

Article

Recreational Ecology: A Review of Research and Gap Analysis

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Abstract: Recreational ecology is an internationally evolving research field addressing the high demand for nature-based tourism and recreation, and its environmental impacts. This review aimed to analyze the research effort of recreational ecology studies published in four renowned journals in the field, the Journal of Sustainable Tourism, Tourism Management, the Journal of Environmental Management, and Environmental Management. Between 1976 and 2017, this review identified 145 papers focused on recreational ecology. The majority of research investigated the direct impacts of terrestrial activities in protected areas, in particular the impacts of walking and hiking on vegetation and trail conditions, and the impacts of wildlife viewing. A conceptual model was developed to describe the varied relationships between nature-based tourists and recreationists and the environment. Future research in recreational ecology should broaden its agenda to increase knowledge on indirect and long-term impacts; including on cryptic or less popular species; establish more specifically how the intensity of impacts depends on the amount of use other than in trampling studies; extend to other geographic areas such as developing countries, and nature-based spaces that are less protected and exposed to high visitation such as urban environments. Importantly, a much stronger focus needs to be on interdisciplinary approaches incorporating both environmental and social science techniques to determine ways of how visitor experiential needs can be reconciled with environmental conservation concerns in a rapidly increasing tourism and recreation economy.

Keywords: nature-based tourism; recreation; environmental impacts; systematic quantitative review; protected areas

1. Introduction

Nature-based tourism has become increasingly popular worldwide [1–6]. Since the 1960s, a growing number of ecologists have been researching nature-based tourism activities and their potential impacts [7–9], particularly in developed countries [8,10]. This has substantiated and defined the field of recreational ecology as the scientific study of visitor impacts including from tourism and recreation activities on the natural environment, and their effective management [7,11,12]. Recreational ecology covers a broad range of activities such as camping, cycling, canoeing, and skiing, acknowledging that different activities are associated with varying types and degrees of impact on the environment [13–15].

Many industry representatives and researchers highlighted the significance of the field of recreational ecology [16–19]. As a result, more than 1000 articles have been published in this field over the past two decades [1,8,20–23], particularly in North America, Europe, and Australia [1,8,10,23,24].

Over time, scholars have also introduced several conceptual models describing the relationship between specific activities and their resulting ecological impacts [7,8,21,25–27].

The primary objective of this article is to determine to what extent recreational ecology research has appeared in four leading journals in this field, the *Journal of Sustainable Tourism* (JOST), *Tourism Management* (TM), *Journal of Environmental Management* (JEM), and *Environmental Management* (EM), to provide a quantitative overview for a Special Journal Issue of *Environments* on *Environmental Impact of Nature-Based Tourism*. The scope of the target journals covers the two focal areas of this Special Journal Issue, namely, tourism and environment, with a strong emphasis on sustainability and conservation management issues. We performed a systematic quantitative literature review [28] on recreation ecology to gather information on the research effort by (1) year, (2) country, and (3) research institute; and on (4) research methods and (5) subject focus to capture current knowledge on impact relationships in a conceptual model and to give recommendations for a future research agenda. A systematic quantitative literature review in accordance with Pickering and Byrne (2014) [28] focuses on a numeric quantification of publications dedicated to the topics under investigation rather than an in-depth narration of results as typical for a narrative review. A major advantage of a systematic quantitative literature review is that it generates a broad quantitative summary of the field. Consequently, a greater number of articles can be analyzed than is common in a narrative review with a narrower focus. This will assist in providing a broad quantitative understanding of the status quo of research and identify current gaps in research to shape a future research agenda. This article is complemented in the same Special Journal Issue by a narrative review of impacts, monitoring and management of nature-based tourism [29] adding to the development of a conceptual model of recreation activities and impacts.

2. Methodology

Content analysis of journals has become a frequently used method during the last decade [30–33] to extend scientific thinking and improve our subject-matter understanding including on the evolution of such knowledge [34,35]. Content analysis has also become a commonly applied tool in tourism studies [34–41]. Our specific systematic quantitative literature review approach is a well-established and robust methodology that has been extensively discussed and applied in various fields (e.g., [28,42–52]).

