



Contents lists available at ScienceDirect

Science of the Total Environment

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

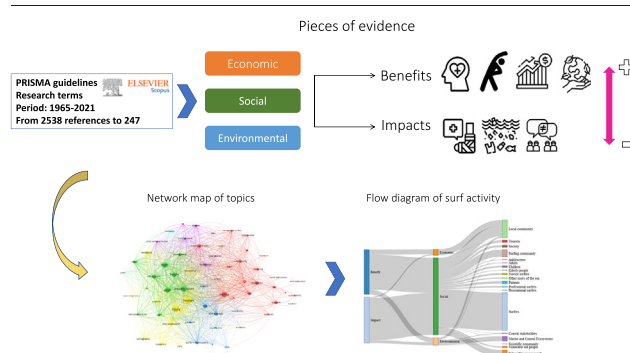
Surfing the waves: Environmental and socio-economic aspects of surf tourism and recreation

Cristina Román^{a,b,*}, Angel Borja^{b,c}, María C. Uyarra^b, Sarai Pouso^b^a Departamento de Ecología y Biología Animal, Facultad de Ciencias del Mar, Centro de Investigación Marina (CIM), Universidad de Vigo, 36310, Campus de Vigo, Spain^b AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Herrera Kaia, Portualdea s/g, 20110 Pasaia, Spain^c King Abdulaziz University, Faculty of Marine Sciences, Jeddah, Saudi Arabia

HIGHLIGHTS

- Surfing is a Cultural Ecosystem Service benefit.
- Surfing provides psychological benefits to surfers.
- Surfers often have pro-environmental behaviour and contribute to local economies.
- Most of the negative impacts of surfing are associated with the risk of injuries.
- The management of nature-based recreational activities should be interdisciplinary.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:

Received 14 October 2021

Received in revised form 19 February 2022

Accepted 21 February 2022

Available online 24 February 2022

Editor: Paulo Pereira

Keywords:

Cultural ecosystem services

Human well-being

Nature-based recreational activity

Surfing benefits

Surfing impacts

Sustainable management

ABSTRACT

Marine ecosystems contribute to human well-being, e.g. through the promotion of nature-based recreational activities such as surfing, which is a benefit obtained from Cultural Ecosystem Services (CES). Our research objective is to identify the benefits and impacts associated to surfing, and who are the main affected subjects and/or objects, achieving a better understanding of the sustainability status of this recreational activity. To this end, a bibliometric study and systematic review was carried out for the period 1965–2021. Benefits and impacts were collated and grouped according to their dimensional focus and type of effects in 6 groups (3-dimensional focus \times 2 type of effects). The results revealed that since the beginning of 21st century surfing research topics are growing and diversifying. This review shows that implications of surfing go beyond direct users (i.e., surfers) and has consequences in diverse dimensions (environmental, socio cultural and economic), involving many stakeholders (e.g., scientific, and local communities). Most of the pieces of evidence collated in this research were related with the people who practice the activity and its social implications (psychological benefits as main benefit and injuries as main impact). Following an interdisciplinary approach, we obtained a holistic understanding of the surfing activity, not only in terms of the different dimensions addressed but on the sectors of the society that obtain benefits or are impacted by the activity. All of them should be considered and integrated to guarantee the sustainable management of this CES benefit.

1. Introduction

Nature is essential for human well-being. Ecosystems provide direct and indirect benefits to humans through their ecological characteristics, functions, or processes, through the so-called ecosystems services (Costanza et al., 1997, 2017) or nature's contributions to people (Díaz et al., 2018). Ecosystem services are classified according to the Common International

* Corresponding author at: Departamento de Ecología y Biología Animal, Facultad de Ciencias del Mar, Centro de Investigación Marina (CIM), Universidad de Vigo, 36310, Campus de Vigo, Spain.

E-mail address: crroman@alumnos.uvigo.es (C. Román).

Classification for Ecosystem Services (CICES) as provisioning, regulating and maintenance, and cultural services (Haines-Young and Potschin-Young, 2018). Overall, most ecosystem services research have addressed provisioning and regulating services (e.g., food provision, carbon sequestration, nutrient cycling), whereas Cultural Ecosystem Services (CES) have received less attention due to their intangibility, which complicates their valuation and quantification (Milcu et al., 2013). Under CES, the CICES (V5.1) classification includes benefits such as social relations, sense of place, educational and aesthetic values, with most studies focusing on those related to recreation and (eco)tourism (Milcu et al., 2013; Gascon et al., 2017; Kosanic and Petzold, 2020). These holds true also for the marine realm, as found by a recent bibliometric study (Rodrigues Garcia et al., 2017) that provided an overview on the growth in the number of publications on marine and coastal CES.

Coastal tourism and recreation contribute substantially to national economies, while at the same time provide pleasure and joy to people through beneficial physical and mental contributions (White et al., 2010; Barbier, 2017), as well as other significant social benefits (Irvine et al., 2013; Rocher et al., 2020). Marine recreational activities, such as rowing, canoeing, sailing, and surfing contribute to better quality of life, sense of place, or physical well-being, among others (Wood et al., 2013). Exposure to 'blue' spaces, including coasts and oceans as well as inland bodies of water, through the practice of recreational activities, is associated with positive outcomes for individual's mental state (e.g., feeling calm or revitalized) as well as overall health and state of well-being (White et al., 2010, 2014, 2016, 2019). Furthermore, practicing outdoor activities and spending time in nature are key determinant factors preventing diseases, and can contribute to reduce mental health problems during stressful life events, such as the COVID-19 pandemic (Oh et al., 2017; Pouso et al., 2021). The research interest on nature-based activities is currently growing (Coventry et al., 2021) but the sustainability of these CES benefits has been largely unexplored (Rodrigues Garcia et al., 2017), and may be compromised by recreational marine activities if carried out unsustainably, harming the ecosystems (Rees et al., 2010; Wyles et al., 2014).

Surfing is one of the many recreational activities supported by the marine environment, i.e., it is a human activity that depends on natural capital (e.g., wave break) or environmental features (e.g., water quality). Therefore, it can be studied as a CES benefit that contributes to human mental and physical health. The influence of this sport spreads throughout different sectors (e.g., economics, environment, and sociocultural) being one of the most popular marine recreational activities in the world (Orams and Towner, 2013). In 2012, the International Surfing Association estimated that there are 35 million surfers worldwide, and valued the worldwide industry associated to the sport in around \$22 billion (Surfer Today, 2018). Such popular activity also poses the potential to negatively impact the location where it takes place, e.g., through surf tourism development (Krause, 2012), e.g., in terms of increasing litter or conflicts with other sea users. The wide touristic implications and pressures of the surfing activity have been studied before (Buckley, 2002; Towner and Orams, 2016). However, recent reviews that have been undertaken around the recreational activity (Pérez Gutiérrez and Cobo Corrales, 2020; Valencia et al., 2020) focused mainly on publication aspects such as productivity, research subjects, and collaboration patterns, instead of exploring the social and ecological aspects of surfing.

The capacity of marine and coastal ecosystems to supply recreational benefits such as surfing depends on the sustainable use and integrated management of those ecosystems, to guarantee that they remain clean and healthy. Furthermore, framing the activity into sustainable tourism development is essential to ensure an equal balance of the effects between economic, social and environmental dimensions (UN World Tourism Organization, 2005).

Following a context of sustainability closely linked to the above, the United Nations (UN) 2030 Agenda for Sustainable Development (UN, 2015), with its 17 Sustainable Development Goals (SDGs), aims to ensure that sustainable development is achieved by 2030, improving scope and balance between the three dimensions of sustainable development above-

mentioned. In addition, this agenda plays part in the UN Decade of Ocean Science for Sustainable Development (2021–2030) (Claudet et al., 2020), which engages to comply with the SDGs (Ryabinin et al., 2019).

In this context, studies that analyze the performance of touristic and recreational activities in the marine realm are urgently needed, in order to measure if they occur sustainably and in line with the above-mentioned agenda. The overall objective of this study is to achieve a better understanding of the sustainability status of the surf activity by identifying the benefits and impacts (positive and negative contributions, respectively) provided by this activity and who, and in which form, are the main subjects and/or objects affected. Our study analyzes surfing sport as a marine recreational activity, which in turn is considered a benefit from the CES group: "Physical and experiential interactions with natural environment" (Haines-Young and Potschin-Young, 2018). To achieve this objective, a systematic literature review has been undertaken and discussed. The findings will help to better understand the past and current status of the surfing activity, providing the basis for a more sustainable management of the activity.

2. Material and methods

2.1. Literature review process

In order to gather the necessary information, a consultation was undertaken in Scopus (www.scopus.com) Database (consultation date: 06/03/2021) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2010). Previous to the literature review, a selection of search terms and key strings were defined by the research team. Since the term 'surf' has different meanings (e.g., navigating on the web, recreational activity), it was important to check the best way to introduce the term in the system to avoid irrelevant retrievals. A set of nine terms combined in a structured manner was finally selected for scientific literature database queries. The terms refer to the activity (general terms: 'surfer', 'surfing'; specific terms: 'recreation', 'tourism', 'activity', 'sports', 'leisure'), as well as the 'benefits' and the 'impacts' (Table 1). Boolean operators were used to perform the combination of search queries, i.e., 'OR' and 'AND', the first one ensures that at least one term must appear, and the second one ensures both terms must appear. Similar approaches have been used in reviews of different ecosystem services (Aronson et al., 2010; Milcu et al., 2013; Gascon et al., 2017; Kosanic and Petzold, 2020).

The Scopus database returned 2538 references for the search terms used, which were exported and analyzed using EndNote X9 for Windows (produced by Clarivate Analytics). All references selected were scientific papers written in English. This resulting publication set was carefully reviewed in three steps (Fig. 1). First, duplicated and/or incomplete references (i.e., absence of authors, source, etc.) were removed, reducing the number of references to 2241. Second, the articles were pre-screened (by reading the title, keywords and abstract) to determine their relationship with the topic investigated and removing those not related to the recreational activity (e.g., web surfing, wave engineering). This resulted in 488

Table 1

List of terms used when searching in the scientific literature, regarding surf, and combinations used in the search (source: Scopus; consultation date 06/03/2021).

