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**An Evaluation of the South African Marine  
Recreational Fisheries Permit System**

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## **ABSTRACT**

Recreational fishing is a popular activity worldwide with millions of fishers harvesting billions of fish annually. With technological advancements and a growing global participation rate, increasing pressure has been placed on fisheries resources. To promote sustainability, the way in which humans interact with these resources requires careful management. However, funding these management strategies is not simple, particularly in Low- and Middle-Income Countries (LMICs). In recreational fisheries, a common source of income for management stems from user-pay funding systems. The use of recreational fishing licenses or permits (referred to as permits in this thesis) is an effective cost-recovery tool to aid in management of these fisheries, while also providing information on the trends in numbers of fishers, information about characteristics of those fishing, and lists of participants for scientific study and communication. However, the efficacy of these user-pay systems is seldom evaluated. South Africa makes use of a permit system for cost recovery of the management of marine-based recreational fisheries. While anecdotal information has suggested that the efficiency of this system is questionable, there is no information to understand the role that it plays in the management of South Africa's marine recreational fisheries. The aim of this thesis is to evaluate the South African marine recreational fishing permit system by examining and analysing sales trends, the utilisation of the funds generated and the permit preferences of recreational anglers. This information will then be used to develop best practice guidelines for the system.

A longitudinal review of the recreational fishing permit sales dataset and government documents revealed the long-term sales trends, income, and associated management activities. Between 2002 to 2019, a total of 5 085 834 marine recreational permits pertaining to the recreational fishery were sold equating to an income of ZAR 767 094 511. Permits with an annual validity were far more popular than permits with a temporary validity and comprised

84.4% percent of total sales contributing ZAR 635 230 700 (94.2% of total) in revenue to the Marine Living Resource Fund. The marine recreational angling permit was the most frequently purchased permit type with a total of 2 899 151 permits sold (mean = 170 538 per annum). Assuming compliance has remained stable and using permit sales as a proxy for participation, participation in marine recreational fisheries is increasing. Furthermore, there is no clear evidence of the funds from recreational fishing permits being used specifically to support recreational fisheries management, enforcement or angling development. After a review of the government's annual reports on expenditure by the Marine Living Resources Fund, it was established that despite the revenue generated, very little attention is given to the management of recreational fisheries in South Africa.

Preferences on aspects of the recreational permits were elicited from existing and former permit holders using a Discrete Choice Experiment (DCE). The DCE was developed by making use of a pilot study that made use of open-ended questions to discern the main themes. These themes were then developed into attributes and levels for the DCE. Results indicated that respondents ( $n = 166$ ) were highly responsive to aspects of the permit concerning the price ( $p < 0.001$ ), the physical format of the permit ( $p < 0.001$ ), the designation of fishing areas ( $p < 0.001$ ), and the level of law enforcement present within the fishery ( $p < 0.001$ ). Generally, respondents preferred a lower priced permit, no new fisheries management zones, and increased law enforcement levels.

Amending policy to prioritize the use of the funds from recreational fisheries for their management is considered to be an important step to improving overall recreational fisheries governance. Improving the current permit system to reflect preferences of anglers would most likely reduce permit non-compliance and enhance the income received from marine recreational fishers. If mandated for use in the recreational fisheries sector, these additional

funds are thought to be crucial in providing aid for management if to engage stakeholders, launch education programmes, conduct research in protected areas, understand participation and effort, and increase public awareness in order to bolster compliance and enhance participation within the fishery.

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# CHAPTER ONE

## INTRODUCTION

Recreational fishing is broadly defined as the harvesting of aquatic organisms that do not contribute to a significant portion of the individual's nutritional input and are not sold for financial gain (FAO, 2012). Recreational fishing can be distinguished from commercial fishing, which is fishing for profit, and can further be distinguished from subsistence fishing, which is fishing for survival (Arlinghaus *et al.* 2015; Brownscombe *et al.* 2019). Recreational fishing is a popular activity worldwide, with at least 220 million participants harvesting billions of fish every year (Arlinghaus *et al.* 2015). In the developed world, participants generally engage in recreational fishing as an escape from daily routines, for the enjoyment and relaxation of the outdoors, and the challenge and adventure that accompany the activity (Arlinghaus *et al.* 2021).

Recreational fisheries participation is generally correlated to economic development (Arlinghaus *et al.* 2002, 2015, 2016; Potts *et al.* 2020) with general increases in participation as the economy of a society develops. This is because more people can afford to go fishing for their leisure rather than for fulfilling their primary resource needs (Arlinghaus *et al.* 2021). However, the growth of participation in recreational fisheries is not infinite, as participation rates generally tend to stabilize and even decline after the initial rise with economic development (Arlinghaus *et al.* 2021). The peak in recreational fisheries participation generally corresponds with a peak in urbanization as this leads to a shift away from outdoor life and societies' interest in fish and wildlife (Arlinghaus *et al.* 2021).

In many High-Income Countries (HICs), recreational fisheries have become the primary resource users in coastal and freshwater ecosystems (Arlinghaus *et al.* 2019) and they have

subsequently developed a long history of recreational fisheries governance (Arlinghaus *et al.* 2015). In contrast, the rise in recreational fishery participation in Low- and Middle-Income countries (LMICs; e.g. India, Mauritania) and has seldom been met with a concurrent response from management authorities (Pitcher *et al.* 2009; Potts *et al.* 2020). This is concerning as these fisheries often compete directly with livelihood fisheries in these countries. Due consideration of recreational fisheries is thus needed in LMICs, beginning with the development of appropriate policy and the facilitation of structural reforms to implement these policies (Pitcher *et al.* 2009; Potts *et al.* 2020).

A core objective of recreational fisheries governance is to balance the socio-economic benefits of the fishery for its stakeholders and minimize the ecological impacts of exploitation on the systems resources (Pitcher *et al.* 2009). According to the Food and Agriculture Organization (FAO) of the United Nations, responsible recreational fisheries management makes use of various strategies. These include well-developed policy and institutional frameworks that inform and implement management strategies and actions, appropriate regulations (aimed at individual recreational fishers) and research that provides policy makers and managers with appropriate information to make informed decisions (FAO, 2012).

In their review of recreational fisheries governance, Potts *et al.* (2020) suggested that both LMICs and HICs that scored highly on effective recreational fisheries governance had several shared attributes. These included high recreational fisheries participation and catch, recognition of the socio-economic importance of recreational fisheries, documented conflicts between the commercial sector and the recreational sector, and strong special interest (lobby) groups that promote the interest of stakeholders in recreational fisheries (Potts *et al.* 2020). In contrast, countries with low actual or perceived participation, economic significance, articulation of conflicts between livelihood (commercial or small-scale) and few or no lobby groups had less

effective recreational fishery governance systems (Potts *et al.* 2020). It was postulated that effective governance was largely driven by societal pressure on managing bodies from recreational fisheries stakeholders (Potts *et al.* 2020).

Various recommendations have been made by experts around the world on how to govern recreational fisheries (Arlinghaus *et al.* 2019; Potts *et al.* 2020). These generally indicate that management should understand the nature of the recreational fishing sector within their country. The information required extends across the socio-ecological system and includes: i) biology of the target species; ii) population status of target species; iii) catch and effort; iv) economic impact; v) efficacy of management and monitoring interventions; vi) consequences of local and global change on these attributes (Arlinghaus *et al.* 2016; Pitcher *et al.* 2009; Potts *et al.* 2020). It is important to have a strong institutional framework governing recreational fisheries with clear policies regarding recreational fishing to guide the goals and objectives, thus allowing for the development of effective management frameworks for the fishery (Arlinghaus *et al.* 2019; Pitcher *et al.* 2009; Potts *et al.* 2020).

A core component of successful recreational fisheries governance is cooperation with all the relevant stakeholders. This is needed to encourage cooperative decision making that promotes compliance from all sectors with regulations (Arlinghaus *et al.* 2016; Pitcher *et al.* 2009; Potts *et al.* 2020). Broad stakeholder engagement mechanisms should be used to bolster individual compliance with regulations in the form of education, transparent use of funds, and policing and law enforcement (Potts *et al.* 2020). The governance system should also have the freedom to be adaptive to address issues such as stock collapse, climate change and ineffective management actions (Arlinghaus *et al.* 2016; Pitcher *et al.* 2009; Potts *et al.* 2020).

Some aspects of recreational fisheries governance can be expensive due to the considerable operating costs required to monitor and promote compliance for widely dispersed and mobile

recreational fishers. Unsurprisingly, many nations have implemented cost-recovery strategies (Hunt *et al.* 2016, Potts *et al.* 2020) and user-pay systems, where recreational fishery participants pay for governance of the recreational fishery, are the most common (Alic *et al.* 2021; Johnston *et al.* 2007; Morales-Nin *et al.* 2010; NSWG, 2021; TOF, 2022; Walls and Ashenfarb, 2022). Recreational fishing licenses or permits (hereafter collectively termed permit) are the most common method of raising funds for management (Arlinghaus *et al.* 2016; Potts *et al.* 2020). This has been exemplified in the United States of America (USA) where fishers (and hunters) have funded conservation efforts for nearly 100 years (Johnston *et al.* 2020; TOF, 2022; Walls and Ashenfarb, 2022). However, some countries do not solely rely on revenue from permits and have implemented a tax on fishing related goods, while others obtain government subsidies to manage recreational fisheries (NSWG, 2021; TOF, 2022; Walls and Ashenfarb, 2022).

Fisheries policy in some countries requires the funds from the sale of recreational fishing permits to be used exclusively for recreational fisheries governance (NSWG, 2021; TOF, 2022; Walls and Ashenfarb, 2022). For instance, in recreational fisheries managing bodies in New South Wales in Australia and many states in America, it is mandated that the revenue from permits is used for promoting recreational fisheries management activities (NSWG, 2021; TOF, 2022; Walls and Ashenfarb, 2022). In these cases, the funds have been used for a range of activities, including research, species and habitat restoration, habitat protection, land acquisition, education, improving public access for fishing and enforcing laws and regulations (NSWG, 2021; TOF, 2022). Ensuring that a country's recreational fisheries policy adequately acknowledges the potential for user pay systems to promote effective governance is vital for sustainable fisheries management practices (NSWG, 2021; TOF, 2022, Potts *et al.* 2020).

In addition to providing funds for fisheries management, permit systems have been used to understand participation in many open-access recreational fisheries. For example, Hanson and Sauls (2011) used recreational fishing sales to characterize the recreational fishery in the State of Florida. Although they found different trends in the sale of permits between residents and non-residents, they found a large increase in participation and highlighted the need for urgent management intervention (Hanson and Sauls, 2011). Hunt *et al.* (2016) used recreational fishing permits sales in Canada to link participation rates to catch (fish biomass) and non-catch related (gender, population density and ethnicity) factors. They showed that areas with lower population densities, higher fish biomass, and a higher proportion of ethnic minorities had higher participation (Hunt *et al.* 2016). Trella and Mickiewicz (2016) used a time series analysis of permit sales to show an increase in fishing participation in the Vistula Lagoon region in Poland. They also identified a clear seasonal trend in permit purchases, with most occurring during the summer months. Personal information on the permit forms has also been used to identify anglers for surveys. For example, Ashford *et al.* (2009) demonstrated an increased sampling efficiency using an angler permit registry over coastal household's registry as a sampling frame for a marine recreational survey. Thus, recreational fishing permits are effective for assessing participation within a fishery as well as a point of access for research surveys to be conducted (Ashford *et al.* 2009; Hanson and Sauls, 2011; Hunt *et al.* 2016; Trella and Mickiewicz, 2016).

The purchase of recreational fishing permits can also be used as an opportunity for angler engagement, education, or research (Alic *et al.* 2021; NSWG, 2021; TOF, 2022). In South Africa, fishers can collect a marine recreational fisheries information brochure from the post office while purchasing a recreational fishing permit (personal observation). However, fishing permits are not always available at Post Offices (personal obs). In some countries, such as

Canada, when buying a permit online you can immediately access updated information regarding laws and regulations for sector specific recreational fisheries (GC, 2023). In the American state of Florida, when buying a recreational fishing permit online, users have access to information such as angling and tackle advice, fish identification, examples of their permit fees at work, local outfitters, and guides and environmental initiatives. Engaging with recreational fishers is vital for a comprehensive recreational fisheries governance system that promotes buy in from all the stakeholders (Potts *et al.* 2020).

Despite the list of benefits associated with recreational angling permits, these can rapidly erode if there is non-compliance (Bergseth and Roscher, 2018; Bova *et al.* 2017; 2018; 2022; Ficke and MacCready, 2019; Pitcher *et al.* 2009). While there may be several drivers for non-compliance, one important consideration is angler preferences (Arias Ficke and MacCready, 2019; Hirsch *et al.*, 2019). If the recreational angling permit system does not fulfil the needs or preferences of recreational anglers, it is likely that compliance will decline (Arias *et al.* 2015; Bova *et al.* 2022; Kim *et al.*, 2007; Mackay *et al.*, 2020).

Several methods have been used to understand angling preferences. One common method is using classic surveys, which can provide insights into angler demographics, fishing habits, and preferred species but can be hindered when the choices don't exemplify the trade-offs that a consumer would make in an intricate system (NOAA Fisheries, 2021). Another method is using public meetings and stakeholder engagement, which can allow governing bodies to receive direct input from anglers and other interested parties (García-Quijano & Ruiz-Frau, 2018). However, public meetings can result in many concerns being overlooked. Social media and online forums can provide a platform for anglers to share their opinions and preferences with governing bodies, although these can be misleading and not represent actual key stakeholders (Kocurek, *et al.*, 2021). A method which has become increasingly popular is discrete choice

(DC) methodology. Discrete choice (DC) methodology is a questionnaire-based method that presents respondents with a range of possible management scenarios (Lee *et al.* 2014). It allows respondents to select their most desired alternative, thus teasing out the most desired aspects of a system by showing the trade-offs respondents make in selecting their desired scenario (Lee *et al.* 2014). This can then be used to develop a future system based on these preferences (Lee *et al.* 2014). Showing trade-offs that consumers make and eliciting their preferences in real world scenarios allow DC methodology to be a versatile and powerful tool in the arsenal of policy makers to understand stakeholder preferences (Lee *et al.* 2014).

South Africa's coastal zone is a vast and ecologically diverse area that is home to a wide variety of flora and fauna (Mann, 2013; Van Der Elst, 1993). The coastline stretches more than 2 500 km and is an important breeding and feeding ground for many marine species (Mann, 2013; Vand Der Elst, 1993). The South African coastline is characterized by the occurrence of the cold Benguela Current on the west coast and the warm Agulhas Current on the east coast (Mann, 2013; Potts *et al.* 2015; Vand Der Elst, 1993). As a result, the coastal zone supports a unique biodiversity of marine plants and animals, which varies depending on the location, depth, and habitat (Mann, 2013; Potts *et al.* 2015; Van Der Elst, 1993). Some of the key biodiversity hotspots can be categorized into five different habitat zones, which include rocky shores, sandy shores, estuaries, reefs, and kelp forests (Potts *et al.* 2015; van der Elst, 1993). Furthermore, South Africa has approximately 270 estuaries which are important nursery and feeding areas for a diverse range of fish and other marine organisms (Whitfield, 1992). The estuaries provide important nursery areas for some commercial and recreational fish species, including linefish (Whitfield, 1992). Linefish is a uniquely South African term that refers to any species of fish targeted using hook-and-line (Mann, 2013). The vast array of habitat types and range of biodiversity within the coastal waters of South African allows recreational fishers

to target approximately 139 species of linefish with many implications for the management of coastal living resources (Mann, 2013; Potts *et al.* 2015; van der Elst, 1993).

The marine recreational fishery in South Africa is a large and diverse sector which operates over a vast length of coastline (Mann 2013; Vand Der Elst, 1993) and has provided South African fisheries management with a monumental task (Potts *et al.* 2020). It was estimated by Potts *et al.* (2021) that there are between 478 132 and 546 799 participants in the marine recreational angling sector. These participants generate ZAR 19 billion (USD 1 billion) in economic activity annually, which supports roughly 94 000 employment opportunities across the country (Potts *et al.* 2021). The economic importance of the recreational fishing community in South Africa highlights their role as key stakeholders in the management of South Africa's fisheries (Potts *et al.* 2021).

While policies and laws have been created to guide the management of South Africa's marine living resources, direct mention of recreational fisheries was omitted until the Sea Fisheries Act of 1973. Other than in the province of KwaZulu-Natal, which had its own provincial Fisheries Licensing Board established by the then Natal Parks Board (now Ezemvelo KwaZulu-Natal Wildlife), which developed a permit system for recreational bait harvesting and spearfishing in the early 1970s (Mann et al. 1997), no other marine recreational fishing permitting system existed in South Africa until 1999. The first comprehensive plan for the management of marine linefish was introduced in South Africa in December 1985 in terms of the Sea Fisheries Act (No. 58 of 1973) based on the proposal developed by van der Elst and Garratt (1984). This was galvanised by the establishment of the National Marine Linefish Committee by the then Minister of Fisheries (Minister Wiley), a representative body that later evolved into the South African Marine Linefish Management Association (SAMLMA)(van der Elst and Schnetler 1999). The plan categorized linefish based on their life histories and

perceived stock status and implemented catch and effort controls including minimum size limits, daily bag limits, and closed seasons for both commercial and recreational fishers (Attwood and Bennett, 1995; Bova 2019; Griffiths and Lamberth, 2002). The Sea Fisheries Act of 1973 was succeeded by the Sea Fishery Act of 1988, which still had relatively little significance for recreational anglers other than the regulations mentioned above (Bova 2019; Griffiths and Lamberth, 2002). A revision of the linefish regulations was undertaken in 1992 by SAMLMA and several adjustments to size and bag limits were made (B. Mann, pers. comm.). Following the first democratic elections in South Africa in 1994, the Marine Living Resource Act (MLRA) (Act No. 18 of 1998) replaced the Sea Fishery Act of 1988 (Bova 2019; Griffiths and Lamberth, 2002). The MLRA was the first to specifically recognise recreational fisheries (and other fishery sectors including subsistence fisheries) and it was in terms of this act that the first national marine recreational licensing system was implemented in 1999.

The end of the 20<sup>th</sup> Century saw a comprehensive assessment undertaken of the status of South Africa's linefish resources (*inter alia* Penney et al. 1999, Griffiths 2000). This highlighted the dire situation of many linefish species which had been overexploited to the point of collapse. This led to the declaration of an emergency in the linefishery in 2000 by the then minister of the Department of Environmental Affairs and Tourism, Minister Valli Moosa (Mann 2013). Under the emergency, new more stringent regulations were developed including a 70% cut in commercial linefishing effort (introduced in terms of medium and then long-term fishing rights between 2003 and 2006) and tighter recreational linefish regulations including stricter bag limits and size limits in April 2005 (RSA 2005). Unfortunately, there have subsequently been no changes made to the marine recreational fishing regulations and the responsible stakeholder forums (i.e. SAMLMA and its successor the RFF) have both collapsed (B. Mann, pers. comm.).

This represents a failure by the responsible government department to effectively manage South Africa's marine linefish resources, particularly those harvested by the recreational sector.

Currently the management of South Africa's marine based recreational fisheries are accomplished using various input and output controls under the MLRA. Input controls include spatial and temporal limitations on fishing effort (such as marine protected areas [MPAs] and closed fishing seasons), while output controls include minimum size limits, daily bag limits and species moratoria. Marine recreational fishers must also adhere to gear restrictions, anglers may use a rod, reel, and line with no more than ten hooks attached, however there is no limit on the number of rods and reels that can be used at one time. Importantly, in terms of the MLRA, recreational anglers may not sell their catch.

One of the most important regulations governing the marine recreational fishing sector is the requirement that any recreational fisher must obtain the relevant marine recreational fishing permit to legally harvest any marine living resource (DAFF 2018; RSA 1998). Furthermore, these permits stipulate a set of regulations that permit holders must adhere to. The funds from permit sales contribute to South Africa's Marine Living Resource Fund (MLRF) to aid in subsidizing the management of marine fisheries (RSA, 1998). The regulations and funds for managing recreational fisheries are aimed to ensure sustainable use of resources, however for regulations to be effective requires compliance from participants.