This study reviewed four highly relevant journals in the field of tourism and recreation, and environmental management, respectively, including the *Journal of Sustainable Tourism* (JOST), *Tourism Management* (TM), the *Journal of Environmental Management* (JEM), and *Environmental Management* (EM) that represent the two pillars of recreational ecology. The *Journal of Sustainable Tourism* explores the relationship between tourism and sustainable development. It provides a forum for research on social and natural sciences related to sustainable tourism management [53–57]. *Tourism Management* is concerned with the planning and management of travel and tourism activities. The *Journal of Environmental Management* and *Environmental Management* publish research on the management of natural and man-made environments, and provide platforms for discussing environmental problems, and the use and conservation of natural resources.

We selected these journals following a preliminary review of more than 15 potential candidates including *Environments*, *Journal of Ecotourism*, *Tourism Recreation Research*, *Journal of Nature Conservation*, *Journal of Outdoor Recreation and Tourism*, *Journal of Cleaner Production*, *Global Environmental Change*, and *Sustainability* whose aims and scope were strongly aligned with the subject focus of recreational ecology. However, our final choice was based on the following criteria: (1) The journal spans at least two decades worth of research; and (2) has published at least 20 recreational ecology articles. (3) Importantly, these target journals represent the broad field of high-quality peer-reviewed, international research in recreational ecology with a specific yet not too specialized focus on the environment, and tourism and recreation, respectively. The aim was to select two journals that represent the tourism and recreation perspective, and two journals that represent the environmental perspective.

The scope rules for our review included articles published on recreational ecology with corresponding keywords searched to identify such articles in JOST, TM, JEM, and EM between

1976 and 2017; complemented by a thorough manual review of articles by journal volume to carefully assess the relevance of each article for our study focus. This two-pronged approach was used to validate the keyword search, ensure comprehensiveness, and to carefully filter the results independently through the lenses of two experienced researchers. This excluded book reviews, research notes, short communications, and conference reports. We recorded the year of publication, location, and institute; keywords; methodology (such as the target sample, study ecosystem, source of impact, measured variables) and subject focus; and number of publications by first author.

3. Results

3.1. Number of Publications by Year

One hundred forty-five articles on recreational ecology were published in our target journals (JOST: 33; TM: 26; JEM: 40; EM: 46; Table 1) between 1976 and 2017. Notably, only EM has published more than 10 recreational ecology papers prior to 2001. From 2001 onwards, the number of papers increased rapidly in these four journals. Between 2001 and 2010, the number of recreational ecology studies doubled from 7 to 14 in JOST, and grew even more so from 1 to 17 in JEM; numbers remained similar in the following decade with a slight increase in JEM and EM from 17 to 22, and from 13 to 16, respectively.

Table 1. Number of recreational ecology papers by year (JOST, TM, JEM, EM 1976–2017).

Year of Publication	JOST	TM	JEM	EM	Total
1976–1982	-	-	-	9	9
1983–1988	-	-	-	4	4
1989–1994	-	-	-	3	3
1995–2000	7	1	1	1	10
2001–2010	14	12	17	13	56
2011–2017	12	13	22	16	63
Total	33	26	40	46	145

JOST—Journal of Sustainable Tourism; TM—Tourism Management; JEM—Journal of Environment Management; EM—Environmental Management.

3.2. Study Locations

Although, recreational ecology studies were undertaken in numerous countries (Figure 1), the majority focused on the USA (24.8%) and Australia (22.0%), followed by New Zealand (4.3%), China (3.4%), and Canada (2.7%). Global reviews comprised 4.8% of the studies, which were published in JEM only. Developed countries produced the majority of studies (58.9%) while developing countries from Africa and Asia were under-represented.

3.3. University Affiliations and First Authorship

Researchers from universities in 36 countries conducted recreational ecology research on five continents. Researchers from US institutes published the highest number of articles (JOST: 3; TM: 3; JEM: 9; EM: 26), followed by Australian (JOST: 7; TM: 6; JEM: 13; EM: 6), New Zealand (JOST: 2; TM: 2; JEM: 1; EM: 1), Chinese (JOST: 2; TM: 1; JEM: 1; EM: 1), and Canadian researchers (TM: 2; JEM: 2) [5,44–47]. Researchers from Asian and African universities were only marginally represented, each publishing three articles in JOST.

One hundred and sixteen unique first authors were noted for these publications. The top twelve repeat authors and their affiliations are listed in Table 2. Most articles accrued from the collaboration of two authors (Table 3).

