man* (pp. 24–55). New York: Van Nostrand Reinhold Company.
McCall, P. L. (1977). Community patterns and adaptive strategies of the infaunal benthos of Long Island Sound. *Journal of Marine Research, 35*, 221–266.
Ministry of Sustainable development and wildlife (2017). *Ministry of Sustainable development and wildlife annual report*Sri Lanka: Sri Lanka.
Ministry of Sustainable development and wildlife (2018). *Ministry of Sustainable development and wildlife annual report* Sri Lanka (Unpublished). Sri Lanka.
Monz, C. A., Cole, D. N., Leung, Y. F., & Marion, J. L. (2010). Sustaining visitor use in protected areas: Future opportunities in recreation ecology research based on the USA Experience. *Environmental Management, 45*, 551–562.
Monz, C., D'Antonio, A., Lawson, S., Barber, J., & Newman, P. (2016). The ecological implications of visitor transportation in parks and protected areas: Examples from research in US National parks. *Journal of Transport Geography, 51*, 27–35.
Monz, C. A., Marion, J. L., Goonan, K., Manning, K., Wimpey, J., & Carr, C. (2010). Assessment and monitoring of recreation impacts and resource conditions on mountain summits: Examples from the Northern Forest, USA. *Mountain Research and Development, 30*(4), 332–343.
Monz, C. A., Pickering, C. M., & Hadwen, W. L. (2013). Recent advances in recreation ecology and the implications of different relationships between recreation used and ecological impacts. *Frontiers in Ecology and the Environment, 11*(8), 441–446.
Morin, S., Moore, S., & Schmidt, W. (1997). Defining indicators and standards for recreation impacts in Nuyts Wilderness, Walpole-Nornalup national park, Western Australia. *CALMScience, 2*(3), 247–266.
Mosisch, T. D., & Arthington, A. H. (1998). The impacts of power boating and water skiing on lakesand reservoirs. *Research Management, 3*(1), 1–17.
Mosisch, T., & Arthington, A. (2004). The impacts of recreational power boating on fresh water ecosystems. In R. Buckley (Ed.). *Environmental impacts of ecotourism* (pp. 125–154). NewYork: CABI Publishing.
Mount, A., & Pickering, C. M. (2009). Testing the capacity of clothing to act as a vector for non-native seed in protected areas. *Journal of Environmental Management, 91*(1), 168–179.
Muhly, T., Semeniuk, C., Massolo, A., Hickman, L., & Musian, M. (2011). Human activity helps prey win the predator-prey space race. *PLoS One, 6*(5), 17050.
Müllner, A., Linsenmair, K., & Wikelski, M. (2004). Exposure to ecotourism reduces survival and affects stress responses in hoatzin chicks (Opisthocomus hoazin). *Biological Conservation, 118*(4), 549–558.
Munck, A., Guyre, P. M., & Holbrook, N. J. (1984). Physiological functions of glucocorticoids in stress and their relation to pharmacological actions. *Endocrine Reviews, 5*(1), 25–44.
Murphy, K., Willby, N., & Eaton, J. (1995). Ecological impacts and management of boat traffic on navigable inland waterways. In D. Harper, & A. Ferguson (Eds.). *The ecological basis for river management* (pp. 427–442). Chichester: Wiley.
Newsome, D. (2003). The role of an accidently introduced fungus in degrading the health of theStirling Range National Park ecosystem in South Western Australia: Status and prognosis. In D. Rapport, W. Lasley, D. Rolston, & N. Niel (Eds.). *Managing for healthy ecosystems* (pp. 375–388). Boca Raton: Lewis Publishers.
Newsome, D. (2013). An 'ecotourist's recent experience in Sri Lanka. *Journal of Ecotourism, 12*(3), 210–220.
Newsome, D., & Davies, C. (2009). A case study in estimating the area of informal trail development and associated impacts caused by mountain bike activity in John Forrest National Park, Western Australia. *Journal of Ecotourism, 8*(3), 237–253.
