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Ways of Moving from Laissez-Faire to Management: An Investigation of Potential Management Strategies for Recreational Sea Angling in Taiwan

Chien-Ho Liu [1] and Chung-Ling Chen [1,2,*]

[1] Institute of Ocean Technology and Marine Affairs, National Cheng Kung University, Tainan 70101, Taiwan; chienholiu@gmail.com
[2] Department of Hydraulic and Ocean Engineering, National Cheng Kung University, Tainan 70101, Taiwan
* Correspondence: chungling@mail.ncku.edu.tw; Tel.: +886-6-2757575 (ext. 63283)

Abstract: The objective of this paper is to identify potential management strategies pertaining to angling in Taiwan where angling is virtually devoid of management. A three-step approach is used—semi-structured interviews, modified Delphi technique, and fuzzy analytical hierarchy process—to develop an inclusive list of potential strategies and construct a three-level structure with strategies and associated weights. It is intended to inform managers of what strategies they may take if management on angling is needed. The results show that angling sites and resource use are considered relatively important dimensions in the second level. Among 13 items, safety education, the establishment of safe angling sites, information provision, angling fees, environmental education, separation of different uses, restriction on catch sale, and conservation efforts, are the top eight rankings in the third level. Management implications from the findings were discussed, with an emphasis on the priority strategies such as establishing safe angling sites and safety education. These strategies reflect the current shared societal, economic, and environmental aspirations of a wide range of stakeholders and facilitate charting the journey towards a managed angling domain.

Keywords: recreational sea angling; management; stakeholders; multi-criteria decision-making

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1. Introduction

Recreational sea angling (also called recreational fishing) is a major pastime in many countries around the world [1]. It is estimated to account for about 12% of fish catches worldwide and generates direct and indirect incomes in coastal regions [2]. For example, marine recreational fishing in California represents an important component of the ocean economy, with 5.3 million angler trips generating almost US$3 billion annually, and producing a total catch of over 12 million fish in 2011 alone [3].

With its unneglectable catch, the recreational fishing sector is deemed to have the potential to negatively affect fish and fisheries [4,5]. Illustratively, in California, the US, members of the genus *Paralabrax* (e.g., Kelp Bass, Barred Sand Bass) are the most popular Southern California gamefishes dating back over a century, having exhibited both long-term and recent fishery population impacts. Specifically, Barred Sand Bass populations exhibited a precipitous decline from 2005 to 2007, followed by continued and significant declines through 2016 [3].

In Taiwan, recreational sea angling has become increasingly popular in recent years. It is an open-access activity and there is not yet a central law or a management framework in place to manage angling except for a limited number of local regulations applying to specific locations. Namely, recreational sea angling in Taiwan is in a laissez-faire state for which everyone is free to engage at almost all public places except for those where angling is otherwise specifically prohibited by law. The possible reasons for this phenomenon are two-fold. One is that angling has long been regarded as a leisure activity and is thus deemed

to have a much lower inherent ecological impact than commercial fishing. The other is that the highly dynamic nature of recreational fishing makes it challenging to make rules. Concerns have consequently emerged over the impacts of angling on marine environments, angling safety, conflicts between angling and other activities (e.g., fishing and water sports), and anglers' environmentally unfriendly behaviors (e.g., littering, catching fish of small sizes or too many fish).

Experiences show that a paradigm shift from laissez-faire to management will occur if overuse and/or competing uses of finite natural resources create problems, such as depletion of resources, destruction of natural environments, social conflicts in the presence of competing resource uses, etc. Fisheries are a typical example. Fish resources are common property and fisheries used to be open access. The need for fishery management to curtail overexploitation of open-access fisheries has been well established [6,7]. Another example is the use of coastal resources. With increasingly diverse and competing uses of coastal resources, various problems (e.g., pollution of coastal waters, overfishing, and destruction of habitats) were documented in the 1970s and 1980s such that management had to be ushered in. Consequently, a paradigm shift has occurred since the 1970s and 1980s from laissez-faire to sectoral management, and further to integrated management [8]. Another example at a national scale is the angling in Portugal, which used to be an open-access activity for a long time, and restrictions were first implemented in 2006 when the decline in most fisheries resources was observed and the tension between commercial, mostly artisanal, and recreational sectors increased [9].