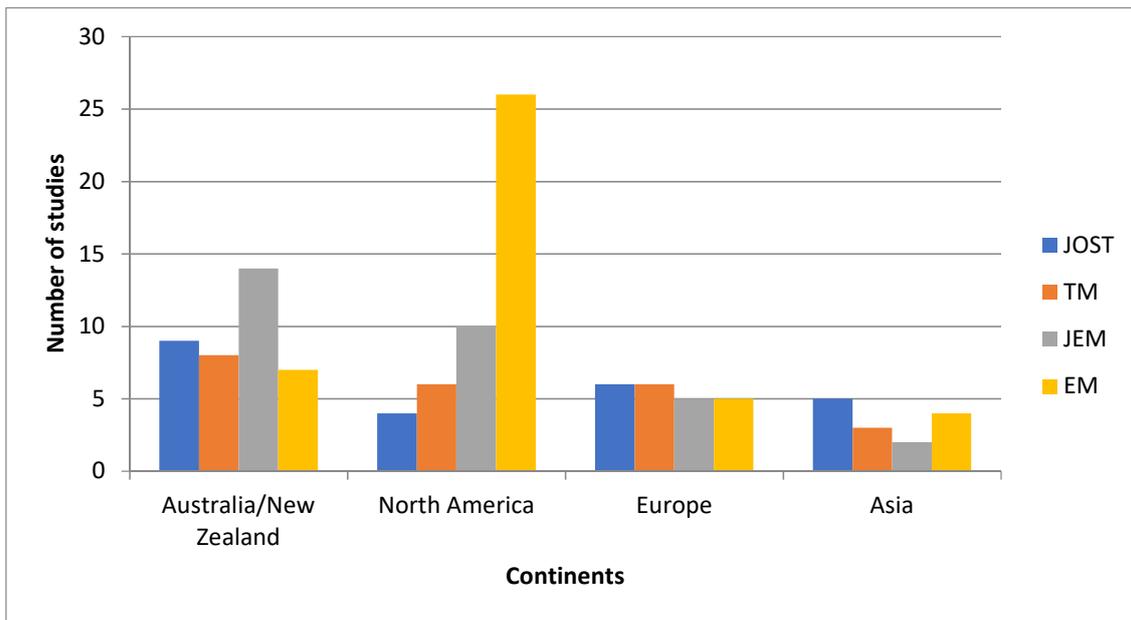


Figure 1. The number of recreational ecology papers by country (JOST, TM, JEM, EM, 1976–2017), excluding global subject-matter reviews.

Table 2. Repeat first authors of recreational ecology papers by university (JOST, TM, JEM, EM, 1976–2017).

Author	University	Instance	Weighted Instance
Pickering, C. M.	Griffith University	6	8.2
Cole, D. V.	Forestry Science Laboratory, Montana	4	5.4
Wolf, I. D.	University of New South Wales	4	5.4
Ballantyne, M.	Griffith University	3	4.1
Bratton, S. P.	Upland Field Research Laboratory, USA	3	4.1
Lucrezi, S.	North-West University, South Africa	2	2.7
Kim, M.	Marshall University	2	2.7
Sun, D.	Griffith University	2	2.7
Wimpey, J.	Virginia Tech	2	2.7
Moore, S. A.	Murdoch University	2	2.7
Oram, M. B.	Massey University	2	2.7
Perez-Maqueo, O.	Institute of Ecology, Mexico	2	2.7

Table 3. Single versus co-authorship of recreational ecology papers (JOST, TM, JEM, EM, 1976–2017).

Number of Authors	JOST	TM	JEM	EM
Single author	6	4	-	9
Two authors	15	10	20	13
Three authors	5	9	10	17
Four or more authors	7	3	10	7
Total	33	26	40	46

3.4. Study Focus

Keywords specified by authors are shown in Figure 2. This included a total of 12 keywords with ‘tourism impact’ being the most frequently used (19.4%), followed by ‘nature-based tourism’, ‘management’, and ‘protected areas’. ‘Tourism impacts’ and ‘recreational ecology’ were the most commonly used keywords in the tourism and environmental management journals, respectively.

