



## Variations in stakeholders' ecosystem service priorities for managing a marine protected area

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### ABSTRACT

Marine protected areas (MPA) increasingly focus on integrating ecosystem services in MPA management. Understanding how MPA stakeholders value and depend on marine ecosystem services is therefore important to account for local priorities in conservation design and management, and for identifying how different stakeholder groups might be affected by MPA management decisions. This study investigates the importance of MPA ecosystem services in Monterey Bay, California. We surveyed four marine stakeholders in eight communities to elicit stakeholders' ecosystem service priorities and to identify how socio-economic variables relate to ecosystem service importance. We found that all stakeholder groups rated supporting and regulating services as more important than cultural and provisioning services, suggesting that marine conservation efforts could place more emphasis on protecting ecosystem services that are less easily observed and experienced. Identified differences in the importance of ecosystem services among the four groups demonstrate that stakeholders value marine ecosystems in different ways and thus might be affected differently by management actions that target specific ecosystem services. Differences were particularly evident between recreational and commercial fishers suggesting that these groups have a different understanding of how the MPA contributes to their well-being. We also found that the importance of services that are harder to experience and observe, including supporting and regulating services and the intrinsic value of the MPA, did not correlate with most socio-economic variables indicating that these services are less related to the socio-economic profile of MPA users compared to cultural and provisioning services.

### 1. Introduction

The implementation of Marine Protected Areas (MPAs) as a conservation tool continues to increase worldwide in response to declining marine biodiversity and increasing human impacts on marine areas [1]. More than 16,000 MPAs have been established globally to date and about 7.7% of the ocean has some level of protection [2]. The continuing increase in MPAs is promoted by multiple national and global initiatives that call for the protection of 30% of the ocean by 2030 [3,4].

MPAs are clearly defined geographical spaces that aim to achieve the long-term conservation of nature with associated ecosystem services [5]. Subsequently, there is a need to not only account for biological conservation values in the design and management of protected areas but

also for associated ecosystem services that indicate the direct and indirect contributions that ecosystems make to human-wellbeing [6-8]. While multiple frameworks exist for assessing ecosystem services (e.g., [9-11]), ecosystem services are often broadly categorized into provisioning, regulating, cultural, and supporting services [12]. Marine provisioning services refer to all products obtained from marine ecosystems, such as food, whereas regulating services refer to benefits obtained from the regulation of ecosystem processes, such as climate regulations and water purification. Cultural services include nonmaterial benefits obtained from ecosystems, such as recreation and ecotourism, aesthetics, education, cultural heritage, or spiritual and supporting services are services needed for the production of all other ecosystem services, such as nutrient cycling or primary production [13].

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As many ecosystem services are tied to healthy marine ecosystems and high biodiversity, protecting marine areas for the sustained provision of these services can be part of overall conservation strategies that focuses on maintaining or increasing marine biodiversity [14]. The integration of ecosystem services into protected area management also broadens the focus beyond biodiversity conservation to include benefits that people derive directly or indirectly from these areas [12,15]. Such

an approach could widen support for MPAs [14], and potentially foster the achievement of both ecological and social positive outcomes of conservation efforts [16,17].

Understanding which marine ecosystem services are important to local communities adjacent to an MPA is important for understanding how people value protected marine ecosystems. This information is critical as MPA management should ideally be integrated into the local



Fig. 1. Surveyed communities in Monterey Bay (large map); Location of Monterey Bay National Marine Sanctuary in central California (inset).

social and ecological context [18,19]. Information on ecosystem service importance can help managers to account for local values in the design and management of MPAs [20–22] and to collect and communicate locally relevant information as part of an MPA evaluation [22,23]. Ecosystem services of marine protected areas though may not be equally important to all stakeholders. The protection of specific ecosystem services or changes in management regulations that affect specific services thus might lead to positive impacts for some groups and negative ones for others [24,25]. Understanding how different stakeholder groups value ecosystem services is therefore important to managers for understanding how stakeholders' values are related to the current management of an MPA and to foster more equitable MPA management.

Yet, knowledge regarding the relative importance of different ecosystem services for coastal communities and which variables shape ecosystem service priorities among specific groups and individuals is very limited for marine ecosystem services [26,27]. Existing research on community perceptions of marine ecosystem services in the context of mangroves and coral reefs in developing countries found that the importance of ecosystem services may differ among social groups or individuals within a community [26,27] and can be influenced by socio-economic factors such as household income, education, and gender [28,27,29]. Yet, these studies are very limited in scope and more research is needed to understand how different MPA stakeholder value ecosystem services and how these values might be related to the broader socio-economic context of an MPA.