All marine fishers, including recreational fishers are required to have a permit. Recreational fishers are required to purchase a monthly or annual permit to comply with current regulations (RSA, 1998). The sale of marine recreational fishing permits in South Africa represents a significant source of revenue for the Marine Living Resource Fund (DEAT 2008 & 2010; DAFF 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 & 2019; DEFF 2020). However, a recent study found that approximately 30% of recreational fishers do not comply with the

permit regulations (Bova *et al.* 2022), which represents a major loss in revenue for the MLRF. There are several interventions, such as increased law enforcement and education (Bova *et al.* 2022), that may improve compliance. In addition, understanding what aspects of the current system permit holders' value most is necessary. While earlier research into temporal permit sales trends for West Coast Rock Lobster permits exist (Cockroft and Mackenzie, 1997), no recent research has been done into trends of South African marine recreational fishing permit sales over time, the use of funds by management bodies, and the preferences of existing marine recreational fishers with regards to permit purchasing behaviour. Therefore, the overall aim of this study is to evaluate the South African marine recreational fishing permit system by analysing sales trends, the utilisation of the funds and the permit preferences of recreational anglers. To achieve this aim, the thesis has the following objectives:

- 1) to analyse the trend in sales of marine recreational fishing permits from their inception to present;
- 2) to investigate what has been done by managing bodies with funds from the sale of recreational fishing permits; and
- 3) use a DC experiment to explore the permit purchasing preferences of recreational fishers which may provide insight into strategies for increasing perceived legitimacy of the permit system, potentially closing the gap in non-compliance.

This thesis comprises four chapters. The first is the general introduction which introduces recreational fishing and its governance in South Africa with a focus on recreational fishing permits. The second chapter examines permit sales trends, and the use of the income derived therefrom. The third chapter makes use of a DCE to examine what aspects of the recreational fishing permit system in South Africa recreational fishers value most. The closing chapter summarizes the findings of chapters 2 and 3 and makes recommendations for improvements to

the South African marine recreational fisheries permit system and general recommendations for the improved governance of the marine recreational fishery.

# CHAPTER TWO

## TRENDS IN PERMIT SALES, INCOME AND USE OF FUNDS FROM THE SOUTH AFRICAN MARINE RECREATIONAL FISHING PERMIT SYSTEM

### 2.1 Introduction

Recreational fishing permit systems are a critical component of recreational fisheries governance as they provide a platform to monitor participation (Ashford *et al.* 2009; Hanson and Sauls, 2011; Hunt *et al.* 2016; Trella and Mickiewicz, 2016), a cost recovery mechanism for managing the fishery (Hunt *et al.* 2015), and opportunities for engagement and research with recreational anglers either online (Alic *et al.* 2021; NSWG, 2021; TOF, 2022) or in-person (personal correspondence). Where recreational fisheries governance is highly functional, funds from the recreational permit system can be used for research, species and habitat restoration, habitat protection, land acquisition, education, improving public access for fishing and enforcing laws and regulations (FWC, 2023; GC, 2023; NSWG, 2021; TOF, 2022). Potts *et al.* (2020) identified a well-functioning cost recovery mechanism to be a critical component of successful recreational fisheries governance.

The use of permit systems for understanding participation rates in recreational fisheries is critical for management. For example, trends in participation provide insights into the demand for recreational fishing and its impact on the fishery's resources (Ficke *et al.* 2019). This information guides management decisions and policies aimed at promoting sustainability within the sector (Ficke *et al.* 2019). Furthermore, understanding the trends in recreational

fishing activity may benefit management by allowing the development of targeted outreach and education programmes (Ficke *et al.* 2019; Hirsch *et al.* 2019; Nielsen *et al.* 2018). Finally, understanding participation can lead to a better understanding of the economic importance of the recreational fishery (in terms of permit sales and economic activity) and thus be used to inform management decisions and policy regarding resource allocation (Ficke *et al.* 2019; Hirsch *et al.* 2019; Nielsen *et al.* 2018).

Theoretically, participation rates in recreational fisheries tend to grow with economic development (Arlinghaus *et al.* 2002, 2015, 2016) and understanding where a nation is on this continuum of recreational fisheries development is important for long-term predictions of participation and future planning of how to govern the system. For example, while the participation rate in South Africa is relatively low (~2%) when compared with the total participation (freshwater and saltwater) of other nations (Arlinghaus *et al.* 2002, 2015, 2016; Potts *et al.* 2020, 2021), it is higher than the marine recreational fishery average of Europe but less than Australia, New Zealand and the United States of America (Hyder *et al.* 2018). It is expected that participation in the South African marine recreational fishery will rise with any future economic development, further necessitating the need to explore approaches for increased management capacity such as cost recovery models.

There are several cost-recovery models that have been implemented in recreational fisheries worldwide. For example, Cyprus makes use of permits to regulate fishing from boats, Croatia use permits to regulate shore fishing and Spain has differing permit requirements for each autonomous community (Hyder *et al.* 2018). South Africa makes use of annual and temporary permits that are available for specific species or gear allowances (RSA, 1998). In the USA, the cost-recovery systems make use of a combination of state (made up permit fees and other state income), federal (made up of excise tax on the sale recreational fishing goods) and local

resources (such as access fees, local non-government organizations and donations) where the federal funding is allocated through a formula using the number of fishing permits sold and the area of water within the state (NOAA, 2023; Walls and Ashenfarb, 2022). Recreational fishing permits are an effective cost recovery system and are in place in many places around the world. However, added funding from state tax and excise taxes along with other sources of income are vital for effective recreational fisheries management (NOAA, 2023; NSWG, 2021; Walls and Ashenfarb, 2022). No matter the source, funding is vital to drive a successful recreational fisheries management program (NOAA, 2023; NSWG, 2021; Walls and Ashenfarb, 2022).

Funds accrued for recreational fisheries management drive key elements within a successful management system (NSWG, 2021). In the USA and Australia, funds were used for different components of management, including research, species and habitat restoration, habitat protection, land acquisition, education, improving public access for fishing and, enforcing laws and regulations (NOAA, 2023; NSWG, 2021; TOF, 2022). The funds were also used to support recreational fishing peak bodies (representative groups for recreational fishing stakeholders) who played various roles in the management of the fisheries including pushing for accountability from government bodies, allowing for communication with government bodies, promoting participation in the fishery, increasing safety for anglers, and educating recreational fishers on sustainable practices (FWC, 2023; NSWG, 2021). Used correctly, funds drive the sustainable use of recreational fisheries resources, scientifically driven management decisions, bolster participation and drive accountability of resource managers (FWC, 2023; NOAA, 2023; NSWG, 2021; TOF, 2022).

South African marine recreational fishing permits allow the user access to many marine invertebrate and fish species. At the time of this research, all marine recreational fishing permits were only available to be acquired from the South African Post-Office (SAPO) branch locations or directly from the DFFE. More recently (2024), the permit was made available online (largely as a result of the collapse of the SAPO). A recreational permit consisted of an A4 piece of paper that requires a user to specify personal details (identification number, passport numbers for foreigners, contact information, race, and other personal details) and from there either one or more permit types can be selected (Figure 2.1). The user must then pay the total value for all permits selected on the permit document. The cost of recreational fishing permits varies in accordance with the types of permits selected and the duration of the permit (temporary or annual).

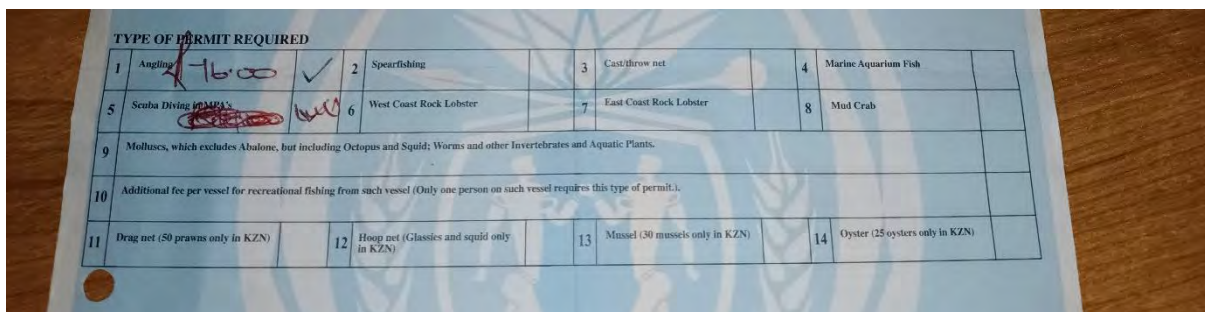


Figure 2.1: Image of South African marine recreational fishing permit types available for purchase from the South African Postal Services.

South African marine recreational fishing permit types can be species, or activity dependent (Figure 2.1). Five species-specific permits exist namely for mud crab, east coast rock lobster, west coast rock lobster, mussels, and oysters. Of these, the mud crab permit is the only one available for an annual or monthly period. Two separate multi-species permits are available. The first permits the harvest of molluscs and other invertebrates including octopus, squid, worms, other invertebrates, and aquatic plants, while the second permits the harvest of marine aquarium fish. Both permits are available for an annual or monthly period.

Gear-specific permits include spearfishing, cast (throw) net, hoop net, drag net and rod-and-line angling. All gear specific permits are available for annual or monthly periods aside from hoop and drag net which are only available as an annual permit. A permit is also required for scuba diving in a marine protected area and can be purchased using the same application process as all other permit types. It is also available as a temporary (monthly) or annual permit. Finally, a permit for recreational fishing from a vessel is needed by the skipper of the vessel. While recreational permits for abalone were historically available, this fishery was closed in 2003 (Raemakers *et al.* 2011). Recreational fishers are required to be in possession of the appropriate permit during their activities (i.e. a paper copy with receipt of purchase).

The price of permits differs regarding type of permit and its validity period (Table 2.1). The cost of the permit is made up of the application fee and then the price of the specific permit. Among them, angling is the cheapest permit at a total of ZAR 76 for an annual permit and ZAR 52 for a temporary permit. Scuba diving in MPAs is the second cheapest at ZAR 92 and 49 for a temporary permit. The rest of the permits are all standardized ZAR 94 for an annual permit and ZAR 57 for a temporary permit.

When measured against income using minimum hourly wage, the price of an angling permit with an annual validity is equivalent to two and a half hours of work. However, if someone were to purchase all permit types in an annual validity this would cost ZAR 1296 and would be equivalent to 45 hours of work or equivalent to five full nine-hour working days.

Table 2.1: Prices of the application fee for each fishing permit (FR), West coast rock lobster (WR), East coast rock lobster (EL), molluscs (ML), mud crabs (MC), marine aquarium fish (MA), angling (AG), spearfishing (SF), hoop-net (HN), drag-net (DN), cast-net (CN), additional fee for angling from a website (AF), scuba diving in marine protected areas (SD), mussels (MS) and oysters (OR) obtained from government gazette notice no.795, 2010.

Validity	FR	WR	ER	ML	MC	MA	AN	SF	HN	DN	CN	AF	SD	MS	OR
Annual	7	87	87	87	87	87	69	87	87	87	87	87	85	87	87
Monthly	7	NA	NA	50	50	50	45	50	NA	NA	50	50	42	NA	NA

The funds from the sale of fishing permits form the basis of a cost-recovery strategy for the general management of marine fisheries resources. However, as SAPOs are responsible for issuing fishing permits to the public at the time of the study, a proportion of the sale is transferred to the SAPO (i.e. in terms of a contractual arrangement between DFFE and the SAPO). After an administration fee from the SAPO, the proceeds from the South African marine recreational fishing permit system flows into the Marine Living Resources Fund (MLRF). The MLRF is a statutory fund listed as a Schedule 3A public entity that falls under the Department of Forestry, Fisheries and the Environment (DFFE, 2022). A schedule 3A public entity is an extension of a public entity with the mandate to fulfil the government's specific economic and social responsibilities (DFFE, 2022; NTRSA, 2019). As a Schedule 3A entity, the MLRF relies on government funding and public income (NTRSA, 2019). The forerunner of the MLRF (known as the Sea Fishery Fund) existed previously under the Sea Fishery Act of 1988 and was modified under Section 10 of the Marine Living Resources Act (MLRA, DFFE, 2022). According to Section 10 of the MLRA there are several sources of income into the fund (DFFE, 2002; RSA 1998). These include fines, penalties, and interest resulting from any offense committed under the MLRA. Additionally, proceeds from the sale of seized vessels, vehicles, aircraft, gear, or fish products also contribute to the fund. The fund is further supported by the collection of interest and fees, including permit fees for both

commercial and recreational purposes, as authorized by the MLRA. Parliament-approved funds, interest on investments, donations approved by the Minister of the Department of Forestry, Fisheries, and the Environment (DFFE), and money from other sources approved by the Minister of Finance can also contribute to the fund. Furthermore, any levy on marine resources is directed into the fund, ensuring its financial sustainability (DFFE, 2002; RSA, 1998).

The MLRF is partly responsible for funding the implementation of the MLRA and its several sub-programmes (DFFE, 2002; RSA 1998). These include the administration of the Fisheries Branch, Marine Resource Management, Aquaculture and Economic Development, Fisheries Research and Development, and Monitoring, Control, and Surveillance (DFFE, 2019). To promote accountability and traceability, the MLRF is subjugated to annual audits by the auditor-general of South Africa. The findings of these audits and the activities of the MLRF are available to the public in annual reports (NTRSA, 2019). While the MLRF annual report shows a relatively comprehensive overview of the income and expenses, the executive summary provides good insight into the activity of each sub-programme. Furthermore, the audit outcome provides an understanding of whether the fund has been used in a manner that is consistent with the legislation governing the fund (DFFE 2021; NTRSA, 2019). Up to now, none of this information has been examined in the context of the contribution of the MLRF to recreational fisheries management and there is little understanding of how recreational angling permit money is used for managing this fishery.

To date, the primary focus of the South African marine recreational fishing permit system has been on cost recovery and recreational sub-sector regulations, rather than utilizing permit data to enhance our understanding of participation and the factors influencing engagement in the fishery. A few studies have estimated the number of participants in the South African marine

recreational fishery. McGrath *et al.* (1997) combined an estimate of 365 000 shore anglers from Van Der Elst (1993) with a telephone poll indicating 7 920 ski-boat fishers, resulting in an estimated total of 419 920 recreational fishers. Another study by Griffiths and Lamberth (2002) utilized a 2% compound interest rate on anglers and 6% on spearfishers from previous studies done by McGrath *et al.* (1997) and Mann *et al.* (1997) and estimated 496 000 recreational fishers (Griffiths and Lamberth, 2002). More recently, Potts *et al.* (2021) estimated the total number of marine and estuarine recreational anglers in South Africa to be between 478 132 and 547 799, representing between 0.7 and 0.8% of the country's population. However, there is limited information on changes in participation over time, which is crucial for understanding the impact on fish stocks, resource allocation for recreational fisheries management, and the economic value of the fishery (Potts *et al.* 2021). Monitoring trends in recreational fisheries participation could provide valuable insights into the true nature of participation rates in South Africa helping managers gain a more comprehensive understanding of recreational fisheries in the country. This chapter aims to obtain a better understanding of the South African marine recreational permit system by examining the trends in permits purchases and expenditure by recreational anglers; and determining how the income from marine recreational fishing permits is used for the management of the recreational fishery.

## **2.2 Methods**

Determining the trends in participation based on permit data, contributions of permit fees to the MLRF, and allocation of MLRF to the management of the marine recreational fishery required a multifaceted approach. This included a public access to information (PAIA) request to the DFFE for the permit information, a desktop review of both publicly available reports pertaining to the management of the MLRF, as well as semi-structured interviews with management officials from the DFFE. The permit sales data was analysed using descriptive

statistics. Furthermore, an estimate of participation was accomplished by accounting for compliance estimates provided by Bova *et al.* (2022) pertaining to recreational fishers not complying with permit requirements, and finally a General Additive Mixed Model was run on the sales data.

The number of permits sold, and the income accrued from the sale of marine recreational fishing permits were not openly available to the public. Accessing this information required a public access request under the Promotion of Access to Information Act (No. 2 of 2000) (PAIA). Two separate requests were made to the DFFE. The first PAIA request was for information of all permits sold (including personal details, demographic information, and type of permit) from the inception of permits 1998 to 2020, however the data was only available from 2001 and only included the type of permit and its validity along with contact details. The second PAIA request was for a summary of permit sales by permit type and the total income derived from recreational fishing permit sales. This information would allow for trends of permit sales over time to be identified as well as provide insight into how much income is derived from permit sales.

Information on permits were supplied from 2001 up to 2020. The year 2001 was omitted from the study as at that stage not all anglers were aware of the permit requirement. The year 2020 was also excluded from data analysis as an anomaly due to the Covid 19 pandemic but was included in figures for further explanation. The number of permit sales were provided by permit type. The average number of sales per permit type and their proportional contribution to total sales was calculated from summary data provided by the DFFE.

To evaluate the effects of the socio-economic factors on recreational angling permit sales, this study made use of a negative binomial Generalized Additive Model (GAM) (Wood, 2017). The

GAM is capable of modelling complex, non-linear relationships between predictors and response variables while accommodating the count nature of the sales data using the negative binomial family with a log link (Wood, 2017).

Models were fitted using Restricted Maximum Likelihood (REML), which is the preferred method for estimating variance components in mixed models (Zuur *et al.*, 2009). REML accounts for the loss of degrees of freedom associated with estimating fixed effects, leading to more reliable variance estimates compared to Maximum Likelihood (ML). This approach allows the model to take into account random effects that account for heterogeneity in permit sales trends.

The dependant variable was the number of permits sold per year. The predictors selected included the year, price, gross domestic product (GDP), population size, inflation rate and unemployment rate. These were selected because they represent key socio-economic factors that may influence the spending behaviour of South Africans with regards to recreational activities, including fishing. However, due to a high multicollinearity and high overdispersion ratios and a lack of significance, price and population were removed from the final model.

Smooth terms were applied to predictors such as year, GDP, inflation, and unemployment rate to capture non-linear effects. The inclusion of a smooth term for year accounted for temporal trends, while thin-plate regression splines ensured computational efficiency by restricting the model to 5 degrees of freedom. This approach was chosen to reveal the drivers of permit sales while addressing the data's inherent complexity and variability.

The equation for a GAM is an extension of a Generalized Linear Mixed Model (GLMM) where the linear predictor includes smooth functions for some of the predictors. The general structure of a GAM can be written as follows:

$$(1) \alpha(\mu_i) = \eta_i = \beta_0 + \sum_{j=1}^p f_j(x_{ij}) + Zb$$

Where:

$\alpha(\mu_i)$  represents the link function that transforms the mean response variable to the linear predictor ( $\eta_i$ ).  $\beta_0$  is the intercept.  $f_j(x_{ij})$  indicates the smooth functions of covariates  $x_{ij}$ . These smooth functions capture non-linear relationships.  $p$  is the number of covariates modelled with smooth terms and  $Zb$  are the random effect where  $Z$  is the design matrix and  $b$  is the vector of the random effects coefficient.

For this research the GAM can be described as follows:

$$(2) \text{Log}(\mu_i) = \beta_0 + f_1(\text{Year}_i) + f_2(\text{Price}_i) + f_3(\text{GDP}_i) + f_4(\text{Population}_i) + f_5(\text{Inflation}_i) + f_6(\text{Unemployment rate})$$

Where:

$\text{Log}(\mu_i)$  is the log of the permit sales  $\mu_i$  for observation  $i$ .  $\beta_0$  is the intercept and  $f_j$  is the smoothing modelling function for the relationships of predictors.