The examples referred to above evidently demonstrate a paradigm shift from non-intervention to management. It, therefore, can be expected that angling in Taiwan will one day go through a paradigm shift from non-intervention to management, given that angling activities are growing, conflicts between commercial fishing and angling occur, and angling has recently been put on the government's policy agenda. In particular, there is a strong push from the angler community to establishing more angling spots as well as making state-wide regulations dedicated to angling [10]. This creates a unique opportunity to investigate potential management strategies which can be referred to when concerned authorities have to take action surrounding the management of angling.

It is widely acknowledged that the participation of stakeholders has become an integral part of the decision-making process. This approach has been used to better address situations where traditional top-down approaches generally fail, in which decisions are often made without broad consultation with stakeholders [11]. Besides, it is argued that internal governance is most effective when the rules emerge from within the user group rather than being imposed by a distant political authority [12]. This indicates users' views on resource management are important in constituting a fruitful part in producing effective policies and measures and then ensuring rule compliance. Consequently, a number of terms such as 'adaptive management', 'co-management', 'community-based resource management', and 'ecosystem-based management' are created and frequently used to indicate the involvement of stakeholders in decision-making [13–17]. As an illustration, in fishery management, participation of fishers in the decision-making process facilitates understanding fishers' experience-based knowledge, which might be useful for management challenges. It also increases the legitimacy of the decision-making process and, thus, enhances compliance with legislation [11]. Furthermore, recent research emphasizes that understanding and managing recreational fisheries requires a social-ecological perspective [18].

In light of the above, this paper aims to investigate potential management strategies based on inputs from stakeholders. However, it should be noted that in Taiwan's socio-economic context, recreational fishing not only involves the taking of fish resources but also are a matter of the allocation of specific areas at fishing harbors and commercial ports for angling and the establishment of safe angling sites. The latter is strongly advocated by anglers who urge the concerned authorities to make endeavors for these initiatives [19]. In this regard, angling management in Taiwan is a multi-faceted matter, inherently involving multi-criteria decision-making (MCDM). Furthermore, understanding and prioritizing the

criteria crucial to angling management is practically important to managers since their relative importance is essential in informing managers of what measures need to be first adopted in the initial stage of management. For this, the fuzzy analytical hierarchy process (fuzzy AHP) is used since it helps determine the criteria that matter in angling management as well as their relative importance. This method has been widely used to solve MCDM problems [20–26].

2. Overview of Recreational Sea Angling in Taiwan

Taiwan, including several outlying islets, is surrounded by the sea. Its coastline stretches up to 1988 km [27]. The abundant marine ecosystems (e.g., coral reefs, mangroves, wetlands) offer diverse habitats for marine organisms. This good marine environment has allowed Taiwan to develop fisheries to provide animal proteins for its nationals for a long time. Besides that, it offers an opportunity for the development of recreational sea angling, particularly since Taiwan's government started pursuing a fisheries diversification policy and a policy to enhance people's access to the sea. The former seeks to diversify the fishery industry into tourism in order to reduce fishers' dependence on fishing production and ease fishing pressure and further create alternative sources of income for fishers [28]. A derivative of this policy is that fishing vessels, if permitted, can serve as recreational angling boats by law. So, people can get on board to engage in angling in coastal waters [29]. The latter is a new policy, called the 'Salute to the Sea', which aims to promote people's understanding of, care of, and access to the sea [30]. To fulfill this policy, multiple strategies have been formulated by many concerned authorities. One of the strategies is to promote angling.

In Taiwan, angling is an activity that does not require permits or any form of registration, with only one exception being a local regulation requiring permits for angling at the Keelung Islet. It is therefore not surprising to find that the number of anglers, the amount of catch, and the temporal and spatial distribution of catch trends are not yet known. This is a warning sign for fisheries resource management. Particularly, this missing information has retarded the ability to understand the magnitude of the recreational fishing sector and its contribution to fish mortality relative to commercial fisheries, and to take precautionary measures to avoid unsustainable fishing [29].