Search terms
"surfing*" OR "surfer*" AND "recreation"
"surfing*" OR "surfer*" AND "touris"
"surfing*" OR "surfer*" AND "activi"
"surfing*" OR "surfer*" AND "sport"
"surfing*" OR "surfer*" AND "leisure"
"surfer*" AND "impact*" OR "surfing*" AND "impact"
"surfer*" AND "impact*" OR "surfing*" AND "benefit"

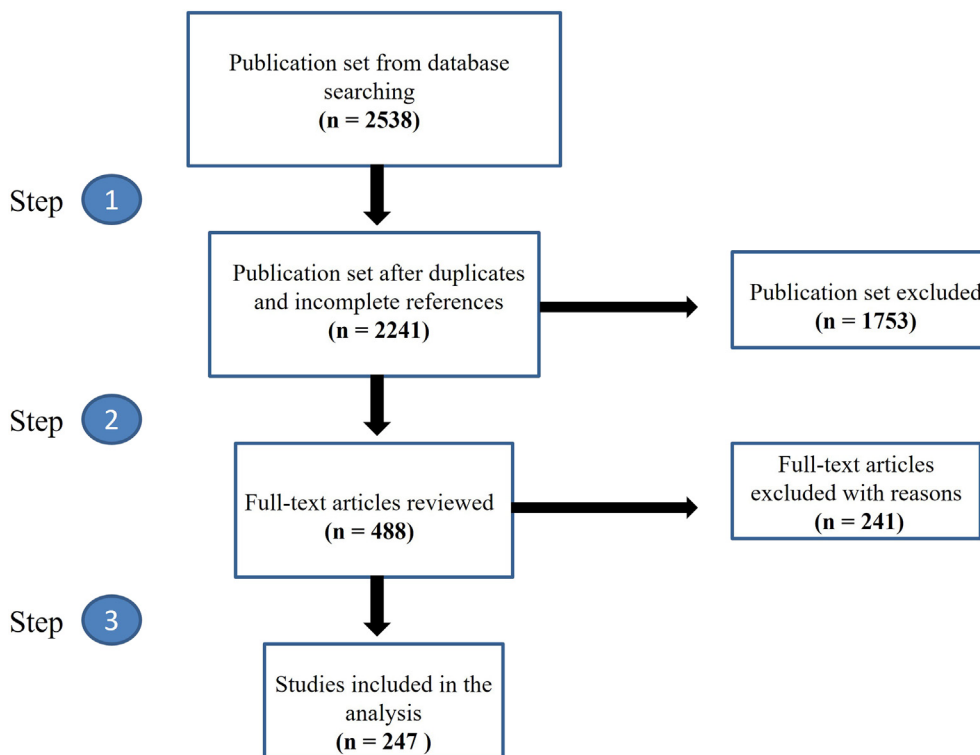


Fig. 1. Literature search workflow diagram followed in the methodology for the bibliometric assessment.

documents relevant to this research. Third, full-text articles were screened and retained or excluded depending on the contents and their real relevance for the objective of this research. After these three steps, the final number of articles used was 247.

2.2. Data extraction and compilation

From each selected article, data were extracted into an Excel spreadsheet. The information was organized according to the environmental, social and economic dimensions related to the main benefits and impacts of the surfing activity. Following the methodology used in recent reviews (Chalastani et al., 2021; Wang et al., 2021) the database was composed of eight blocks (Table 2). Blocks 1, 2, 3, 4 and 5 compile general characteristics of the publication (e.g., title, authors) while blocks 6, 7, 8 and 9 compile the specific pieces of evidence that they provide, with each publication possibly contributing with more than one evidence. For assigning the publication to a research topic (block 3), we first design a topic list with those that we expected to arise from the review (e.g., tourism, health). The list was completed and adapted while performing the review.

2.3. Data analysis

After data extraction, VOSviewer (version 1.6.16) (van Eck and Waltman, 2014) was used to perform the bibliometric analysis. This software allows constructing, analyzing and visualizing maps based on bibliometric network data and has been used in different reviews (Lis et al., 2020; Borja and Elliott, 2021; Rosato et al., 2021). The results are displayed in clusters to provide the connections among the bibliometric data. “A cluster is a set of closely related nodes where each node is assigned to exactly one cluster” (van Eck and Waltman, 2014). In knowledge domain maps, each node represents an item, such as an author, a keyword, country, or reference and the links between them indicates their collaborative relationships. A link is a connection or a relation between two items. Examples of links are bibliographic coupling between publications, co-authorship between researchers, and co-occurrence

between terms. The strength of a link may for example indicate the number of cited references two publications have in common, the number of publications two researchers have co-authored, or the number of publications in which two terms occur together (van Eck and Waltman, 2014).

The first bibliographic analysis carried out was to explore the co-occurrence of keywords. “The number of co-occurrences of two keywords is the number of publications in which both keywords occur together in the title,

Table 2

Description of the criteria adopted for extracting data related to publications compiled in the bibliometric analysis. Note that in effects (*) within the negative impacts, those that implied a risk or a negative contribution in a fortuitous way (i.e., human hazards), where indicated with an asterisk to keep track of those documents.

Methodology blocks	Examples
1. General information	Title, author/s, year of publication, and journal
2. Document type	Book chapter, conference paper, article, review, letter and note
3. Research topic	Health and well-being, tourism, marine pollution, socioeconomic, conflicts, injuries, and coastal management
4. Spatial coverage	Global, continental, mixed, national, sub-national or local scale
5. Research methods	Database, fieldwork, interviews, lab test, literature review, medical report, online, physical or telephone surveys or participant observation
6. Dimensional focus	Economic, social, or environmental
7. Type of activity effect*	Benefit as positive contribution of surfing, (focused on an advantage or profit gained thanks to the presence or the practice of the activity), impact as negative effect of surfing, (focused on the adverse effects generated by the presence or the practice of the activity)
8. Evidence group	Specific benefit/impact (e.g., local business development, income inequality)
9. Who/what are involved	Positively or negatively affected subject or objects (e.g., surfing community, patients, marine and coastal ecosystems)

abstract or keyword list” (van Eck and Waltman, 2014). Secondly, co-authorship patterns were analyzed to identify trends of collaboration. Data cleaning was performed by removing not useful words (e.g., ‘article’, ‘priority journal’, ‘conference paper’) and merging similar keywords in a ‘thesaurus file’ to indicate that different keywords in fact refer to the same term (van Eck and Waltman, 2014). In addition, and using the End-Note dataset, a study of the most cited authors, and their affiliation to each cluster of knowledge was undertaken. The objective of this analysis was to identify the hottest topics.

Regarding the systematic review, a social-ecological system approach was followed, extracting from the relevant literature the effects that surfing generates, and analyzing the environmental and socio-economic factors involved in the activity, as well as the stakeholders impacted and/or benefited from it. The pieces of evidence on the impacts and benefits related with the surfing activity were subsequently analyzed. Chi-square test, followed by Fisher’s test as a post-hoc test (Shan and Gerstenberger, 2017), was used to elucidate if there is a significant difference ($p < 0.05$) between the dimensional focuses of the evidence (‘environmental’, ‘social’ or ‘economic’) in terms of the type of effects that surf generates (benefit, impact). In this study, health risks were coded as impacts (i.e., social impacts). Therefore, those pieces of evidence were organized according to their dimensional focus and type of effects in a total of six evidence groups (3-dimensional focus \times 2 type of effects). Each evidence group would integrate pieces of evidence with same or similar topics (e.g., ‘Individual psychological benefit and well-being: quality of life, general well-being’ would integrate pieces of evidence such as surfing leading to feelings of freedom or surfing as an activity practiced for sensation seeking). Thus, each article was analyzed considering the dimension and users/environment addressed. Since one article could explore different dimensions (e.g., social and environmental), and address different users (e.g., surfers, local communities, the environment itself), for each article we could report more than one evidence. Each evidence provided a unique combination of dimension, type of effect and users (e.g., Evidence 1. Addressing social impacts on surfers; Evidence 2. Addressing social impacts on local communities, etc.). Finally, a Sankey diagram was built with the aim of better understanding of the diversity of stakeholders or environmental features (e.g., coastal and marine ecosystems) impacted or benefited by the surfing activity. All the data management, statistical analyses and figures were carried out in R version 4.0.0.

3. Results

3.1. Characterization of publications

The database compiled ($n = 247$) comprises 231 articles, 5 conference papers, 3 book chapters, 3 reviews and 5 publications of other type (i.e., note, letter), according to the classification of the Scopus database (the whole material can be consulted in a .ris file in the Supplementary Material (SM1)). The evolution of these publications encompasses research from 1965 to 2021 (Fig. 2). Considering the research topics and the number of publications, we identified three periods: (i) from 1965 to 2000 the number of publications related to the surfing activity remained low (<4 per year), with practically only one topic (injuries); (ii) between 2001 and 2012 there was a slow increase in the number of papers, with values between 3 and 12 per year, and several topics ‘injuries’ was still the most common topic, ‘socioeconomic’ and ‘marine pollution’ appeared more frequently, and new topics, such as ‘health and well-being’ (in 2001), ‘tourism’ (in 2002), ‘coastal management’ (in 2006), and ‘conflicts’ (in 2009) emerged; and (iii) between 2013 and 2021, there was a significant expansion in the number of papers, with values between 13 and 26 per year, as well as the diversity of topics (there was still a predominance of the ‘injuries’ topic, but increased others such as ‘tourism’, ‘health and well-being’, ‘coastal management’ and ‘conflicts’).

The comparison of the topics investigated with the spatial coverage of the publications showed clear distinctions on research tendencies between countries (Fig. 3). Overall, the most recurrent investigated topic was ‘injury’, representing the highest number of publications for most countries, especially in USA (45 out of 68) and within publications of unknown location (i.e., publications that have not specified their location or have been related to general medical reports) (17 out of 20).

The second most relevant topic in terms of number of publications was ‘health and well-being’, for which countries such as Australia, USA, New Zealand, United Kingdom, or Portugal, had the largest number of publications in this field ($n \leq 8$). Other topics like ‘coastal management’, ‘conflicts’, or ‘socio-economics’, show a similar pattern, with few existing publications ($n \leq 5$) mainly coming from the same countries.

