

Exploring Sustainable Dive Tourism: An Empirical Study of the Profile and Environmental Awareness Among South African Dive Tourists

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Abstract

The rapid expansion of dive tourism, driven by a desire to explore pristine locations before they deteriorate, has led to increased habitat alteration and biodiversity loss. Understanding the characteristics and environmental behaviour of diving tourists is essential for promoting the sustainability of diving destinations. This research investigates dive tourists' profiles and environmental knowledge at KwaZulu-Natal, South Africa dive sites. The study was conducted with a sample size of 242 dive tourists from an estimated population of 560. Data were collected through an online survey due to COVID-19 restrictions, focusing on demographic profiles, environmental behaviours, and perceptions of environmental impacts among dive tourists. Analysis using SPSS revealed that most dive tourists are young to middle-aged adults, predominantly white, with a high level of education and employment status, indicating significant disposable income. The key findings show a strong preference for Aliwal as a diving location, potentially leading to environmental stress due to high visitation. Although most divers know ethical and ecological practices, there is a gap in awareness about specific environmental impacts, highlighting the need for enhanced educational initiatives. The study highlights the importance of consistent briefing on environmental issues by dive operators and the potential of leveraging digital platforms for environmental education. The research further informs the necessity for sustainable dive practices and effective management strategies to preserve marine ecosystems.

Keywords

Dive Tourism

Environmental Behaviour

Sustainability

Demographic Profiles

Environmental Education

1. Introduction

Dive tourism, a specialised segment of marine-based tourism focused on underwater recreational activities such as scuba diving and snorkelling, has become a significant component of global tourism, attracting divers seeking unique underwater experiences in diverse destinations worldwide (Forrest et al., 2023). Its exponential growth over recent decades has positioned it as a major contributor to the global tourism industry and coastal economies, driven by the appeal of exploring vibrant coral reefs, encountering diverse marine life, and immersing oneself in the tranquillity of the underwater spaces (Forrest et al., 2023). Economically, dive tourism significantly contributes to local economies, particularly in regions with unique marine life, generating substantial revenue and employment opportunities (Nababan, 2023; Schuhbauer et al., 2023). It generates between 8.5 and 20.4 billion USD annually, supports up to 124,000 jobs globally, and contributes at least 4 billion USD annually, with over 150 million USD benefiting local communities in Southeast Asia alone (Schuhbauer et al., 2023; Nababan, 2023).

Environmentally, dive tourism is a double-edged sword, offering opportunities for conservation awareness but introducing potential threats to fragile marine environments through physical damage, pollution, and disturbance of marine life (Lamb et al., 2014). The rapid expansion of dive tourism, driven by a desire to explore pristine locations before they deteriorate, has led to increased habitat alteration and biodiversity loss (Cavallini et al., 2023; Firth et al., 2023; Forrest et al., 2023). Divers' physical presence directly damages coral reefs through contact (Solihin et al., 2020; Hammerton, 2018), while activities such as boat transfers and anchoring introduce noise, chemical pollution, coastal development, light, and plastic pollution (Firth et al., 2023). Small island states are particularly vulnerable to climate change and ocean dynamics, which pose serious risks to dive sites (Azmi, 2021). The marine and coastal tourism sector, having witnessed exponential growth over the past two decades, is associated with extensive environmental degradation, including pollution, habitat destruction, and disturbance of marine life (Lamb et al., 2014).

Understanding the characteristics and motivations of dive tourists is crucial for adapting tourism products, conservation efforts, and marketing strategies to this niche market (Güneş and Hens, 2007). Dive tourists are not a monolithic group; their profiles vary significantly depending on age, gender, experience level, motivations, and the diving activities they pursue (Gregory and Dimmock, 2019). The stereotypical diver profile as young and male is being challenged by an ageing population and an increase in the participation of women over 40 (Gregory and Dimmock, 2019). A key aspect of understanding dive tourist profiles involves examining their level of recreational specialisation, in terms of the degree of commitment and skill development in diving (Zhang et al., 2023). Highly specialized divers are more likely to invest time and resources in diving, travel to remote locations, and participate in advanced training programs (Zhang et al., 2023). Diving is often a supplementary activity done during holidays (Cavallini et al., 2023; Marconi et al., 2022), and experienced divers may hold more critical views regarding dive site health and management than novice divers (Lucrezi et al., 2019).