This study explores differences in the importance of multiple marine ecosystem services across four stakeholder groups in a temperate MPA, the Monterey Bay National Marine Sanctuary (MBNMS) in California. We focus on identifying the importance of provisional, cultural, supporting, and regulating services to coastal communities adjacent to the MBNMS, and on exploring whether the importance given to these ecosystem services differs among different stakeholder groups. In addition, we assessed whether the importance of ecosystem services is related to the perception of environmental issues in the Sanctuary as well as to socioeconomic variables of individual community members, including age, gender, education, livelihood dependency, years of residency, and type of ocean uses in the Sanctuary.

## 2. Methods

### 2.1. Study site

The study was conducted in eight coastal communities adjacent to Monterey Bay, which is part of the Monterey Bay National Marine Sanctuary (MBNMS) in central California (Fig. 1).

The MBNMS has been a federal marine protected area since 1992 and is governed by the National Oceanic and Atmospheric Administration (NOAA). The Sanctuary encompasses a shoreline length of 276 miles and an area of 6094 square statute miles. The marine ecosystem in Monterey Bay is highly diverse and productive and contains one of North America's largest underwater canyons. Commercial fishing and marine recreation are allowed within the sanctuary, but oil drilling, ocean dumping, and seabed mining are prohibited [30].

### 2.2. Data collection

Data were collected via a questionnaire-based survey between June and July 2016. Local residents, including commercial fishers, recreational fishers, and marine recreational users were surveyed using a random household survey. Households were randomly selected based on postal records in eight communities bordering Monterey Bay including Santa Cruz, Capitola, Aptos, Rio del Mar, Moss Landing, Marina, Monterey, and Pacific Grove. In addition, a census sampling approach was applied to survey commercial tourism operators operating in the Sanctuary including whale watching operators, sea kayaking operators, and scuba diving operators. In total, 1150 surveys were distributed.

Questionnaires for households (N = 1116) were left at the door with a cover letter and a notice that the questionnaire would be picked up two days later. Commercial marine tourism stakeholders (N = 34) were surveyed at their place of work. The overall response rate was 34% (N = 391) with a response rate of 32.5% for local residents who are using the MBNMS for commercial fishing and marine recreation, including surfing, kayaking, recreational fishing, wildlife watching, and boating (N = 363), 81.8% for scuba diving operators (N = 9), 87.5% for whale watching operators (N = 8), and 100% response rate for sea kayaking operators (N = 11).

The self-administered questionnaire contained a closed question asking about the importance of the marine environment in Monterey Bay on a scale from 1 = not at all important to 5 = Very important for seven marine ecosystem services including productive food webs, ocean water quality, recreation, intrinsic values, cultural values, commercial use of resources (e.g., fishing) and regulation of climate. These services were selected based on the context of the MBNMS. Provisioning services included commercial use including commercial fishing and commercial tourism, as a proxy for income, as these activities are the only allowed commercial uses in the Sanctuary. In addition, we included three cultural ecosystem services in the survey including recreation, cultural values, and intrinsic values as the MBNMS has a strong focus on the protection of cultural resources and the provision of recreation. We further included food webs as a supporting service since the area is known for its nutrient-rich waters that fuels a vibrant food web due to up-welling processes [31]. Regulating services included climate regulation and ocean water regulation, as climate change and the regulation of water pollution feature prominently in the management of the MBNMS [32]. The next section included questions on participation in eight marine activities including commercial fishing, recreational fishing, surfing, scuba diving, wildlife watching, swimming, sea kayaking, and boating on a 5-point scale from never (0) to almost every day (5), as well as questions on years living in Monterey Bay, livelihood dependency on a scale from 0 = no dependency, 1 = additional source of income, and 2 = main source of income, membership in an environmental NGO (0 = no, 1 = yes), gender (1 = female, 0 = male), year of birth, level of education from 1 = less than high school, 2 = high school or GED, 3 = Associate's degree, 4 = College undergraduate degree, 5 = Graduate or professional degree. The last question covered stakeholder group affiliation and included commercial fishermen, the general public, and tourism operator categories. Based on the type of marine activity that the general public respondents participated in the most, general public stakeholders were further classified as recreational fishers or marine recreation users. Table 1 summarizes the socio-economic aspects of the four stakeholder groups.