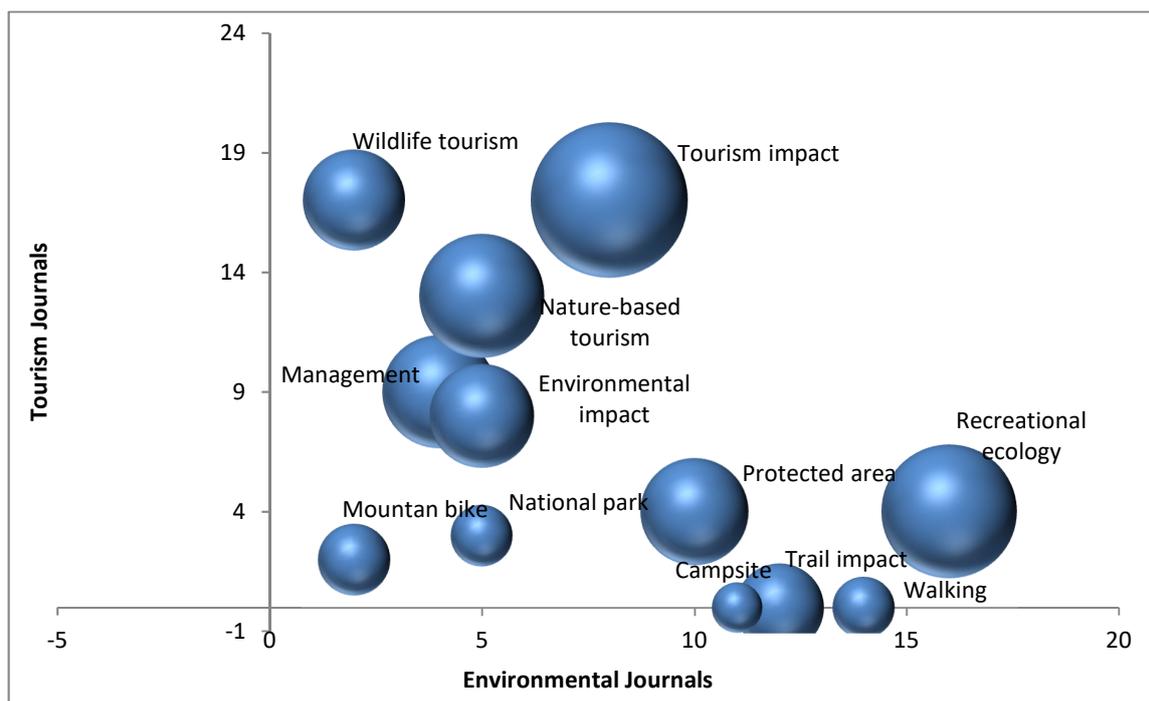


Figure 2. Keyword analysis of recreational ecology papers (JOST, TM, JEM, EM, 1976–2017).

This review identified 14 key main study themes among the 145 journal articles (Table 4). The majority focused on specific terrestrial tourism activities and their impacts, in particular, those related to walking/hiking, biking, and wildlife viewing. Far less articles were focused on aquatic activities such as rafting, boat impacts, and diving. A smaller number of studies chose the ecosystem as the focal point rather than the activity (23%), in particular the impacts on protected areas [58–62]. A couple of special-interest subjects such as overcrowding and tourism mobility appeared mainly in JOST. JEM, on the other hand, provided a platform for review articles (6%) from total sample, focusing on recreational ecology and its impact on vegetation, marine fauna, and species biodiversity. Vehicle track studies investigating impacts of driving activities and camping studies were most prominent in EM compared to the other journals [63,64].

Table 4. Subject focus of recreational ecology papers (JOST, TM, JEM, EM, 1976–2017).

Study Area	JOST		TM		JEM		EM	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	
Terrestrial Activities								
Walking/Hiking	4	12.1	4	15.3	19	47.5	13	28.3
Camping	2	6.0	1	3.8	1	2.5	10	21.8
Biking	2	6.0	-	-	2	5	1	2.2
Vehicle track/Driving	-	-	-	-	1	2.5	6	13.0
Littering	1	3.0	-	-	-	-	-	-
Caving	-	-	-	-	1	2.5	-	-
Wildlife viewing	3	9.0	8	30.7	3	7.5	2	4.3
Aquatic Activities								
Diving	3	9.0	-	-	-	-	4	8.7
Rafting	1	3.0	-	-	-	-	-	-
Boating impacts	-	-	-	-	1	2.5	-	-
Resource Focus								
Natural area/Protected area	6	18.1	6	23.0	2	5	5	10.8
Soil, water, air	3	9.0	-	-	-	-	-	-

Table 4. Cont.