Despite the increasing popularity of dive tourism and growing awareness of its economic and environmental significance, comprehensive research on dive tourists' environmental awareness and responsible behaviour remains relatively limited (Cavallini et al., 2023). Mounting evidence suggests that the environmental consciousness of travellers has increased significantly in recent years, driven by heightened awareness, public pressure, environmental legislation, and increased media coverage (Sultan et al., 2020). Cavallini et al. (2023) maintain that the environmental behaviours of dive tourists are influenced by a complex interplay of factors, including pre-trip environmental awareness, perceptions of the dive site's ecological vulnerability, and the influence of dive operators and fellow divers. Encouraging tourists to act in ways that minimise environmental impacts is critical (Buonincontri et al., 2017). Dive operators play a pivotal role in shaping the

environmental behaviour of dive tourists through pre-dive briefings, adherence to responsible diving practices, and active participation in marine conservation initiatives (Prabhakaran et al., 2013).

The association between environmental awareness and sustainable tourism practices is critical for ensuring the long-term viability of tourism destinations, particularly those reliant on natural resources such as coastal and marine environments (Prabhakaran et al., 2013). The escalating environmental consciousness among travellers globally, driven by heightened awareness, public demand, environmental regulations, and extensive media coverage, needs to be translated into tangible, sustainable behaviours, especially among dive tourists who directly interact with fragile ecosystems (Sultan et al., 2020; Butler, 1991). Understanding environmentally conscious tourists' and divers' needs and motivations is vital to promoting sustainable tourism practices, which involves exploring their perceptions, expectations, and behaviours concerning environmental stewardship and conservation (Prabhakaran et al., 2013). Education plays a pivotal role in shaping the environmental consciousness of tourists, with comprehensive and accessible information about the ecological sensitivity of destinations, the potential impacts of tourism activities, and best practices for minimising environmental footprints significantly influencing behaviour (Shekhar, 2024; Castellanos-Verdugo et al., 2016). According to Prabhakaran et al. (2013), the success of sustainable dive tourism hinges on the collaborative efforts of dive operators, local communities, and regulatory bodies to promote responsible diving practices, enforce environmental regulations, and invest in conservation initiatives.

South Africa's unique and diverse marine ecosystems present distinct ecological characteristics, making research on the environmental behaviour of divers in these areas valuable for understanding impacts on local marine biodiversity and identifying necessary conservation measures. Existing research on dive tourism in South Africa has explored the extent of damage caused by divers to hard and soft corals and assessed the ecological sustainability of current scuba diving activity (Walters and Samways, 2001), profiled scuba divers' travel motives to Sodwana Bay (Geldenhuys et al., 2014), examined motivations and experiences of independent divers in Cape Town's kelp forests and their influence on pro-environmental attitudes (Lucrezi and du Plessis, 2022), and investigated local impacts of dive tourism in Sodwana Bay (Mograbi and Rogerson, 2007), trends in scuba diving within adventure tourism (Giddy and Rogerson, 2018), sustainable dive ecotourism on coral reefs (Walters and Samways, 2001), disability inclusion in dive tourism (Lucrezi and Makuyana, 2023), and profiles of shark cage divers (Mabaleka et al., 2020). However, no study examines explicitly the environmental behaviour of dive tourists in South Africa. Researching South African dive tourists' characteristics and environmental behaviour addresses gaps in the literature by providing empirical data on an underrepresented group, contributing to novel insights specific to the region, and laying a foundation for future studies on sustainable dive tourism practices.

2. Theoretical Framework

Sustainable tourism represents a paradigm shift in the tourism industry, emphasising the importance of minimising negative impacts on the environment, local communities, and cultural heritage, while maximising the economic benefits for host destinations (Sharpley, 2000). The origin of sustainable tourism can be traced back to early conservation movements that sought to curb the exploitation of natural environments, gradually evolving to encompass social justice, cultural preservation, and economic equity (Liu, 2023). The World Commission on Environment and Development played a pivotal role by defining sustainable development as meeting present needs without compromising future generations' ability to meet their own and therefore sustainable tourism development ensures that tourism activities contribute to the long-term well-being of a destination without depleting its resources or compromising its attractiveness (Bramwell et al., 2017). Tourism relies heavily on the environment; without preservation, landscapes and attractions will lose their appeal, causing

the industry to decline (Butler, 2020). Sustainable tourism aims to diminish adverse effects and amplify positive contributions at tourist destinations, advocating for responsible practices that safeguard natural and cultural assets. Marine tourism encompasses various activities in coastal and marine environments, including recreational boating, fishing, whale watching, snorkelling, and diving. Hence, marine environments are considered biodiversity hotspots, providing critical habitats for many species, many of which are highly sensitive to human activities and environmental changes. The exponential growth of marine and coastal tourism over the past two decades has led to increasing concerns about its potential impacts on fragile marine ecosystems.