A series of diagnostic checks were performed to ensure the reliability of the GAM results. The proportion of deviance explained and the adjusted  $R^2$  value were examined to assess model performance. The ratio of Pearson's residual sum of squares to residual degrees of freedom was computed to confirm the appropriateness of the negative binomial distribution. The adequacy of the smooth terms were assessed using the 'gam.check' function (R studio). This included evaluating the basis dimension ( $k=5$ ) and ensuring the smoothness selection process was optimal. Generalized cross validation scores were also reviewed to confirm that the chosen smoothing parameters minimized model complexity while maximizing predictive performance.

A correlation analysis was conducted to assess potential multicollinearity among predictors. A correlation matrix was generated to evaluate pairwise relationships between continuous predictor variables. Furthermore, the ratio of the sum of squared Pearson residuals to the residual degrees of freedom was computed in order to assess the overdispersion in the negative binomial model. These diagnostic checks ensured the robustness of the model and helped identify potential issues related to predictor interactions and model fit.

Smooth terms were visualized using partial effects plots with confidence intervals to interpret the relationship between predictors and permit sales with rug plots being included to indicate the distribution of data points along each predictor.

The desktop review analysed all the MLRF annual reports specifically for mention of management efforts related to recreational fisheries. These reports have followed a similar structure since their inception. The early reports were available through the DFFE website (<https://www.dffe.gov.za/>). However, many of the more recent reports were not available and they were downloaded from various non-governmental websites (<https://pmg.org.za/>) and databases (<https://www.gov.za/>). The Google search engine was used to find the remaining reports by searching the standardised report title “Marine Living Resource Fund Annual Report <YEAR>”. Despite using the government websites and search various engine results, the years 2001 up until 2006 were not found. Furthermore, the year 2008 was also not found. A thematic content analysis was conducted for each of the annual reports. Thematized governance activities including recreational fishery policy development, monitoring and surveillance, stock assessments, stakeholder engagement, and the development of management frameworks were identified in each report. For instance, if recreational fisheries were found to be mentioned in a MLRF annual report with a direct mention to recreational fisheries stakeholder engagement, this would be classified as a direct contribution to governance. Activities were categorised as

a direct contribution to recreational fisheries management, an indirect contribution (where activities aligned with other fisheries had positive consequences for the recreational sector, e.g. a stock assessment for a commercial species that is also targeted by recreational fishers), or not relevant to recreational fisheries management. The state of the activity was categorized as either fully accomplished or in development.

Informed DFFE officials were contacted to set up semi-structured interviews with questions around the recreational permit system, the use of recreational fishing permit money, and the governance of recreational fisheries (see Appendix I). The interviews aimed to understand what proportion of funds derived from the sale of recreational permits are paid to the South African Post Office (who has administered the sale of permits), what management measures are put in place specifically for the recreational fisheries by DFFE, how budget is allocated to fisheries management, and the capacity of Monitoring, Control, and Surveillance officers regarding different fisheries sectors. These were provided to representatives one week before the interview. The interviews were conducted by telephone, and follow-up information was provided via email. The officials interviewed are not named to maintain anonymity. Each of the questions were addressed during the interviews, however, many stimulated further discussions and these, when relevant to the research, were also reported. The interview was recorded with the consent of the interviewee and the answers to each question were summarised in text (Ethics approval number: 2021-5044-6418).

Table 2.2: A table of the structured questions provided to the Department of Forestry Fisheries and the Environment officials for a semi structured interview.

Question
1) What is the flow of income from marine recreational fishing permit sales from purchase to the MLRF?
2) What expenses are incurred through administering the permits through the post office?
3) What is the budget allocation process for the chief directorates from the MLRF?
4) Is there a budget for recreational fisheries management?

- 
- 5) How many officers are tasked with overseeing recreational fisheries?
  - 6) What proportion of their time do fisheries officers spend on recreational fisheries?
  - 7) What research is conducted on recreational fishing (i.e., Effort, CPUE, Perceptions and Attitudes)?
  - 8) Is there a management plan for recreational fisheries in South Africa?
  - 9) Are there plans for the DFFE to improve the recreational fishing permit system?
  - 10) Are there any specific management plans for overexploited species other than commercially important species?
  - 11) How often are recreational fishing stakeholder meetings held?
  - 12) How does the DFFE engage with recreational fishing stakeholders?
  - 13) How does the DFFE refer to these stakeholder engagements in any annual reports?
  - 14) Is the MLRF used for improving recreational fishing access or infrastructure?
  - 15) Has the DFFE considered the economic benefits of improving/promoting recreational fisheries participation?
- 

## 2.3 Results

A total of 5 085 834 marine recreational permits were sold between 2002 and 2019, with an average annual sale of  $282\,362 \pm 40\,788$  per annum (Table 2.3, Table 2.4). A total of 84.4% (4 291 594) were annual, while the remainder were monthly permits (Table 2.3, Table 2.4). The most purchased permit type was recreational angling (57.0%), followed by molluscs and other invertebrates (14.5%) and west coast rock lobster (11.6%) (Table 2.3, Table 2.4, Figure 2.2). Other permit types contributed less than 5% to the overall sales (Table 2.3). Marine recreational fishing permit sales increased by 39% from 2002 to 2019 (Figure 2.3). There was an anomalous peak in sales in 2020 (Figure 2.3). When accounting for the 30% lack of compliance shown by Bova *et al.* (2022) on the number angling permits sold in 2015/2016 financial year (the same year used by Potts *et al.* (2021) to estimate participation) there were an estimated 293 157 anglers.

Table 2.3: Number and percentage of total sales of South African marine recreational fishing permits from 2002 to 2019, broken down into the various permit types.

Permit Type	Temporary	Annual	Both	% Total Sales
Angling	557 210	2 341 941	2 899 151	57.0
Molluscs	50 493	684 285	734 778	14.4
West Coast Rock Lobster	91 306	498 195	589 501	11.5
Angling from vessel	13 992	201 730	215 722	4.2
Cast net	16 609	133 019	149 628	2.9
East Coast Rock Lobster	11 176	114 192	125 368	2.4
KZN mussel	856	70 924	71 780	1.4
Spearfishing	9 535	62 050	71 585	1.4
Scuba diving	5 033	63 216	68 249	1.3
Abalone	14 624	40 752	55 376	1.0
Mud Crab	14 254	40 455	54 709	1.0
Marine aquarium	2 803	11 977	14 780	0.2
KZN oyster	0	10 357	10 357	0.2
KZN hoop net	4 854	1 383	6 237	0.1
KZN drag net	246	3 516	3 762	<0.1
<b>Total</b>	<b>794 240</b>	<b>4 291 594</b>	<b>5 085 834</b>	<b>100</b>

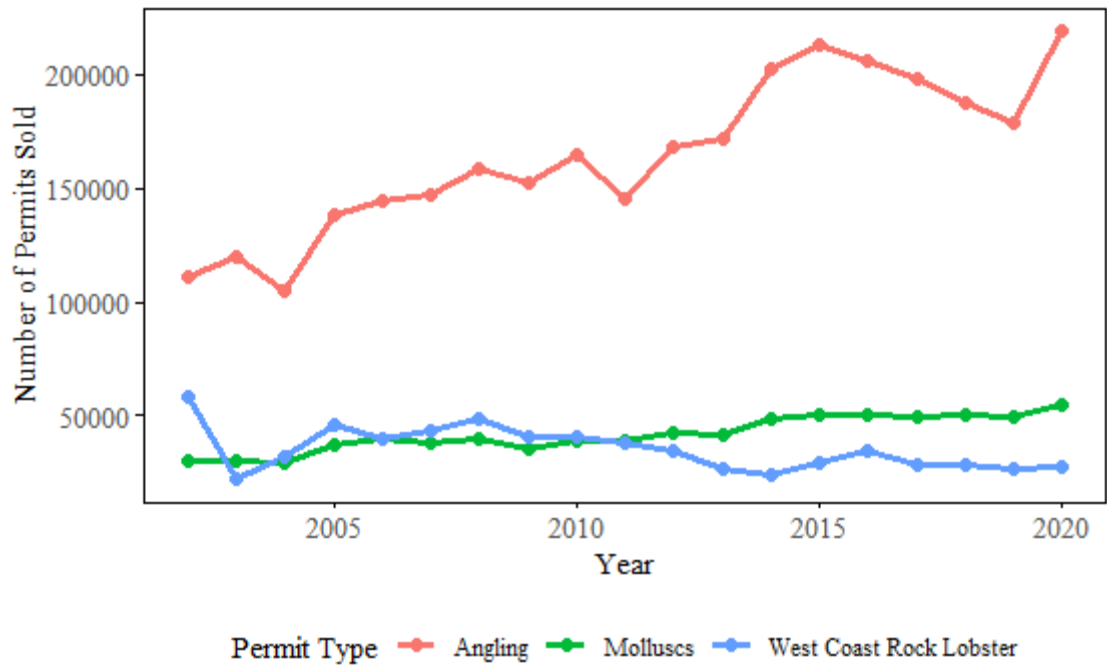


Figure 2.2: Sales of the top three most popular South African marine recreational fishing permit types from the year 2002 up until 2020. Data source: Promotion of Access to Information Act request to the Department of Forestry, Fisheries and the Environment.

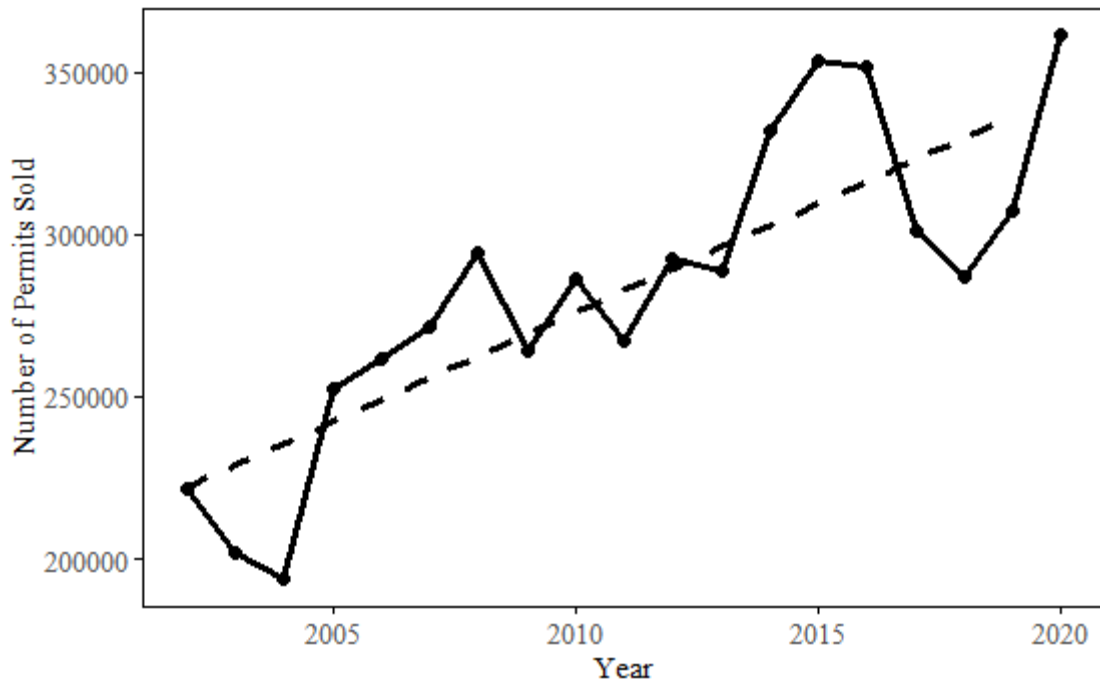


Figure 2.3: The total number of marine recreational fishing permits sold per year, and a fitted linear regression model (dotted line  $y = 6.724073e+03x + -1.323946e+07$ ,  $r^2 = 0.65$ ) over the period from 2002 up until 2020 Data source: Promotion of Access to Information Act request to the Department of Forestry, Fisheries and the Environment

A negative binomial generalized additive model (GAM) with a log link function was fitted to assess the relationship between the number of marine recreational fishing permits issued and key economic and temporal variables, namely Year, GDP, Inflation, and Unemployment Rate. Population and Price were removed as predictors due to their multicollinearity with year and GDP, reducing redundancy and improving model interpretability. The GAM model explained a significant proportion of the variance in permit sales with an adjusted  $R^2 = 0.82$  and 88.9% of the deviance explained. The REML score was 217.43 and the scale estimate was 1, indicating a reasonable fit.

Of the smooth terms, only year had a significant effect on the permit counts ( $p < 0.001$ ), indicating a non-linear temporal trend. However, none of the socioeconomic predictors were

found to be of any importance to permit buying trends as GDP ( $p=0.141$ ), inflation ( $p=0.280$ ) and unemployment rate ( $p=0.582$ ) had no significant effects (Table 2.4).

Table 2.4: Parametric coefficients and smooth terms for the Generalized Additive Model

Smooth Term	edf	Ref.df	F	p-value	Significance
s(Year)	2.991	3.511	23.635	<0.001	***
s(GDP)	1.001	1.002	2.167	0.141	
s(Inflation)	1.001	1.001	1.169	0.28	
s(Unemployment)	1	1.001	0.303	0.582	

Plots of the smoothing terms (Figure 2.4) indicated that that permit buying trends exhibited a significant non-linear temporal trend with noticeable fluctuations across years and a general upward trend. The smooth functions for GDP, Inflation and Unemployment rate suggested weak and non-significant relationships with permit numbers.

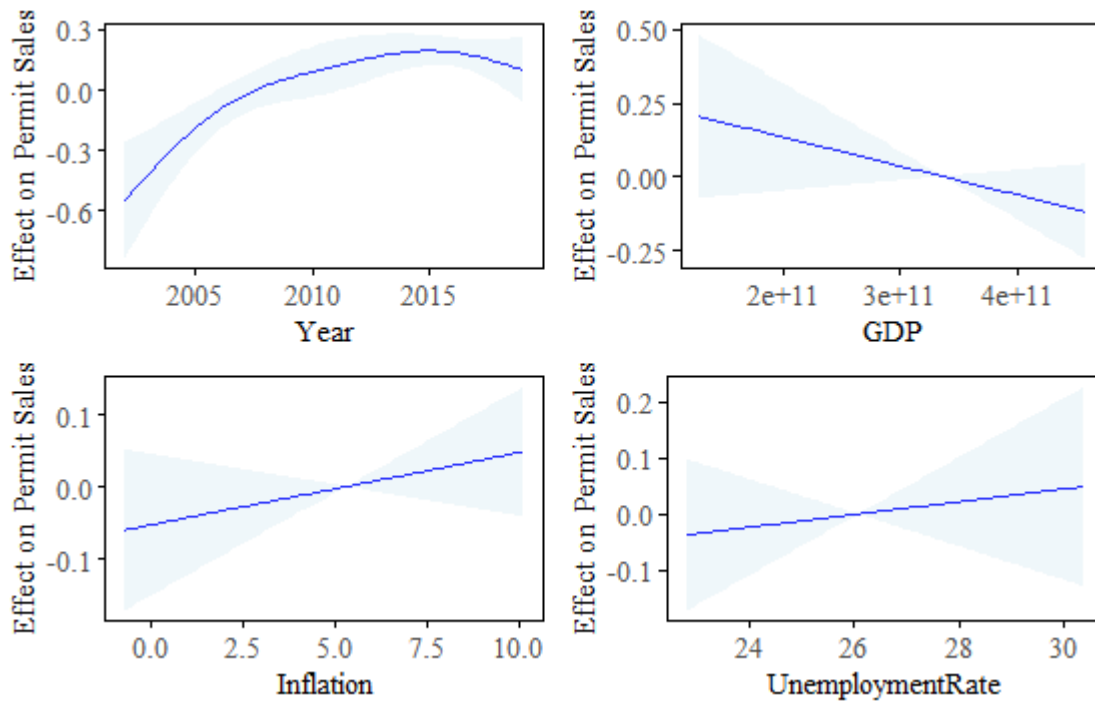


Figure 2.4: Smoothed Effects of Temporal and Economic Variables on Marine Recreational Fishing Permit Sales. Each plot represents the estimated smooth function for a predictor, with the solid blue line indicating the estimated effect and the shaded light blue ribbon representing the 95% confidence interval.

The adequacy of the model was confirmed with the diagnostic checks. The overdispersion was calculated as 0.985 and was indicative that the negative binomial assumption appropriate. Basis dimension checking results showed that the smoothing parameters were well estimated as all k-index values exceeded 0.99 ( $p > 0.35$ ).

Variance inflation factor values for all predictors were extremely large (inf) suggesting strong multicollinearity. Correlation analysis revealed correlations between year and price (0.90), as well as between GDP and price (0.91). Hence, they were removed from the model. Of the predictors that were kept, year and GDP also showed a strong correlation (0.73) with weaker associations among other variables.

The cumulative income generated from the sale of all marine recreational fishing permits between 2002 and 2019 amounted to ZAR 767 094 512 (Table 2.4). Annual permits accounted for 92.8% of this income, while monthly permits contributed 7.2%. Among the permit types, angling permits generated 53.8% of the total income, followed by permits for molluscs and other invertebrates (17.6%), and west coast rock lobster (13.0%) (Table 2.4). The lowest income from recreational fishing permits was obtained in 2004 (ZAR 17 815 407) while the highest was in 2020. The mean annual income from recreational fishing permits was ZAR 37 427 184 ± 44 401.9. The annual income from the sale of marine recreational fishing permits increased by 153% between 2002 and 2019 (Figure 2.4).

Table 2.5: Table of averages for marine recreational permit sales from 2002 up to 2019 for all permits, per permit validity, per permit type, the income from the sale of all permits and per permit validity.