Although ‘tourism’ related publications were available for e.g., Australia, Japan, Spain, and Portugal, generally in low numbers, it is worth noting that for several Indo-Pacific countries (i.e., Indonesia, Thailand, Fiji, Maldives, and Papua New Guinea) all the surf-related

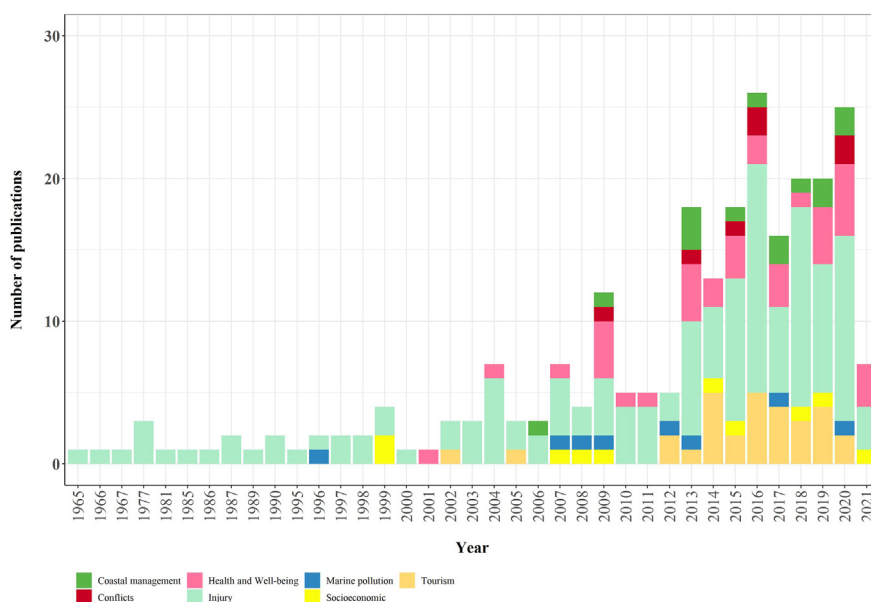


Fig. 2. Annual distribution of publications with respect to the research topics (i.e., coastal management, conflicts, health and well-being, injury, marine pollution, socio-economic and tourism). The bar graph shows the number of publications per year according to the total ($n = 247$).

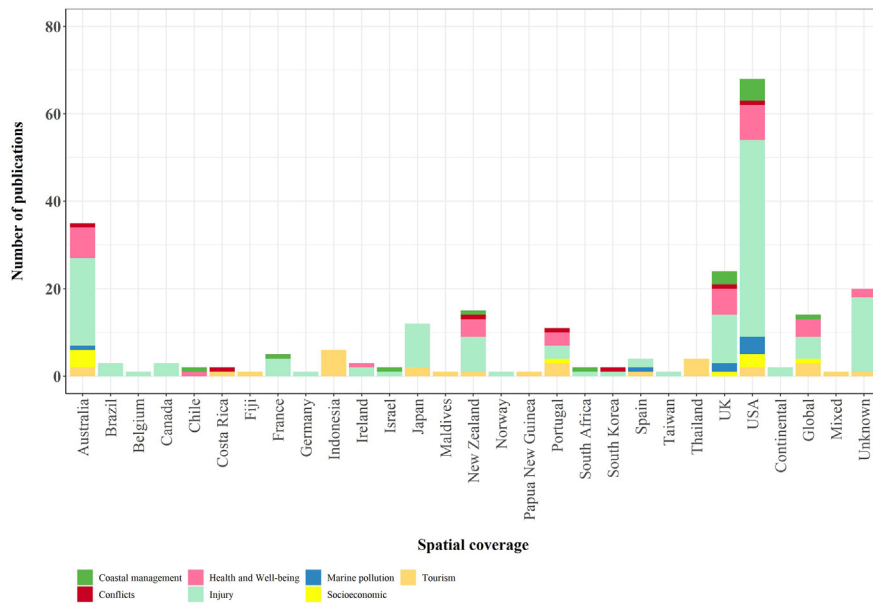


Fig. 3. Geographical distribution of publications with respect to the research topics (i.e., coastal management, conflicts, health and well-being, injury, marine pollution, socio-economic and tourism). The bar graph shows the number of publications per country (above mentioned as spatial coverage) according to the total (n = 247).

publications were focused on ‘tourism’ (n ≤ 6). Several publications were grouped as continental (n = 1), global (n = 5) or mixed (n = 1).

3.2. Authors and keywords clusters

Although many small author’s clusters were identified, they are generally disconnected from each other (Fig. 4; Table SM2.1). A first large

cluster, divided in three sub-groups, includes 13 authors, with M. Climstein being the most connected author. This cluster shows several links in their scientific production, dedicated mainly to injuries associated with the surfing practice. Three smaller clusters, close to the first one, but disconnected, can also be seen. These clusters also cover publications in the fields of injuries and composed by the authors S.E. Anderson (in green), K.S. Taylor (in yellow) and J.F. Griffith (in purple), respectively. In addition, smaller (1–3

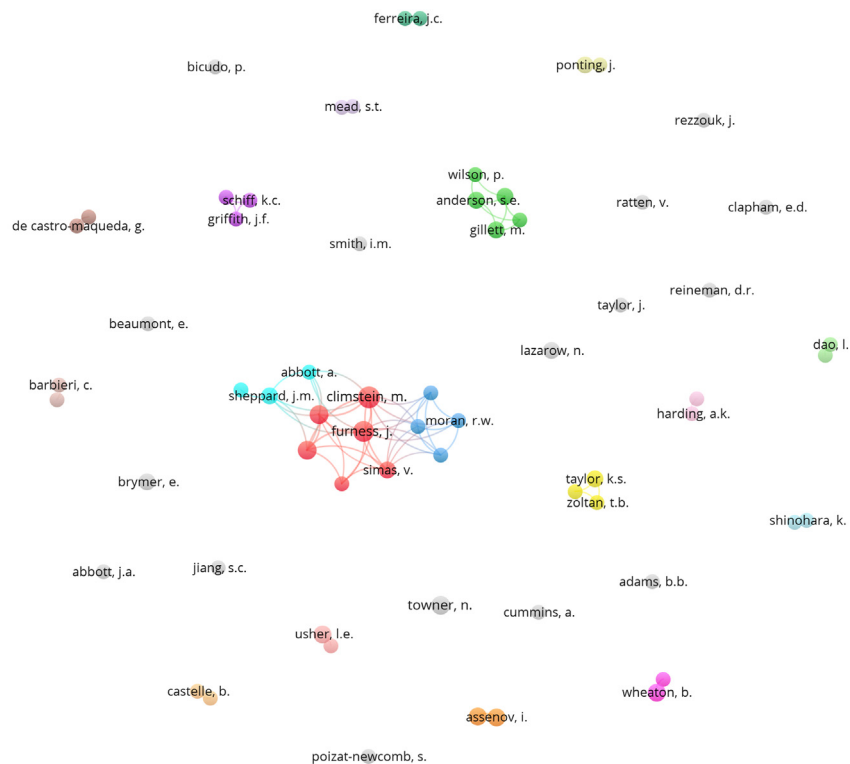


Fig. 4. Co-authorship network map based on total link strength. The map shows the 64 most well-connected authors.

authors) and disconnected groups are publishing on topics such as surf 'tourism' (e.g., S.A. Martin) (Fig. 4 - orange color), 'socio-economics' (e.g., J.C. Ferreira) (Fig. 4 - dark green color), 'conflicts' (e.g., L.E. Usher) (Fig. 4 - light red color), 'marine pollution' (e.g., B. Wheaton) and 'human health and well-being' (e.g., R. Olive) (Fig. 4 - pink color).

The most highly cited papers by topic are identified in Table SM2.2. Around 60% of the authors were not part of any cluster. Adams (2002), a publication on 'injury', has the highest number of citations ($n = 114$). Other highly cited publications were related to 'tourism' (e.g., Barbieri and Sotomayor, 2013), 'health and well-being' (e.g., Brymer and Oades, 2009) and 'marine pollution' (e.g., Wheaton, 2007) with 80, 77, and 74 citations, respectively.

The keywords co-occurrence analysis reveals a network structured of 63 nodes (items) and 1189 links, which result in six main clusters (Fig. 5). The proximity of the nodes indicates how these topics are related to each other. A total of 310 keywords were obtained and occurred at least three times. After applying the thesaurus file, they were reduced to 260 providing a clearer overview of the dominant keywords. The term 'human' was the most used keyword, followed by 'injury', and 'aquatic sport', while 'surfing' and 'male' occupied the fourth and fifth positions.

The resulting network map shows that within each cluster there is a different dimensional focus, which may be related to the above-mentioned main topics. The largest cluster (Cluster 1, Fig. 5 - red color) focused on the recreational perspective of surfing (recreation and tourism) and its connection with environmental conditions of the ocean and seas. 'Cluster 2' (Fig. 5 - green color) refers to the interaction of people of different demographic characteristics (e.g., child, adult, male, female) with aquatic sports. 'Cluster 3' (Fig. 5 - dark blue color) focuses on risks associated with surfing, mainly related with injuries. It also includes the concept of 'surf therapy' which may suggest publications related with health and well-being in contrast to the above-mentioned risks. 'Cluster 4' (Fig. 5 - yellow color) represents a clear focus on clinical aspects. 'Cluster 5' (Fig. 5 - purple color) indicates health risks (diseases). The small 'Cluster 6' (Fig. 5 - blue light color) refers to seasonality of the surfing activity.

3.3. Analysis of the activity

From the total number of publications selected ($n = 247$), 724 pieces of evidence were extracted and compiled. Its classification according to the dimensional focus (i.e., social, environmental, economic), showed a clear dominance of the social dimension (609 pieces of evidence, 84.1%) over the environmental (64 pieces, 8.8%) and economic dimensions (51 pieces, 7%) (Table 3). When exploring the pieces of evidence with respect to their effect (i.e., impact or benefit), there were significant differences between and within their dimensional focus (Chi-squared test $p < 0.001$ and $p < 0.05$ between the three dimensions after post hoc test) (Table 3). In addition, and when exploring the type of effects reported within each dimension, for the environmental and economic dimensions, the proportion of benefits (62.5% and 82.4%, respectively) was much higher than that of impacts (37.5% and 17.6%, respectively); while in the social dimension, the proportion of impacts (56.2%) was slightly higher than the benefits reported (43.8%).