Ecological carrying capacity, a concept deeply rooted in ecological science, refers to the maximum number of individuals of a particular species that an environment can sustainably support without causing significant degradation (Ji, 2010; Deka and Pachua, 2019). Initially developed in the context of population ecology, this concept has found increasing relevance in tourism, particularly in ecologically sensitive areas that focus on dive and marine tourism (Deka and Pachua, 2019; Li et al., 2022). The surge in marine and coastal tourism over the past two decades has heightened the importance of understanding and managing carrying capacity to mitigate potential negative impacts on fragile marine ecosystems. Carrying capacity analysis is essential for promoting the sustainable development of marine tourism, ensuring that natural resources are utilised responsibly (Hatibu, 2024; Adam et al., 2024). Exceeding the ecological carrying capacity can lead to a cascade of detrimental effects, including habitat destruction, pollution, reduced biodiversity, and decreased aesthetic appeal, ultimately undermining the very resources that attract tourists in the first place (Ji, 2010). The convergence of tourism and environmental responsibility has given rise to environmental stewardship, which is paramount, particularly in dive and marine tourism, which directly rely on healthy aquatic ecosystems. Environmental stewardship embodies a proactive approach to conservation, emphasising responsible planning, management, and sustainable practices that minimise negative impacts and enhance the integrity of natural resources (Sultan et al., 2020). Dive tourism, while offering economic benefits to local communities and fostering appreciation for marine biodiversity, can inadvertently contribute to environmental degradation through various channels, including physical damage to coral reefs, pollution from boats and diving equipment, and disturbance of marine wildlife (Lamb et al., 2014). Thus, integrating environmental stewardship principles into dive tourism operations is not merely an ethical imperative but a fundamental requirement for long-term sustainability.

3. Literature Review

3.1 Characteristics of dive tourists

Dive tourism has emerged as a prominent niche in the broader tourism industry, attracting considerable scholarly interest in dive tourists' motivations, experiences, and characteristics. These tourists exhibit complex profiles influenced by various factors, including motivations, satisfaction levels, and the impact of service providers such as dive guides. The motivations driving scuba diving enthusiasts are diverse and can be classified into intrinsic and extrinsic rewards. Albayrak et al. (2019) highlight "push" motivations such as the thirst for exploration, thrill, personal growth, social interaction, and challenge. Conversely, "pull" motivations include tourism services, safety, accessibility, and the allure of pristine dive sites.

Cavallini et al. (2023) and So (2023) provide insights into dive tourists' demographic, socio-economic, and experiential characteristics. Generally, dive tourists are well-educated, with a significant proportion holding university degrees or higher qualifications. They tend to be employed professionals or entrepreneurs and are predominantly young to middle-aged, with a significant number between 20 and 49 years old (Zhang et al., 2022). The frequency of diving can be categorised into core divers, who dive more than eight times a year, and casual divers, who dive between one and seven times annually. Albayrak

et al. (2019) indicate that dive tourists are generally affluent due to the high costs associated with diving, including certification, gear, trips, and insurance. They are often involved in other sports and are typically environmental advocates, including researchers, dive experts, and underwater photographers. Research on shark tourism by Altobeli et al. (2009) shows that shark tourists are highly educated and youthful and view themselves as adventure seekers with a genuine interest in contributing to shark conservation and research. Similarly, Rocha et al. (2020) note a significant increase in marine wildlife viewing activities, such as diving with marine megafauna.

3.2 Environmental behaviour of dive tourists

The environmental behaviour of dive tourists is a complex issue explored through various lenses in the literature. Musa et al. (2011) found that divers' personalities and experiences influence their underwater behaviour, demonstrating that responsible behaviour is associated with certain personality traits and diving experiences. This suggests that environmental consciousness and behaviour shape dive tourists' profiles. Experienced divers tend to exhibit more responsible environmental behaviour than novices, as their level of specialisation and environmental awareness increases with experience (Alkins et al., 2021). This is supported by studies in Sri Lanka, where experienced divers showed strong support for conservation-oriented reef management actions, although they resisted measures that might compromise their diving experience (Perera et al., 2022). A study on German-speaking diving tourists revealed that ecological aspects are more important to them than the cost of a diving trip, indicating a high level of environmental concern within this demographic (Hodeck et al., 2021). Various factors, including diver experience, education, and the intention-behaviour gap, influence environmental awareness among dive tourists. While most divers express a positive attitude towards environmental protection, there is often a misalignment between their intentions and actual behaviours underwater. For instance, a survey of 581 Hong Kong divers revealed that over 90% believe in their responsibility to protect dive sites. However, actual underwater behaviours often do not align with these intentions due to perceived behavioural control issues and technical challenges during dives (So et al., 2023). The intention-behaviour gap is further highlighted by findings that divers, on average, perceive their contact with marine biota to be significantly lower than it is, indicating a need for better awareness and control measures (So et al., 2023).