Permit Type	Average Annual Sales		
	Temporary	Annual	Total
Income (ZAR)	2 161 889.4±1 246 824.6	33 409 226.5±13 793 494.8	37 427 184.1±44 401.9
Total	33 200.7±12 467.1	249 161.2±30 633.7	282 362.1±40 787.8
Angling	26 555.0±9 737.7	134 372.9±23 737.4	160 927.9±32 305.7
Molluscs	1 444.2±1 285.5	39 346.5±7 884.1	40 790.7±7 265.3
West Coast Rock Lobster	1 849.0±1 928.4	30 901.1±14 815.8	32 750.0±13 755.5
Angling from vessel	424.4±254.1	11 626.1±2 463.2	11 979.8±2 422.4
Cast net	688.0±244.2	7 622.0±1 968.0	8 310.0±2 174.2
East Coast Rock Lobster	385.9±345.2	6 578.9±1 153.5	6 964.8±1 440.2
KZN mussel	47.5±456.2	3 940.2±3 756.2	3 987.7±3 805.5
Spearfishing	373.8±147.4	3 600.1±1 476.9	3 974.0±1 501.8
Scuba diving	279.6±541.6	3 512.0±3 521.1	3 791.6±3 995.5
Mud Crab	741.5±612.1	2 431.7±1 555.1	3 038.1±1 737.7
Abalone	N/A	3 076.4±7 978.6	3 076.4±7 978.6
Marine aquarium	129.5±43.2	691.1±79.4	820.7±103.8
KZN oyster	N/A	575.3±540.1	575.3±540.1
KZN hoop net	269.6±456.2	76.8±77.0	346.5±498.1
KZN drag net	13.6±25.3	195.3±185.7	209.0±200.6

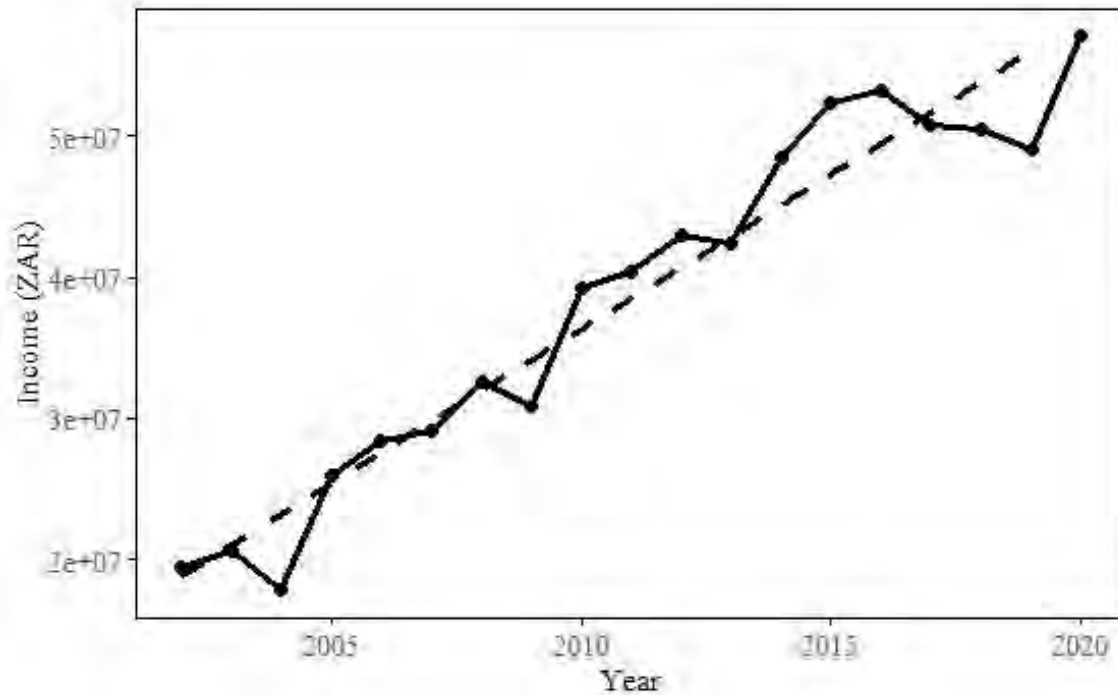


Figure 2.5: The income (in ZAR) from of marine recreational fishing permits sales, trend in income (dotted line  $y = 2.186198e+06x + -4.357924e+09$ ,  $r^2 = 0.93$ ) per capita from the year 2002 up until 2019 Data source: Promotion of Access to Information Act request to the Department of Forestry Fisheries and the Environment for permit sales data

The MLRF reported expenditure on several activities that related to recreational fisheries governance between 2007 and 2020 (reports from 2001 up to 2006 and 2008 were unavailable). Research directed at species targeted by the recreational fisheries was conducted in 2007 (Table 2.4). However, from 2009 onwards, research was only conducted on species that were shared with the commercial sector (e.g. west coast rock lobster *Jasus lalandii*). Initially (from 2007 to 2012), there was evidence of an attempt to develop a recreational fisheries policy and a recreational fisheries management framework, although this was never accomplished (see Table 2.4). However, a management framework for recreational charter fishing was developed and finalized by 2012. This included a framework to permit charter fishing vessels separately, but the policy was never finalised or implemented. In the years 2010 and 2012, the annual report highlighted funding for compliance efforts that were specifically directed at recreational

fishers (Table 2.4). However, compliance efforts in subsequent years were focussed on the commercial fisheries, although some of the species targeted in some sub-sectors of the commercial fishery (e.g. the commercial linefishery) overlap with the recreational fishery (Table 2.4).

Reports from 2009 to 2012 indicated that some stakeholder engagement with recreational fishers took place through working groups (i.e. through SAMLMA and the RFF) (Table 2.4). However, after 2012, there was no evidence for further stakeholder engagements. Processing of recreational fishing permits and making that data available to the public only became prevalent in the annual reports between 2015 and 2019 (Table 2.4). Furthermore, the development of an online system for the sale of marine recreational fishing permits along with more durable forms of a fishing permit, in smart card format (such as a driver's permit), was initiated in 2016, but had still not been fully completed at the time of this study (except for making the permit accessible for purchase online which was introduced in 2024).

While the MLRF is partly responsible for funding the management of South Africa's marine living resources, and the annual reports do not specify how the income derived from various sources is utilized after it enters the MLRF (DFFE 2021).

Table 2.6: Summary of the contributions in terms of policy development (PD), research (RS), development of management plans (MP), development of management frameworks (MF), monitoring of catch and effort (CE), compliance, surveillance and enforcement activities (PC), stakeholder engagement (SE), stock assessment (SA), implementation of stock rehabilitation programs (SR), facilitating working groups (WG), processing permits (PP), development of an online permit system (EP) and the dissemination of information to the public (PI) by the Marine Living Resources Fund (MLRF) and the Department of Forestry Fisheries and the Environment to recreational fisheries governance between 2007 and 2021. The year 2009 was omitted due to its lack of availability. **Red**= nothing accomplished, **orange** = developmental stage, **blue** = accomplished for commercial species that are also targeted by the recreational fishery, **green** = accomplished.

Year	PD	RS	MP	MF	CE	PC	SE	SA	SR	WG	PP	EP	PI
2007	Orange	Green	Red	Orange	Blue	Blue	Red	Blue	Red	Blue	Red	Red	Red
2008	Blue	Blue	Orange	Orange	Blue	Blue	Green	Blue	Red	Blue	Red	Red	Red
2010	Red	Blue	Blue	Red	Blue	Green	Orange	Blue	Red	Blue	Red	Red	Red
2011	Orange	Blue	Orange	Orange	Blue	Green	Green	Blue	Red	Blue	Red	Red	Red
2012	Orange	Blue	Orange	Green	Blue	Green	Green	Blue	Red	Green	Red	Red	Red
2013	Red	Blue	Blue	Red	Blue	Blue	Blue	Blue	Red	Red	Red	Red	Red
2014	Red	Blue	Blue	Red	Blue	Blue	Red	Blue	Red	Red	Red	Red	Red
2015	Red	Blue	Blue	Red	Blue	Blue	Red	Blue	Red	Red	Green	Red	Red
2016	Red	Blue	Blue	Red	Blue	Blue	Red	Blue	Red	Red	Green	Orange	Green
2017	Red	Blue	Blue	Red	Blue	Blue	Red	Blue	Red	Red	Green	Orange	Green
2018	Red	Blue	Blue	Red	Blue	Blue	Red	Blue	Red	Blue	Green	Red	Red
2019	Red	Blue	Blue	Red	Blue	Red	Red	Blue	Red	Blue	Green	Red	Red
2020	Red	Green	Red	Red	Blue	Blue	Blue	Blue	Red	Blue	Green	Red	Red

Table 2.7: A summary of the outcomes and findings of the auditor general for the Marine Living Resources Fund Annual Review. An Unqualified report indicates the financial statements present fair and true with no material misstatements. A qualified opinion indicates that the financial statements show some material misstatement or limitations but otherwise present as fair. A disclaimed audit indicates that there is insufficient evidence for the auditor to form an opinion on the financial statements.

Year	Department	Audit	Other Findings
2006/2007	Marine and Coastal Management (DEAT)	Qualified	Misconduct investigations, fraud, corruption, non-compliance with procurement policies.
2007/2008	Marine and Coastal Management (DEAT)	Unqualified	Misconduct investigations, non-compliance with procurement policies, under-expenditure of budget, material misstatements
2009/2010	Marine and Coastal Management (DEAT)	Unqualified	Misconduct investigations, non-compliance with procurement policies, under-expenditure of budget, material misstatements
2010/2011	Fisheries Branch (DAFF)	Unqualified	Transfer of MLRF to DAFF, mismanagement findings, material under-expenditure, non-compliance with regulations, fraud, corruption, under-expenditure of ZAR 295.7 million.
2011/2012	Fisheries Branch (DAFF)	Unqualified	Continued issues with mismanagement, fraud, non-compliance with policies, under-expenditure of budget, material misstatements in annual reports
2012/2013	Fisheries Branch (DAFF)	Unqualified	Continued issues with mismanagement, fraud, non-compliance with policies, under-expenditure of budget, material misstatements in annual reports
2013/2014	Fisheries Branch (DAFF)	Unqualified	Continued issues with mismanagement, fraud, non-compliance with policies, under-expenditure of budget, material misstatements in annual reports
2014/2015	Fisheries Branch (DAFF)	Unqualified	Continued issues with mismanagement, fraud, non-compliance with policies, under-expenditure of budget, material misstatements in annual reports
2015/2016	Fisheries Branch (DAFF)	Unqualified	Continued issues with mismanagement, fraud, non-compliance with policies, under-expenditure of budget, material misstatements in annual reports
2016/2017	Fisheries Branch (DAFF)	Unqualified	Continued issues with mismanagement, fraud, non-compliance with policies, under-expenditure of budget, material misstatements in annual reports
2017/2018	Fisheries Branch (DAFF)	Qualified	Audit found significant issues with compliance, fraud, and material misstatements.
2018/2019	Fisheries Branch (DAFF)	Disclaimed	Worst audit outcome: disclaimed audit opinion due to mismanagement, fraud, non-compliance, and material under-expenditure
2019/2020	Department of Environment, Forestry, and Fisheries (DFFE)	Qualified	MLRF transferred to DEFF, mismanagement of funds, material under-expenditure, significant compliance issues raised.

In total the annual reviews of the fund showed that the auditor general gave a disclaimed audit opinion once, a qualified audit opinion three times and an unqualified opinion 9 times (Table 2.5). The auditor general of South Africa reviewed the annual report of the MLRF and along with providing an audit opinion stating their findings. The findings of the reviews revealed that various investigations were made into misconduct by government department staff in terms of fraud, corruption, and mismanagement of the fund (Table 2.5). There were many years where staff did not adhere to any of the policy or regulations that govern the fund in terms of local purchasing, advertising of tenders, approving tenders without inviting competitive bids, material misstatements in the annual reports, not setting realistic targets, and not taking steps against individuals that were in contravention of regulations and policy (Table 2.5). There were also many years where the MLRF demonstrated under spending of the budget with a total ZAR 295.7 million of government grants not being spent. (DAFF 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 & 2019; DEFF 2020).

A thematic summary of the responses to each question asked to the DFFE management officials (see Table 2.2 Appendix I) and further discussions is presented below:

*1) What is the flow of income from the marine recreational fishing permits sales from purchase to the MLRF.*

The South African Post Office (SAPO) has been contracted to facilitate the purchase of recreational angling permits. Money is collected from fishers by the SAPO and transferred directly into the MLRF. The Fisheries Branch of the DFFE is responsible for the MRLF and it is used to fund all fisheries governance activities.

*2) What expenses are incurred through administering the permits through the post office?*

The SAPO receives approximately 20% of the total revenue derived from the sale of marine recreational fisheries permits. Based on the income from the least five years, this value is around ZAR 9 893 951 per annum.

*3) What is the budget allocation process for the Chief Directorates within DFFE from the Marine Living Resources Fund?*

The different Chief Directorates (sub programmes) within the Fisheries Branch of the DFFE develop an annual budget before an internal allocation process is followed. It should be noted that the approximately ZAR 300 000 000 per annum available from the MLRF budget is insufficient to accomplish all the DFFE's fisheries management duties. Once the budgets for the various Chief Directorates are agreed upon, they are approved by the Deputy Director General (head of Fisheries Branch) and by the accounting authority of the MLRF.

*4) Is there a budget for recreational fisheries management?*

There is no budget allocated to recreational fisheries as the funds are distributed directly to the Chief Directorates. Three of these directorates; Marine Resource Management, Fisheries Research and Development, and Monitoring, Compliance and Surveillance, partly focus on activities associated with the governance of recreational fisheries.

The Chief Directorate of Marine Resource Management is largely responsible for developing allocations, regulations, and recovery plans for collapsed stocks. The directorate is divided into management groups which include Inshore Resources (which includes the commercial and recreational linefisheries, abalone and rock lobster fisheries). This group comprises several resource groups, including a linefish group that manages fish targeted by the recreational and commercial linefishery, rock lobster group and seaweed group. Other management groups include Offshore Resources, which includes various commercial and industrial fisheries and

small-scale fisheries, which largely focusses on the implementation of the small-scale fisheries policy.

The Marine Resources Research Directorate is responsible for conducting research into the status of marine living resources. This directorate is organised into resource research groups such as rock lobster, squid, and linefish (which includes both recreational and commercial species). In terms of monitoring the recreational fishery, the DFFE used to conduct telephonic surveys to obtain catch and effort information (mainly for the abalone and west coast rock lobster fisheries). However, this was discontinued in 2015 due to budgetary and staff constraints. Furthermore, the catch and effort monitoring programme in KwaZulu-Natal ceased when the DFFE failed to renew the contract with Ezemvelo Wildlife in 2016 (see Kramer et al 2019).

The Compliance, Monitoring and Enforcement Directorate is responsible for enforcing the regulations and preventing unlawful use of our marine living resources. They are responsible for the commercial, recreational, and small-scale sectors.

*5) How many officers are tasked with overseeing recreational fisheries?*

There are approximately 183 Fishery Control Officers (FCOs) able to be deployed for enforcement of the regulations of all marine fisheries (commercial, recreational, and small-scale).

*6) What proportion of their time do fisheries officers spend on recreational fisheries?*

Fishery Control Officers spend approximately 10% of their time on enforcement activities related to management of the marine recreational fishery.

*7) What research is conducted on recreational fishing (i.e. Effort, CPUE, Perceptions and Attitudes)?*

Research is carried out on fisheries resources (i.e. West coast rock lobster, linefish, hake, etc.) rather than on recreational fisheries specifically. This is primarily stock assessment research and is mainly focussed on species captured by the commercial fishery. Thus, research is only conducted on the few recreational fishery species that are also important targets in commercial fisheries. No human dimension research is conducted by this directorate. This can primarily be attributed to a lack of funding and human resources. However, if data are made available (for example by independent research groups), DFFE will consider using it. An example of this is the data collected by independent observers onboard commercial fishing vessels for rock lobster and other fisheries.

*8) Is there a management plan for recreational fisheries in South Africa?*

There is currently no management plan for any specific fishery. The marine resource groups (such as an abalone resource group and rock lobster resource group etc.) provide recommendations for the allocation of total allowable effort, total allowable catch, and resource recovery programmes (limits catch and effort allocation) for different commercial resource user groups.

*9) Are there any plans for the DFFE to improve the recreational fishing permit system?*

Yes, there are. DFFE is planning to implement an E-permit (online system of purchasing marine recreational fishing permits) system. Note that at the time of questioning this was still in the planning stages. Since the completion of this research project, the E-permit system has been implemented.

*10) Are there any specific management plans for overexploited species other than commercially important species?*

Species that are not exploited commercially do not receive much, if any attention.

*11) How often are recreational fishing stakeholder meetings held?*

No stakeholder meetings are held. Stakeholders need to form a recognized industrial body that represents recreational anglers. Recreational fisheries have been neglected because DFFE has previously not recognized the social, economic, and ecological importance of recreational fisheries.

*12) How does the DFFE engage with recreational fishing stakeholders?*

Although there was a Recreational Fisheries Forum (RFF), which provided a platform for information exchange between the department and recreational fishing representatives in the early 2000s, there is currently no stakeholder engagement with recreational fishers.

*13) How does the DFFE refer to these stakeholder engagements in any annual reports?*

There is currently no stakeholder engagement with recreational fishers.

*14) Is the MLRF used for improving recreational fishing access or infrastructure?*

The MLRF is currently not used to improve recreational fisher access or infrastructure.

*15) Has the DFFE considered the economic benefits of improving/promoting recreational fisheries participation?*

No consideration has been given to the economic benefits of improving and promoting recreational fisheries participation.

## 2.4 Discussion

The sale of recreational fishing permits and the income derived represent a substantial (12.5% on average) and increasing contribution to the overall MLRF budget, which provides the DFFE with considerable funding for fisheries management activities. However, there is little evidence to suggest that much of this funding is dedicated towards management activities directly associated with the marine recreational linefishery.

The results of this chapter have demonstrated that despite the considerable monetary contribution by recreational fishers to the MLRF, the South African recreational fishery receives little direct management attention (Table 2.4). This lack of management attention may hint at a lack of recognition to the economic importance (Potts *et al.* 2021), and the impact of the marine recreational fishery on linefish resources (Potts *et al.* 2020, Bova *et al.* 2022). The lack of recognition is reflected in all spheres of governance. This was recognised by the DFFE officials who were interviewed, and the reasons given were that the department had not recognized the social, economic, and ecological importance of recreational fisheries. The first step to changing this would have to be a policy shift. Presently, although recreational fisheries are defined and mentioned directly within the MLRA, the policy is weak, particularly regarding how recreational permit funds are used, the requirement of stakeholder engagement with recreational fisheries and the mandatory development and implementation of a recreational fisheries management framework.

In terms of the marine recreational permit system, the current policy does not require any proportion of the funds from recreational fishing permit sales to be ear marked for the management of recreational fisheries, which is in stark contrast to countries identified as having good recreational fisheries governance (Potts *et al.* 2020). In their review of global recreational

fisheries governance, Potts *et al.* (2020) identified the USA and Australia to be the nations with the best recreational fisheries governance practices. Both countries, have implemented user-pay systems. Within these systems, funds accrued from recreational fishing permits have to be spent for the management and benefit of recreational fisheries (NSW, 2021; TOF 2022; Walls and Ashenfarb, 2022). In addition, an excise tax on fishing equipment in the USA, such as tackle, boats, boat motors, and many other fishing related goods, are placed into the Sport Fish Restoration program (Dingell-Johnson Act, 1950) and are used to supplement funding of recreational fisheries management effort towards the enhancement of recreational fisheries resources (Walls and Ashenfarb, 2022). Furthermore, in the USA, state revenue acquired through the receipt of permit sales is matched by the federal government through revenue derived from the Sport Fish Restoration Program to be directed towards the management of fisheries. It is suggested that these potential mechanisms should be considered when drafting amendments to the MLRA.

A clear lack of stakeholder engagement was obvious both from the MLRF reports (Table 2.4) and the interviews with government officials. In these interviews it was suggested that the management agency had decided not to pursue any proactive stakeholder engagement because it was too complex. Further, there was a suggestion that the stakeholders need to form a recognized industrial body that represent recreational fishers. Indeed “peak bodies” or recreational fishery interest groups are a central component of the management of recreational fisheries in the USA and Australia and play a critical role by representing the views and interests of recreational fisheries, holding the management agency to account during the decision-making process and even performing various management functions (NSWG, 2021; RFA 2023). However, critical to the success of these groups is funding and most peak bodies are supported primarily by fisheries management agencies and in many cases through the funds

from recreational angling permits (NSWG, 2021; RFA 2023). Interestingly, both SAMLMA and the RFF were “recognised industrial bodies” in terms of the MLRA but both failed to survive primarily due to a lack of response from DFFE and subsequent frustration of the stakeholders (B. Mann, pers. comm.). A policy amendment to ensure funding support for the development and operation of a recognised industrial body that represents recreational fishers will be critical for improving recreational fisheries management. Similarly, a commitment from government in terms of the policy amendment is required to act upon and implement recommendations made by such a body.

The existing structure of the DFFE hinders recreational fisheries management. Presently, several sub-programmes (directorates) are responsible for the implementation of the MLRA (DFFE, 2002; RSA 1998). Within the Fisheries Branch these are: Marine Resource Management, Aquaculture and Economic Development, Fisheries Research and Development, and Monitoring, Control, and Surveillance (DFFE, 2019). Thus, there is no directorate within DFFE that assumes direct responsibility for the management of recreational fisheries, or any other specific fishery sector for that matter. Rather, the responsibility for the management of recreational fisheries is primarily taken by the Marine Resource Management Directorate, while the activities of the recreational anglers are monitored and controlled by the Monitoring, Control, and Surveillance Directorate.

Within the Fisheries Research and Development Directorate there are several scientific working groups. Of these, the linefish and rock lobster working groups are responsible for formulating monitoring plans and conducting stock assessments of the species targeted by both the commercial and recreational fishery. The working groups then use these findings to make recommendations on regulatory changes for each fishery to the resource managers (within the Marine Resource Management Directorate), who then modify them as appropriate before

obtaining endorsement for promulgation. Management decisions are therefore made based primarily on the population status of target species, with some additional input from the managers.