Newsome, D., & Dowling, R. (2010). *Geotourism: The tourism of geology and landscape.* Oxford: Goodfellow Publisher.
Newsome, D., Dowling, R., & Moore, S. (2005). *Wildlife tourism.* Clevedon: Channel View Publications.
Newsome, D., & Lacroix, C. (2011). Changing recreational emphasis and the loss of 'natural experiences'in protected areas: An issue that deserves consideration, dialogue and investigation. *Journal of Tourism and Leisure Studies, 17*(2), 315–333.
Newsome, D., Milewski, A., Phillips, N., & Anne, R. (2002). Effects of horse riding on national parks andother natural ecosystems in Australia: Implications for management. *Journal of Ecotourism, 1*(1), 52–74.
Newsome, D., Moore, S., & Dowling, R. (2012). *Natural area tourism: Ecology, impacts, and management.* Uk: Channel View Books.
Newsome, D., Smith, A., & Moore, S. (2008). Horse riding in protected areas: A critical review andimplications for research and management. *Current Issues in Tourism, 11*(2), 144–166.
Oberbillig, D. E. (2000). *Providing positive wildlife viewing experiences: A practical handbook.* Colorado Division of Wildlife Publication.
Olson, T. L., Gilbert, B. K., & Squibb, R. C. (1997). The effects of increasing human activity on Brown Bear use of an Alaskan River. *Biological Conservation, 82*(1), 95–99.
Ongerth, J., Hunter, G., & DeWalle, F. (1995). Watershed use and Giardia cyst presence. *Water Research, 29*(5), 1295–1299.
Orams, M. (1997). Historical accounts of human-dolphin interaction and recent developments in wild dolphin based tourism in Australasia. *Tourism Management, 18*(5), 317–326.
Orams, M. (2001). Types of ecotourism. In D. B. Weaver (Ed.). *The encyclopedia of ecotourism* (pp. 23–36). Cambridge: CABI Publishing.
Orams, M. (2002). Feeding wildlife as a tourism attraction: A review of the issues and impacts. *Tourism Mnagement, 23*(3), 281–293.
Parsons, E. C. M. (2012). The negative impact of whale-watching. *Journal of Marine Biology, 2012*, 1–9.
Phillips, N., & Newsome, D. (2002). Understanding the impacts of recreation in Australian protected areas: Quantifying damage caused by horse riding in D'Entrecasteaux National Park, Western Australia. *Pacific Conservation Biology, 7*(4), 256–273.
Pickering, C. M. (2010). Ten factors that affect the severity of environmental impacts of visitors in protected areas. *Ambio, 39*, 70–77.
Pickering, C. M., Rossi, S., & Barros, A. (2011). Assessing the impacts of mountain biking and hiking on subalpine grassland in Australia using an experimental protocol. *Journal of Environmental Management, 92*(12), 3049–3057.
Pickering, C. M., & Byrne, J. (2013). The benefits of publishing systematic quantitative literature reviews for PhD candidates and other early-career researchers. *Higher Education Research and Development, 33*(3), 543–548.
Pickering, C. M., Castley, G., Hill, W., & Newsome (2010). Environmental, safety and management issues of unauthorised trail technical features for mountain bicycling. *Landscape and Urban Planning, 97*(1), 58–67.
Pickering, C. M., & Growcock, A. (2009). Impacts of experimental trampling on tall alpine herbfields and subalpine grasslands in the Australian Alps. *Journal of Environmental Management, 91*(2), 532–540.
Pickering, C. M., & Hill, W. (2007). Impacts of recreation and tourism on plantbiodiversity and vegetation in protected areas in Australia. *Journal of Environmental Management, 85*(4), 791–800.