The open-access of angling stands in stark contrast to the highly restricted access to commercial fishing. It is noted that the Fisheries Act was enacted to regulate fishing activity to achieve sustainable utilization of fisheries resources and thus, a huge volume of regulations have been made, including catch reporting, restrictions on certain fishing gear, and vessel licensing. By contrast, there is no such law as the Fisheries Act dedicated to managing angling. However, it should be noted that recreational and commercial fishing are conceptually distinct, but they share many common features, including the potential to degrade environments, change ecosystems, generate waste, and cause the collapse of stocks [31].

Anglers generally can engage in angling at any public place except for the spots where angling is specifically prohibited by laws, such as the Fishing Harbor Act, the Commercial Port Act, and the National Park Act. In general, angling is not allowed in fishing harbors, commercial ports, or national parks. However, the concerned authorities may relax these restrictions by allowing angling at specific locations if it does not interfere with fishing operations at fishing harbors, navigation at commercial ports, or reduce conservation effects in national parks. As of April 2021, a total of 89 spots are opened for angling, including 45 spots at fishing harbors, 15 at commercial harbors, 11 at the Kenting National Park, and 18 at the Keelung Islet [32] (Figure 1).

Figure 1. Distribution of spots opened for angling by the concerned authorities.

While angling is not managed in Taiwan, a newly established agency—the Ocean Conservation Administration—was designated as the central agency to take over responsibility for angling by the Executive Yuan in 2020. While not yet taking any initiatives to stipulate any laws or create a statutory framework dedicated to angling, this agency promotes a few voluntary measures, such as creating an online catch reporting system to encourage anglers to report catch and making a code of conduct to promote anglers' environmentally friendly behavior and enhance angling safety. Specifically, this code provides a list of voluntary safety instructions, including wearing lifejackets and non-slip boots, purchase of insurance, keeping an appropriate distance between anglers, and always checking the weather conditions and sea forecast before heading out. It also mentions environmental behaviors on which anglers are encouraged to act, including not littering and bagging their own trash, using no more than two rods, reels, and lines at a time, releasing small fish, and bringing back fish of the recommended size [33].

The initial outcome from the catch reporting system was not promising, with a small number of 581 anglers reporting a total of 1649 data between May and August 2020 [34]. The fish commonly angled year-round are of the demersal species, such as seabream, seabass, snapper, and mullet. The pelagic species are also targeted seasonally, including mackerel, beltfish, grouper, and dolphin fish. The fish species angled are very similar to the ones from coastal and offshore fisheries.

3. Research Methods

The research method involves a three-stage process. The first stage is to gather potential management strategies or measures as diverse as possible by using semi-structured interviews, which are facilitated by a literature review. The second stage is to validate the measures gathered in the first stage using a modified Delphi technique. The third stage is to employ the fuzzy AHP method to calculate the weights of measures validated in the second stage. A research flow diagram was shown in Figure 2.