Study Area	JOST		TM		JEM		EM	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Marine	-	-	1	3.9	3	7.5	5	10.8
Natural heritage	1	3.0	1	3.9	-	-	-	-
Mountain region	-	-	1	3.9	-	-	-	-
Special Interest Subjects								
Overcrowding	7	21.2	1	3.9	-	-	-	-
Climate change	-	-	1	3.9	-	-	-	-
Reviews								
Vegetation	-	-	-	-	7	17.5	-	-
Wildlife viewing	-	-	2	7.6	-	-	-	-
Total	33	100	26	100	40	100	46	100

Microclimatic variables (e.g., soil compaction), vegetation variables (e.g., cover), and trail characteristics (e.g., width) were common measures of impact in JEM and EM while studies in JOST and TM focused more strongly on the social science aspects of recreation ecology (55%); that is, visitors' perception and attitudes toward ecological impacts. Overcrowding was another social aspect investigated in 9% of the total studies.

The most frequently recommended measure for minimizing recreational impacts was improving visitor infrastructure (30%), followed by improving visitor regulations, management, and monitoring (18%). Another recommendation was to improve visitors' education on ecological impacts (34%) and to conduct more research on recreational ecology (18%).

3.5. Methodology

We classified the methodology applied in recreational ecology studies, as being original research versus a review; environmental versus social science, or mixed methods that combine environmental and social science approaches; and qualitative versus quantitative versus a hybrid of these two (Table 5). A study was classified as being 'qualitative' if it applied commentaries, observations, and expert opinions, while the term 'quantitative' was used for experimental research [65–69]. A combination of qualitative and quantitative approaches was deemed to be a 'hybrid' study according to Tsang and Hsu (2011) [70], and Atkinson and Brandolini (1999) [71]. Special-interest methodologies included GPS tracking and GIS mapping applied to identify recreational impacts.

Table 5. Methodologies applied in recreational ecology papers (JOST, TM, JEM, EM, 1976–2017).

* Methodology	JOST		TM		JEM		EM	
	<i>N</i>	%	<i>n</i>	%	<i>N</i>	%	<i>N</i>	%
Qualitative	14	42.4	2	7.7	6	15.0	3	6.3
Quantitative	10	33.3	22	84.6	21	52.5	41	85.5
Hybrid	6	18.8	-	-	4	10.0	2	4.1
Reviewing	-	-	2	7.7	7	17.5	2	4.1
Mixed methods	3	9.0	-	-	2	5	-	-
Total	33	100	26	100	40	100	48	100

* A study was classified as 'qualitative' if it included commentaries, observations, and expert opinion. 'Quantitative' studies included experimental research. 'Hybrid' studies combined qualitative/quantitative approaches. 'Mixed methods' refer to interdisciplinary studies combining environmental/social science.

This study revealed that review papers were mainly published in JEM, and the majority of quantitative articles were published in EM. Qualitative studies were mainly represented in JOST consistent with its greater emphasis on social science. In contrast though TM published mainly

quantitative studies. Mixed methods appeared rare in all journals which underpins that much needed multi-disciplinary studies are still scarce in the field of recreational ecology whether that pertains to tourism and recreation journals, or environmental management journals.

4. Discussion and Future Research Directions

4.1. Geographic Focus

The importance of recreational ecology research has increased strongly in the past two decades, as evidenced by the increasing number of publications in JOST (33), TM (26), JEM (40), and EM (46), particularly after 2001. Most of this research originated in the USA and Australia. While the former was expected, the latter is notable and could be explained by the existence of major Australian research initiatives with a distinct focus on recreation ecology research, especially the Sustainable Tourism Cooperative Research Centre which supported over 170 PhD scholars. In addition, Australian world-leading institutes such as the Griffith Institute for Tourism and progressive Australian national park agencies with a strong research focus including the NSW National Parks and Wildlife Service and Parks Victoria have further stimulated collaborative research efforts in recreation ecology in Australia. Four of the five authors who have produced more than one publication as first author in this field are affiliated with these institutes/agencies, which highlights the value of such initiatives for research in recreation ecology.