Pickering, C. M., Hill, W., Newsome, D., & Leung, Y. F. (2010). Comparing hiking, mountain biking and horse riding impacts on vegetation and soils in Australia and the United States of America. *Journal of Environmental Management, 91*(3), 551–562.
Pickering, C. M., & Mount, A. (2010). Do tourists disperse weed seed? A global review of

unintentionalhuman-mediated terrestrial seed dispersal on clothing, vehicles and horses. *Journal of Sustainable Tourism, 18*(2), 239–256.
Prakash, S. L., Perera, P., Newsome, D., Kusuminda, T., & Walker, O. (2019). Reasons for visitor dissatisfaction with wildlife tourism experiences at highly visited national parks in Sri Lanka. *Journal of Outdoor Recreation and Tourism, 25*, 102–112.
Rajasuriya, A., Zahir, H., Muley, E. V., Subramanian, B. R., Venkataraman, K., Wafar, M. V. M., et al. (2000). Status of coral reefs in South Asia: Bangladesh, India, Maldives and Sri Lanka. In C. Wilkinson (Ed.). *Status of coral reefs of the world: 2000* (pp. 95–115). Townsville: Australian Institute of Marine Science.
Ranaweerage, A., Ranjeewa, A. D. G., & Sugimotoa, K. (2015). Tourism-induced disturbance ofwildlife in protected areas:A case study of free ranging elephants in Sri Lanka. *Global Ecology and Conservation, 4*, 625–631.
Rathnayake, R. (2015). Recreational Planning: Estimation of visitors satisfaction at Kawdulla national park in Sri Lanka. *Wildlanka, 3*(1), 38–48.
Regel, J., & Putz, K. (1997). Effect of human disturbance on body temperature and energy expenditure in penguins. *Polar Biology, 18*, 246–253.
Reid, S., & Marion, J. (2005). A comparison of campfire impacts and policies in seven protected areas. *Environmental Management, 36*, 48–58.
Rodger, K., Moore, S., & Newsome, D. (2007). Wildlife tourism in Australia: Characteristics, the place of science and sustainable futures. *Journal of Sustainable Tourism, 15*(2), 160–179.
Roe, D., Leader-Williams, N., & Dalal-Clayton, B. (1997). *Take only photographs, leave only footprints. The environmental impacts of wildlife tourism.* London: International Institute for Environment and Development.
Rouphael, A., & Inglis, G. (1997). Impacts of recreational SCUBA diving at sites with different reef topographies. *Biological Conservation, 82*(3), 329–336.
Sato, C. F., Wood, J., & Lindenmayer, D. (2013). The effects of winter recreation on alpine and Subalpine fauna: A systematic review and meta analysis. *PLoS ONE, 8*(5).
Sekercioglu, C. (2002). Impacts of bird watching on human and avian communities. *Environmental Conservation, 29*(3), 282–289.
Shashikala, M. M. D., & Perera, P. K. P. (2018). November). A preliminary study on the impacts of recreational disturbances on selected water birds in Bundala Ramsar wetland. *Proceedings of the 23rd international forestry and environment symposium 2018 of the department of forestry and environmental science*. Sri Lanka: University of Sri Jayewardenepura.
Siegel, H. S. (1980). Physiological stress in birds. *BioScience, 30*(8), 529–534.
Smith, A., & Newsome, D. (2002). An integrated approach to assessing, managing and monitoring campsite impacts in Warren national park, Western Australia. *Journal of Sustainable Tourism, 10*(4), 343–359.
Smith, A., Newsome, D., & Enright, N. (2012). Does provision of firewood reduce woody debris loss around campsites in south-west Australian forests? *Australasian Journal of Environmental Management, 19*(2), 108–121.
Spenceley, A., Snyman, S., & Eagles, P. F. J. (2019). A decision framework on the choice of managemnt models for and protected area tourism services. *Journal of Outdoor Recreational and Tourism, 26*, 72–80.