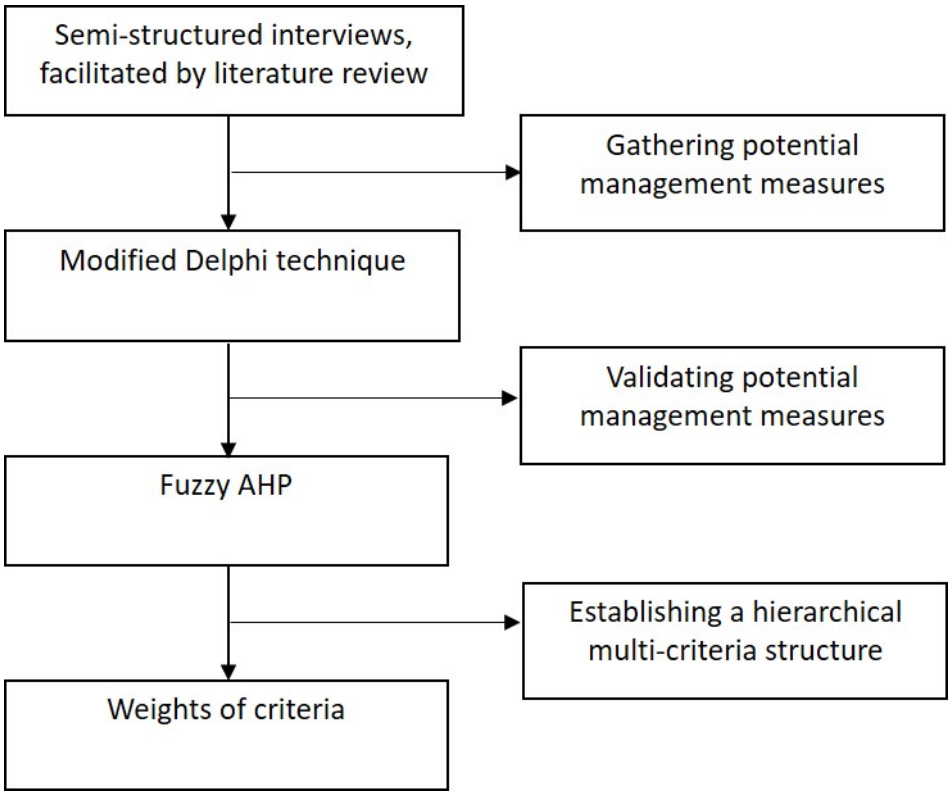

Figure 2. Procedures in establishing an evaluation structure for potential management strategies on recreational sea angling.

3.1. Semi-Structured Interviews

Semi-structured interviews were used to obtain information regarding stakeholders' views on potential management measures. This approach was intended to collect stakeholders' opinions to establish a measure list. The research used purposive sampling techniques to select participants who are familiar with angling activities in Taiwan. The research tried to diversify the participant composition to ensure a variety of perspectives. A total of 15 interviewees were invited to join this research, including four veteran anglers, three fishermen, three government officials in charge of angling, two from fishing harbor authorities and two from commercial port authorities, and one scholar. Each interview typically lasted about one hour and each interviewee was initially informed of the research aims, the potential management measures, and the claims anglers recently made to the concerned authorities.

It should be noted that the information on management measures revealed to participants was mainly drawn from the literature review. It was intended to inspire participants' ideas with a focus on management measures that can be applied in Taiwan's context. For example, in Ireland, regulatory measures on seabass angling include season closures during the spawning period, a limit of two fish per day, and a minimum size of 40 cm, as well as a more stringent regulation, ushered in 2018 calling for 'catch and release' only [11]. In Portugal, recreational fishing regulations put in place in August 2006 include harvest controls, such as daily bag limits, minimum landing sizes, fishing licenses, and spatial restrictions, even though no information about the planning process (e.g., stakeholders' involvement) or the scientific rationale to support these restrictions was made available to the public [9]. In South Africa, recreational fishing regulations promulgated under the Marine Living Resources Act are made to ensure long-term sustainable utilization of fish resources, including permits, bag limits, temporal and spatial restrictions, catch for one's own use, and the maximum number of rods and hooks used for a permit holder [35]. In California, the US, regulations of minimum size limits and daily bag limits were imposed

for three *Paralabrax* species. The former was intended to decrease total fishing mortality rates and the latter was intended both to decrease fishing mortality rates in the short term and to increase spawning biomass in the long term [3]. In Taiwan, a local regulation, only applying to rock angling at Keelung Islet, designates 18 rock sites allowed for angling and specifies the maximum number of anglers at each site, the angling period, permits, mandatory insurances for anglers, the minimum size for retained fish, and recording catch data. Besides, the vessel used for carrying anglers to rocks must be registered for recreational fishing [36].

The potential measures (or items) mentioned in the interviews were then combined in a structured manner in two ways. One is that items referring to similar things were grouped into a common item. The other is that by their attributes, items were roughly grouped into different categories. A total of 20 items were gathered and then went through a validation process by using a modified Delphi technique.

3.2. Modified Delphi Technique

The modified Delphi technique is a widely used method for gathering data from participants within their domain of expertise [37–39]. It focuses on insights garnered from a panel of experts and is practiced as a group communication process, without requiring participants to work face to face, which is intended to achieve a convergence of opinions concerning a specific topic [40]. The process starts with a set of selected items, which may be drawn from various sources, such as literature reviews and interviews with experts. The modified version of the Delphi has the advantage of improving the initial round response rate, time saving, reducing the effects of bias due to group interaction, and providing controlled feedback to participants [41].