Education is crucial in bridging this gap; divers with higher certification levels, such as divemaster, exhibit significantly better environmental awareness and lower contact rates with marine biota than less experienced divers (So et al., 2023). Effective educational strategies, such as pre-dive and video briefings covering environmental aspects, diver behaviour norms, and accountability, have been recommended to enhance diver awareness and responsible behaviour (Sumanapala et al., 2022). The economic and socio-cultural aspects of diving tourism also play a role in promoting environmental awareness. Studies have shown that divers' motivations and preferences, such as the desire to explore marine life and the importance of safety, influence their inclination towards conservation (Cavallini et al., 2023). Environmentally responsible behaviour (ERB) during diving activities is crucial for sustainable tourism, as it helps avoid negative impacts on the local environment and enhances the overall diving experience. Therefore, a comprehensive approach that includes education, effective management strategies, and understanding diverse motivations and behaviours is essential to improve environmental awareness and promote sustainable diving practices.

3.3 Dive tourism in South Africa

Dive tourism is a significant component of South Africa's Blue Economy, attracting domestic and international tourists to its diverse marine environments. South Africa's rich marine biodiversity, including pristine coral reefs and kelp forests, provides an attractive destination for local and international divers (Dimopoulos et al., 2021; Nolwazi et al., 2020). The scuba diving

industry in South Africa is rapidly expanding, with popular destinations such as Sodwana Bay and Cape Town drawing significant attention. Sodwana Bay, located on the northern coast of KwaZulu-Natal, is renowned for its vibrant coral reefs and is a hotspot for younger divers, primarily motivated by personal challenge, devotion, relaxation, and exploration (Geldenhuys et al., 2014). The perceived value of diving experiences in Sodwana Bay is high, with tourists valuing the quality, benefits, and social aspects of their diving activities (Seymour, 2012). In Cape Town, the kelp forests have gained popularity, especially after the release of the documentary "My Octopus Teacher," which highlighted the unique cold-water diving experiences available in these habitats. Divers in Cape Town are motivated by a range of factors, including observation, relaxation, adventure, and photography, and they exhibit firm conservation commitments and place attachment to the local marine environment (Lucrezi and du Plessis, 2022). Responsible behaviour by dive tourists is crucial for the sustainability of marine tourism, especially in sensitive ecosystems like coral reefs and kelp forests. Additionally, niche forms of marine tourism, such as Great White shark cage diving in Gansbaai, offer thrilling experiences that contribute to conservation efforts by educating the public and supporting local communities despite the controversies surrounding the potential negative impacts on shark behaviour and health (McKay, 2020).

Despite its economic benefits, dive tourism faces several challenges that threaten its sustainability. External and environmental risks challenge the sustainability of dive tourism in South Africa. External risks include domestic crime, political instability, economic downturns, and restrictive regulations, impacting tourism's viability (Dimopoulos et al., 2021). Environmental risks such as climate change, industrialisation, and pollution also threaten coral reef ecosystems, which are crucial to the dive tourism experience (Dimopoulos et al., 2022). These risks affect the reefs and have broader implications for the surrounding ecosystems and local communities that rely on them for their livelihoods. Effective management and sustainable practices are essential to address these challenges and ensure the sector's long-term viability (Dimopoulos et al., 2019; Dimopoulos et al., 2021; Dimopoulos et al., 2022).

4. Methodology

This study was conducted at two prominent dive sites in KwaZulu-Natal Province, South Africa: Umkomaas and Umhlanga. These sites were selected based on accessibility, high dive tourist traffic, and divers' willingness to participate. Umkomaas hosts the Aliwal Shoal, a stony reef located approximately 5 km offshore, renowned for its exceptional marine biodiversity. The shoal supports various hard and soft corals and tropical and subtropical fish. It is a critical habitat for iconic species such as Ragged Tooth Sharks (*Carcharias taurus*), Tiger Sharks (*Galeocerdo cuvier*), Manta Rays (*Mobula spp.*), Dolphins (*Delphinidae*), and Whale Sharks (*Rhincodon typus*). These attributes make it a premier destination for divers seeking encounters with large marine fauna. Umhlanga, on the other hand, is characterised by vibrant coral reefs and abundant tropical fish populations. The dive sites in this area include diverse underwater environments, such as shipwrecks and rocky reef formations, and support a variety of marine life, including invertebrates, crustaceans, and apex predators like the Zambezi Shark (*Carcharhinus leucas*).