While the management system described above has been in use for decades, it has inherent flaws that hinder the management of recreational fisheries and poses serious threats to the long-term sustainability of the fishery. Firstly, the focus on the management of individual species is concerning as it does not account for changes in the fishery system itself (ultimately fisheries management is about managing people not fish). While the commercial and small-scale sectors are restricted access fisheries achieved by limiting the number of permits issued and/or having strict entrance requirements (e.g. long-term fishing rights), the recreational fishery is open access. Thus, participation in the recreational fishery can change quickly as was shown by the 38.9% increase in permit sales (assumed to be participation) between 2002 and 2019 (Figure 2.3). The lack of consideration for components of the fishery system, aside from the status of target species is an issue. For example, increases in recreational effort in this system (and likely the associated catch of target species), should at least be accompanied with a regulatory framework and an emphasis on improving compliance, which was found to be extremely poor in this fishery (Bova *et al.* 2022). In addition, while there is some overlap in target species between the recreational and commercial fisheries, several species are targeted solely by the recreational fishery so are currently excluded from management consideration.

Stock assessments of species targeted by the recreational fishery have mainly been done by academic institutes outside government (e.g. white steenbras (Bennett 1993), leervis (Maggs *et al.* 2016), etc.). Stock assessments conducted by government scientists focus on the top eight species harvested by the commercial linefishery (Table 2.4). This is simply because commercial rights holders are mandated to report their catches, which provides fishery-

dependent data for stock assessment (known in South Africa as the National Marine Linefish System [NMLS] that was started in 1984). There are concerns with this approach. The first is that the catch and effort information of the recreational sector is not considered in these assessments. This is problematic as the boat-based recreational fishery is substantially larger (in terms of participation), is more dispersed and more mobile, as the motivation for fishing are beyond profit (Potts *et al.* 2019). Therefore, the stock assessments of these commercial species are conducted without a large proportion of the catch information and may therefore be unreliable.

A second concern with the stock assessment approach conducted by the government working groups is that none of the recreational fishery species can be assessed and managed as there is no monitoring information available for this fishery. This is a serious issue because the populations of several of the recreational target species have collapsed (Mann 2013) and many have been categorised as threatened or endangered (Mann 2013). Ultimately, the combination of the current DFFE structure and the lack of monitoring of the recreational fishery has resulted in the stagnation in improvements to the current system. For example, there have been no substantial amendments made to the recreational fishery regulations since April 2005. Therefore, structural changes within the DFFE to incorporate the open access recreational fisheries into monitoring, assessment and management are urgently required. One of the barriers to these structural changes that was identified by the DFFE representatives was the lack of capacity and specific expertise on recreational fisheries. While this may not be remedied in the immediate future, the development of partnerships with non-governmental organisations, such as universities and research institutions may be necessary to jointly motivate for funding from the MLRF or from other funding agencies.

While the structure problems in the Marine Resource Management Directorate were problematic, the Monitoring, Compliance and Surveillance (MCS) Directorate did not appear to place much focus on the recreational sector. While the mandate of this directorate was to protect all South Africa's marine living resources, the MLRF reports suggested that most compliance effort was focussed on harbours where fish were landed and within MPAs. In addition, the commercial fishers were the primary focus to ensure adherence of rights holders to regulations and a lot of emphasis was placed on abalone and west coast rock lobster (DEAT 2008 & 2010; DAFF 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 & 2019; DEFF 2020; DFFE 2021). However, the MCS directorate did partner with law enforcement entities (such as the South African Police Service), resulting in increased monitoring surveillance effort and investigations into allegations of non-compliance (DEAT 2008 & 2010; DAFF 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 & 2019; DEFF 2020; DFFE 2021). Information from the DFFE representatives suggested that 10% of all compliance efforts are dedicated toward recreational fishing related activity. While this indicates that the sector is not completely neglected, the socio-economic and environmental importance of recreational fisheries demands increased attention from the responsible management authorities in South Africa (Potts *et al.* 2019).

In addition to the lack of enforcement activity directed at the recreational fishery, the directorate takes an instrumental approach to fisheries compliance. This approach assumes that fishers are rational actors and that the decision to remain compliant is dependent on the perceived risk associated with being caught (Bova *et al.* 2022). The reliance on the instrumental approach is concerning, particularly as Bova *et al.* (2022) questioned its efficacy in a recreational fisheries context. Bova *et al.* (2022) suggested that alternative interventions that align with the normative approaches may be important to improve recreational fishery

compliance. In this study, only one such intervention, an engagement between the management authority and recreational fishery stakeholders around rules, regulations, and compliance, was documented in 2010 (DAFF 2011). Ultimately, the diversification of MCS strategies to include normative interventions and behavioural nudges, such as improving education around the existing regulations, targeted advertisement campaigns aimed at correcting lack of compliance (Bova *et al.* 2017), education regarding conservation minded practices (Mackay *et al.* 2018), and transparent and effective use of funding by governing bodies, is required to improve governance effort towards recreational fisheries management which can enhance perceptions of legitimacy (Bova *et al.* 2022).

Another finding was the poor audit outcomes in the annual reports of the MLRF. In South Africa, there is a recognition by public administration, academics, practitioners, and civil society that corruption in the public sector has detrimental consequences for service delivery (Manyaka 2014). Corruption can also have adverse effects on common pool resources such as South Africa's marine living resources (Sundstrom, 2012). Sundstrom (2012) suggested that corruption exists within the small-scale fishing sector whereby fisheries inspectors would accept bribes to overlook non-compliant activities. This would have deleterious effects on marine living resources as it allows for unrestrained harvest which can lead to overexploitation of many stocks (Sundstrom, 2012). Corruption undermines the development goals of the country and diminishes trust in the government officials (Manyaka, 2014; Sundstrom, 2012). Scandals over institutionalized state corruption and misconduct from government officials and the state capture trials highlights the pervasiveness of these activities within South Africa (Madonsela, 2019). Misconduct from officials is detrimental to the compliance behaviour of citizens of the country with regulations as they do not have faith in the system that is imposed upon them (Manyaka, 2014; Sundstrom, 2012). With corruption being so prevalent in the

country and no studies exploring the use of MLRF funding, research into the spending of the MLRF would provide valuable insight into which fishery sectors DFFE prioritizes, and which sectors they largely seem to ignore (Madonsela; 2019; Manyaka, 2014; Sundstrom, 2012).

The trends in permit sales provided an opportunity to gain insight into South African marine recreational fisheries participation. Due to the availability of several different permit types (Figure 2.1), the number of general angling permits sold is the best indicator of participation rates of marine based recreational fishers. The number of angling permits sold in the 2015-16 financial year was 205 210, roughly equivalent to 0.5% of the population in South Africa. This is much lower than the estimate made by Potts *et al.* (2021) that there were between 478 132 and 547 799 marine and estuarine anglers. However, the number of angling permits sold could under-represent the true level of participation in the marine recreational fishery due to the lack of compliance within the fishery (Bova 2019; Bova *et al.* 2017; 2018; 2022).

Compliance with regulations is a major issue in South Africa's recreational fishery (Bova *et al.* 2022). However, a recent study (Bova *et al.* 2022) found that approximately 30% of coastal marine shore-based anglers had fished without a valid permit in the 12-months prior to being interviewed. Furthermore, Saayman *et al.* (2017) demonstrated that only 73% of respondents had valid marine recreational fishing permits at the time of the survey. When accounting for the 30% lack of compliance shown by Bova *et al.* (2022) and the number angling permits sold in 2015-16 financial year, there were potentially 293 157 anglers. However, even with this correction, estimates of participation were lower than the most recent estimates (Bova *et al.* 2022; Potts *et al.* 2021).

The difference in participation estimates made by Potts *et al.* (2021) and the number of permit sales depicted in this study could be a result of several factors. For instance, Potts *et al.* (2021)

may have over-estimated the participation in South Africa's recreational fishery because more permitted anglers answered the questionnaire resulting in a positive bias in the estimate. Earlier studies using roving creels may not have adequately accounted for avidity bias and thus over-estimated shore-based fishers. It is also possible that outdated systems used by South African Post Offices or the DFFE may have led to errors in record-keeping for permit sales. For instance, recreational abalone permits were reportedly sold for several years after the fishery had been closed. While much of the above is speculation, the number of recreational angling permits sold clearly under-represents the actual number of participants in the sector. Nonetheless, the upward trends in participation rates suggest that the sector is indeed growing.

Unlike many other developing countries, South Africa did not demonstrate any link between economic development and recreational fisheries participation. Furthermore, there was no link with permit sales to various socioeconomic predictors such as inflation and unemployment rate. This is not the same as trends that have been observed in many developed world nations where recreational fishing participation tends to increase with increased economic development (Arlinghaus *et al.* 2021). This has also increasingly been observed in developing world countries, such as Brazil, China, India, Maldives, and Nepal (Arlinghaus *et al.* 2021; FAO 2009, 2010; Freire and Sumaila 2019; Gupta *et al.* 2016; Yang *et al.* 2017). One potential explanation may lie in the lack of compliance present in the South African marine recreational fishing sector that may decouple broader socioeconomic trends (Bova *et al.* 2022). Another may be because the angling permit price is a major limiting factor for purchasing permits as the price is perceived to be too expensive when compared to average income and is thus seen as a financial burden. Finally, logistical and regulatory factors could inhibit permit purchasing behaviour rather than socio-economic factors (e.g. that lack of availability of fishing permits at many post offices).

Despite the general increasing trend, licence sales boomed over the COVID-19 period (361 230 sold in 2020). This is likely due to the role that the global pandemic played on recreational activities. The onset of the Covid-19 pandemic resulted in South Africa being placed under a national state of disaster (Sowman *et al.* 2021). This brought about a national lockdown along with various regulations imposed by the government upon the populace of South Africa, with one being the closure of all fisheries (Sowman *et al.* 2021). After much pressure from the public through the media, commercial, small-scale and recreational fishing was allowed in an amendment to the lockdown regulations (Sowman *et al.* 2021). A consequence of this was that recreational fishers were allowed beach access (as long as they were in possession of an angling permit), while the general public were prohibited from accessing beaches for other recreation purposes. As a result, many of the non-angling public purchased recreational fishing permits simply to access the beach rather than for fishing. This did not align with the global norm, as a study conducted by Pita *et al.* (2021) indicated a decrease in recreational fishing globally. However, an increase in sales in this case does not coincide with a true increase in participation as fishing permits were simply used to gain beach access by many non-fishers.

## **Conclusion**

This chapter has highlighted several challenges with the recreational fishing permit system in South Africa. This study has demonstrated that the main use of recreational fishing permits by government is for cost recovery rather than for monitoring participation. However, the income from permits is not being directly used for recreational fisheries management in South Africa but rather augments the funding for the management of commercially important species with a lack of engagement of recreational fishers in the management of the fishery. The lack of management attention of the recreational fishery has contributed to a perceived lack of

legitimacy of the management agency, and subsequently poor compliance which may impact on the status of many fish stocks and the livelihood fisheries.

Interestingly, during the National Linefish Survey conducted in South Africa from 1994-96 (Brouwer et al. 1997), marine anglers were asked whether they would be prepared to pay for a fishing permit. Fifty-one percent of shore anglers said they would (McGrath et al. 1997), but only on condition that the funds generated would be used for improved fisheries research and management and not just become another form of tax. Clearly the latter has happened, and their concerns were justified.

An overhaul to the permit system and the management of recreational fisheries is needed to bolster compliance. Improvements to the management of recreational fisheries should consider compliance efforts beyond the instrumental approach to include normative measures such as advertisement campaigns, stakeholder education, and transparent management. These interventions would not only benefit the recreational sector, but the overall management of coastal resources, which support large numbers of vulnerable people.

## CHAPTER THREE

### REVEALING SOUTH AFRICAN RECREATIONAL ANGLER PERMIT PREFERENCES USING A DISCRETE CHOICE EXPERIMENT

#### 3.1 Introduction

Compliance with recreational fishing permits is an integral part of user-pays systems, allowing for cost recovery by managing bodies (Bergseth and Roscher, 2018; Bova *et al.* 2017; 2018; 2022; Ficke and MacCready, 2019; Pitcher *et al.* 2009; Potts *et al.* 2020) and accurate estimates of participation (Hanson and Sauls, 2011; Hunt *et al.* 2016; Trella and Mickiewicz, 2016). In South Africa, poor compliance with marine recreational regulations has been well-documented (Bova 2019; Bova *et al.* 2017; 2018; 2022). For instance, Bova *et al.* (2022) found that 52% of South African marine shore-based anglers were non-compliant with fishery regulations, with approximately 21.6% fishing without obtaining a valid permit. Such non-compliance undermines the economic viability, ecological sustainability, and social equity of the recreational fisheries sector (Potts *et al.* 2019). Understanding this non-compliance and creating tailored interventions to encourage compliance can ensure there remains a viable and sustainable recreational fisheries management system in South Africa (Ficke and MacCready, 2019; Hirsch *et al.*, 2019; Bova *et al.*, 2024).

While regulatory approaches, such as seasonal restrictions, bag limits, and mandatory permits, form the backbone of current management strategies, high non-compliance rates suggest these measures alone are insufficient (Bova *et al.*, 2017, 2022). Although increased enforcement could improve compliance, it is often cost-prohibitive and may fail to address underlying behavioural drivers (Arias, 2015; Bova *et al.*, 2022). Alternative approaches, such as modifying the structure of the recreational fishing permit system, could foster compliance by aligning

with anglers' preferences and motivations. For example, adjusting permit pricing, ensuring responsible use of funds accrued, emphasizing conservation benefits, or improving permit acquisition processes may encourage buy-in and reduce resistance (Arias *et al.* 2015; Bova *et al.* 2022; Kim *et al.*, 2007; Mackay *et al.*, 2020)

Discrete Choice Experiments provide a robust framework for eliciting preferences by simulating real-world decision-making scenarios (Bielaire 1998; Doherty *et al.* 2014; Katz 2018; Kim *et al.* 2007; Lee *et al.* 2014; Liese *et al.* 2017; Mackay *et al.* 2020). DCE's evolved from Lancaster's theory of consumer behaviour (1986), in which the utility derived from an alternative is associated with the attributes of the alternatives. By posing hypothetical changes to the permit system, such as varying permit prices, conservation benefits, and ease of purchase, DCEs enable researchers to identify the trade-offs that anglers are willing to make (Kim *et al.* 2007; Lee *et al.* 2014; Liese *et al.* 2017; Mackay *et al.* 2020). This understanding is critical for guiding policymakers in designing user-centred permit systems that promote buy-in and foster compliance with recreational fisheries policy (Kim *et al.* 2007; Lee *et al.* 2014; Mackay *et al.* 2020).

To date, no studies have been conducted that reveal the preferences of South African recreational anglers with regards to the marine recreational fishing permit system, except the early questionnaires conducted during the National Linefish Survey (1994-96) prior to the implementation of the system (Brouwer *et al.* 1997, Sauer *et al.* 1997, Mann *et al.* 1997, McGrath *et al.* 1997). In this chapter, the DCE methodology was chosen as a quantitative research method to assess the strength of preferences and trade-offs of South African marine recreational anglers, which potentially influence their decisions to purchase marine recreational fishing permits. For this research, the potential attributes were identified by Hewett (unpublished data) and Saayman *et al.* (2017) to be: *i*) the form of the permit when it is issued,

*ii*) the level of enforcement (policing) and *iii*) integrated ocean and coastal management areas (such as MPAs). However, to provide choice questions that accurately depict the true nature of the South African recreational permit system, the attributes and levels had to be identified using a qualitative assessment (Doherty *et al.* 2014; Johnson *et al.* 2013). Once these are understood, a model can provide in-depth insights into the potential drivers behind license purchases. The findings of this study aim to contribute to the broader objective of sustainable fisheries management in South Africa by offering data-driven insights into how the permit system can be restructured to align with angler preferences, thus promoting compliance with permit requirements.

### **3.2 Methods**

For an effective DCE design, each choice object requires the selection of context-specific attributes (characteristics of permits) and levels (degrees of variation of the characteristics) (Johnson *et al.* 2013). This study aimed to identify and assess attributes, levels within attributes, alternatives, and choice tasks per survey. This multifaceted approach first required a pilot study to saturate themes to identify attributes and levels from which a DC experiment could be designed. Then, it involved a structured survey, a questionnaire design, and a participant recruitment methodology. Finally, substantial statistical analyses were required to determine the illicit recreational fishing permit preferences of recreational anglers in South Africa.

A pilot study was conducted before the DCE to inform the design of the experiment. The pilot study involved the development of a structured questionnaire that included open-ended questions (see Appendix II). The questionnaire was designed from a literature review that focused on recreational fishing licensing aspects such as permit price, permit format (A4 paper format at time of survey), improvements to integrated management efforts, allocation of funds from permit sales, and taxation on fishing gear (Alic *et al.* 2021; Bennear *et al.* 2005; Bennet

*et al.* 2014; Birdsong *et al.* 2021; Mackay *et al.* 2020; NSWG, 2021; TOF 2022). Contact information, including cell phone numbers of marine recreational angling permit holders, was obtained through the DFFE through a PAIA request. Using Microsoft excel, cell phone numbers were pasted into a column, and a random number was generated next to them using the function “Rand()”. These random numbers were placed in ascending order to allow for randomization of cell phone numbers. Anglers were contacted randomly, and their consent to participate in the study was requested. Upon receiving consent, participants were either interviewed telephonically or provided with a link to an online survey via email (Ethics approval number: 2021-5044-6418). Three hundred and fifty-five anglers were called in order to obtain 50 responses.

Thematic analysis was applied to the answers for the open-ended questions to understand participant preferences around recreational fishing permits. Thematic analysis is a qualitative method used to identify, analyse and interpret patterns or themes within data (Clarke and Braun 2016). This process involved the careful analysis of responses to identify recurring ideas or concepts that seemed important to the respondents (Clarke and Braun 2016). Through an iterative approach, the data were reviewed multiple times to ensure saturation and to refine themes. While many themes were apparent, this research focuses on only the most salient themes to ensure the feasibility of the DCE. These were determined to be the cost of the permit in terms of price, its physical format (e-license, paper, etc.), types of integrated management areas (Closed areas, mixed-use areas, etc.) and law enforcement levels (policing presence). These identified themes were used as the foundation for the development of attributes (characteristics of permit and the policy surrounding it) and the corresponding levels (values or variations that an attribute can take). These formed the basis for developing alternatives (the

scenario developed from the same combination of attributes at varying levels) for the DCE (Table 3.1).

Table 3.1: Attributes and levels for the discrete choice experiment chosen as per the results of the pilot study.

Attribute	Definition	Level
Permit Price	The price of a marine recreational angling permit	ZAR 38 ZAR 57 ZAR 76 ZAR 95 ZAR 114
Integrated Management Areas	Types of fisheries management areas that currently occur and potential future areas that may exist (i.e. Marine Protected Areas, Open-Access Areas, and Catch and Release Only Zones)	Additional zones closed to fishing New catch and release only zones New recreational fishing only zones No new zones closed to fishing
Permit format	The physical format in which the permit will be made available to the consumer	Paper permit Laminated card permit Digital Permit
Law Enforcement	The extent that the recreational fishing management officials actively enforce rules and regulations, catch individuals breaking the rules and regulations, and penalize them for non-compliance	Decrease in law enforcement No change in law enforcement Increase in law enforcement

This experiment employed the R package *DCEtool* to create a statistically efficient design, optimizing the experimental framework through advanced statistical tools (Perez-Tronsco, 2022).

A D-efficient design balances the representation of attributes and levels across the choice tasks (choices between alternatives), ensuring that the results capture the full range of the trade-offs participants are willing to make while preventing the cognitive burden of presenting all possible combinations. Therefore, this design was chosen because testing all combinations of alternatives would result in an unpractically large questionnaire that would likely result in a lack of completed questionnaires due to respondent fatigue.