Considering the effect and dimension, evidence pieces were classified in specific thematic groups (Table 4). This revealed that social benefits were mainly related to individual and collective *psychological benefits* that surf generates, such as quality of life improvement, general well-being, self-satisfaction or self-esteem (139 out of the 267 total social benefits). The increase in popularity of an area for surfing, and even its transformation in a surf tourism destination, is recorded in many publications as a catalyst for *socio-cultural benefits* for the local community (58). Other examples of social benefits include the *physical benefits* obtained from practicing the sport, benefits from *environmental activism and awareness* or *surfing site preservation* as well as from *safety* provision for surfers and beach users in general.

The principal impacts identified in the social dimension were related to *health hazards* (272 out of the total 342 social impacts), which included pieces of evidence related with common surfing injuries, gastrointestinal illness risks, accidents by drowning or collision with their own board, and carcinogenic risks due to sun exposure (Table 4). Other social impacts included *conflicts* and localism behaviors (e.g., towards tourist surfers), as

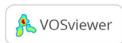
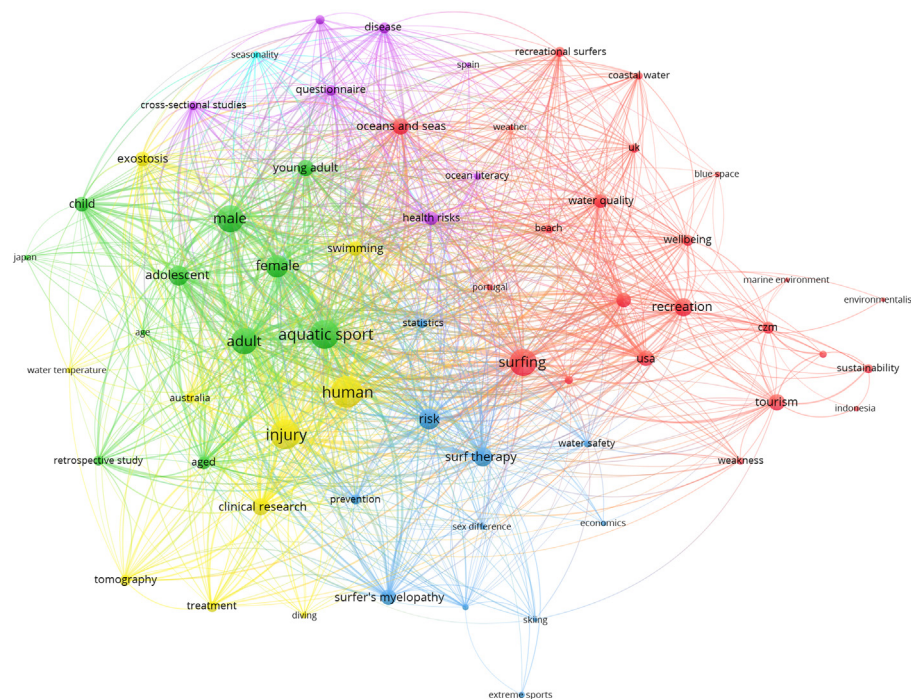


Fig. 5. Network map of the 260 keywords co-occurrence. The size of the nodes represents their 'occurrences' indicating that these keywords occur frequently in the literature. Lines are connecting the nodes based on the magnitude of their correlation (link strength).

Table 3

Comparison between dimensional focus and types of effects. Percentages presented in respect to the total amount of evidence (n = 724). The statistical test performed was Chi-squared test and post-hoc Fisher's test. Different letters (A, B, C) indicate significant differences (p < 0.05) between groups, after the corresponding post-hoc test.

	Dimensional focus						Statistical test	
	Economic		Environmental		Social		x ²	p-value
	n	%	n	%	n	%		
Benefit	42	5.8%	40	5.5%	267	36.8%	32.9	<0.001
Impact	9	1.2%	24	3.3%	342	47.2%		
Post-hoc test	A		B		C			

well as overcrowding, damage of cultural roots, or negative psychological and other effects due to surf tourism development.

The major environmental benefit was related to conserve and protect the *surfing space* (15 out of 40), which lead surfers to take care for beaches and its surroundings (Table 4). Also, *environmental awareness* (15 out of 40), which was associated to ocean literacy, e.g., through beach clean-up campaigns (Table 4). However, the opposite was found in other documents (i.e., *lack of environmental awareness*) and collated as social and environmental impacts. Another large group of pieces of evidence on environmental benefits was *local ecological knowledge* that surfers pose, and how this knowledge can contribute to coastal management plans.

For the economic dimension, most benefits were linked to *economic development* (27 out of 42), including cases such as the enhancement of regional economies or generation of employment opportunities (Table 4). However, some negative economic consequences were also found (n = 9), mainly related with surf tourism development. For example, the income inequality between surfing areas and adjacent areas where there is no surf impact.

Finally, the Sankey diagram showed that the main stakeholders and features affected by and/or benefited from the surfing activity are: (i) different sectors of the surfing community (individual surfers, novice surfers, professional surfers, recreational surfers, surfing community); (ii) specific age groups (children, adolescents, adults, elderly people); and vulnerable people (patients, vulnerable young and old people); (iii) people that do not practice the activity but are impacted/benefited by it due to close relationship/location with the surfing activity (i.e., local community, coastal stakeholders, other users of the sea, tourists) or by other reasons (society, scientific community); and (iv) features of the marine and coastal environment (Fig. 6).

Among people that practice the activity, specific age groups (e.g., children, adolescents, elderly people) and vulnerable people (e.g., patients, vulnerable young people) received mainly benefits from the surf practice (Fig. 6). However, regarding members of the surfing community (e.g., surfers, novice, professional and recreational surfers), most literature covered negative impacts. Among people that do not practice the activity, most pieces of evidence related to the benefits that surf generates, specifically to local communities where surfing activity occurs, with a lower proportion of impacts over benefits (Fig. 6). Other groups such as society at large, coastal stakeholders, or scientific community, also receive benefits but to a lesser extent. However, for tourists and other users of the sea, impacts were present in a higher degree than benefits (Fig. 6). Features such as marine and coastal ecosystems received both benefits and impacts from surfing activity.

4. Discussion

4.1. Research teams and topics in the surfing literature

According to the evidence collated in this research, the progress and evolution of topics showed a prominent diversification among the three periods identified, with a transition to multidisciplinary research in recent times, (e.g., Lazarow, 2007; Lazarow et al., 2008; Silva and Ferreira,

2013). One of the earliest topics surveyed and mentioned has been related to injuries (e.g., Erickson and Von Gemmingen, 1967; Allen et al., 1977). However, research topics that emerged in the last decade have been specially bonded to tourism, human health and well-being, among others (e.g., Martin and Assenov, 2012, 2014b; Caddick et al., 2015; Ponting and O'Brien, 2015). According to a recent analysis of the surfing activity (Pérez Gutiérrez and Cobo Corrales, 2020) medical science was the most represented area from 1967 to 2017, while fields such as economic sciences, history and psychology were more recent topics. Other authors, such as Valencia et al. (2020) highlighted the increasing number of publications about surf tourism over the last decade, which we also found in our review. This gradual expansion and diversification of surfing literature along the different periods can be due to different reasons. At the beginning of the 20th century, surfing began its expansion from the roots of Pacific cultures such as Polynesia, Hawaii and Peru to the rest of the world (Lazarow, 2007; Esparza, 2016). Since the 1960s, surf acquired a growing role in the film industry, magazines and social media (Johnson and Orbach, 1986; Martin and Assenov, 2012). The rapid spread of the sport generated many followers and crowds started going to the beach to play part in surfing. As shown in our review, standing out countries are United States, Australia, Brazil, and Portugal. In the 1980s, surf began to generate an economic impact along different countries; a case is Hawaii, which showed a significant impact of the activity to the economy and tourism industry (Johnson and Orbach, 1986; Lazarow, 2007; Martin and Assenov, 2012). Since the beginning of 21st century (until between 2010 and 2020), the number of publications increased, mainly due to online platforms. Some authors argue that this boom could be associated to the inclusion of surfing within the Tokyo 2020 Olympic Games program (Pérez Gutiérrez and Cobo Corrales, 2020; Valencia et al., 2020). Looking at our results, the number of publications increased overall, achieving a maximum in 2016 with 26 papers, which agrees with the results obtained by Pérez Gutiérrez and Cobo Corrales (2020).

In the 21st century, research with a multidisciplinary approach emerged, with diverse new issues related to practice of surf and its tourism character such as pollution (Laviolette, 2006) or management surfing breaks (i.e., coastline area where waves start to break due to the bottom morphology) and bathers' capacity (i.e., safe spatial distribution of bathers, including surfers) (Scarfe et al., 2009a,b; Basterretxea-Iribar et al., 2019). Likewise, this justifies why as surfing spreads to more countries, the research topics around the surfing activity diversify, as a response to the need of assessing the environmental, socio-cultural and economic pressures associated to it. Therefore, in countries with much more tradition of surfing, such as Indo-Pacific countries, USA, Australia or Portugal, research has progressed in different directions according to external requirements and country-specific capacities, opportunities and needs. The disparities between them in terms of priorities seem to be the basis of the different research focus in recent years, where countries such as USA or Australia were focusing on socio-economics, coastal management, human health and well-being, while other countries, such as Indonesia, Thailand or Papua New Guinea, focused mainly on topics such as tourism (Ponting and O'Brien, 2014). The latter is likely to be related to their self-promotion as international tourism destination, and the aim of recruiting foreign business and revenues (Buckley, 2002), which introduces a growing interest on how to manage the surf tourism and recreational capacity (Ponting et al., 2005; Ponting and O'Brien, 2015). All in all, the articles published in recent years have helped to improve the understanding of this recreational activity, including its environmental and social implications.