The research involved a study population of 560 dive tourists, including 340 from the Aliwal Dive Centre in Umkomaas and 220 from Umhlanga Scuba. Participants were selected using a convenience sampling method. According to Krejcie and Morgan's (1970) sample size determination table, a minimum of 242 participants was required to ensure statistical reliability for this population size. Consequently, 242 dive tourists were included in the study, satisfying the necessary sample size threshold. An online survey was distributed through the Aliwal Dive Centre and Umhlanga Scuba databases. The survey, developed to examine dive tourists' profiles and environmental awareness, was a 40-question instrument divided into three sections: dive tourist demographic data, environmental awareness of divers and the perceived

environmental impacts of divers. The survey used a variety of question types, including multiple-choice, checkbox, Likert-scale, and open-ended questions. These formats allowed for detailed profiling of respondents and a comprehensive exploration of their environmental knowledge, attitudes, and behaviours. The scaling methods used in the questionnaire include nominal scales for categorical data, ordinal scales for Likert-scale responses and unstructured responses for open-ended questions. The questionnaire measured several key constructs critical to the research objectives: demographic and socioeconomic profile (e.g., age, education, tourist status), diving experience and behaviour (e.g., years diving, logged dives, diving habits), environmental awareness (e.g., knowledge of diving impacts, MPAs, Green Fins principles), attitudes toward marine conservation (e.g., support for MPAs, views on dive tourism's impact), environmental behaviours and practices (e.g., adherence to sustainable diving practices, self-reported harmful actions), perceptions of dive site health (e.g., ratings of water quality, coral health), and suggestions for sustainability (e.g., ideas for improving the dive industry). These constructs provide a framework for understanding the interplay between divers' profiles and their role in promoting or hindering marine conservation in KZN. Quantitative data from the survey were analysed using the Statistical Package for the Social Sciences (SPSS, Version 28). The study adhered to ethical research standards, with approval obtained from the Aliwal Dive Centre and Umhlanga Scuba. Participants provided informed consent before completing the survey, and their anonymity was ensured through data anonymisation protocols.

5. Results and discussion

5.1 Socio-demographic characteristics of dive tourists

The data presented in Table 1 indicates a relatively balanced gender distribution among dive tourists, with 52.4% female and 47.6% male respondents. Age distribution shows a higher concentration of dive tourists in the 26-35 age bracket (46.6%), followed by 36-45 years (24.3%). The lower representation of older age groups (46-55 years, 11.7%; 56-65 years, 10.7%; over 65 years, 6.8%) indicates that younger to middle-aged adults are more prevalent among dive tourists. This demographic trend aligns with the physical and financial demands of diving, which are generally more manageable for younger individuals. These findings further resonate with So et al. (2023), who found that dive tourists are predominantly young to middle-aged, with a significant number between 20 and 49 years old.

The race distribution of dive tourists in this study is skewed, with 90.3% of respondents identifying as White and very low representations of African (1.0%) and Indian (8.7%) ethnicities. The predominance of White dive tourists in the study sample likely results from socioeconomic, historical, cultural, and methodological factors. Diving's high costs, including equipment, training, and travel, align with the higher disposable incomes of White households in South Africa, a disparity rooted in apartheid's legacy. Historical restrictions on non-White access to coastal recreation and limited cultural exposure to diving among Black African, Coloured, or Indian communities further contribute. Dive operators may target marketing toward affluent White local and international tourists, while dive sites' remote locations pose logistical barriers for less affluent groups. The implication is that racial demographics shape environmental attitudes, diving practices, and access to resources like dive training, with White respondents likely having greater diving opportunities due to socioeconomic advantages. This may skew study responses toward more experienced divers or those with specific conservation views, while underrepresenting other groups, such as local communities with distinct interactions with marine environments, potentially missing critical views.

Regarding employment status, most respondents (73.0%) are employed, highlighting the importance of disposable income for participating in dive tourism. Other researchers concur with these findings. For example, Djeri et al. (2014) found that disposable income significantly influences dive tourism participation, as evidenced by various studies examining the

economic, social, and psychological factors affecting tourism behaviours. Jeyacheya and Hampton (2016) also found that higher disposable income allows individuals to engage more frequently in dive tourism in Malaysia, as they can afford the associated costs such as travel, equipment, and certification fees. The data confirms that most divers have a high level of education, with 42.7% holding a Bachelor's degree and 22.3% a Diploma. This educational profile suggests that dive tourists are generally well-informed and may be more receptive to conservation messages and sustainable practices. Correspondingly, Oliveira et al. (2018), in a study conducted on Sal Island, Cape Verde, revealed that 85% of the surveyed divers had higher education qualifications, indicating a well-educated demographic likely to engage in and appreciate educational initiatives related to marine biodiversity and conservation. Dive tourism operators can leverage this by incorporating educational components into their offerings, such as workshops on marine conservation and responsible diving practices.