A questionnaire was designed based on the items established in the above interviews. Each item included three options for participants to check: agreement, disagreement, and agreement if changes are made. In the last option, participants were required to specify the changes. Besides that, a column for comments was designed in the last part of the questionnaire to solicit further input regarding the deletion or addition of items, or grouping of items.

A panel of 28 participants, including the 15 from the previous interviews, was established (Table 1). They were chosen based on their knowledge and experience in angling activities and marine resource uses. The questionnaire was first sent out to them by email in July 2019. In subsequent rounds, the questionnaire was revised after taking into consideration the comments made by experts. The procedure continued until all items achieved more than two-thirds of agreement from respondents, which occurred in the third round. The items achieved from the process were then used in the establishment of an MCDM model.

Table 1. Composition of participants.

Group	Number
Angler	6
Fishman	5
Government	5
Scholar	4
Fishing harbor authority	3
Commercial port authority	2
NGO	3
Total	28

It should be noted that during the process no more items were added to the list established in the first stage, indicating that the items gathered in the semi-structured interviews covered all the potential management measures that could be thought of by the interviewees. However, some items were deleted, and some were combined and renamed to incorporate a broader scope. This will be presented in the next section.

3.3. Fuzzy AHP Method

The AHP, developed by Saaty (1980), uses a multi-level hierarchical structure of objectives, criteria, and subcriteria and prioritizes them by using a set of pairwise comparisons [42]. The pairwise comparison is made between every two elements on the same hierarchy, and the inverse scaling method is used to create judgment matrices based on 1–9. A judgment matrix that passes the consistency inspection is considered to be the weight of criteria for this hierarchy [43].

The AHP requires crisp judgment from decision-makers. However, due to the complexity and uncertainty involved in real-world problems, a decision-maker may sometimes feel more confident to provide fuzzy judgments than crisp comparisons [44]. The fuzzy AHP, a combination of fuzzy set theory and AHP, was thereby used to deal with the uncertainty for its advantage of reducing subjectivity for decision-makers, enabling them to obtain accurate and important criteria weights [45].

The second questionnaire was made (as seen in Appendix A) based on the items achieved by using the modified Delphi technique. It was delivered in September 2019 to the same participants who were surveyed in the first questionnaire. In the computation of criteria weight, the judgments obtained from participants were converted into a triangular fuzzy number [46]. The details are presented in the Supplementary Material.

4. Results

4.1. A Final Set of Items

A final list of 13 items and their corresponding categories (Table 2) were obtained based on the modified Delphi technique. These items represent the general and common views of a wide range of stakeholders regarding the potential management measures/strategies in the context of Taiwan. During the process, five items were deleted: patrols stationed at angling sites, catch and release only, maximum number of anglers at an angling site, casting more than a certain number of poles and hooks at a time, and minimum age for angling. It should be noted that while the former four items were deleted due to more than two-thirds of respondents indicating disagreement, the deletion of the 'minimum age for angling' is based on the comments given by participants that this item can be adequately incorporated into permits/registration by setting the age requirement for permits or registration.

Table 2. Weights for dimensions and items in the evaluation structure of potential angling management strategies.

Dimension	Local Weight (A)	Item	Local Weight (B)	Local Ranking	Global Weight (A * B)	Ranking
Angling sites	0.338	Information provision	0.356	2	0.1203	3
		Separation of different uses	0.256	3	0.0865	6
		Establishment of safe angling sites	0.388	1	0.1311	2
Resource use	0.261	Fish size limits	0.237	3	0.0619	9
		Temporal restriction	0.086	5	0.0224	12
		Bag limits	0.083	6	0.0217	13
		Restriction on catch sale	0.256	1	0.0688	7
		Catch reporting	0.091	4	0.0238	11
		Conservation efforts	0.247	2	0.0645	8
Eligibility of angling	0.180	Registration/permits	0.374	2	0.0617	10
		Angling fees	0.626	1	0.1033	4
Education	0.244	Safety education	0.622	1	0.1468	1
		Environmental education	0.378	2	0.0892	5

In addition, some items were combined to incorporate a broader scope. Specifically, 'wearing safety gear' and 'purchasing insurance' were merged into one item named 'safety education'. 'Releasing small fish' and 'no littering' were merged as one item called 'environmental education'.