Our results confirm that although established research topics (e.g., injuries) have larger weight according to the number of publications, citations or collaborations between researchers, other emergent and innovative topics (e.g., human health and well-being) have acquired relative predominance due to its buoyant promotion in a narrow timeline. Collaborations between authors in this topic have been diverse within the period 1965–2021 (note that articles were retrieved in Scopus in March 2021 and the annual cycle for the last year was not completed). Throughout the co-authorship network map, it is possible to see a clear disconnection

Table 4

Classification of evidence based on common characteristics found within each dimension and each type of effect. Note that risks (*) are included as a subgroup of social impacts.

Effect	Dimension	Evidence group	Number
Economic	Benefit	Economic development	27
		Increases non-market value	6
	Impact	Local business development	9
		Income inequality	3
		Increase of prices	2
		Negative consequences of surf tourism development	3
Environmental	Benefit	Environmental externality	1
		Environmental awareness: environmental activism	6
		Environmental awareness: environmental engagement	3
		Environmental awareness: sustainable behavioral patterns	6
		Local ecological knowledge	8
	Impact	Conserve surfing space	15
		Scientific data collection	2
		Environmental impacts of surfing industry: burning of fuel	1
		Environmental impacts of surfing industry: surf products	2
		Environmental impacts of surf tourism: commercial industry	2
		Environmental impacts of surf tourism: impacts on flora and fauna	3
		Environmental impacts of surf tourism: increase of coastal urbanization	4
		Environmental impacts of surf tourism: increase of sewage and waste	5
		Environmental impacts of surf tourism: transport of material goods	1
		Environmental impacts of surf tourism: unsustainable behavioral patterns	7
		Lack of environmental awareness	2
		Social	Benefit
Collective psychological benefits and well-being: sense of belonging to nature, cooperation	4		
Collective psychological benefits and well-being: surfing group maintenance	5		
Individual psychological benefits and well-being: behaviour	11		
Individual psychological benefits and well-being: pleasure and joy	20		
Individual psychological benefits and well-being: quality of life, general well-being	44		
Individual psychological benefits and well-being: reduces mental health symptoms	16		
Individual psychological benefits and well-being: self-satisfaction and self-esteem	31		
Physical benefits: aerobic capacity	3		
Physical benefits: energy supplementation, lower risk of injuries	4		
Physical benefits: general well-being	2		
Physical benefits: risk consciousness	3		
Physical benefits: training	14		
Physical benefits: treatment of injuries or diseases	4		
Socio-Cultural benefits for local community: citizenship	4		
Socio-Cultural benefits for local community: community engagement	14		
Socio-Cultural benefits for local community: contact with other cultures	8		
Socio-Cultural benefits for local community: education	13		
Socio-Cultural benefits for local community: inclusion	4		
Socio-Cultural benefits for local community: infrastructure and services	7		
Socio-Cultural benefits for local community: leisure	2		
Socio-Cultural benefits for local community: NGO	1		
Socio-Cultural benefits for local community: surfing knowledge	6		
Environmental awareness: consultancy	1		
Environmental awareness: environmental activism	6		
Environmental awareness: environmental engagement	11		
Environmental awareness: NGO formation	1		
Surfing site preservation: aesthetics	3		
Surfing site preservation: engagement	5		
Surfing site preservation: identity	5		
Safety: surf rescue	7		
Impact	Conflicts between surfers and other users: access to surfing sites		1
	Conflicts between surfers and other users: crowding		20
	Conflicts between surfers and other users: local aggression towards tourists		5
	Conflicts between surfers and other users: surfing schools		2
	Damage cultural roots/Cultural costs of tourism		15
	Surf tourism development: lack of regulation		5
	Surf tourism development: overcrowding		4
	Accidents: drowning*		6
	Accidents: hit by something*		2
	Accidents: shark attacks*		2
	Carcinogenic risks: skin injuries*		7
	Risk of diseases: water quality*	22	
	Sport injuries: animals*	7	
	Sport injuries: contusions, lacerations, fractures*	141	
	Sport injuries: exostoses*	33	
Sport injuries: eyes injuries*	6		
Sport injuries: myelopathy*	24		
Sport injuries: others*	10		
Sport injuries: skin injuries*	4		
Sport injuries: Surfers' knots*	5		
Sport injuries: tumor*	3		

Table 4 (continued)

Effect	Dimension	Evidence group	Number
		Physical impacts: fluid loss, fatigue	3
		Psychological impacts: feelings of being addicted to the surfing activity	4
		Psychological impacts: feelings of excitement during and before surfing	7
		Psychological impacts: frustration due to surf tourism	1

between the different sub-topics and research groups. On one side, the sub-topic ‘injury’ presents much more connection than the other topics among the different research teams. Despite this, looking at the links between them, we have identified different working groups (Dimmick et al., 2013; Climstein et al., 2016; Furness et al., 2015; Simas et al., 2019). However, most recent topics (i.e., well-being and tourism) seem to be less connected to each other, as shown in Table 2, probably because still there is not a critical mass for international collaboration on these sub-topics. Still, publications on ‘human health and well-being’ topic have shown the most promising results in terms of number of citations in a narrow timeline.

There are several research teams that have carried out research independently (Wheaton, 2007; Martin and Assenov, 2012; Silva and Ferreira, 2013; Usher and Gómez, 2016; Wheaton et al., 2017). This lack of collaboration shows the immature state of studies’ integrity and interdisciplinarity. Although the number of authors, institutions and countries involved in surfing research and the number of publications have both increased, international collaboration between research groups are still scarce (Pérez Gutiérrez and Cobo Corrales, 2020). Some collaborations have been identified between USA and Australia, in terms of tourism (Valencia et al., 2020). Pérez Gutiérrez and Cobo Corrales (2020) consider that Australian institutions are most productive and highly collaborative, exemplifying the scientific knowledge transfer. Still, in our literature review we found that although the surfing activity is analyzed from multiple disciplines, the collaboration between them (i.e., interdisciplinary studies) is still scarce.

4.2. Analysis of the benefits and impacts of the activity

Many of the **social benefits** reported in the literature involved specific age groups and vulnerable people (i.e., adolescents, children, adults and elderly people), who may be psychologically benefited while doing surfing therapy (Britton and Foley, 2021). Some of these publications focused on children and adolescents with adverse childhood experiences, and for whom practicing surf resulted on improvements on symptoms of depression or anxiety, sleep quality, self-efficacy or social connectivity (Pereira et al., 2020). Physiological benefits of surf therapy have also been found for children with selected disabilities (e.g., autism spectrum disorder and down syndrome) such as reduction in total body and fat free mass and a substantial enhancement in bone mineral density (Clapham et al., 2020). Moreover, for patients with mental problems (major depressive disorder (MDD), posttraumatic stress disorder (PTSD) and Alzheimer’s disease (AD)), it has been proved that water-based activities, such as surfing, incurs in greater improvements in depressive symptoms and can promote well-being through the concept of ‘blue gym’ (White et al., 2016). This ‘blue gym’ provides strength training, balance rehabilitation as well as cognitive performance, which may increase the maintenance of autonomy. Also, it may work as group supportive therapy (Fleischmann et al., 2011; Rogers et al., 2014; Caddick et al., 2015; Pérez et al., 2017; Walter et al., 2019). Other social benefits identified involved local communities, which may profit from surf tourism in the form of socio-cultural benefits,

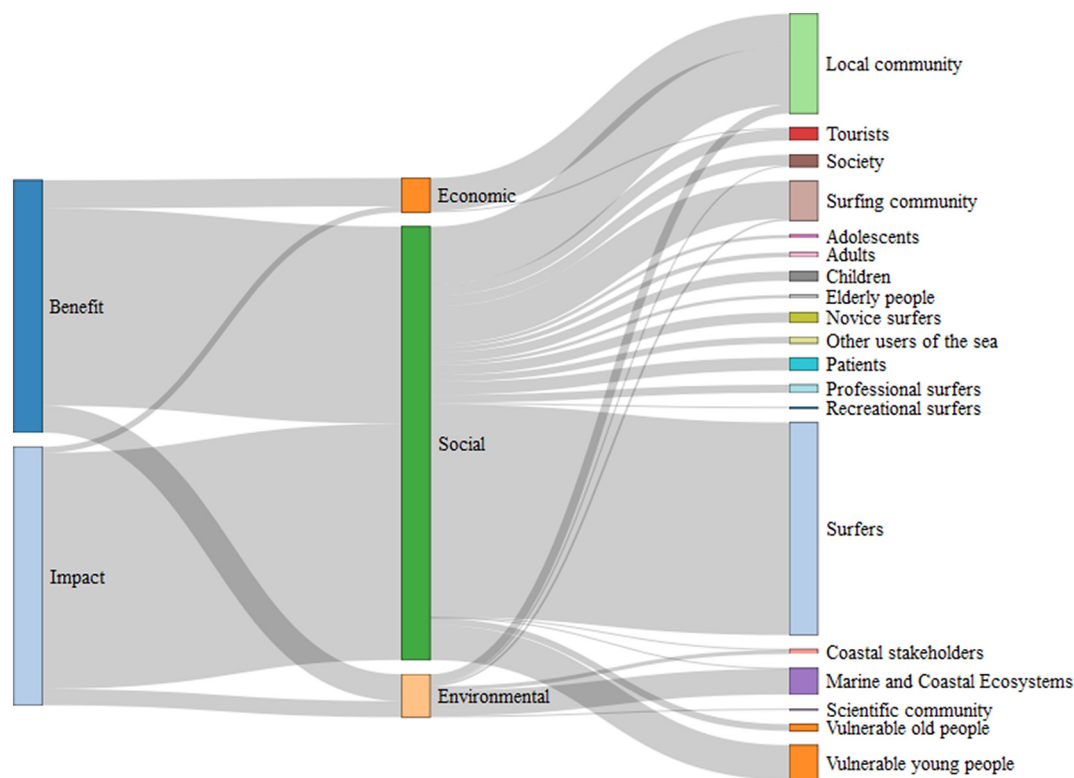


Fig. 6. Flow diagram (Sankey diagram) divided in three nodes related to type of effect, dimensional focus, and stakeholder or features (from left to right). The width of connections or flows between nodes is proportional to the number of evidence found in the literature review.

e.g., language acquisition, increase in the knowledge about the world outside (Towner and Orams, 2016; Towner and Milne, 2017; Towner and Davies, 2019) or even involve surfing community coming up with a kind of community engagement which refers to ‘generating obligation to safeguard and care for the environment for future generations’ (Aramoana Waiti and Awatere, 2019) or ‘providing a local surfing space as a community resource’ (Beaumont and Brown, 2016). Also, surf can benefit the local community and its environment in the form of promotion actions of citizen science and awareness, contributing to the public water safety and site awareness, enhancing community activities for village beautification, or organizing campaigns and community events for beach cleaning (Martin and Assenov, 2014a,b; Kim and Kwon, 2020).