Table 1. The demographic characteristics of dive tourists

Dive tourist characteristics		Frequency	Percent
Gender	Male	49	47.6
	Female	54	52.4
Age group	26-35 years	48	46.6
	36-45 years	25	24.3
	46-55 years	12	11.7
	56-65 years	11	10.7
	More than 65 years old	7	6.8
Race	African	1	1.0
	Indian	9	8.7
	White	93	90.3
Occupation	Employed	76	7.3
	Pensioner	7	6.8
	Student	12	11.7
	Unemployed	8	7.8
Level of education	Masters	8	7.8
	Bachelor's degree	44	42.7
	Certificate	7	6.8
	Diploma	23	22.3
	High school	15	14.6
	Other	6	5.8

5.2 Respondents' diving behaviour

The behaviour and patterns of dive tourists significantly impact environmental sustainability. Analysing the results reveals several key trends and implications for managing and mitigating the ecological impact of diving activities. The data presented in Table 2 reveals that Aliwal is the most preferred diving location, with 41.7% of divers indicating it as their usual spot. In contrast, Umhlanga and other locations receive fewer visits, suggesting that while they face less immediate pressure, they could still benefit from targeted conservation efforts as dive tourism grows. The preference and concentration at Aliwal could lead to high environmental stress, highlighting the need for focused management strategies to

prevent overuse and maintain ecological balance. The data shows that a significant percentage of divers (31.1%) have over 12 years of diving experience, indicating a mature and potentially knowledgeable dive community. The findings on divers' experience levels and their potential as environmental stewards connect to theories of pro-environmental behaviour and environmental citizenship (Steg and Vlek, 2009). These theories suggest that knowledge, awareness, and experience lead to responsible behaviours. Studies cited (Perera et al., 2022; Lin and Tsao, 2023) confirm that experienced divers are more likely to adopt sustainable practices, supporting the Value-Belief-Norm (VBN) theory, which links personal values and environmental awareness to action (Stern, 2000).

Studies confirm that experienced divers are more likely to engage in pro-environmental behaviours due to their heightened awareness and understanding of marine ecosystems and can positively influence environmental conservation (Perera et al., 2022; Lin et al., 2023; Lucrezi and du Plessis, 2022). However, many divers are relatively new to the sport, with 43.6% having less than three years of experience. This segment may not be as informed about the environmental impacts of diving, highlighting the importance of educational initiatives to promote sustainable practices among these novice divers.

Certified divers, who form a significant portion of the global diving community, undergo rigorous training and certification processes to ensure their safety and proficiency underwater. The Professional Association of Diving Instructors (PADI) issues approximately 900,000 diving certificates annually, contributing to an estimated 6 million active divers worldwide (Wilks, 2017). Certification is crucial as it significantly reduces the risk of diving injuries. The distribution of diving certifications and levels reveals a diverse range of expertise among dive tourists in this study. With 38.8% being advanced divers and 13.6% holding instructor-level certifications, there is a strong presence of skilled individuals who can act as environmental stewards. However, Mota (2015) cautions that the mere fact of being a certified diver does not necessarily translate to pro-environmental behaviour. The data on logged dives shows that 57.3% of divers in Umhlanga and 41.7% in Aliwal logged more than 20 dives at the time of the study. Studies confirm that the frequency and intensity of diver contact with the reef increase with the number of dives, leading to physical damage and ecological disturbances. For instance, research conducted in the Philippines revealed that 88% of divers made contact with the reef at least once per dive, with a mean contact rate of 0.12 per minute, and that larger dive groups reduced the ability of dive guides to manage diver behaviour effectively (Roche et al., 2016). Similarly, in Eastern Australia, the mean number of contacts per 30-minute dive ranged from 35 to 121, with some divers causing significant coral breakage, indicating that high visitation rates can approach the limit of ecological sustainability (Harriott et al., 1997). This trend highlights the need to monitor these sites and implement sustainable dive practices to minimise ecological damage. The cumulative effects of intensive dive site use over the long term necessitate responsible diving behaviours and proper controls to ensure the sustainability of dive tourism. While diving does not inherently threaten the environment, poor practices and lack of awareness can lead to significant ecological damage, emphasising the need for continuous monitoring and management.

The data in Table 2 reveals that most dives (40.8%) last around 1 hour, with a significant number (33%) being shorter, around 45 minutes. Longer dives, while less common, can have a higher potential for environmental impact. Guidelines for optimal dive duration and practices could help reduce environmental impact, balancing the enjoyment of the sport with the preservation of marine ecosystems. The study confirmed that summer is the most popular time for diving in KZN, with 44.7% of divers preferring this season. This peak in diving activity can increase environmental pressures during certain times of the year. To address this, promoting diving during less busy periods and implementing measures to manage visitor numbers during peak seasons can help distribute the environmental load more evenly.