4.2. A Three-Level Hierarchy

Based on the items established, a three-level hierarchy was then constructed. The highest level of the hierarchy is the overall goal: establishing an evaluation structure

for potential management strategies on recreational sea angling in the context of Taiwan. Under the overall goal, the second level represents the main dimensions of management, including angling sites, resource use, eligibility of angling, and education. Various sets of items associated with each dimension at the second level are linked to the third level. There are 13 items in total at the third level.

Using the fuzzy AHP method, the weights of dimensions and their associated items were computed (as seen in the Supplementary Material) and presented in Table 2. The results show that angling sites (0.338) and resource use (0.261) are the two most important dimensions, followed by education (0.236) and eligibility of angling (0.165).

As seen in the column of local ranking, the items of the establishment of safe angling sites (0.388), restriction on catch sale (0.256), angling fees (0.626), and safety education (0.622) show the highest importance with respect to each dimension in order of angling sites, resource use, eligibility of angling, and education, respectively. By looking at the global weight and global ranking, the items of safety education (0.1468), establishment of safe angling sites (0.1311), information provision (0.1203), angling fees (0.1033), environmental education (0.0892), separation of different uses (0.0865), restriction on catch sale (0.0688), and conservation efforts (0.0645) are the top eight rankings.

5. Discussion

The findings of this research have important implications for angling management in Taiwan. First, since angling sites is the most important dimension, priority should be given to establishing angling sites. This is not surprising since the establishment of angling sites is a very basic foundation for promoting angling activities, securing angling safety, guiding anglers to safer locations, and importantly reducing potential conflicts between angling and other activities such as commercial fishing. The items pertaining to this dimension—information provision, separation of different uses, and establishment of safe angling sites—all gain high global weights, ranking 3, 6, and 2, respectively. This evidently indicates that these measures deserve much attention. Specifically, the establishment of safe angling sites involves checking sites for their coastal types, slippery conditions, tidal ranges, occurrences of rough waves, potential hazards, etc., and then finding safe locations for angling. Furthermore, safety equipment and/or facilities are adequately offered and/or installed at the site to enhance site safety and reduce the risk of injuries. Associated equipment and facilities include such items as angel rings, safety harnesses, ladders, Automatic External Defibrillators, safe access to sites, and safety signs.

Information provision concerns enhancing anglers understanding of the site environment and providing them with the site information as comprehensively as possible. The classic economic theory supposes that the more informed consumers are, the more rational and efficient their market decisions will be [47]. In the same vein, it is expected that the more informed anglers are, the more likely they are to be able to make rational decisions, such as on the selection of angling sites and the time of angling. The information is diverse, from site maps, physical environments, wave and weather conditions, facilities and services, codes of conduct, safety notices, to potential hazards, such as slippery rocks and strong waves. The information can be conveyed via a variety of channels, including signage at the site, brochures, websites, and apps. Among them, websites and apps are particularly crucial since anglers can get regular updates if they are planning to be out for any length of time. Anglers, before or during a trip, can therefore make informed decisions on whether to change plans or cancel the trip if the forecast is unfavorable. In addition, signage is commonly used to display safety, codes of conduct, and other related information at the entry points to angling sites. Well-designed and positioned signage is a cost-effective long-term method of communicating a consistent message to people [48].

Separation of different uses is a crucial approach to prevent conflicts between incompatible activities and/or isolate certain activities to be contained to a particular area in order to reduce potential hazards [49]. For example, conflicts might arise in fishing harbors where anglers' throwing rods and lines might interfere with fishing operations. It is therefore

important to have an adequate division of space between angling and fishing to meet the demands of both fishers and anglers. In addition, it is noted that the separation of different uses often involves decision-making on the priority uses in the same area. For this, making a spatial plan presents a good way of facilitating decision-making on the priority uses through a participative and transparent manner. The plan helps identify the priority uses and their respective allocated areas and thus avoid potential conflicts among them.