By contrast, surf can create social impacts which mainly affect surfers and local communities. On one hand, different members of surfing community (i.e., individual surfers, novice surfers, professional surfers, and recreational surfers) suffer from injuries and diseases experimented while surfing. Hence, many of the reviewed publications were medical reports, specially related to exostoses of the external auditory canal (Seftel, 1977), as well as ‘surfer’s myelopathy’, which is a non-traumatic spinal cord injury that affects inexperienced surfers (Thompson et al., 2004) or much more common injuries associated to fractures, lacerations, muscular, joint, skin origin, etc. (Furness et al., 2014; Dimmick et al., 2019; Rogich et al., 2020). On the other hand, local communities experienced conflicts with non-local surfers and tourists, resulting on cultural damage by surf tourism, due to global cultural gentrification and over-crowding (Hill and Abbott, 2009; Doering, 2018), may even experience local aggressions towards non-local surfers generating a ‘local hierarchy’ known as *surf localism* (Anderson, 2013; Beaumont and Brown, 2016). Other cultural costs of tourism were related to foreigners’ bad behaviors and influence, which can contribute to the degradation of local culture (Krause, 2012; Towner and Orams, 2016; Towner and Davies, 2019).

Regarding the **economic dimension**, local communities obtain benefits from surf tourism which, in several cases, have been an advantage for them as a tool for revitalizing the local economy or enhancing regional economy (Poizat-Newcomb, 1999a; Poizat-Newcomb, 1999b; Lazarow, 2007; Lopes and Bicudo, 2017; Kim and Kwon, 2020), as well as contributing to the local business development ‘increasing the fixation and employability of the local population and promoting the improvement of local infrastructures and services’ as recognized by Machado et al. (2018). However, the popularization of a site for surfing can generate impacts such as increases in local prices (Krause, 2012). Some authors claim that this phenomenon generates unequal income distribution and reinforcement of urban–rural disparities (Towner and Orams, 2016; Doering, 2018). In general, it was found that surf tourism does not contribute to the improvement of the quality of life of the population (Valencia et al., 2020).

Lastly, regarding to **environmental dimension**, marine and coastal ecosystems can be positively affected from the participation of surfers in different collateral activities, becoming role models for citizens. For example, surfers can contribute to coastal and marine management being a tool for understanding the environmental resources and supply locally relevant environmental data to inform resource management (Reineman, 2016), or projects related with sea-level rise impacts (Reineman et al., 2017). Other benefits include the involvement of surfing communities in campaigns against pollution of the seas (Surfers against sewage, 1996; Holland-Smith et al., 2013; Surfrider Foundation Europe, 2021), which enhances the environmental activism (Kim and Kwon, 2020) and promotes sustainable surfing environmental practices, as well as the protection and safeguarding of natural resources (Machado et al., 2018). Indeed, famous surfers have become referents in the fight against marine litter, even creating Non-Governmental Organizations, such as *Surfers Against Sewage* (Surfers Against Sewage, 2021). However, surfing can also generate environmental impacts. According to Portman and Zhulpa Camporesi (2020), frequent surfers may have fewer pro-environmental behaviors and unsustainable lifestyles in their daily life, in terms of recycling, plastic use, organic shopping and environmental actions. Surfing has also been associated with generation of negative impacts to the marine and coastal

ecosystems, such as rubbish and solid waste production, impacts on local flora and fauna due to trampling over sand dunes or encroachment on bird nesting areas (Martin and Assenov, 2014a,b; Towner and Orams, 2016; Towner and Milne, 2017).

4.3. Research limitations

This study has some limitations that could have biased the results, to some extent. First, the review excluded manuscripts not written in English and grey literature, limiting the findings only to that language. Second, the searching terms could limit the final results (e.g. ‘surfing’ is used in different contexts, such as ‘web surfing’), however, this bias was minimized by a careful revision of all papers, removing those not related to the topic investigated. Third, disentangling benefits and impacts of the activity was difficult in some cases, due to the absence of clear indications in the papers collated. Despite these limitations, the findings could be considered as representative of the activity and representative of the dimensions investigated here.

4.4. The activity in a wider context

This research integrates the current knowledge around the benefits and impacts associated with surfing, providing valuable information for the future management of the activity. The pieces of evidence collated confirmed that surf activity has brightened to several and relevant attributes which avail its relevance as a benefit from CES: it is a recreational activity with socio-cultural, environmental and economic relevance (i.e., value in the ecosystem services cascade) and can positively contribute to human well-being (i.e., ‘benefit’ in the ecosystem services cascade) (Potschin-Young and Haines-Young, 2011) if carried out carefully.

It has become a relevant economic activity dependent on environmental conditions, and therefore, its management should follow (eco)tourism principles: “responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education” (TIES, 2015).

Due to the multiple disciplines affecting and affected by the activity, our results emphasize the need for closer collaboration between different research disciplines, moving to interdisciplinary studies, to advance towards a more sustainable management of the surfing activity in the near future, reducing/minimizing the impacts identified in this research.

The research undertaken here is closely related to the objectives of several UN SDGs Surf can be used to promote SDGs and achieve their targets in different ways: (i) it has been seen that some locations and countries have an important economic sector linked to surf, which can contribute to alleviate poverty (SDG1) in some developing countries; (ii) ensuring healthy lives and promoting well-being for all at all ages (SDG3) is closely related with the practice of this sport, and are clear physical and mental benefits from a nature-based recreational activity; and (iii) conserving and sustainably using the oceans (SDG14), using this activity, and surfers, to promote the awareness about ocean problems (e.g. litter, pollution), increase the protection of areas to practice nature-based recreational activities, contributing to the increase of benefits to small island developing states and least developed countries from the sustainable use of marine resources, such as tourism.

In this context, the UN ‘Decade of Ocean Science for a Sustainable Development’ (Ryabinin et al., 2019) could promote studies associated to healthy oceans and human welfare benefits, which are closely related (Borja et al., 2020). Understanding recreational marine-based activities could improve coastal and marine management plans and efforts, e.g. through the maritime spatial planning activity, taking into account the activity and the areas of recreation practice to reserve space for a sustainable use of the ocean by human activities (Ehler and Douvère, 2009). The need to guarantee the sustainability of recreational marine activities, such as surfing, and the analysis of these activities as benefits from CES, should be addressed under an interdisciplinary approach, embedding social, environmental and economic dimensions (Martin and Assenov, 2014a).

5. Conclusions

The increasing social interest for surfing came with an increase in the scientific interest, and an expansion in the number of publications and topics covered in the literature. Surfing activity generates impacts and benefits in social, economic and environmental spheres, with consequences for a diverse group of stakeholders beyond surfers. To advance towards a sustainable management of the surfing activity, and the environmental context where it takes place, decision makers should consider the evidence collected in the scientific literature in the last decades. An interdisciplinary approach should be adopted to guarantee that all the stakeholders impacted by/benefited from the activity participate in the design and adoption of management measures to mitigate the negative impacts of surfing and maximize its benefits.

CRedit authorship contribution statement

S. Pouso, M.C. Uyarra and A. Borja, developed the research idea; C. Román collated and structured all the information; all authors revised the selected papers; C. Román undertook the analyses and made figures and tables; all authors discussed the results and decided on contents; C. Román wrote the first draft and all authors contributed equally to the final manuscript, in successive interactions.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was a collaboration between Vigo University and AZTI. This is contribution number 1092 from AZTI's Marine Research, Basque Research and Technology Alliance (BRTA). Two reviewers and the editor have provided useful comments, which have improved the first version of this manuscript. The icons used in the graphical abstract were obtained from Flaticon (<https://www.flaticon.es/>). Funding for open access charge: Universidade de Vigo/CISUG.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.scitotenv.2022.154122>.