Far less studies were published in developing countries of Africa and Asia, as is a typical pattern reported elsewhere [24,34]. For recreation ecology this poses a significant challenge as many developing countries support a thriving nature-based tourism industry as a primary source of income for local communities in areas of highest conservation value. Investigations conducted in these countries would therefore be critical. A possible confounding factor in our geographic assessment is that we targeted fee-based, international English-language journals which may be less accessible to research in developing countries. There, recreational ecology research might be better represented in geographically-specialized journals or grey literature [72,73]. Still, to reach a broad international audience, recreational ecology research from developing countries needs to harness the outreach of broadly accessible publishing channels, supported by the publication of special journal editions in the field.

4.2. Study Focus

Terrestrial tourism and recreation activities such as walking and hiking were the subjects of most recreational ecology articles. These activities have also received much attention in other journals often in the context of vegetation trampling studies. Such studies offer a comparatively straightforward means to investigate relationships between activity and impact which is one reason for their prevalence. Also, walking and hiking are widely accessible activities that are popular worldwide especially in protected areas, and they have obvious direct impacts on vegetation and trails which warrants investigation and management. Other activities have received less attention either because they are practiced by a smaller population of tourists/recreationists or are more challenging to investigate such as water-based and off-road recreation activities.

With more than 1000 articles published in recreational ecology in the past two decades, a large variety of activities has been researched, some exceeding the scope of these four journals, which may explain the more traditional focus on walking and hiking activities. In addition, recreation ecology is a dynamic field with new activities constantly adding to the spectrum of existing activities thereby creating new research avenues; for instance, adventure racing has not yet been addressed in either of these journals but few off road driving impacts are studied in EM. Therefore, expanding the depth and scope of studies and monitoring new activity trends is essential for recreational ecologists.

Some of these activities are more classically considered to be 'recreation' rather than 'tourism'. However, travel experiences were thought to occur on a continuum ranging from recreational activity to tourism experiences [74]. The four journals we have reviewed have proved welcoming of articles in either realm. The geographic bias that we noted may play another role in the subject focus of these

journals as some forms of impact such as littering are less prevalent in countries with well-developed and reinforced tourism and recreation policies and management systems.

Given the nature of the activities that were the focus of the research in the journals that were reviewed, vegetation and trampling effects [71] were most commonly reported on. These impacts occurred due to hiking, walking, and mountain biking in protected areas [65,66]. This included a reduction in vegetation cover, along with changes in height and species composition, and the introduction and spread of non-native species [7,75–78]. Long-term impacts were identified consisting of the decline in plant growth, flowering, and seed production. However, there was little research addressing less obvious, indirect and complex impacts relating to synergistic effects of co-occurring types of disturbance. This is a general issue affecting the recreational ecology literature beyond these four journals (JOST, TM, JEM, and EM), with some notable exceptions (e.g., [79,80]). Similarly, our review identified limited research on visitor impacts on cryptic species such as reptiles or insects that are often not the primary focus of tourism activities. The bias towards the popular and attractive species (especially, birds and mammals), and those that can be more easily researched (vegetation compared to mobile wildlife) has been noted elsewhere [81]. This limits our understanding of the full extent of tourism and recreation impacts.

The strong focus on protected areas is a useful and necessary aspect of recreational ecology. However, research on tourism and recreation impacts and management external to these areas is also required. For instance, recreation undertaken in urban green spaces should form an integral part of the research agenda of recreational ecologists, considering that most of the everyday encounters by the majority of people occur within urban or suburban green spaces. These spaces are pressured by steadily increasing population sizes and the simultaneous decrease in the green space of cities. Increasing urbanization has created many impacts on urban green spaces with imminent effects on the quality of life of its visitors and residents of surrounding neighborhoods [82–84]. As per Roberts (2011) [85], these impacts will increase drastically by 2025 due to a rising urban population of up to 75% worldwide.

We found only a few studies on the factors that modify and potentially intervene in the relationship between visitor usage and impact. This type of ‘noise’ poses a challenge in observational studies for recreation ecologists when aiming to tease out the factors that influence the outcome of tourism and recreation activities. A shift in perspective may be warranted that appreciates these factors as a ‘modulating’ force rather than a nuisance on which to capitalize, for instance, in education programs. For example, a better understanding of modulating factors such as weather conditions could be incorporated into education messaging by green space managers to raise awareness of how to behave under certain environmental conditions in order to cause the least disturbance in wildlife observations.

4.3. Management Implications

All forms of tourism and recreation produce negative environmental impacts. This review highlighted the need for more research and improved regulations on minimizing impacts. Impacts can be managed but studies on how to achieve this for specific activities in different environments is limited due to the sheer variety of tourism and recreation activities, and the diversity of the environments in which they take place. Our review suggests that it is even less known how different management tools reduce impacts, not the least because most studies focus on short-term impacts at recreational sites.