### 2.3. Data analysis

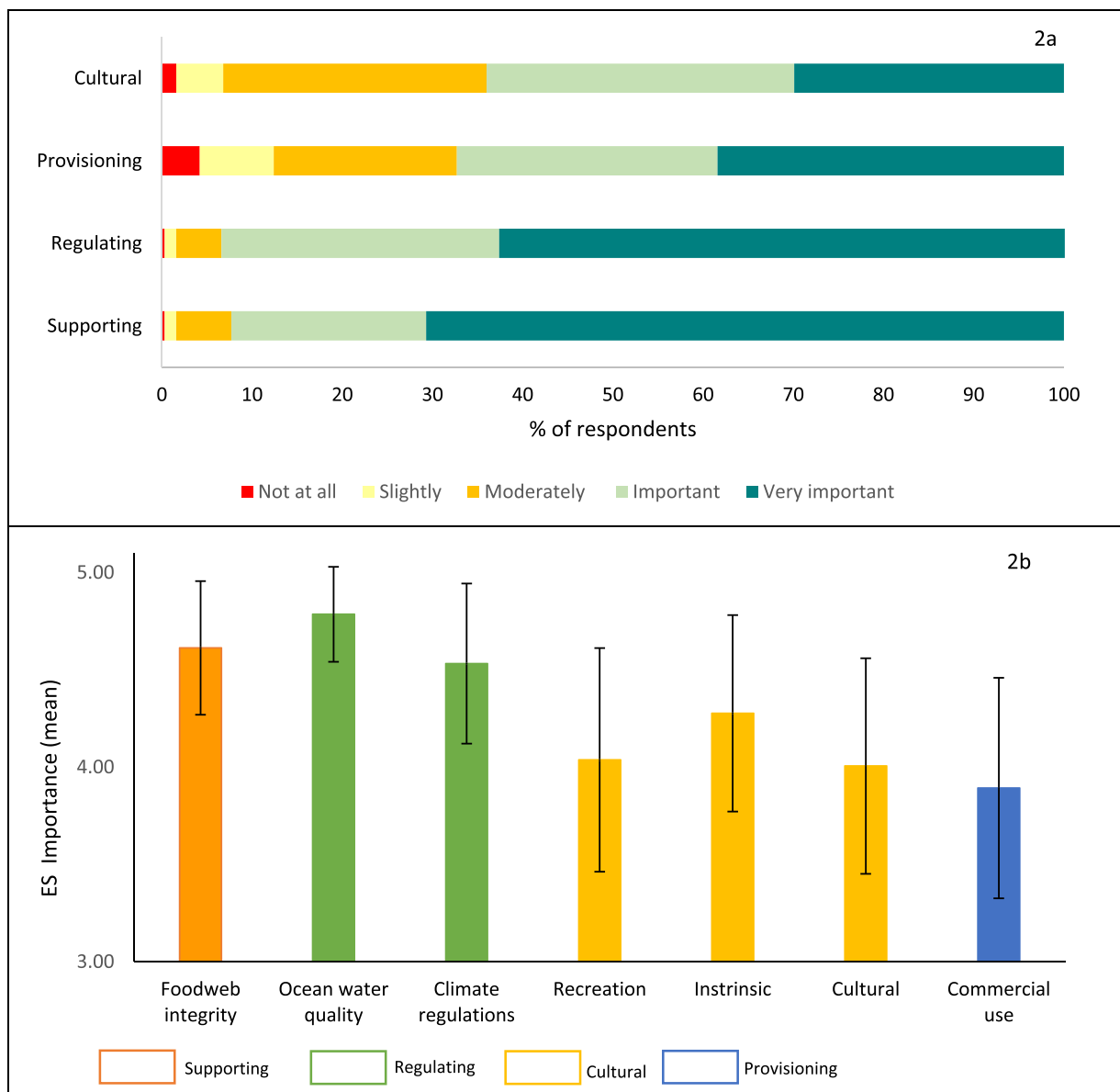
Ecosystem services were categorized into four main categories including supporting, regulating, provisioning, and cultural ecosystem services. Cultural ecosystem services included the importance of the ocean for cultural values, intrinsic values, and recreation. Regulating services included ocean water quality and climate regulation. Supporting services consisted of food web and provisioning included commercial use of the ocean. Statistical differences in ecosystem services' importance among stakeholder groups were assessed using non-parametric statistics (Kruskal Wallis test). Correlations between the importance of ecosystem services and socio-demographic variables were assessed using Spearman's rank correlation.