A well-structured DCE is designed to balance complexity and respondent engagement. According to a review done by Vanniyasingam *et al.* (2016), most DC studies make use of 20 or less choice tasks, with 16 or fewer attributes, between two and seven attribute levels, and between two and six alternatives. This study incorporated four attributes with levels ranging from three to five, two alternatives per choice set and 16 choice sets (table 3.1)(See Appendix III).

The main study also made use of contact information of recreational angling permit holders gathered from a PAIA request to the DFFE for recruitment purposes. The phone numbers supplied on permit information were used to call angling permit holders and obtain permission to survey them as required by Rhodes University Ethics Committee requirements (Ethics approval number: 2021-5044-6418). A total of 3 952 anglers were called and asked to participate using a prewritten script (Appendix IV), however only 500 provided permission to be recruited for the survey. Many of the cell phone numbers no longer existed, were unavailable or participants refused to participate. Upon obtaining permissions, respondents supplied their email addresses in order to participate, and a mailing list was created using Qualtrics survey software. A total of 500 email addresses were obtained from participants that agreed to participate, and a recruitment email was sent to each. After the initial emails were released, a follow up email was sent out two weeks later to remind respondents to take part in the survey. As an incentive to complete the survey a Shimano Spheros 10 000 fishing reel was available to be won via lucky draw competition of respondents who completed the survey. Incentives can provide a useful tool to increase response rate (Smith *et al.* 2019).

In the DCE, it is assumed that the utility of the alternatives is characterized on the basis that respondents select an alternative that serves the greatest utility for them (Johnson *et al.* 2013). This DCE makes use of the random utility model (1) where  $U_{iq}$  represents utility derived for

consumer  $q$  from option  $i$ . The utility is made up of an observable component and an unobservable component and can be represented by the following equation.

$$(1) U_{iq} = V_{iq} + \varepsilon_{iq}$$

where:

$U_{iq}$  represents utility derived for consumer  $q$  from option  $i$

$V_{iq}$  is an attribute vector representing the observable component of utility from option  $i$  for consumer  $q$

$\varepsilon_{iq}$  is the unobservable component of latent utility derived for consumer  $q$  from option  $i$ .

The multidimensional deterministic attribute vector ( $V_{iq}$ ) can be assumed to be in the linear additive form:

$$(2) V_{iq} = \beta_{1i}f_1(s_{1iq}) + \dots + \beta_{ki}f_k(s_{kiq})$$

where:

$\beta_{ki}$  are the utility parameters for option  $i$  and

$s_{kiq}$  are 1 to  $k$  different attributes with differing levels.

$f_k(s_{kiq})$  represents a transformation of the attribute values.

Thus, the random utility equation (1) can be represented as:

$$(3) U_{iq} = \beta_{1i}f_1(s_{1iq}) + \dots + \beta_{ki}f_k(s_{kiq}) + \varepsilon_{iq}$$

By recognising that the individual ( $q$ ) will select the alternative ( $i$ ) if the utility ( $U_{iq}$ ) is greater than any other utility ( $U_{iq}$ ) in alternatives provided in the choice set. The functions ( $f_k(s_{kiq})$ ) capture the effects of the attribute levels ( $s_{kiq}$ ).

Alternative  $i$  is preferred to alternative  $j$  if the probability of choosing  $i$  is higher than the probability of choosing  $j$  and can be displayed as  $P[(V_{iq} + \varepsilon_{iq}) > (V_{jq} + \varepsilon_{jq})]$ , and thus the choice can be predicted by estimating the probability of individual ( $q$ ) ranking the alternative  $i$  higher than any other alternative  $j$  in the choice set of alternatives.

The maximum likelihood estimation approach is used to determine the probability that consumer  $q$  chooses the alternative  $i$  from a choice set, whereby estimates are obtained through the maximisation of a probabilistic function concerning the parameters. This approach requires the random components ( $\varepsilon_{iq}$ ) to be independently, equally distributed, and independent of irrelevant alternatives. This type of statistical analysis is referred to as a type 1 distribution and using this method, the unobserved random components associated with each alternative must be converted into a workable component of the probability equation. Once this has been accomplished the resultant choice model is known as the multinomial model and it takes the following form:

$$(4) P(i|A) = \frac{1}{\sum_{j=1}^J \exp - (V_i - V_j)}$$

where:

$P(i|A)$  is the probability of an individual choosing alternative  $i$  over alternative  $j$  in the choice set  $A$ .

$V_i$  represents the utility from the  $i$ th alternative.

$V_j$  represents the utility of the  $j$ th alternative.

The underlying assumptions for the model are that the scale parameters have a constant variance (typically equalled to 1) and that the random components do not exhibit serial correlation. The utility parameters are set and there is no heterogeneity between individual

preferences. Furthermore, the multinomial logit model used categorical variables with a reference level for each attribute. The coefficients for the levels thus represent a change in utility compared to the reference level. The reference levels for each attribute were as per Table 3.2.

Table 3.2: Reference levels for each attribute of the discrete choice experiment

Attribute	Reference level
Price	ZAR0 change in price
Permit Format	Paper
Fisheries management Areas	No new zones
Law Enforcement Price	Decreased Law Enforcement

The Newton-Raphson method is an iterative numerical method that can be applied to provide estimates for the parameters of a multinomial model by maximizing the log-likelihood function (Arida 2016). This is accomplished through iterations of the model which is accomplished by using initial parameter value to calculate the gradient (first derivative of the log-likelihood with respect to the parameters) and the hessian (the matrix of second derivatives). The parameters can then be updated using the following formula:

$$(5) \beta_{new} = \beta_{old} - H_{-1} g$$

where:

$\beta_{new}$  are the updated parameter values,  $\beta_{old}$  are the old parameter values,  $H$  is the Hessian matrix,  $g$  is the gradient and  $H_{-1} g$  is the direction to move in the parameter space to increase the likelihood.

After updating the parameters, a convergence test was run to ensure that the parameter estimates were stable and there were no errors with the model, the data, or both.

The fit of the multinomial model was tested using the Mcfadden  $R^2$ . This value shows the proportionate improvement of the fitted model over the null model, where the null model contains just the intercept with no predictors. It can be calculated as follows:

$$(6) R_{Mcfadden}^2 = 1 - \frac{\ln(\mathcal{L}_{Model})}{\ln(\mathcal{L}_{Null})}$$

The average marginal effects of one unit of change of parameters were calculated for the model by taking the difference in estimated probability of the attribute being selected with and without the variable while holding the distribution of other variables at their sample value and then taking the sample mean of these differences. Equation (4), the probability of choosing alternative  $i$ , can be written as follows:

$$(7) P(i|A) = \frac{\exp(v_i)}{\sum_{j=1}^J \exp(v_j)}$$

Therefore, the equation for marginal effects can be written as the following:

$$(8) \frac{\partial P(i|A)}{\partial s_k} = P(i|A) * (1 - P(i|A)) * \beta_k$$

The willingness to pay (WTP) is the monetary amount respondents were willing to pay for a one unit increase or decrease in a specific attribute while holding all other attributes constant. In discrete choice models, the WTP can be calculated by dividing the coefficient of a specific attribute ( $\beta_k$ ) by the coefficient of price ( $\beta_{Price}$ ). The equation for WTP can be described as follows:

$$(9) WTP = \frac{\beta_k}{\beta_{Price}}$$

However, in many cases, increasing price is accompanied by a negative effect on utility (Train, 2009). Thus, an increase of an attribute with a positive utility coefficient would decrease WTP due to the negative price coefficient. Even though an increase in that attribute would increase the utility for the respondents.

Therefore, this study made use of an absolute value for the price coefficient when calculating the WTP (Train, 2009). Consequently, equation (8) can be corrected to the following:

$$(10) \text{WTP} = \frac{\beta_k}{|\beta_{\text{price}}|}$$

All statistics were conducted using R statistical software and the mlogit package (Croissant, 2020).

### 3.3 Results

Out of 187 individuals who responded to the survey, 166 (33.2% of the 500 invited participants) provided fully completed responses. These responses yielded a total of 2,656 choice observations based on 16 choice sets per respondent. With two alternatives presented per choice set, this provided a dataset of 5,312 alternatives for analysis. To test the fit of the model a McFadden  $R^2$  was computed and was found to be slightly low ( $R^2=0.198$ ) (Table 3.3). While slightly low the  $R^2$  adequately explained the variation in the data (McFaden 1979).

The respondents were mostly male (96.9%) that were between the ages 50 and 54 (18.4%). Most of the respondents had obtained at least a professional certificate (tertiary certificate) (35.3%), were employed (76.8%), and earned over ZAR307 001 per annum (57.1%).

Table 3.2 shows the results of the multinomial regression analysis estimations of attribute-level utilities, providing insight into trade-offs made by respondents. As the price of recreational

fishing permits increased there was a significant ( $-0.007$ ;  $p < 0.001$ ) decrease in utility (Table 3.3, Figure 3.1). Similarly, the promulgation of additional MPAs had a significant negative impact ( $-0.489$ ;  $p < 0.001$ ) on the utility that recreational anglers derived from purchasing permits (Table 3.3, Figure 3.1). Recreational anglers showed a preference for the inclusion of additional recreational fishing only zones ( $0.361$ ;  $p < 0.001$ ) (Table 3.3, Figure 3.1). The creation of a digital permit appeared to be undesirable as it had a negative effect on the utility derived from the purchase of a recreational fishing permits by recreational anglers ( $-0.203$ ;  $p < 0.01$ ) (Table 3.3, Figure 3.1). An increase or no change in law enforcement was highly desirable as both had strong positive coefficients ( $1.206$  and  $1.126$ ), respectively ( $p < 0.001$ ) (Table 3.3, Figure 3.1).

An increase in the age of respondents had a significant impact on the utility a recreational angler had for permit ( $p < 0.05$ ) (Table 3.3), however the coefficient was very weakly negative ( $-0.010$ ). Education level, income level, and gender of the respondents had no significant effect on the respondent preferences

Table 3.3: Table of the coefficients, standard errors, and significance levels for the multinomial logistic regression model used to analyse preferences in the discrete choice experiment.

Attribute	Estimate	Std_Error	Z value	p-value	Significance
(Intercept)	0.2422376	0.7968394	0.3040	7.61129e-01	
Price	-0.0079730	0.0014362	-5.5515	2.83300e-08	***
Additional zones closed to fishing	-0.4899277	0.0822543	-5.9563	2.58100e-09	***
New catch and release only zones	-0.0489269	0.1576984	-0.3103	7.56366e-01	
New recreational fishing only zones	0.3617559	0.0878629	4.1173	3.83400e-05	***
Additional zones closed to fishing	-0.0015673	0.0735449	-0.0213	9.82998e-01	
Digital Permit	-0.2031567	0.0743511	-2.7324	6.28800e-03	**
No change in law enforcement	1.2068511	0.0718162	16.8047	2.20000e-16	***
Increase in law enforcement	1.1260153	0.0824927	13.6499	2.20000e-16	***
Employed	-0.3099424	0.1874500	-1.6535	9.82360e-02	.
Matric	0.2411926	0.4727945	0.5101	6.09952e-01	
Professional certificate/diploma	0.2748589	0.4727477	0.5814	5.60966e-01	
Undergraduate degree:	0.0121335	0.5005112	0.0242	9.80659e-01	
Post graduate degree	0.1413999	0.4777291	0.2960	7.67243e-01	
R1-R19 200	0.3542357	0.6381363	0.5551	5.78820e-01	
R19 201-R307 000	0.0851394	0.6135584	0.1388	8.89637e-01	
R307 001 and above	0.1592589	0.6116268	0.2604	7.94566e-01	
Age	-0.0109454	0.0045191	-2.4220	1.54350e-02	*
Male	0.2076102	0.3775831	0.5498	5.82429e-01	
Other/non-binary	-0.9576796	0.7260667	-1.3190	1.87170e-01	
Log-Likelihood: -1278					
McFadden R <sup>2</sup> : 0.19877					
Likelihood ratio test: $\chi^2 = 634.11$ (p.value = < 2.22e-16)					
Significance. codes: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					

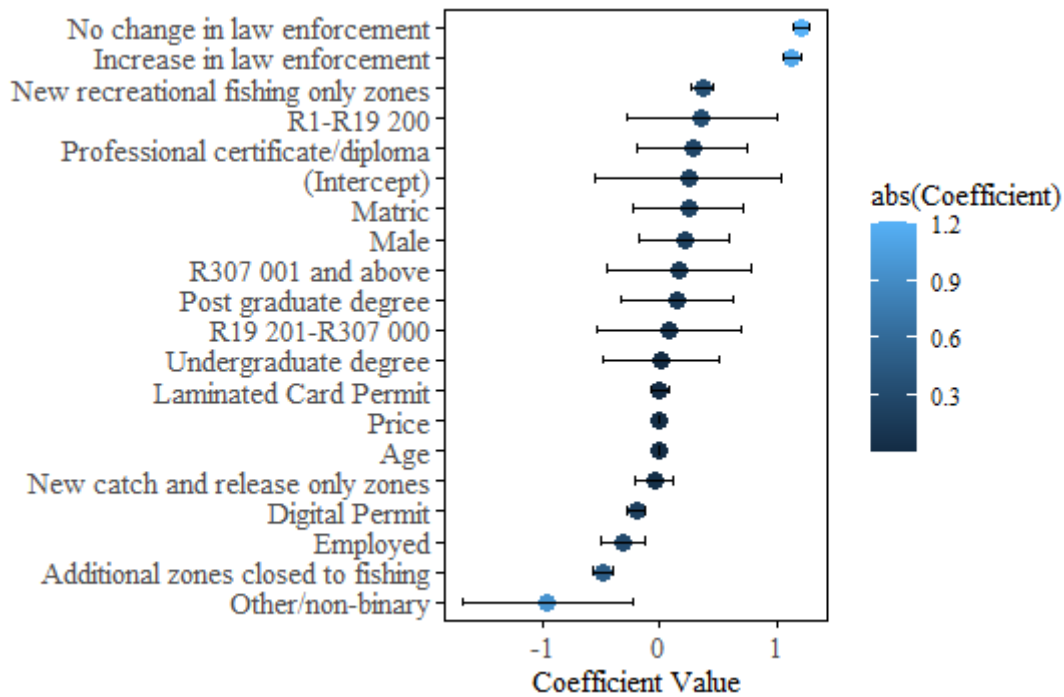


Figure 3.1: A forest plot indicating the marginal utilities for each attribute level and demographic variable included in the multinomial logit model for analysing anglers' preferences in the discrete choice experiment. The error bars represent 95% confidence intervals, while the colour intensity reflects the absolute magnitude of the coefficients.

The marginal effects from the discrete choice experiment, derived from the multinomial logit model, quantify the change in the probability of respondents choosing a recreational fishing permit due to a one-unit increase in specific attributes, holding all else constant. The most significant effect was observed for maintaining current law enforcement levels, which increased the probability of choosing a permit condition by 22.45% over decreased law enforcement, followed closely by an increase in law enforcement efforts, which raised the probability by 20.95% over decreased law enforcement (Figure 3.2). Expanding areas dedicated only to recreational increased the likelihood of purchasing a permit by 6.73%, while establishing additional protected areas reduced this probability by 9.11% (Figure 3.2). Switching to a digital permit system decreased the likelihood of purchasing by 3.78%, and a one-unit increase in permit price lowered it by 0.14% (Figure 3.2). Among demographic

factors, a one-unit increase in age corresponded to a 0.20% reduction in the probability of purchasing a permit. These findings highlight the impact of both permit attributes and demographic factors on consumer decision-making.

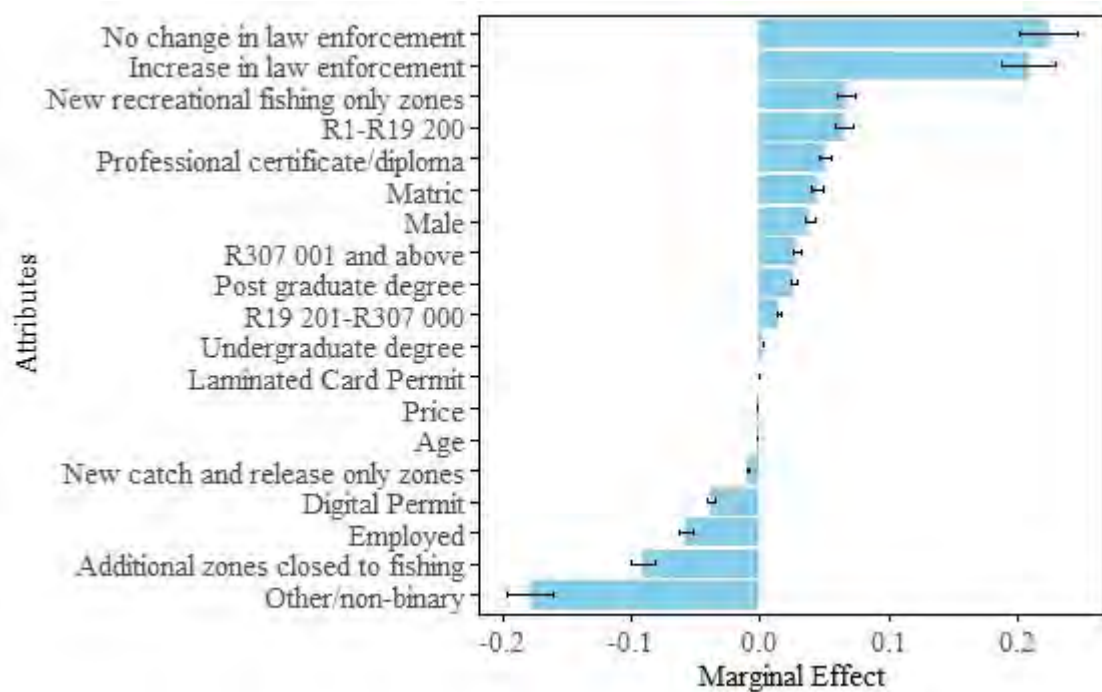


Figure 3.2: Bar chart of the marginal effects on the probability of a respondent purchasing a recreational fishing permit using the results of the multinomial model for the alternatives and the demographics.

### 3.4 Discussion

The results of this study revealed the preferences of marine recreational anglers in South Africa for various recreational fishing permit attributes, as determined through a Discrete Choice Experiment (DCE). The multinomial model of discrete choice analysis used for this research was able to distinguish several attributes of significance to South African marine recreational angling license holders. It was able to discern the utilities associated with attributes pertaining to levels of law enforcement, the zonation of fishing areas, and the permit format and these are discussed in the context of the future of the South African recreational fishery permit system.

This study found that South African recreational anglers are willing to pay more to retain the current paper recreational fishing permit over transitioning to a digital version. While this preference is notable, digital systems offer a host of advantages, such as reducing the administrative costs associated with the South African Postal Office, enhancing accessibility for anglers, and serving as a point of communication between management and anglers to facilitate research and disseminate important information.

Nevertheless, implementing an online system is accompanied by a host of challenges. One challenge of implementing an online system is that many recreational fishers are poor, potentially limiting their access to digital systems (Bova 2019; Potts *et al.* 2022). However, this does not explain the observed preference, as most respondents reported being in the highest income bracket. Limited digital literacy could contribute to discomfort in using online systems (Moore *et al.* 2015), along with privacy and data security concerns as anglers fear potential misuse of personal information or cybersecurity breaches (Belanger and Crossler, 2011). Additionally, some anglers may view fishing as an escape from technology and dislike relying on electronic devices during recreational activities (Arlinghaus *et al.* 2015). Age could also be a factor, as the modal age group was 50–54 years, and older anglers might struggle to adapt to new technologies due to changes in physical and cognitive abilities (Lee 2022; Moore *et al.* 2015). Furthermore, concerns of exposing cellphones to harsh environmental conditions during fishing activities may also deter some anglers. Regardless, many countries around the world effectively make use of digital platforms for sales (FWC, 2023; GC, 2023; NSWG, 2021). While some users may have some concerns over the new system, it allows for accessibility along with traditional formats still being available. These factors highlight potential trade-offs between the substantial benefits of a digital permit paired with an online system, which could

bring significant benefits to the management of recreational fisheries in South Africa, and the preferences and practical concerns of South African recreational angler.