Table 2. Diving patterns and behaviour

Characteristics of diving behaviour		Frequency	Percent
Usual diving location	Aliwal	43	41.7
	Umhlanga	7	6.8
	Both	21	20.4
	Other	32	31.1
The number of years diving in KZN?	Less than a year	19	18.4
	1-3 years	26	25.2
	4-6 years	15	14.6
	7-9 years	6	5.8
	10-12 years	5	4.9
	More than 12 years	32	31.1
Current diving certification	Other	4	3.9
	Dive guide	12	11.7
Diver level	Rescue diver	12	11.7
	Dive instructor	14	13.6
	Beginner	21	20.4
	Advanced	40	38.8
The number of logged dives to date? (KZN)	11-15	3	2.9
	16-20	7	6.8
	5-10	7	6.8
	Other	10	9.7
	Less than 5	17	16.5
	More than 20	59	57.3
The number of logged dives to date? (Umhlanga)	16-20	2	1.9
	5-10	5	4.9
	Other	5	4.9
	More than 20	27	26.2
	Less than 5	64	62.1
The number of logged dives to date? (Aliwal)	11-15	6	5.8
	16-20	6	5.8
	5-10	10	9.7
	Other	10	9.7
	Less than 5	28	27.2
	More than 20	43	41.7
Average dive duration based on a single dive?	1 hour	42	40.8
	More than 3 hours	2	1.9
	2 hours	2	1.9
	3 hours	6	5.8
	30 minutes	17	16.5
	45 minutes	34	33.0
	1 hour	42	40.8
What is the best time in the year to dive into KZN?	Spring (August–mid-October)	10	9.7
	Winter (May–July)	21	20.4
	Autumn (Mid-February–April)	26	25.2
	Summer (Mid-October–February)	46	44.7

5.3 Environmental knowledge of dive tourists

This section required the respondents to indicate their knowledge and views on certain diving practices, marine environmental damage, and ethical environmental practices. Based on the findings presented in Table 3, the study results reveal strengths and gaps in environmental awareness and behaviour among dive tourists, which have significant implications for the sustainability of diving activities.

Table 3. Environmental knowledge of divers

Characteristics of divers based on the environmental behavior		Frequency	Percent
How important is it that the marine environment is protected from environmental damage?	Fairly important	6	5.8
	Important	1	1.0
	Not at all important	1	1.0
	Very important	95	32.2
Have you been aware of the impacts of certain diving practices on the environment?	Yes	11	10.7
	No	92	89.3
If yes to the above, how were you aware of such impacts?	Colleagues	6	5.8
	Dive instructor	36	35.0
	Newspaper/Magazine	3	2.9
	Other	12	11.7
	Own internet research	10	9.7
	Social media	26	25.2
When participating in KZN, have you always been briefed by the dive operator's pre-dive?	Yes	89	86.4
	No	14	13.6
Were you briefed on safety issues?	Always	90	87.4
	Never	1	1.0
	Sometimes	12	11.7
Were you briefed on environmental issues?	Always	51	49.5
	Never	10	9.7
	Sometimes	42	40.8
Are you familiar with the ethical and environmental practices whilst diving	Yes	101	98.1
	No	2	1.9

According to the data presented in Table 3, a substantial number of divers (32.2%) consider it "very important" to protect the marine environment from damage, indicating a high level of awareness and concern among dive tourists. Cottrell and Meisel (2004) concur that perceived knowledge about marine environmental issues strongly predicts personal responsibility among scuba divers. Likewise, Hodeck et al. (2021) found that ecological aspects are more important to diving tourists than the price of a diving trip, indicating a strong inclination towards sustainability within diving. However, the relatively small percentage who view it as only "fairly important" or "important" (6.8% combined) suggests that there is a range of attitudes towards environmental protection. The fact that some divers do not prioritise environmental protection highlights a need for more widespread awareness and education about preserving marine ecosystems. The data reveals a concerning gap in awareness regarding the environmental impacts of diving practices. With 89.3% of divers unaware of these impacts, there is a significant opportunity for improvement in environmental education. Among those who are aware, the primary sources of

information are dive instructors (35.0%) and social media (25.2%). This suggests that while formal education through instructors plays a key role, divers rely on informal sources. The limited use of other channels, like newspapers or personal internet research, indicates that there may be a lack of accessible resources for learning about environmental impacts.