Sri Lanka Tourism Development Authority (2018). *Annual statistical report 2018*Sri Lanka: Sri Lanka Tourism Development Authority.
Sri Lanka Tourism Strategic Plan (2017). *Sri Lanka tourism strategic plan 2017-2020.* Sri Lanka: Ministry of Tourism Development and Christian Religios Affairs.
Steidl, R., & Powell, B. (2006). Assessing the effects of human activities on wildlife. *George Wright Forum, 23*(2), 50–58.
Steven, R. (2018). Long-term study highlight the conundrum of nature-based tourism in marine procted areas. *Animal Conservation, 21*(6), 459–460.
Steven, R., Pickering, C., & Castle, J. (2011). A review of the impacts of nature based recreationon birds. *Journal of Environmental Management, 92*(10), 2287–2294.
Stuart-Dick, R. I. (1987). *Parental Investment in the eastern grey kangaroo*Ph.D. thesis. Armidale: University of New England.
Sumanapala, D. (2017). Comparison of characteristics of Asian and non-Asian tourists visiting eco-lodges in Sri Lanka. *Sri Lanka Journal of Social Sciences, 40*(2), 119–126.
Sumanapala, D. (2018). A review: National parks in Sri Lanka and impending development and research. *Asian Journal of Tourism Research, 3*(2), 121–147.
Sumanapala, D., & Wolf, I. D. (2019). Recreational ecology: A review of research and gap analysis. *Environments, 6*(7), 81.
Sumanapala, D, & Wolf, I, D (2020). Man-Made Impacts on Emerging Geoparks in the Asian Region. *Geoheritage, 12*(3), 1–9.
Sun, D., & Walsh, D. (1998). Review of studies on environmental impacts of recreation and tourism in Australia. *Journal of Environmental Management, 53*(4), 323–333.
Taylor, A., & Knight, R. (2003). Wildlife responses to recreation and associated visitor perceptions. *Ecological Applications, 13*(4), 951–963.
Tisdell, C., & Wilson, C. (2002). Ecotourism for the survival of Sea Turtles and other wildlife. *Biodiversity & Conservation, 11*(9), 1521–1538.
Torland, M., Weiler, B., Moyle, B. D., & Wolf, I. D. (2015). Are your ducks in a row? External and internal stakeholder perceptions of the benefits of parks in new south Wales, Australia. *Managing Sport and Leisure, 20*(4), 211–237.
Torn, A., Tolvanen, A., Norokorpi, Y., Tervo, R., & Siikamaki, P. (2009). Comparing the impacts ofhiking, skiing and horse riding on trail and vegetation in different types of forest. *Journal of Environmental Management, 90*(3), 1427–1434.
Turton, S. (2005). Managing environmental impacts of recreation and tourism in rainforests at theWet Tropics of QueenslandWorld Heritage Area. *Geographical Research, 43*(2), 140–151.
United Nations Educational, & Scientific and Cultural Organization (2017). *Sinharaja forest reserve- Description.* retrieved from URL https://whc.unesco.org/en/list/405.
Vickery, J. (1995). Access. In W. J. Sutherland, & D. A. Hill (Eds.). *Managing habitats for conservation* (pp. 42–58). Cambridge: Cambridge University Press.
Warrington, P. (1999). *Impacts of outboard motors on the aquatic environment.* British Columbia Lake Stewardship Society.
Weaver, D. (2001). Ecotourism as mass tourism: Contradiction or reality? *Cornell Hotel and Restaurant Administration Quarterly, 42*(2), 104–112.
Weaver, T., & Dale, D. (1978). Trampling effects of hikers, motorcycles and horses in meadows andforests. *Journal of Applied Ecology, 15*(2), 451–457.
Weerakoon, D. (2012). A brief overview of the biodiversity of Sri Lanka. In D. K. Weerakoon, & S. Wijesundara (Eds.). *The national red list 2012 of Sri Lanka.* Colombo. Sri Lanka: Ministry of Environment.