## 3. Results

All ecosystem services in the sanctuary were ranked as important or very important by more than 70% of all respondents (Fig. 2a). Supporting and regulating services were given the highest importance with 70.7% of respondents rating supporting ecosystem services and 62.7%

**Table 1**  
Socio-demographic characteristics of four stakeholder groups.

	Commercial fishers	Recreational fishers	Tourism operator	Marine recreation user	All
N	24	17	24	275	391
Livelihood dependency (%) No Dependency	43.5	94.1	12.5	92.0	82.9
Additional source of income	26.1	5.9	29.2	5.7	8.8
Main source of income	30.4	0	58.3	2.3	8.2
Education (%) Less than high school	4.2	0	0	0.4	0.6
Highschool/GED	16.7	23.5	12.5	11.0	12.2
Associate degree	12.5	17.6	16.7	11.0	11.9
College degree	45.8	17.6	58.3	36.4	37.7
Graduate degree	20.8	41.2	12.5	41.2	37.7
Age (mean)	55.2	58.1	35.3	60.2	58.6
Gender (%) Female (1)	33.3	23.5	50.0	57.6	51.0
Male (0)	66.7	76.5	50.0	42.4	49.0
Years living in MB (mean)	26.0	24.4	9.7	31.5	29.3
Environmental NGO (%) yes	20.8	5.9	16.7	24.4	21.4
no	79.2	94.1	83.3	75.6	78.6



**Fig. 2.** a Importance of ecosystem service categories to coastal residents (% of respondents, N = 391). **Fig. 2b:** Mean value of importance for individual ecosystem services (mean importance value, error bar= SD, N = 391).



rating regulating ecosystem services of very high importance. Cultural ecosystem services that include recreation, cultural and intrinsic values had the lowest percentage of respondents who rated this service as very high importance (29.9%). A similar result was evident for provisioning services, as commercial use was of very high importance to only 38.4% of respondents (4.2%).

The highest diversity in importance values was observed for the three cultural ecosystem services and commercial use, as these services had higher standard deviations compared to other services (Fig. 2b). Thus, there seemed to be more agreement on the importance given to regulating and supporting services compared to provisioning and cultural ecosystem services among respondents.

Comparing the importance of ecosystem services between the four stakeholder groups, we found significant differences in the importance given to cultural ecosystem services ( $H=10.435, p < 0.05$ ), supporting services ( $H= 11.739, p < 0.01$ ), and provisioning services ( $H=12.838, p < 0.01$ ). Cultural and provisioning services were more important to commercial fishers than other users. (Fig. 3). Supporting services were highly important to all groups with the exception of recreational fishers. Comparing the two fishery groups in this study, we detect differences in values for all four ecosystem service categories with commercial fishers putting higher importance on all services than recreational fishers. The two recreational groups, including commercial tour operators and recreational users, seem to be more similar, with the exception of cultural values, which are most important to commercial tour operators than to recreational users.

Among cultural services, significant differences were detected for recreation ( $H=23.680, p < 0.001$ ), which was rated more important by the two commercial groups than the two recreational user groups. Other significant differences detected for food web integrity ( $H=11.739, p < 0.01$ ) and ocean water quality ( $H=14.312, p < 0.01$ ), which were both significantly more important to commercial fishers, tourism operators, and marine recreational users than recreational fishers as well as commercial use, which was most important for commercial fishers

( $H=12.383, p < 0.01$ ).

In terms of the distribution of importance values across the four stakeholder groups, commercial user groups including commercial fishers and tour operators had a more similar distribution in their values compared to recreational users as both groups placed the highest importance category on multiple, similar ecosystem services (Fig. 4). The two recreational groups had less extreme values and ranked most services as moderately important to important.

Correlation analysis revealed that provisioning and cultural ecosystem services were significantly correlated with multiple socio-economic variables, whereas supporting and regulating services did not significantly correlate with most socio-economic variables (Table 2). Provisioning services were significantly and positively correlated with age, livelihood dependency, years living in the Monterey Bay area, and frequency of ocean use, with the strongest correlation for livelihood dependency. Among cultural ecosystem services, only recreation correlated significantly with multiple socio-economic variables including age, livelihood dependency, and marine uses.