Secondly, the high score of resource use implies that managers should pay more attention to the use of fisheries resources. The associated items, restrictions on catch sale, conservation efforts, and fish size limits, are particularly deemed important based on their respective local weights. The item of restriction on catch sale, ranking first in this dimension, particularly indicates that there is a need to differentiate between angling and commercial fishing. It is noted that angling has been criticized for catching too much fish for sale and profit, impacting the resources available to their commercial counterparts [29]. It is, therefore, crucial to impose the allocation of quota between anglers and fishers when the catch of specific fish species by both sides becomes an issue. It is noted that both sides catch almost the same fish species in Taiwan. Conservation efforts refer to protecting the marine environment and enhancing fish stocks. This item is particularly important to sites where resource uses are intense. The approaches are commonly employed to fulfill this item, such as placing artificial reefs, releasing fish fries, restoring marine habitats, the establishment of marine protected areas (MPAs), regularly monitoring marine environments, and enforcing illegal activities, e.g., trawling within 3 miles from the shoreline. In particular, the establishment of MPAs has been recognized as the most effective approach to marine resource conservation [50,51].

Thirdly, the items under the dimension of education deserve attention due to their high rankings in the global weight. This indicates that managers should pay more attention to instilling knowledge associated with angling among anglers. The conventional thinking in the field of environmental education has been that we can change behavior by making human beings more knowledgeable about the environment and its associated issues [52]. This thinking suggests that if anglers are more knowledgeable about the environment and safety, they will in turn become more aware of the environment and safety, and thus be more motivated to act responsibly towards the environment and take care of their own safety when angling. Safety education is particularly important, as indicated by the highest global weight.

Safety education should focus on enhancing anglers' understanding of how to avoid hazards and reduce the risk of injuries. To this end, the concerned authorities are encouraged to sponsor safety programs and assist anglers in taking necessary actions to ensure their own safety. For example, anglers have knowledge of wave and marine conditions and, thus, are able to make rational decisions on when and where they go angling. They also need to know how to avoid potentially hazardous sites or objects by checking the physical states of angling spots. Furthermore, they need to know the appropriate clothing, footwear, and safety gear (e.g., personal floating devices), the ways to check lifejackets for wear and tear and maintain them to keep them functioning, the necessary actions if washed into the water, and any safety-related information. These programs can be presented on any website that anglers can check anytime, or in physical lectures that anglers are encouraged to attend in person.

Angler behavior can be influenced through regulations, but it is often best accomplished by cultivating bottom-up social change movements [53]. Environmental education plays a critical role in this movement since it aims to instill marine stewardship among anglers and helps cultivate conservation-minded practices. Specifically, not littering when angling, placing no more than two rods and poles at one angling site per angler, catching only a moderate number of fish, releasing fish of small sizes, reporting catches, etc., are strongly recommended.

To enhance safety education as well as environmental education among anglers, the concerned authorities should take charge of making or sponsoring the relevant programs.

These programs should be made in an inclusive, participative, consultative, and adaptive way such that they can be improved regularly and meet the need of the angler community.

Fourthly, in addition to the items mentioned above, the item of angling fees, ranking fourth in the global weight, deserves attention. It refers to charging a reasonable fee for angling at established angling sites where a certain level of service is offered (e.g., regular maintenance of facilities, toilets, and parking lots). This item's high score indicates that the principle of user-pay has been generously accepted by stakeholders.

Lastly, it should be noted that the item of environmental education gains a score higher than that of each item pertaining to the dimension of resource use. This may indicate that stakeholders prefer 'guidance via education' to 'immediate regulation on the resource use'. This may not be surprising since angling in Taiwan now is in a non-intervention state and immediate imposition of bag limits, fish size limits, or catch reporting is expected to incur a sudden change to the status quo and therefore tend to trigger complaints or protests from the angler community. For management to be effective, guiding anglers to develop a practice of acting responsibly towards the environment via education is perhaps a better option at the initial stage of management.

6. Conclusions

This paper first identified that angling in Taiwan is in a laissez-faire state and expected that it will be one day put under management. Given this, managers should understand what potential management strategies are deemed important by stakeholders when seeking to establish a management framework at the initial stage. The study has focused on establishing a multi-criteria structure to inform priority strategies in the building of recreational sea angling management in Taiwan's context. While it is not possible to generalize the results from this study, it may serve as a useful reference for other countries, particularly those who also similarly face an unmanaged angling industry.