As per our findings, visitor education exhibits vast potential to minimize environmental impacts [86–90]; and so does the improvement and management of infrastructure. This was evidenced in our sample through discussion of changed trail material and improved maintenance, along with visitor management. How such measures are perceived and accepted by the public, and how to make them more readily acceptable (e.g., through persuasive communication (e.g., [91]) was less of a focus in our target journals. Another strand of research that deserves attention is the capacity, capability, and willingness of national park and other green space management agencies on adopting and reinforcing tourism and recreation management measures, especially in light of conflicting political pressures and complex stakeholder influences [92–94].

4.4. Conceptualizing the Relationship between Nature-Based Tourists and Recreationists and the Natural Environment

In spite of the variety of subjects that were studied in the 145 articles included in this review, common relationships were established that we have conceptualized in Figure 3. We noted that visitor activities were thought to affect the natural environment via four main pathways: direct stimulation, harvesting, habitat alteration, and the modification of biotic relationships. A ‘direct stimulation’ occurs through perturbing sensory stimuli produced by human presence or infrastructure (e.g., [44,95]). This may also include a sensory stimulus in the form of a mechanical disruption of the environment triggered by physical contact with humans (e.g., [96,97]). Another form of direct impact is the intentional or accidental harvesting of natural resources (e.g., [98,99], for example through trampling or road accidents. Indirect impacts were described in the form of tourism-induced changes in the habitat which may elicit secondary effects on fauna or flora (e.g., [65,100]), most prominently in conjunction with tourism and recreation infrastructure developments or maintenance. The modification of biotic relationships constitutes another commonly noted indirect impact, for instance through the introduction of exotic species along recreational tracks (e.g., [101,102]).

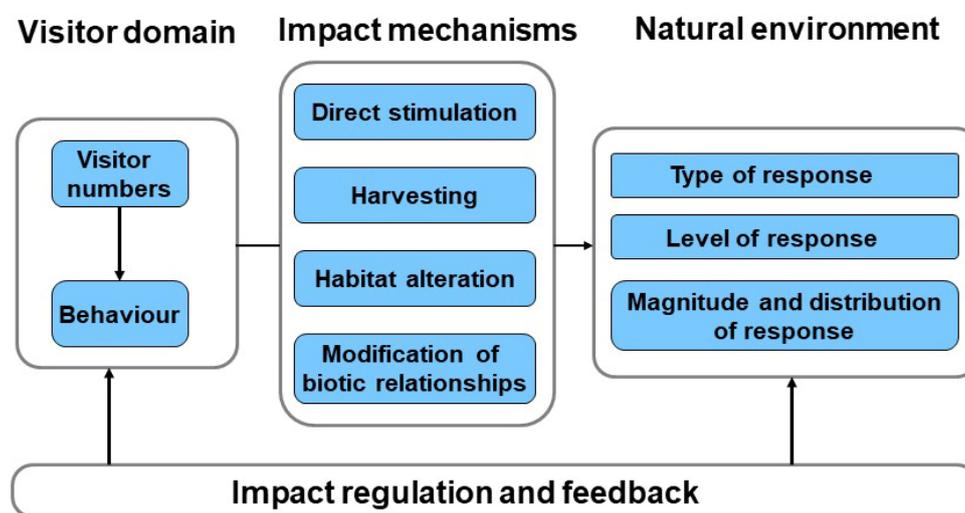


Figure 3. A conceptual framework of the relationship between nature-based tourists and recreationists and the natural environment.

A wide variety of impacts may be measured at various levels of organization from the individual to the species and whole communities, triggering various responses (physiological, behavioral, etc.) in the affected ecosystems (e.g., [79,80]). The impact mechanism, type, level, and magnitude of the environmental response was thought to relate to visitor numbers and behavior (individual, and intrinsic to the specific activity) which in turn affected the usage intensity and distribution of use (e.g., [103,104]). Environmental impacts had negative feedback effects on visitors who also directly impacted on each other through for instance overcrowding (e.g., [105,106]).