Furthermore, since this research was undertaken, DFFE has introduced recreational fishing permits in a digital format, which is purchasable online. As the ability to purchase these permits online was not available during the survey, there may be limitations surrounding the interpretation of preferences for a digital permit. It's possible that respondents may have assumed that a digital permit would still need to be acquired in-person from the SAPO, which could affect their perceptions of the feasibility of such a format. The ability to purchase a permit online is likely preferred by many of the respondents in this study as the population was represented by educated and high-income earning individuals, who most likely have higher rates of internet literacy (Mossberger *et al.*, 2007).

Levels of law enforcement in the South African marine recreational fishery have been (Brouwer *et al.* 1997) and remain low (Chapter 2). It is often presumed that strengthening enforcement measures may help address non-compliance issues, as recreational anglers generally believe that increased enforcement would reduce rule violations (Hewett *et al.*, in prep). This belief was reflected in the DCE, where respondents demonstrated an increased WTP to either maintain or enhance current enforcement levels.

Since current enforcement levels are very low, it is likely that few of the respondents can imagine a scenario where there is less enforcement and therefore these results likely suggest that most anglers prefer the status quo, very low levels of enforcement. However, a recent study by Bova *et al.* (2022) found that enforcement levels in a given area did not directly determine non-compliance rates. This suggests that while anglers may oppose reductions in enforcement, possibly due to concerns about resource degradation and the deterrent effect of enforcement, it

may not be the most significant driver of compliance. Furthermore, Bova *et al.* (2022) suggested that enforcement efforts in South Africa may be perceived as ineffective, yet respondents still expressed a WTP significantly more to prevent any reduction in enforcement levels. This aligns with findings from Bova *et al.* (2017), which indicated that anglers often perceive their peers to be less compliant than themselves, potentially reinforcing the belief that weakening enforcement could exacerbate non-compliance.

Globally, the effectiveness of law enforcement in recreational fisheries varies. In some regions, strict enforcement has been linked to improved compliance (Furlong 1991; Walker *et al.* 2007; Arias *et al.* 2015) while in others, compliance is driven more by social norms, education, and angler engagement rather than direct enforcement (Mackay *et al.* 2018, 2020, Arias 2015). Studies suggest that a combination of enforcement, outreach, and community involvement is often the most effective strategy for ensuring compliance (Cooke *et al.*, 2013; Arias 2015). These findings highlight the complexity of enforcement in recreational fisheries and suggest that while anglers may support increased enforcement, its effectiveness is contingent on broader governance strategies and stakeholder engagement.

The respondents in this study viewed additional closed areas (MPAs) as undesirable. This sentiment is not unusual, as global attitudes towards MPAs are varied. Consumptive users, such as fishers, tend to hold more negative perceptions of MPAs when restrictions impact their access to fishing or harvesting areas (Bennett and Dearden, 2014; Engel *et al.*, 2014; McNeil *et al.*, 2018; Webb *et al.*, 2004). In contrast, stakeholders who benefit from conservation efforts, such as tourism operators or non-extractive users, often show higher support for MPAs, particularly when alternative economic opportunities or compensation measures are in place (Hawkins *et al.*, 2016; Intonti *et al.*, 2024; Lucrezi, 2021; Lotze *et al.*, 2018).

These global trends are mirrored in the South African context, where the establishment of MPAs has been influenced by socio-economic concerns, management efficacy, and stakeholder engagement (Francolini *et al.*, 2022; Peer *et al.*, 2022; Sowman and Sunde, 2018). Although MPAs have been shown to conserve biodiversity, mitigate climate change, and preserve marine ecosystems, resulting in various potential socio-economic benefits (Kirkman *et al.*, 2021; Laffoley *et al.*, 2019; Mann-Lang, 2021; Maestro *et al.*, 2019), recreational fishing communities may not always understand these benefits. For example, South African recreational fishers may perceive new MPAs as a loss of fishing opportunities, particularly when stakeholder engagement in MPA planning is limited (Peer *et al.*, 2022). While recent MPA network promulgation involved extensive stakeholder consultation (Kirkman *et al.*, 2023; Sink *et al.*, 2023), older MPAs have not, further contributing to the skepticism (Peer *et al.*, 2022).

The resistance to expanding MPAs may also stem from a broader lack of compliance with rules and regulations that exist in South Africa (Bova *et al.* 2017; 2018; 2022; Kirkman *et al.* 2023; Peer *et al.* 2022). The respondents to this survey may believe that the development of additional MPAs would be an ineffective measure to protect recreational fisheries resources if current enforcement mechanisms fail to address violations. Further research into the attitudes and perceptions of recreational fishers towards MPAs and Other Effective Conservation Measures (OECMs) may be extremely beneficial toward developing ecologically sound policy and driving outreach programs to highlight their ecological and socio-economic benefits. Ensuring that anglers are active participants in MPA planning is vital for fostering buy in and promulgating effective MPAs.

The value placed in zones dedicated to recreational fisheries by the respondents is likely due to perceived competition with commercial and small-scale fishers (Arias and Sutton, 2013).

Globally, it is well documented that recreational fishing communities believe that other sectors (commercial, small scale and subsistence) are to blame for declines in fishing stocks even though much of the evidence shows that the converse is true for many species (Martin *et al.* 2016; Michailidis *et al.* 2020). This misconception is fueled by a complex array of factors, including perceived competition for resources, socio-economic and cultural differences, governance and management challenges, and information gaps, which together exacerbate conflicts between other sectors and recreational fishing communities (Kadagi *et al.* 2020; Lal *et al.* 1992; Martin *et al.* 2016; Michailidis *et al.* 2020). While a decrease in competition may be an apparent reason for an increased utility, the decrease in utility for buying a permit that would result in additional zones for catch and release (not significant) indicates that respondents prefer a consumptive form of recreational fishing. The likely cause could be that anglers value tangible returns on their fishing costs, have behavioural drivers and motivations for keeping fish, and/or are not sufficiently educated on the ecological benefits of protecting fisheries resources (Birdsong *et al.* 2021; Kirkman *et al.* 2021; Laffoley *et al.* 2019; Mann-Lang, 2021; Maestro *et al.* 2019).

This research found that the choice experiment was suitable for obtaining South African recreational anglers' preferences with regard to the marine recreational fishing permit system. While the  $R^2$  was slightly low, it was adequate to explain the variance within the data. A potential for this lack of explanatory power may lie in the assumptions of the multinomial model that the respondent preferences were homogenous. This may not fully capture individual variation. A potential refinement to this study would be to apply the data to a mixed logit model that can provide deeper insights by accounting for preference heterogeneity.

The response rate was lower than the minimum response rates suggested by some of the literature (Bailey, 1987; Babbie, 1990; Schutt, 1999). Nevertheless, according to Johnson and

Orme (2003) and Pearman (1991), the total responses were adequate to determine preferences. The low response rate means there is the potential for response bias as 67.0% of the sample group was unaccounted for. Future studies should aim to improve response rates through more extensive outreach and engagement strategies.

The demographic profile of this study was broadly consistent with other studies conducted regarding South African marine recreational fisheries. The majority of the respondents were male (96%) which aligns with finding from Potts *et al.* (2021) and Bova (2019). The modal groups of this study were slightly older with 18.4% in the 50-54 category than the modal groups in previous studies, fell into higher earning categories 57.1% earning over ZAR 307 001, with 35% of respondents having earned at least a professional certificate and 76.8% being employed. This indicates a wealthier, more educated demographic than that described in Potts *et al.* (2021), who reported larger proportions of lower-income fishers, and in Bova (2019), where younger and lower-income anglers were more prominent. These differences could be attributed different survey methods as well as differing recruitment pools for respondents. Potts *et al.* (2021) looked at both marine and freshwater recreational fisheries while Bova (2019) focused on shorebased anglers. This study drew respondents from permit data, hence the difference from the studies done by Bova and Potts. An older, wealthier and more educated demographic may skew results as respondents may be willing to pay more if they have access to more funding.

Finally, this research sampled individuals that had already obtained a recreational fishing permit. As a result, this study did not include information from individuals who refuse to comply with recreational fishing permit requirements (~21.6%). These individuals may have much stronger beliefs surrounding recreational fishing permits which could have strongly influenced the results of the DCE. Future research should aim to incorporate a more

representative sample of the recreational fishing population, to include those that are fishing without a permit. Since a list of these individuals is not available, a roving creel sampling survey, with a ballot box methodology (Bova *et al.* 2018) would be necessary to ensure that a representative sample of non-compliant individuals is obtained. This will be crucial in ensuring that interventions to promote compliance with the permit requirement are effective.

## **Conclusion**

This research demonstrated the utility of a DCE in eliciting preferences from South African recreational anglers. The findings underscore the importance of aligning management strategies with user priorities to enhance compliance and satisfaction. For instance, it is vital to increase transparency and effectiveness of enforcement efforts while ensuring trust among anglers. Recreational anglers should be involved in the planning and management of MPAs to build support and awareness of conservation initiatives. The digital system should address practical and psychological barriers through education, security measures, and a user-friendly system design. By addressing these areas, South African recreational fisheries management will promote a policy that is user-centred, which will promote ecological sustainability.

## CHAPTER FOUR

### CONCLUSIONS AND GENERAL RECOMMENDATIONS

Despite the importance of recreational fisheries in South Africa, there has been no research exploring temporal trends in recreational fishing permit sales, nor any assessment of how funds generated from these permits are utilized. Additionally, no studies have examined what factors could improve permit compliance. This research found an increasing trend in recreational licence sales, which generated a considerable and growing annual income into the MLRF (Chapter 2). However, based on analysis of MLRF records, and semi-structured interviews with officials from the DFFE, it became apparent that the revenue from permit sales was not used to manage the recreational sector. The DCE (Chapter 3) indicated that a change to an online permit system, an increase in price, a decrease in the levels of enforcement and the establishment of additional Marine Protected Areas (that are exempt from fishing) may reduce the proportion of anglers that purchase a recreational angling permit and this would in turn, negatively impact revenue. This final chapter aims to discuss these main findings and develop recommendations for improvements to the South African recreational permit system for improved governance and to make best practice recommendations for improved recreational angling permit systems around the world.

Effective recreational fisheries management is grounded in appropriate policy (Potts *et al* 2020). Presently, while the MLRA (1998) does recognise and even define recreational fishing, this policy is outdated and focuses primarily on the ecological dimension rather than the human dimension of fisheries, with a top-down regulatory approach. The policy does however specify the need for the purchase of a recreational permit but does not specify how the revenue from the permits sales should be used but rather dictates that the revenue is placed into the Marine Living Resources Fund for marine fisheries management. Based on the findings of this study

(Chapter 2), it was clear that the majority of revenue from recreational angling permits was not utilized for management functions in the recreational sector. The primary reason for this appears to be the organisational structure of the management agency, who have grouped the recreational sector with the small-scale and the components of the commercial sector who target fish captured with hook and line (linefish) (see Chapter 2). Therefore, management is directed toward species (or in this case, a large group of species, the linefish), rather than on a fishery sector. This is facilitated, as specified in the policy, by a linefish scientific working group, which focuses almost exclusively on the stock assessments of linefish and uses this information to make recommendations on top-down regulatory changes; and the linefish management group, who are responsible for the implementation of these proposed regulations (see Chapter 2).

The focus on the management of the recreational sector has been further reduced by the recent (2012) promulgation of the Small-Scale Fisheries Policy (2012), which has necessitated the establishment of a small-scale fisheries working group which is responsible for its implementation. This progressive policy has many of the central tenets (including co-management and consideration for the human dimension) recommended for contemporary fisheries management. However, largely due to the extensive requirement of public participation, the implementation of this policy has been extremely slow and has not been smooth (Sowman and Sunde, 2021). This has been cost prohibitive and based on the findings of Chapter 2, this process has potentially been partially funded by the revenue generated by the recreational fishery permits. Ultimately, the weaknesses in the MLRA and unbalanced policy are clearly reflected in the way in which the management agency is structured, how the revenue from the recreational permits are utilized, and how the recreational fishery is (or is not) managed.

Potts *et al* (2022) in their review of existing recreational fisheries governance structures recommended that a comprehensive and adaptive recreational fisheries management policy must establish clear objectives and goals that prioritize effective cost recovery strategies, meaningful stakeholder engagement, robust compliance and surveillance measures, data driven sustainable ecological practices and equitable socio-economic outcomes. This is the approach taken by the USA and Australia, who were identified to have the best managed recreational fisheries worldwide (Potts *et al* 2020). In terms of amending the MLRA to promote effective cost recovery strategies, it may be necessary to specify that at least a portion of the revenue from recreational permits should be allocated to the management of the resources targeted by the recreational (and small-scale) sector. It should also ensure that this expenditure be included in the MLRF annual report and that it is made publicly available.

Further amendments to the MLRA are required to improve the current organizational structure of the management agency (DFFE) and facilitate better management of the recreational sector. Currently, marine resources are managed under Chief Directorates within the Fisheries Branch of the Department of Forestry, Fisheries, and the Environment (DFFE). These directorates, which include Marine Living Resources Management, Fisheries Research and Development and Monitoring Compliance and Surveillance, oversee various working groups, each responsible for developing management strategies for different resources and fisheries (e.g., linefish, rock lobster, squid, small-scale sector, etc.) (Chapter 2). An appropriate amendment to this organisational structure that may facilitate better recreational fisheries management would be the establishment of a specific working group for recreational fisheries. Alternatively, there may be a need to consider the restructuring of the directorates completely to focus on the different fishing sectors, rather than their activities as a whole.

When coupled with the above amendments to the policy, a recreational fisheries working group would result in a formal platform for addressing the unique challenges associated with managing this sector including species-specific regulations, compliance measures, catch and effort monitoring and data collection, and stakeholder engagement. This structure would facilitate science-based decision-making, improve monitoring and enforcement, and ensure that recreational fisheries are managed sustainably with reduced conflict between the commercial and small-scale sectors. Furthermore, if the revenue from recreational permits is channelled appropriately, the improved management and services to recreational anglers will likely result in an increase in compliance with the recreational permit requirement and bolster cost recovery. Many countries around the world use the revenue from recreational fishing permit sales for a host of management related activities including research, species and habitat restoration, habitat protection, land acquisition, education, improving public access for fishing and enforcing laws and regulations (Johnston *et al.* 2020; NSWG, 2021; TOF, 2022; Walls and Ashenfarb, 2022).

A management body, such as a recreational fisheries working group, is more effective when coupled with a recreational fisheries stakeholder forum. These forums serve as a vital platform for collaboration between anglers, policymakers, scientists and conservation groups (NSWG, 2021; TU 2025; Gallichan, 2025). These have been shown to promote an open dialogue to identify key issues, promote sustainable fishing practices, and enhance compliance with regulations in many countries around the world (NSWG, 2021; TU 2025; Gallichan, 2025). They provide a structured mechanism for stakeholders to be involved in the decision-making process, thus ensuring that policies are both practical and widely accepted (NSWG, 2021; TU 2025; Gallichan, 2025). These stakeholder forums can also aid in data sharing, improving enforcement strategies and support conservation efforts (NSWG, 2021; TU 2025; Gallichan,

2025). Ultimately, a stakeholder forum is more effective for a balanced and adaptive management approach that would benefit managing authorities to make effective management decisions for the benefit of all stakeholders and the marine living resources.

The recreational sector may also provide further opportunities for cost recovery. For example, the findings from Chapter 3 indicated that recreational fishers showed an increased WTP for exclusivity of access to fisheries areas with no competition from small-scale or commercial fishers. With Section 15 of the MRLA allowing the minister to form new areas by notice of gazette, it may be possible to create recreational fisheries zones. Recreational anglers would then be able to purchase either day, month or yearly permits for access to these areas. This strategy is currently implemented by the South African National Parks (SANP, 2025) where ZAR 1070 is charged as an entry fee for 12 entries into the Cape of Good Hope Nature Reserve for fishing (SANP, 2025). However, zonation of this nature is extremely complex and would require broad consultation to ensure that it would not selectively benefit one fishery sector over another. Nevertheless, when exclusive zones for recreational fishing are considered, they may bring with them huge potential for social development through tourism (Potts *et al.* 2022), which can provide significant benefits for coastal communities and bring an overall benefit to society.

Since this study was conducted, the traditional paper permit has been replaced with an online recreational fishery permit in South Africa. While recreational fishers were dissatisfied with the old SAPO system of obtaining permits and the current online system is an upgrade from that, the new system still has several shortcomings. No formal research to consider the preferences of recreational anglers was conducted prior to the development of the online system. This is concerning, particularly because this study indicated that an electronic permit system would decrease the utility anglers derived from purchasing a fishing permit (Chapter

3). Understanding stakeholder preferences is a fundamental tenet of management and recreational fisheries management authorities around the world use surveys to understand the attitudes and perceptions of anglers with regards to proposed changes in policy (Georgsen *et al.* 2015; Scyphers *et al.* 2021; Stern and Coleman, 2015; Tokotch *et al.* 2012). If the intention is to maximise recreational permit sales, it may be necessary to conduct some research on the perceptions of the new online system and its alternatives, and if necessary, amend the system to allow permits to be sold using alternative methods, such as at retail outlets, as is the case in the USA (FWC, 2023).

Ideally, for an effective recreational fishery permit system, compliance with the requirement of a fishing permit should be maximised. The strategy for promoting compliance in South Africa's recreational fisheries has been instrumental, which relies on the law enforcement, fines and other regulatory measures to modify behaviour. However, with only 10% of law enforcement efforts directed toward recreational fisheries (Chapter 2), an extensive coastline, high levels of participation and with widely distributed effort, this approach is always likely to be challenging (Bova *et al.* 2023). However, the findings of this study have shown that anglers may be willing to pay substantially more for recreational fishing permits if the levels of enforcement are increased (Chapter 3). In a South African setting, increased levels of perceived law enforcement did not lend to an increased compliance although in many other countries it does. (Arias *et al.* 2015; Bova *et al.* 2022; Brouwer *et al.* 1997; Furlong 1991; Walker *et al.* 2007). Hence, better use of funds accrued in the MLRF and perhaps even an increase in permit price could aid enhance law enforcement strategies and promote research into alternative compliance measures.

For instance, the permit system can be better utilised to fund a social norm approaches while assisting in law enforcement. For instance, the online system can be enhanced to have links or

pages with various types of information that is relevant to recreational fishers. For example, many countries include information on the regulations, responsible angling guidelines, conservation goals, contact information to fishing guides, fisheries management areas, target species and other wildlife and best catch and release practices (Björkvik *et al.* 2023; FWC, 2023; GC, 2023 NSWG, 2021). Furthermore, many countries make use of such websites as a platform to report illegal fishing activities often coupling these with monetary rewards (FWC, 2023; NSWG, 2021). In a South African context, where law enforcement has vast areas of coastline to manage, this would be an important tool, aiding in the effective use of law enforcement resources and further promoting a sense of custodianship for marine resources amongst the recreational fishing community. Finally, some countries make use of these websites as a point of dissemination of permit funds usage reports. This level of stakeholder engagement would allow for greater transparency with the use of permit funds and thus inspire confidence that permit fees are contributing to effective governance of recreational fisheries.

Improving compliance is an important component of enhancing the current recreational fisheries management system. With the most recent estimates of permit compliance showing high rates of non-compliance (Bova *et al.* 2017). In a system where the funds from recreational fishing permit sales directly impact the budget for the managing body, it would be vital to improve compliance. Furthermore, a lack of compliance would go against the proposed changes to recreational fishing policy. However, Bova *et al.* (2022) showed that in a South African context compliance was not necessarily affected by the level of perceived law enforcement, thus indicating this this approach could be misguided. The results of Hewett *et al.* (in prep) demonstrated that anglers believe that improvement in law enforcement would achieve better compliance with fishery rules and regulations. It is therefore likely that the increased WTP for permits with regards to law enforcement is perpetuated by a desire to see

improved compliance with rules and regulations. It is true that recreational fishers perceive their peers to be less compliant with rules and regulations than themselves hence the desire to improve compliance. Thus, a new dynamic approach of combining law enforcement, transparent use of funding and promoting access to rationales behind regulations and social norms campaigns would be needed to combat compliance in a South African setting.