The results showed that four dimensions constitute the management framework, which are, by their rankings, angling sites, resource use, education, and eligibility of angling. The results further revealed important management strategies pertaining to each dimension, including the establishment of safe angling sites, safety education, information provision, angling fees, and restriction on catch sales. However, limitations do exist. One is that the collection of potential measures initially drawn from the literature in the research methods may fail to cover the measures presented in non-English literature. For this, a broader review of the literature and/or a wider consultation with more key informants is recommended in future research. The other concerns the practicability of the management framework. While a number of realistic measures have been proposed to fill in the framework, these measures should be tailored to specific contexts in practical terms. Therefore, it would be a meaningful area for future research to test the effectiveness of these specific-context measures in solving the problems arising from angling.

All in all, the management framework of angling and its associated potential strategies proposed in this study reflect the current shared societal, economic, and environmental aspirations of a wide range of stakeholders. They facilitate charting the journey towards a managed angling domain, which adapts to the increasing demand for safe angling sites as well as for the enhanced awareness of safety and marine environments among anglers. It is hoped that this managed domain, if it is to be built, would evolve further to adapt to future demands as social, economic, and environmental aspirations change over time, and consequently help achieve long-term successful management of marine resources.

Supplementary Materials: Steps of the fuzzy AHP approach and calculation of criteria weights are available online at https://www.mdpi.com/article/10.3390/su13148111/s1, Table S1: Random inconsistency indices (RI), Table S2: Linguistic scales and fuzzy scales for importance, Table S3: Consistency tests for items relating to angling management.

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Appendix A

Introductory page of the questionnaire for fuzzy AHP analysis

The research evaluates the relative importance of four dimensions and their associated items regarding recreational sea angling management. Four dimensions are angling sites, safety, resource use, eligibility of angling, and education. Their associated items and the explanation are presented in the Table A1.

Table A1. Dimensions and items.

Dimensions and Items	Explanation
Angling sites	
Establishment of safe angling sites	Concerned authorities take actions to establish angling sites where adequate safety equipment and facilities are properly installed and maintained to ensure safety and their normal function.
Separation of different uses	Developing plans of separating different uses so as to prevent conflicts between angling and other uses such as fishing, navigation.
Information provision	Provision of full information pertaining to the angling sites.
Resource use	
Fish size limits	Setting restrictions on the size of fish catches.
Temporal restriction	Angling is not allowed during a specific period of time for the sake of conservation (e.g., protecting spawning populations).
Bag limits	Setting a limit on the weight or number of catch per angler and per trip or per day.
Restriction on catch sale	Setting a restriction on the catch sale
Catch reporting	Anglers are required to report catch.
Conservation efforts	Conservation work is undertaken by the concerned authorities to improve marine environments and enhance fish stocks
Eligibility of angling	
Registration/permits	Anglers need to have permits or registration for their angling activities.
Angling fees	Charging a reasonable fee for angling at the established angling sites.
Education	
Safety education	Education on angling safety should be enhanced to expand anglers' knowledge on how to ensure their own safety when angling.
Environmental education	Environmental education is encouraged in order to instill marine stewardship among anglers and promote them to act responsibly towards the environment.

For the pair-wise comparison between dimensions such as angling sites and resource use, the question asked is: "If you think that the dimension 'angling sites' is weakly important (WI) as compared with the dimension 'resource use' in establishing the multi-criteria evaluation structure for potential management strategies on angling in Taiwan's context, then please check Table A2."

Table A2. Pair-wise comparison between dimensions.

Dimension	AI	VSI	SI	WI	EI	WI	SI	VSI	AI	Dimension
Angling sites				✓						Resource use

Note: AI: absolutely important, VSI: very strongly important, SI: strongly important, WI: weakly important, EI: equally important.

For the pair-wise comparison between items such as information provision and separation of different uses under the dimension 'angling sites', the question asked is: "If you think that under the dimension 'angling sites', the item 'information provision' is strongly important (SI) as compared with the item 'separation of different uses' in establishing the multi-criteria evaluation structure, then please check Table A3."

Table A3. Pair-wise comparison between items under the dimension 'angling sites'.

Item	AI	VSI	SI	WI	EI	WI	SI	VSI	AI	Item
Information provision							✓			Separation of different uses

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