Weiler, B., Moyle, B. D., Torland, M., Wolf, I. D., & Witsel, M. (2014). Lessons learned from pilot testing an experimental communication intervention: generation Y and park benefits. *CAUTHE 2014.Tourism and hospitality in the contemporary world: Trends* (pp. 667–678). Changes and Complexity.
Weiler, B., Moyle, B. D., Wolf, I. D., De Bie, K., & Torland, M. (2017). Assessing the efficacy of communication interventions for shifting public perceptions of park benefits. *Journal of Travel Research, 56*(4), 468–481.
Wildlife, & Nature Protection Society of Sri Lanka (2019). *Wildlife & nature protection society of Sri Lanka annual report* Sri Lanka.
Wimpey, J., & Marion, J. (2011). A spatial exploration of informal trail networks within Great Falls Park. *Journal of Environmental Management, 92*(3), 1012–1022.
Winter, P. L., Selin, S., Cerveny, L., & Bricker, K. (2019). Outdoor recreational, nature-based tourism, and sustainability. *Sustainability, 12*(81), 2–12.
Woldendorp, G., & Keenan, R., J (2005). Coarse woody debris in Australian forest ecosystems: A review. *Australia Ecology, 30*(8), 834–843.
Wolf, I. D., Ainsworth, G. B., & Crowley, J. (2017). Transformative travel as a sustainable market niche for protected areas: A new development, marketing and conservation model. *Journal of Sustainable Tourism, 25*(11), 1650–1673.
Wolf, I. D., Brown, G., & Wohlfart, T. (2018). Applying public participation GIS (PPGIS) to inform and manage visitor conflict along multi-use trails. *Journal of Sustainable Tourism, 26*(3), 470–495.
Wolf, I. D., & Croft, D. B. (2010). Minimizing disturbance to wildlife by tourists approaching on foot or in a car: A study of kangaroos in the Australian rangelands. *Applied Animal Behaviour Science, 126*(1–2), 75–84.
Wolf, I. D., & Croft, D. B. (2012). Observation techniques that minimize impacts on wildlife and maximize visitor satisfaction in night-time tours. *Tourism Management Perspectives, 4*, 164–175.
Wolf, I. D., & Croft, D. B. (2014). Impacts of tourism hotspots on vegetation communities show a higher potential for self-propagation along roads than hiking trails. *Journal of Environmental Management, 143*(1), 173–185.
Wolf, I. D., Croft, D. B., & Green, J. G. R. (2019). Nature conservation and tourism: A paradox? *Environments, 6*(9), 104.
Wolf, I. D., Hagenloh, G., & Croft, D. B. (2012). Visitor monitoring along roads and hiking trails: How to determine usage levels in tourist sites. *Tourism Management, 33*(1), 16–28.
Wolf, I. D., Hagenloh, G., & Croft, D. B. (2013). Vegetation moderates impacts of tourism usage on bird communities along roads and hiking trails. *Journal of Environmental Management, 129*(15), 224–234.
Wolf, I. D., Stricker, H. K., & Hagenloh, G. (2015). Outcome-focussed national park experience management: Transforming participants, promoting social well-being, and fostering place attachment. *Journal of Sustainable Tourism, 23*(3), 358–381.
Wolf, I. D., Wohlfart, T., Brown, G., & Bartolomé Lasa, A. (2015). The use of public participation GIS (PPGIS) for park visitor management: A case study of mountain biking. *Tourism Management, 51*, 112–130.
Woodall, P. F., Woodall, L. B., & Bodero, D. A. V. (1989). Daily activity patterns in captive elephant shrews (Macroscelididae). *African Journal of Ecology, 27*(1), 63–76.
Zhong, L., Deng, J., Song, Z., & Ding, P. (2011). Research on environmental impacts of tourism in China: Progress and prospect. *Journal of Environemntal Mangement, 92*(11), 2972–2983.