Presently, there was no evidence to suggest that the permit system was used for anything besides cost recovery in South Africa (Chapter 2). However, permit systems themselves offer a wealth of additional opportunities to support recreational fisheries management. For example, this research used time series analysis that indicated yearly trends in permit sales and this information could be used to predict future sales trends (see Chapter 2 and Hunt *et al.* 2016), seasonal trends (Trella and Mickiewicz, 2016) and area specific trends (Hunt *et al.* 2016). Such insights are extremely valuable, particularly in a system where managing bodies are reliant on revenue from recreational fishing permit funds (NSWG, 2021; TOF, 2022). Furthermore, recreational fishing permits can be used as a tool to strategically allocate resources for management effort. For example, Hunt *et al.* (2016) found that captured biomass and fishing licenses sales were correlated, highlighting that fishing permit sales can be used as a proxy for effort. Thus, further research is needed to link marine recreational fishing permit sales to effort in a South African context if compliance is improved.

Implementation of protocols to conduct further research using the online permit platform would further increase the efficacy of the permit system. For instance, with all permit sales now available in a database it should be relatively easy to extrapolate data to allow for quick analysis of seasonal, demographic and geographic trends in sales (Jiorle *et al.* 2016; Venturelli *et al.* 2016). This could be another tool for the proposed recreational fisheries working group to allocate resources and provide feedback to stakeholders. Furthermore, an online permit system

could act as a point of contact with stakeholders for surveys regarding catch rates, policy updates, regulation changes and creation of potential fisheries management areas (Alic *et al.* 2021; Jiorle *et al.* 2016; NSWG, 2021; TOF, 2022; Venturelli *et al.* 2016). This would streamline data collection and allow for a representative sample group.

## **Conclusion**

In conclusion, although the South African marine recreational fishing permit system is functional, it only serves a cost-recovery function for management of marine fisheries and not for the recreational sector. This is primarily due to the existing policy, which does not specify the utilisation of these funds. The consequent lack of funding directed to recreational fisheries management hampers the management of the sector, and this is exacerbated by a management structure which has no research or management group specifically responsible for recreational fisheries management. The lack of utilisation of the online system for communication and outreach represents a missed opportunity, particularly because recreational fishers would like to see improved compliance activities and showed a preference for a non-competitive, more transparent fishery management system.

Although this study was specific to South Africa, many of the characteristics and the efficacy of its governance are not dissimilar to many nations around the world (Potts *et al.* 2020). Therefore, some general recommendations for the development of recreational angling permit systems should be considered:

- Recreational fisheries policy should specify how the costs for recreational fisheries management are recovered. Specifically, policy should indicate the role of the permit system in cost recovery. The utilisation of these funds should be clearly articulated in policy and should ensure that the revenue is allocated through

appropriate channels to fund the management of the recreational fishery and provide a transparent indication of spending.

- A structural change to the management agency to include a working group specifically focused on recreational fisheries that would be driven by clear policy to promote management practices including improved socio-economic development and ecological sustainability.
- The online system should be streamlined to be a user-friendly system that would allow for ease of purchase even for those who lack digital literacy. Furthermore, permits should be made available at retail outlets to prevent discrimination against individuals who do not have any access to the internet.
- Update the current online system into an integrated system that promotes both a social norms and instrumental approaches at combating non-compliance. It should provide the regulations for the fishery with the rationale behind each regulation and the latest research relevant to recreational fisheries. Information regarding responsible fishing practices, including best catch and release practices along with environmentally friendly behaviour should be readily available to educate anglers on sustainable fishing practices. Reporting illegal behaviour should be encouraged with rewards to those who do so.
- Finally, managing bodies should create a yearly report on the recreational fisheries sector. This should include the use of recreational fishing permit funds. Research into permit sales trends such as seasonal sales trends, demographic user information and geographic user information. Additional research (possibly in collaboration with tertiary institutions) into effort distribution, angler motivations and preferences, economic contributions of the sector, compliance behaviour, and the

effectiveness of current regulations in promoting sustainable recreational fishing practices. The yearly reports should also include any regulation updates, policy changes and changes to management structures.

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## LIST OF APPENDICES

### **I: Interview questions for officials of the DFFE.**

- 1) What is the flow of income from the marine recreational fishing permits sales from purchase to the Marine Living Resource Fund.
- 2) What expenses are incurred through administering the permits through the post office?
- 3) What is the budget allocation process for the chief directorates from the MLRF?
- 4) Is there a budget for recreational fisheries management?
- 5) How many officers are tasked with overseeing recreational fisheries?
- 6) What proportion of their time fisheries officers spend on recreational fisheries?
- 7) What research is conducted on recreational fishing (Effort, CPUE, Perceptions and Attitudes)?
- 8) Is there a management plan for recreational fisheries in South Africa?
- 9) Are there any plans for the DFFE to improve the recreational fishing permit system?
- 10) Are there any specific management plans for overexploited species other than commercially important species?
- 11) How often are recreational fishing stakeholder meetings held?
- 12) How does the DFFE engage with recreational fishing stakeholders?
- 13) How does the DFFE refer to these stakeholder engagements in any annual reports?
- 14) Is the MLRF used for improving recreational fishing access or infrastructure?

15) Has the DFFE considered of the economic benefits of improving/promoting recreational fisheries participation?

## **II: Discrete choice experiment pilot study questionnaire**



As a stakeholder in the South African recreational fishing sector, you have been selected by MSc candidate, Aidan du Preez, from the Department of Ichthyology and Fisheries Science at Rhodes University under the supervision of Professor Warren Potts and Doctor Christopher Bova to contribute your opinion of the South African recreational fishing permit system.

This research intends to generate a better understanding of South African recreational fishers' attitudes and perceptions of the current recreational fishing permit system. It also aims to promote stakeholder engagement.

Your participation in this research study is voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time. You may also refuse to answer any question that you do not wish to answer. The procedure involves asking questions about your opinion of the South African recreational fishing permit system and then requests you express your opinion over the ways in which funds should be used for the improvement of recreational fisheries and their management.

This survey should take approximately 5-10 minutes to complete. Your privacy is important, and all data are kept completely confidential. The surveys will not contain information that will personally identify you to protect your confidentiality. All data that is processed will remain anonymous and conform to the Protection of Personal Information Act.

In terms of the Protection of Personal Information Act, it remains your right to request the researcher to provide with a detailed explanation of exactly how confidentiality and anonymity will be achieved. You may request to know how your personal information will be stored securely, for how long it will be stored, and whether it is likely to be used again in further research. In terms of the Protection of Personal Information Act, you possess the right to receive feedback about this research. Feedback will take the form of a thesis produced in fulfilment of a Master of Science in Ichthyology and published in peer reviewed journal articles, unless you elect not to receive feedback.

If you have any questions about the research study, please contact Aidan Du Preez (g17d2132@campus.ru.ac.za) or the Rhodes University Ethics Coordinator (ethics-committee@ru.ac.za). This research has been reviewed according to Rhodes University ethics procedures for research involving human subjects and the National Health Research Ethics Council (Ethics approval number: 2021-5044-6418).

The results of this study will be used for scholarly purposes only. This research is not affiliated with any law enforcement agency or media/market related agency and this information will not

be used in any way that could cause harm to you. You may refuse to answer any question and may withdraw from the survey at any time.

Choosing the "Yes" box below indicates that:

- you have read the above information
- you voluntarily agree to participate
- you are at least 18 years of age

Yes (1)

No (2)

2 At the current prices of marine recreational fishing permits, would you agree that the price is an accurate representation of the value you receive from purchasing them?

Strongly Agree (1)

Somewhat agree (2)

Neither agree nor disagree (3)

Somewhat disagree (4)

Strongly disagree (5)

3 What types of benefits do you expect to receive from purchasing a recreational fishing permit?

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4 Where would you like to be able to purchase marine recreational fishing permits from? (They are currently available at South African post offices and the Department of Forestry, Fisheries and the Environment)

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5 In which format would you like to see marine recreational fishing permits be made available in future? (Permits are currently available in paper format but could include digital or more durable forms)

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6 In your opinion, what can be done to improve the management of marine recreational fisheries?

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7 What do you think funds gathered from the sale of marine recreational fishing permits should be used for?

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8 Do you believe that tax paid on fishing goods should be used explicitly for recreational fisheries management?

- Definitely not (1)
- Probably not (2)
- Might or might not (3)
- Probably yes (4)
- Definitely yes (5)

9 How likely would you be to pay a small tax on fishing gear if you were 100% certain that it would be used for recreational fisheries research and management?

- Extremely unlikely (1)
- Somewhat unlikely (2)
- Neither likely nor unlikely (3)
- Somewhat likely (4)
- Extremely likely (5)

10 What is the highest percentage tax you would pay if the funds were guaranteed to be used for recreational fisheries research and management? (Please specify the percentage %)

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11 Which marine recreational fishing related permits have you purchased in the last five years?

- Angling Annual (1)
- Angling Monthly (2)
- Spearfishing Annual (3)
- Spearfishing Monthly (4)
- Cast/Throw Net Annual (5)
- Cast/Throw Net Monthly (6)
- Marine Aquarium Fish Annual (7)
- Marine Aquarium Fish Monthly (8)
- Scuba Diving In MPAs Annual (9)
- Scuba diving In MPAs Monthly (10)
- West Coast Rock lobster annual (11)
- East Coast Rock Lobster annual (12)
- Mud Crab Annual (13)
- Mud Crab Monthly (14)
- Drag Net Annual (KZN only) (15)

- Hoop Net Annual (KZN only) (16)
- Mussel (17)
- Oyster (18)
- Molluscs, marine worms, other invertebrates and plants Annual (19)
- Molluscs, marine worms, other invertebrates and plants Monthly (20)
- Additional fee for recreational fishing from a vessel (21)
- I have not purchased any of the above in the last five years (22)

12 If you have any other comments or suggestions for the South African marine recreational fishing permit system please feel free to add them below.

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### III: Discrete choice experiment questionnaire



As a participant in the South African recreational fishery, you have been selected to contribute your opinion of the South African recreational fishing permit system. As a reward for completing this survey you will be entered into a lucky draw to win a Shimano Spheros 10 000.

This research intends to better understand South African recreational fishers' attitudes and perceptions of the current recreational fishing permit system. It also aims to promote stakeholder engagement between managing bodies and the fishermen. The survey forms part of the research of MSc candidate, Aidan du Preez, from the Department of Ichthyology and Fisheries Science at Rhodes University under the supervision of Professor Warren Potts and Dr. Christopher Bova to contribute your opinion of the South African recreational fishing permit system. Participation in this research study is voluntary. You may choose not to participate. You may withdraw anytime if you decide to participate in this research survey. You may also refuse to answer any question that you do not wish to answer. The procedure involves asking questions to choose your preferred alternative out of two alternative hypothetical scenarios across multiple choice sets. These choice sets have been developed with pertinence to the South African recreational fishing permit system. This survey should take approximately 10-12 minutes to complete. Your privacy is important, and all data are kept completely confidential. The surveys will not contain information that will personally identify you to protect your confidentiality. All data processed will remain anonymous and conform to the Protection of Personal Information Act. In terms of the Protection of Personal Information Act, it remains your right to request the researcher to provide a detailed explanation of exactly how confidentiality and anonymity will be achieved. You may request to know how your personal information will be stored securely, how long it will be stored, and whether it will likely be used again in further research. Regarding the Protection of Personal Information Act, you possess the right to receive feedback about this research. Feedback will take the form of a thesis produced in fulfilment of a Master of Science in Ichthyology and published in peer reviewed journal articles unless you elect not to receive feedback.

If you have any questions about the research study, please contact Aidan Du Preez (g17d2132@campus.ru.ac.za) or the Rhodes University Ethics Coordinator (ethicscommittee@ru.ac.za). This research has been reviewed according to Rhodes University ethics procedures for research involving human subjects and the National Health Research Ethics Council (Ethics approval number: 2021-5044-6418).

The results of this study will be used for scholarly purposes only. This research is not affiliated with any law enforcement agency or media/market-related agency, and this information will not be used in any way that could cause harm to you. You may refuse to answer any question and withdraw from the survey anytime. Choosing the "Yes" box below indicates that:

you have read and understand the above information.

you voluntarily agree to participate.

you are at least 18 years of age.

Yes

No

The following questions require you to choose what you feel is the most desirable scenario of two alternative scenarios. Each choice will vary slightly with regards to marine recreational fishing permit price, types of special use fishing areas (such as a catch and release only zones), formats in which the permit will be made available, and levels of law enforcement. To understand what these mean, definitions are provided below:

Permit Price:

The price of marine recreational angling permits only.

The cost would vary by five levels.

### Fisheries Areas:

Fisheries areas refer to potential changes to the current areas where recreational fisheries are allowed to fish. These potential changes include:

**"Additional zones closed to fishing":** New areas where all forms of fishing are prohibited.

**"New catch and release only zones":** Areas where fishing is allowed but no fish may be kept.

**"New recreational fishing only zones":** Areas where only recreational fishing is allowed.

**"No new zones closed to fishing":** No changes to the current recreational fisheries areas.

### Permit form:

The permit form refers to the forms in which the permit could be made available.

**"Paper permit":** The same as the current format.

**"Laminated card permit":** Hardier, more compact permits such as a driver's license.

**"Digital permit":** Electronic permit that could be held on a cell phone.

### Law enforcement:

Law enforcement refers to the recreational fishing management agents actively enforcing rules and regulations, catching individuals breaking the rules and regulations, and penalizing them for non-compliance.

Law enforcement will vary in three degrees around the current perceived level.

**"Decrease in law enforcement" "No change in law enforcement" "Increase in law enforcement"**

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 1

**Alternative 1**

Permit price of R38

Additional zones closed to fishing

Paper permit

Increase in law enforcement

**Alternative 2**

Permit price of R95

No new zones closed to fishing

Digital permit

No change in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 2

**Alternative 1**

Permit price of R114

New recreational fishing only zones

Laminated card permit

Increase in Law enforcement

**Alternative 2**

Permit price of R38

New catch and release fishing only zones

Digital permits

Decrease in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 3

**Alternative 1**

Permit price of R95

Additional zones closed to fishing

Paper permit

Decrease in law enforcement

**Alternative 2**

Permit price of R38

New catch and release fishing only zones

Laminated card permit

No change law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 4

**Alternative 1**

Permit price of R95

New recreational fishing only zones

Laminated card permit

Increase in law enforcement

**Alternative 2**

Permit price of R114

New catch and release fishing only zones

Digital permit

Decrease in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 5

**Alternative 1**

Permit price: R57

No new zones closed to fishing

Digital permit

Increase in law enforcement

**Alternative 2**

Permit price of R95

New catch and release fishing only zones

Laminated card permit

Decrease in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 6

**Alternative 1**

Permit price of R38

Additional zones closed to fishing

Paper permit

No change in law enforcement

**Alternative 2**

Permit price of R76

New recreational fishing only zones

Digital permit

Decrease in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 7

**Alternative 1**

Permit price of R38

New recreational fishing only zones

Laminated card permit

Decrease in law enforcement

**Alternative 2**

Permit price of R114

Additional zones closed to fishing

Paper permits

Increase in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 8

**Alternative 1**

Permit price of R38

Additional zones closed to fishing

Digital permits

No change in Law enforcement

**Alternative 2**

Permit price of R57

New catch and release fishing only zones

Paper permit

Decrease in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 9

**Alternative 1**

Permit price of R114

No new zones closed to fishing

Paper permit

Decrease in law enforcement

**Alternative 2**

Permit price of R76

Additional zones closed to fishing

Digital permit

Increase in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 10

**Alternative 1**

Permit price of R57

Additional zones closed to fishing

Laminated card permit

Decrease in law enforcement

**Alternative 2**

Permit price: R76

New catch and release fishing only zones

Paper permit

No Change in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 11

**Alternative 1**

Permit price of R57

New recreational fishing only zones

Paper permit

No change in law enforcement

**Alternative 2**

Permit price of R95

No new zones closed to fishing

Digital permit

Increase in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 12

**Alternative 1**

Permit price of R57

Additional zones closed to fishing

Laminated card permit

No change in law enforcement

**Alternative 2**

Permit price of R38

No new zones closed to fishing

Paper permit

Increase law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 13

**Alternative 1**

Permit price of R57

No new zones closed to fishing

Paper permit

No change in law enforcement

**Alternative 2**

Permit price of R114

New recreational fishing only zones

Digital permit

Decrease in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 14

**Alternative 1**

Permit price of R38

New recreational fishing only zones

Digital permit

Decrease in law enforcement

**Alternative 2**

Permit price of R76

Additional zones closed to fishing

Laminated card permit

Increase in law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 15

**Alternative 1**

Permit price of R76

Additional zones closed to fishing

Paper permit

Decrease in law enforcement

**Alternative 2**

Permit price of R57

New catch and release fishing only zones

Digital permit

Increase law enforcement

Please select the scenario that you would prefer to see with regards to the marine recreational fisheries permit system.

Choice set 16

**Alternative 1**

Permit price of R76

No new zones closed to fishing

Laminated card permit

Decrease in law enforcement

**Alternative 2**

Permit price of R95

New recreational fishing only zones

Paper permit

No change in law enforcement

### Demographic information

Please select your gender

- Male
- Female
- Other/non-binary

Please state your age

Please select your level of education

- Pre matric
- 
- Matric
- 
- Professional Certificate/diploma
- 

Undergraduate degree

Post graduate degree

Please select your level of income per year

- No income
- R1-R19 200
- R19 201-R307 000

R307 001 and above

Please select your employment status

- Unemployed
- 
- Employed
- Retired

Student

Thank you for taking part in the research survey! For your chance to win the SHIMANO SHPEROS 10 000. Please put down your email address below. This will automatically place you in the lucky draw.

If you have any comments regarding the marine recreational fishing permit in South Africa please feel free to leave them bellow.

[Powered by Qualtrics](#)

#### **IV: Script for phone calls to gather response group**

Hello, how are you doing today?

My name is Aidan du Preez from the Rhodes University department of Ichthyology and Fisheries sciences. I'm calling to find out whether you would like to participate in a survey regarding the fishing permit scheme with the chance to win a Shimano Spheros 10 000?

Answer: No

Thank you for your time, have a pleasant day.

Answer: Yes

The procedure will involve emailing you a survey that would ask you to select your preferred hypothetical scenario of the South African recreational fishing permit system. Would you be happy to give us your email address with the knowledge that it would only be used for research?

This research intends to generate a better understanding of South African recreational fishers' attitudes and perceptions of the current recreational fishing permit system to promoting stakeholder engagement and improve recreational fisheries management.

Your privacy is important, and all data will be kept completely confidential, and no questions will be asked that will personally identify you. All data that is processed will remain anonymous and conform to the Protection of Personal Information Act.

The results of this study will be used for scholarly purposes only. This research is not affiliated with any law enforcement agency or media/market related agency and this

information will not be used in any way that could cause harm to you. You may refuse to answer any question and may withdraw from the survey at any time.

An email with a link will be sent to you in the following weeks .

**V: Table of features for the Multinomial Model**

	Key Features	Outputs	Assumptions	Strengths	Limitations
<b>Multinomial Logit (MNL)</b>	Estimates average utilities for attributes across all respondents.	One set of coefficients (utilities), standard errors, significance, predicted probabilities, marginal effects.	Assumes <i>Independence of Irrelevant Alternatives (IIA)</i> ; preferences are homogeneous across individuals.	Simple to estimate and interpret; good baseline model.	Cannot capture heterogeneity; no correlations among attributes; “one ranking” only.