According to the data, most divers (86.4%) report being briefed by their dive operators before participating in dives, a positive sign of operational adherence to safety and environmental practices. However, 13.6% of divers do not receive such briefings, which suggests a potential inconsistency in applying these practices. Most divers (87.4%) are briefed on safety issues, crucial for ensuring personal safety and preventing accidents. In contrast, only 49.5% receive briefings on environmental issues, with 40.8% being briefed occasionally. This discrepancy highlights the need for a more consistent and inclusive approach to environmental briefings to ensure that all divers are informed about best practices and the potential impacts of their actions. An overwhelming majority of divers (98.1%) claim to be familiar with ethical and environmental practices while diving. This high level of reported familiarity suggests that divers generally acknowledge the importance of these practices. However, the gap between reported familiarity and actual awareness, as indicated by the low percentage of divers aware of the impacts of certain diving practices, points to a discrepancy that may arise from inadequate implementation or understanding of ethical guidelines.

6. Conclusion and Recommendation

This study on dive tourists in KwaZulu-Natal (KZN) provides valuable information on their socio-demographic profiles, diving behaviours, and environmental knowledge. The gender distribution is relatively balanced between female and male divers, with a concentration of younger to middle-aged individuals, particularly those in their late twenties to mid-thirties, followed by those in their late thirties to mid-forties. This demographic trend reflects the physical stamina and financial resources required for diving, aligning with global patterns where younger adults dominate the sport due to its demands. However, the racial composition of the sample, heavily dominated by White respondents with minimal representation of African and Indian divers, raises significant concerns about representativeness. This skew likely stems from a combination of socioeconomic disparities rooted in South Africa's apartheid legacy, historical restrictions on non-White access to coastal recreation, cultural differences in recreational preferences, and methodological biases such as reliance on convenience sampling through dive centres with predominantly White clientele. Such underrepresentation limits the study's ability to capture diverse perspectives, particularly from local communities who may interact with marine environments differently, potentially skewing findings toward the attitudes and practices of more affluent, experienced divers. The dominance of employed respondents with high educational attainment, particularly those holding Bachelor's degrees or diplomas, suggests a well-educated population likely receptive to conservation measures. However, a substantial gap in environmental awareness is evident, with many divers unaware of the ecological impacts of their practices, compounded by inconsistent pre-dive briefings that often prioritise safety over environmental concerns. Diving behaviours indicate a strong preference for Aliwal as a dive site, alongside frequent diving by novice and experienced divers, raising concerns about ecological stress on popular reefs. While many divers express a strong commitment to protecting marine environments, the disconnect between reported familiarity with ethical practices and actual knowledge highlights the need for more effective education and enforcement of sustainable diving practices to safeguard KZN's marine ecosystems.

To enhance the sustainability of dive tourism in KwaZulu-Natal, dive operators should implement mandatory pre-dive briefings emphasising environmental impacts alongside safety, supplemented by workshops targeting novice divers to foster conservation awareness, potentially in collaboration with organisations like Green Fins. Future research must address the study's racial skew by adopting inclusive sampling through partnerships with diverse community organisations and

offering multilingual, offline surveys to ensure proportional representation. To mitigate ecological stress on popular sites like Aliwal, operators should cap dive group sizes, promote off-peak diving, install mooring buoys, and conduct regular ecological assessments. Using experienced divers as environmental stewards through training and incentives can promote sustainable practices. At the same time, diversified marketing, affordable packages, and community-based programs can attract non-White divers, reducing socioeconomic and cultural barriers to participation.

Future research on dive tourism in KwaZulu-Natal should employ a multi-faceted approach, including longitudinal studies to track diver behaviour, reef health, and conservation intervention efficacy at high-traffic sites like Aliwal. Qualitative methods, such as interviews with underrepresented racial groups, could reveal unique conservation perspectives and participation barriers, informing inclusive policies. Experimental studies evaluating educational tools like workshops, virtual reality, or social media campaigns could identify optimal methods for promoting sustainable practices. Investigating dive tourism's socioeconomic impacts, particularly job creation for historically disadvantaged communities, would align conservation with South Africa's equity goals. Comparative analyses with global dive destinations, such as the Great Barrier Reef, could contextualise KZN's challenges, while citizen science initiatives engaging educated divers in biodiversity monitoring could enhance long-term ecological sustainability. This study aligns with sustainability discourses by focusing on ecological carrying capacity, environmental stewardship, social equity, education, and adaptive management. It contributes empirical research and practical recommendations that operationalise these theories, particularly in a marine tourism context. However, integrating political ecology, climate adaptation, and decolonial perspectives could further enhance its theoretical depth and practical impact, ensuring that dive tourism in KZN supports global sustainability goals and local equitable development.

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