Impact-regulating factors were discussed in some studies that intervene in the visitor-environment impact relationship and thus modulate the environmental response (e.g., [95,107]). This may include environmental factors such as the type of the ecosystem or weather conditions, which may for instance affect the impact of wildlife observations. Also, natural constraints were noted that determine where and when visitation and associated impacts can occur such as trampling impacts confined to trailsides in mountainous regions. Tourism management, more or less restrictive/direct, was considered a vital factor for controlling visitor impacts on the environment which may consist of the regulation of visitor numbers, their behavior (including factors that influence a certain behavior, such as attitudes and expectations) and visitors’ spatio-temporal distributions (e.g., [108,109]).

4.5. Methodological Approach

This review demonstrates that both social and environmental sciences have contributed to developing the field of recreational ecology. However, this has mainly occurred individually. Interdisciplinary research is lacking that combines questions and methodologies from social and environmental science. An interdisciplinary approach would be particularly beneficial in a discipline such as recreational ecology where relations are established between environmental impacts and human behavior, attitudes, and perceptions towards the environment.

As recreation ecology aims to understand the interface between tourists/recreationists and the environment, research is needed on how to improve visitor experiences so that they combine sustainable resource usage with sustainable visitor experience development. Given the diverse subject-matter expertise required, such studies are unsurprisingly rare. Notable exceptions published in other journals include, for instance, research on the effects of night-time observations of Australian wildlife which aimed to develop experiences that achieve maximum visitor satisfaction while maintaining minimal impacts on wildlife [110]. A related Australian study researched how to approach wildlife along roads and trails under the same aim of achieving high tourist satisfaction with minimal impact [111]. In both of these studies, a systematic experimental investigation was conducted which included simulated visitor behavior and resulting impact measurements. This was coupled with a questionnaire-based survey on visitor needs, preferences, and environmental attitudes. Importantly, pathways were shown on how to reduce impacts while increasing visitor satisfaction. This evidences that satisfying visitor experiences do not need to be intrusive. Expanding such multi-tiered experimental research to other study systems would greatly benefit the field of recreational ecology and enhance our understanding of the optimal design of tourism and recreation experiences including critical parameters such as the best tour group size. This type of research should further address feedback mechanisms which we are only starting to understand; for example, environmental impacts and their influence on visitor perception and enjoyment of nature-based tourism activities [112].

All journals published empirical case studies and ad-hoc observations and to a lesser extent systematically designed experimental studies as described above [110,111], other than trampling studies. Carefully designed experimental studies will allow greater insights into cause-effect mechanisms between the source of and resulting tourism and recreation impacts.

5. Conclusions

Our review highlighted the increasing importance of recreational ecology studies in the past two decades as published in *JOST*, *TM*, *JEM*, and *EM*, highly relevant journals in the field. However, to fully understand impacts and management of tourism and recreation activities in areas of highest conservation concern, the geographic distribution needs to extend to the less developed countries [113]. The publishing environment could facilitate this type of research through special issues targeting recreation ecology in underrepresented geographical areas.

Some actions may close some of the gaps we have noted based on the present study and in comparison with previous reviews [22,24,73]. For example, monitoring trends on new tourism and recreation activities is critical to keep abreast on this ever-evolving field. Less obvious, indirect, and complex impacts relating to synergistic effects of multiple disturbances should form part of the future research agenda in recreational ecology; as should research on tourism and recreation impacts on cryptic species.

Perhaps most importantly, far more interdisciplinary studies are needed that capitalize on the tools and techniques adopted by both environmental and social scientists; especially, well-designed experimental studies that account for both human and environmental aspects of socio-ecological tourism and recreation systems. Incorporating geospatial research through public participatory approaches (e.g., [41]) will provide great benefits to recreational ecologists.

The conceptual model that we have developed can be used to categorize the elements of a recreational ecology study system to better understand which components need to be investigated as

they may influence/govern the relationship of a specific system in question. This is particularly useful as the field of recreational ecology is vast and our model allows for a simply yet effective classification of possible impact pathways and relationships.

Finally, a variety of nature-based tourism and recreation activities, and study systems beyond national parks including urban nature spaces need to be considered, as impacts vary with the source of impact and the environmental context. As a whole, nature-based tourism and recreation activities need systematic and extended monitoring programs to minimize long-term recreational impacts in green spaces. This warrants a more in-depth understanding of the effectiveness of management actions, and their acceptance by the public and the implementing agencies. This study aimed to provide some direction for a future research agenda acknowledging that extending this review beyond the selected four journals would add further insight.

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