References

- Adams, B.B., 2002. Dermatologic disorders of the athlete. *Sports Med.* 32, 309–321.
- Allen, R.H., Eiseman, B., Straehley, C.J., Orloff, B.G., 1977. Surfing injuries at waikiki. *JAMA J. Am. Med. Assoc.* 237, 668–670.
- Anderson, J., 2013. Cathedrals of the surf zone: regulating access to a space of spirituality. *Soc. Cult. Geogr.* 14, 954–972.
- Aramoana Waiti, J.T., Awatere, S., 2019. Kaihekenaru: Maori surfers' and a sense of place. *J. Coast. Res.* 87, 35–43.
- Aronson, J., Blignaut, J.N., Milton, S.J., Le Maitre, D., Esler, K.J., Limouzin, A., et al., 2010. Are socioeconomic benefits of restoration adequately quantified? A meta-analysis of recent papers (2000–2008) in restoration ecology and 12 other scientific journals. *Restor. Ecol.* 18, 143–154.
- Barbier, E.B., 2017. Marine ecosystem services. *Curr. Biol.* 27, R507–R510.
- Barbieri, C., Sotomayor, S., 2013. Surf travel behavior and destination preferences: an application of the serious leisure inventory and measure. *Tour. Manag.* 35, 111–121.
- Basterretxea-Iribar, I., Sotés, I., Maruri, M.D.L.M., 2019. Managing bathers' capacity at overcrowded beaches: a case on the Spanish North Atlantic coast. *Tour. Manag.* 71, 453–465.
- Beaumont, E., Brown, D., 2016. 'It's not something I'm proud of but it's ... just how I feel': local surfer perspectives of localism. *Leis. Stud.* 35, 278–295.
- Borja, A., Elliott, M., 2021. In: Sheppard, C. (Ed.), Chapter Three - From an economic crisis to a pandemic crisis: The need for accurate marine monitoring data to take informed management decisions. *Advances in Marine Biology*. Academic Press, pp. 79–114 Available at: <https://www.sciencedirect.com/science/article/pii/S0065288121000213>.
- Borja, A., White, M.P., Berdalet, E., Bock, N., Eatock, C., Kristensen, P., et al., 2020. Moving toward an agenda on ocean health and human health in Europe. *Front. Mar. Sci.* 7. <https://doi.org/10.3389/fmars.2020.00037>.
- Britton, E., Foley, R., 2021. Sensing water: uncovering health and well-being in the sea and surf. *J. Sport Soc. Issues* 45, 60–87.
- Brymer, E., Oades, L.G., 2009. Extreme sports: a positive transformation in courage and humility. *J. Humanist. Psychol.* 49, 114–126.
- Buckley, R., 2002. Surf tourism and sustainable development in Indo-Pacific islands. I. The industry and the islands. *J. Sustain. Tour.* 10, 405–424.
- Caddick, N., Smith, B., Phoenix, C., 2015. The effects of surfing and the natural environment on the well-being of combat veterans. *Qual. Health Res.* 25, 76–86.
- Chalastani, V.I., Tsoukala, V.K., Coccossis, H., Duarte, C.M., 2021. A bibliometric assessment of progress in marine spatial planning. *Mar. Policy* 127. <https://doi.org/10.1016/j.marpol.2020.104329>.
- Clapham, E.D., Lamont, L.S., Shim, M., Lateef, S., Armitano, C.N., 2020. Effectiveness of surf therapy for children with disabilities. *Disabil. Health J.* 13. <https://doi.org/10.1016/j.dhjo.2019.100828>.
- Claudet, J., Bopp, L., Cheung, W.W.L., Devillers, R., Escobar-Briones, E., Haugan, P., et al., 2020. A roadmap for using the UN decade of ocean science for sustainable development in support of science, policy, and action. *One Earth* 2, 34–42.
- Climstein, M., Furness, J., Hing, W., Walsh, J., 2016. Lifetime prevalence of non-melanoma and melanoma skin cancer in Australian recreational and competitive surfers. *Photodermatol. Photoimmunol. Photomed.* 32, 207–213.
- Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., et al., 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, 253–260.
- Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., et al., 2017. Twenty years of ecosystem services: how far have we come and how far do we still need to go? *Ecosyst. Serv.* 28, 1–16.
- Coventry, P.A., Brown, Jennifer, V.E., Pervin, J., Brabyn, S., Pateman, R., Breedvelt, J., et al., 2021. Nature-based outdoor activities for mental and physical health: systematic review and meta-analysis. *SSM - Population Health* 16, 100934.
- Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R.T., Molnár, Z., et al., 2018. Assessing nature's contributions to people. *Science* 359, 270–272.
- Dimmick, S., Brazier, D., Wilson, P., Anderson, S.E., 2013. Injuries of the spine sustained whilst surfboard riding. *Emerg. Radiol.* 20, 25–31.
- Dimmick, S., Gillett, M., Buchan, C., Sheehan, P., Franks, M., Ratchford, A., et al., 2019. Prospective analysis of surfing and bodyboard injuries. *Trauma (United Kingdom)* 21, 113–120.
- Doering, A., 2018. Mobilising stoke: a genealogy of surf tourism development in Miyazaki, Japan. *Tourism Planning and Development* 15, pp. 68–81.
- Ehler, C., Douvère, F., 2009. Marine Spatial Planning: a step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No. 53, ICAM Dossier No. 6. UNESCO, Paris 99 p.
- Erickson, J.G., Von Gemmingen, G.R., 1967. Surfer's nodules and other complications of surfboarding. 201, 134–136.
- España, D., 2016. Towards a theory of surfing expansion: the beginnings of surfing in Spain as a case study. *RICYDE: Revista Internacional de Ciencias del Deporte* 12, pp. 199–215.
- Fleischmann, D., Michalewicz, B., Stedje-Larsen, E., Neff, J., Murphy, J., Browning, K., et al., 2011. Surf medicine: surfing as a means of therapy for combat-related polytrauma. *J. Prosthetics Orthotics* 23, 27–29.
- Furness, J., Hing, W., Abbott, A., Walsh, J., Sheppard, J.M., Climstein, M., 2014. Retrospective analysis of chronic injuries in recreational and competitive surfers: injury location, type, and mechanism. *Int. J. Aquat. Res. Educ.* 8, 277–287.
- Furness, J., Hing, W., Walsh, J., Abbott, A., Sheppard, J.M., Climstein, M., 2015. Acute injuries in recreational and competitive surfers: incidence, severity, location, type, and mechanism. *Am. J. Sports Med.* 43, 1246–1254.
- Gascon, M., Zijlema, W., Vert, C., White, M.P., Nieuwenhuijsen, M.J., 2017. Outdoor blue spaces, human health and well-being: a systematic review of quantitative studies. *Int. J. Hyg. Environ. Health* 220, 1207–1221.
- Haines-Young, R., Potschin-Young, M., 2018. Revision of the common international classification for ecosystem services (CICES V5. 1): a policy brief. *One Ecosyst.* 3, e27108.
- Hill, L.L., Abbott, J.A., 2009. Surfacing tension: toward a political ecological critique of surfing representations. *Geogr. Compass* 3, 275–296.
- Holland-Smith, D., Love, A., Lorimer, R., 2013. British surfers and their attitudes and values toward the environment. *Ecopsychology* 5, 103–109.
- Irvine, K., Warber, S., Devine-Wright, P., Gaston, K., 2013. Understanding urban green space as a health resource: a qualitative comparison of visit motivation and derived effects among park users in Sheffield, UK. *Int. J. Environ. Res. Public Health* 10, 417–442.
- Johnson, J.C., Orbach, M.K., 1986. The role of cultural context in the development of low-capital ocean leisure activities. *Leis. Sci.* 8, 319–339.
- Kim, H., Kwon, S.-Y., 2020. Working for a sustainable surfing community: becoming a local surfer at a new home destination. *Sustainability (Switzerland)* 12. <https://doi.org/10.3390/SU12176865>.
- Kosanic, A., Petzold, J., 2020. A systematic review of cultural ecosystem services and human wellbeing. *Ecosyst. Serv.* 45, 101168. <https://doi.org/10.1016/j.ecoser.2020.101168>.
- Krause, S.M., 2012. Pilgrimage to the Playas: surf tourism in Costa Rica. *Anthropol. Action* 19, 37–48.
- Laviolette, P., 2006. Green and extreme: free-flowing through seascape and sewer. *Worldviews: environment. Culture, Religion* 10, 178–204.
- Lazarow, N., 2007. The value of coastal recreational resources: a case study approach to examine the value of recreational surfing to specific locales. *J. Coast. Res.* 12–20.
- Lazarow, N., Miller, M.L., Blackwell, B., 2008. The value of recreational surfing to society. *Tour. Mar. Environ.* 5, 145–158.
- Lis, A., Sudolska, A., Tomanek, M., 2020. Mapping research on sustainable supply-chain management. *Sustainability* 12. <https://doi.org/10.3390/su12103987>.

- Lopes, J.T., Bicudo, P., 2017. Surfing tourism plan: Madeira Island case study. *Eur. J. Tourism Res.* 16, 45–56.
- Machado, V., Carrasco, P., Contreiras, J.P., Duarte, A.P., Gouveia, D., 2018. Governing locally for sustainability: public and private organizations' perspective in surf tourism at Aljezur, Costa Vicentina, Portugal. *Tourism Plann. Dev.* 15, 692–704.
- Martin, S.A., Assenov, I., 2012. The genesis of a new body of sport tourism literature: a systematic review of surf tourism research (1997–2011). *J. Sport Tourism* 17, 257–287.
- Martin, S.A., Assenov, I., 2014a. Developing a surf resource sustainability index as a global model for Surf Beach conservation and tourism research. *Asia Pac. J. Tourism Res.* 19, 760–792.
- Martin, S.A., Assenov, I., 2014b. Investigating the importance of surf resource sustainability indicators: stakeholder perspectives for surf tourism planning and development. *Tourism Plann. Dev.* 11, 127–148.
- Milcu, A.I., Hanspach, J., Abson, D., Fischer, J., 2013. Cultural ecosystem services: a literature review and prospects for future research. *Ecol. Soc.* 18. <https://doi.org/10.5751/ES-05790-180344>.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., 2010. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int. J. Surg.* 8, 336–341.
- Oh, B., Lee, K.J., Zaslowski, C., Yeung, A., Rosenthal, D., Larkey, L., et al., 2017. Health and well-being benefits of spending time in forests: systematic review. *Environ. Health Prev. Med.* 22. <https://doi.org/10.1186/s12199-017-0677-9>.
- Orams, M.B., Towner, N., 2013. Riding the wave: history, definitions, and a proposed typology of surf-riding tourism. *Tour. Mar. Environ.* 8, 173–188.
- Pereira, A.I., Ferreira, C., Oliveira, M., Evangelista, E.S., Ferreira, J., Roberto, M.S., et al., 2020. Effectiveness of a combined surf and psychological preventive intervention with children and adolescents in residential childcare: a randomized controlled trial. *Revista de Psicologia Clínica con Niños y Adolescentes* 7, 22–31.
- Pérez Gutiérrez, M., Cobo Corrales, C., 2020. Surfing scientific output indexed in the Web of Science and Scopus (1967–2017). Available at: <http://hdl.handle.net/10902/18555>.
- Pérez, M.R., Rodríguez, C.R., González, J.G.P., 2017. Narrative review and development of an intervention program for reducing Alzheimer's effects through the practice of surf in older people. *Retos* 106–110.
- Poizat-Newcomb, S., 1999a. The genesis of a sports tourism activity-surfing (Part i). *J. Sport Tourism* 5. <https://doi.org/10.1080/10295399908718671>.
- Poizat-Newcomb, S., 1999b. The genesis of a sports tourism activity-surfing (Part ii). *J. Sport Tourism* 5. <https://doi.org/10.1080/10295399908718672>.
- Ponting, J., McDonald, M., Wearing, S., 2005. De-constructing wonderland: surfing tourism in the Mentawai Islands, Indonesia. *Loisir Soc.* 28, 141–162.
- Ponting, J., O'Brien, D., 2014. Liberalizing nirvana: an analysis of the consequences of common pool resource deregulation for the sustainability of Fiji's surf tourism industry. *J. Sustain. Tour.* 22, 384–402.
- Ponting, J., O'Brien, D., 2015. Regulating "Nirvana": sustainable surf tourism in a climate of increasing regulation. *Sport Manag. Rev.* 18, 99–110.
- Portman, M.E., Zhulpa Camporesi, A., 2020. Attitudes and behaviours of marine recreationists towards conservation and environmental protection: a case study of Tel Aviv, Israel. *Mar. Policy* 122. <https://doi.org/10.1016/j.marpol.2020.104133>.
- Potschin-Young, M., Haines-Young, R., 2011. Ecosystem services. *Prog. Phys. Geogr.* 35, 575–594.
- Pouso, S., Borja, Á., Fleming, L.E., Gómez-Baggethun, E., White, M.P., Uyarra, M.C., 2021. Contact with blue-green spaces during the COVID-19 pandemic lockdown beneficial for mental health. *Sci. Total Environ.* 756, 143984. <https://doi.org/10.1016/j.scitotenv.2020.143984>.
- Rees, S.E., Rodwell, L.D., Attrill, M.J., Austen, M.C., Mangi, S.C., 2010. The value of marine biodiversity to the leisure and recreation industry and its application to marine spatial planning. *Mar. Policy* 34, 868–875.
- Reineman, D.R., 2016. The utility of surfers' wave knowledge for coastal management. *Mar. Policy* 67, 139–147.
- Reineman, D.R., Thomas, L.N., Caldwell, M.R., 2017. Using local knowledge to project sea level rise impacts on wave resources in California. *Ocean Coast. Manag.* 138, 181–191.
- Rocher, M., Silva, B., Cruz, G., Bentes, R., Lloret, J., Inglés, E., 2020. Benefits of outdoor sports in blue spaces. The case of school nautical activities in Viana Do Castelo. *Int. J. Environ. Res. Public Health* 17, 1–14.
- Rodrigues Garcia, J., Conides, A.J., Rodriguez Rivero, S., Raicevich, S., Pita, P., Kleisner, K.M., et al., 2017. Marine and coastal cultural ecosystem services: knowledge gaps and research priorities. *One Ecosyst.* 2. <https://doi.org/10.3897/oneco.2.e12290>.
- Rogers, C.M., Mallinson, T., Peppers, D., 2014. High-intensity sports for posttraumatic stress disorder and depression: feasibility study of ocean therapy with veterans of operation enduring freedom and operation Iraqi freedom. *Am. J. Occup. Ther.* 68, 395–404.
- Rogich, J.J., Kim, R.Y., Chang, S., Kaneshige, J., Dao, L., 2020. Pelvic ring fracture during a professional surfing event at the banzai pipeline. *Wilderness Environ. Med.* 31, 91–96.
- Rosato, P.F., Caputo, A., Valente, D., Pizzi, S., 2021. 2030 agenda and sustainable business models in tourism: a bibliometric analysis. *Ecol. Indic.* 121, 106978. <https://doi.org/10.1016/j.ecolind.2020.106978>.
- Ryabinin, V., Barbière, J., Haugan, P., Kullenberg, G., Smith, N., McLean, C., et al., 2019. The UN decade of ocean science for sustainable development. *Front. Mar. Sci.* 6. <https://doi.org/10.3389/fmars.2019.00470>.
- Scarfe, B.E., Healy, T.R., Rennie, H.G., Mead, S.T., 2009. Sustainable management of surfing breaks: case studies and recommendations. *J. Coast. Res.* 25, 684–703.
- Scarfe, B.E., Healy, T.R., Rennie, H.G., 2009. Research-based surfing literature for coastal management and the science of surfing: a review. *J. Coast. Res.* 25, 539–557.
- Seftel, D.M., 1977. Ear canal hyperostosis: surfer's ear. An improved surgical technique. *Arch. Otolaryngol.* 103, 58–60.
- Shan, G., Gerstenberger, S., 2017. Fisher's exact approach for post hoc analysis of a chi-squared test. *PLoS ONE* 12, e0188709. <https://doi.org/10.1371/journal.pone.0188709>.
- Silva, S.F., Ferreira, J.C., 2013. Beach carrying capacity: the physical and social analysis at Costa de Caparica, Portugal. *J. Coast. Res.* 1039–1044.
- Simas, V., Remnant, D., Furness, J., Bacon, C.J., Moran, R.W., Hing, W.A., et al., 2019. Lifetime prevalence of exostoses in New Zealand surfers. *J. Primary Health Care* 11, 47–53.
- Surfer Today, 2018. How many surfers are there in the world? Surfer Today. Available at: <https://www.surfertoday.com/surfing/how-many-surfers-are-there-in-the-world>.
- Surfers against sewage, 1996. *Environmental Health Perspectives*. 104, pp. 684–685. <https://doi.org/10.2307/3433205>.
- Surfers Against Sewage, 2021. Surfers Against Sewage. Available at: <https://www.sas.org.uk/>.
- Surfrider Foundation Europe, 2021. CURL: analyser l'exposition des surfeurs aux pollutions chimiques de l'Océan. Available at: <https://surfrider.eu/nos-missions/qualite-eau-sante-usagers/curl-analyser-l'exposition-surfeurs-aux-pollutions-chimiques-locean-70198.html>.
- The International Ecotourism Society (TIES), 2015. TIES Announces Ecotourism Principles Revision. Available at: <https://ecotourism.org/news/ties-announces-ecotourism-principles-revision/>. (Accessed 29 November 2021).
- Thompson, T.P., Pearce, J., Chang, G., Madamba, J., 2004. Surfer's myelopathy. *Spine* 29, E353–E356.
- Towner, N., Davies, S., 2019. Surfing tourism and community in Indonesia. *J. Tour. Cult. Chang.* 17, 642–661.
- Towner, N., Milne, S., 2017. Sustainable surfing tourism development in the Mentawai Islands, Indonesia: local stakeholder perspectives. *Tourism Plann. Dev.* 14, 503–526.
- Towner, N., Orams, M., 2016. Perceptions of surfing tourism operators regarding sustainable tourism development in the Mentawai Islands, Indonesia. *Asia Pac. J. Tourism Res.* 21, 1258–1273.
- UN World Tourism Organization, 2005. Making Tourism More Sustainable - A Guide for Policy Makers. in, 11–12. Available at: <https://www.e-unwto.org/doi/book/10.18111/9789284408214>. (Accessed 9 September 2021).
- United Nations, 2015. Transforming our world: The 2030 agenda for sustainable development. United Nations, Department of Economic and Social Affairs, New York Available at: <https://sdgs.un.org/publications/transforming-our-world-2030-agenda-sustainable-development-17981>.
- Usher, L.E., Gómez, E., 2016. Surf localism in Costa Rica: exploring territoriality among costan Rican and foreign resident surfers. *J. Sport Tourism* 20, 195–216.
- Valencia, L., García, M.O., del Carmen Serrano Barquín, R., 2020. Surf tourism: a review of new lines and topics of research (2012–2018). *Investigaciones Turísticas* 215–238.
- van Eck, N.J., Waltman, L., 2014. Visualizing bibliometric networks. In: Ding, Y., Rousseau, R., Wolfram, D. (Eds.), *Measuring Scholarly Impact: Methods and Practice*. Springer International Publishing, Cham, pp. 285–320 https://doi.org/10.1007/978-3-319-10377-8_13.
- Walter, K.H., Otis, N.P., Glassman, L.H., Ray, T.N., Michalewicz-Kragh, B., Kobayashi Elliott, K.T., et al., 2019. Comparison of surf and hike therapy for active duty service members with major depressive disorder: study protocol for a randomized controlled trial of novel interventions in a naturalistic setting. *Contemp. Clin. Trials Commun.* 16. <https://doi.org/10.1016/j.conctc.2019.100435>.
- Wang, B., Zhang, Q., Cui, F., 2021. Scientific research on ecosystem services and human well-being: a bibliometric analysis. *Ecol. Indic.* 125. <https://doi.org/10.1016/j.ecolind.2021.107449>.
- Wheaton, B., 2007. Identity, politics, and the beach: environmental activism in surfers against sewage. *Leis. Stud.* 26, 279–302.
- Wheaton, B., Roy, G., Olive, R., 2017. Exploring critical alternatives for youth development through lifestyle sport: surfing and community development in aotearoa/New Zealand. *Sustainability (Switzerland)* 9. <https://doi.org/10.3390/su9122298>.
- White, M.P., Alcock, I., Grellier, J., Wheeler, B.W., Hartig, T., Warber, S.L., et al., 2019. Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Sci. Rep.* 9, 7730. <https://doi.org/10.1038/s41598-019-44097-3>.
- White, M.P., Pahl, S., Wheeler, B.W., Fleming, L.E.F., Depledge, M.H., 2016. The 'Blue Gym': what can blue space do for you and what can you do for blue space? *J. Mar. Biol. Assoc. U. K.* 96, 5–12.
- White, M.P., Wheeler, B.W., Herbert, S., Alcock, I., Depledge, M.H., 2014. Coastal proximity and physical activity: is the coast an under-appreciated public health resource? *Prev. Med.* 69, 135–140.
- White, M., Smith, A., Humphries, K., Pahl, S., Snelling, D., Depledge, M., 2010. Blue space: the importance of water for preference, affect, and restorativeness ratings of natural and built scenes. *J. Environ. Psychol.* 30, 482–493.
- Wood, S.A., Guerry, A.D., Silver, J.M., Lacayo, M., 2013. Using social media to quantify nature-based tourism and recreation. *Sci. Rep.* 3. <https://doi.org/10.1038/srep02976>.
- Wyles, K.J., Pahl, S., Thompson, R.C., 2014. Perceived risks and benefits of recreational visits to the marine environment: integrating impacts on the environment and impacts on the visitor. *Ocean Coast. Manag.* 88, 53–63.