Positive correlations were also detected for cultural value with ocean use, including commercial fishing and recreation, as well as gender, and environmental NGO membership. Yet, even though correlations were significant, most correlations were not very strong, based on the correlation coefficients between 0.1 and 0.299, with the exception of recreational value with recreational use. Intrinsic values did not correlate with any socio-economic variable.

#### 4. Discussion

Marine conservation efforts are increasingly considering ecosystem services in the design and management of MPAs [33-35]. To foster the well-being of coastal communities adjacent to MPAs, understanding the importance of ecosystem services to marine stakeholder groups is critical for conservation managers and policy makers to account for local priorities in the design and management of MPAs and to understand how

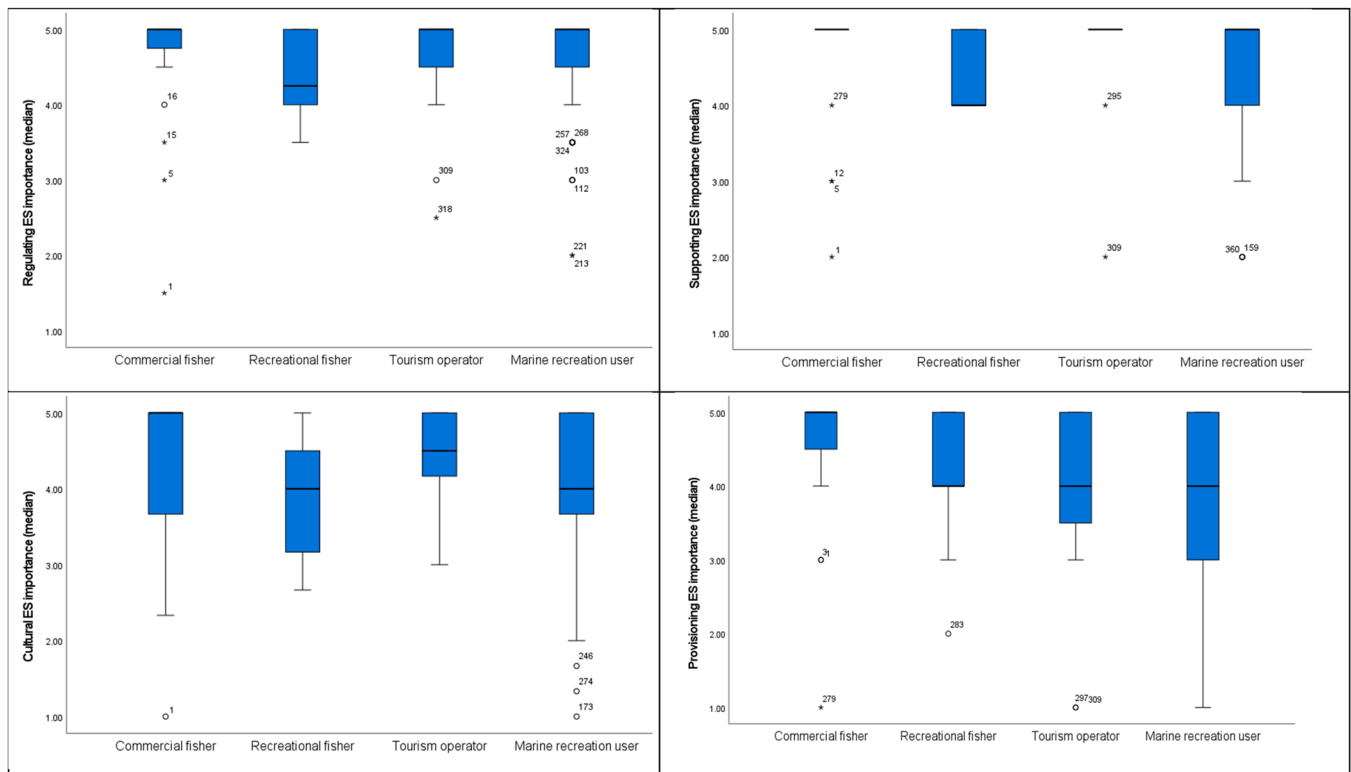


Fig. 3. Ecosystem service importance across stakeholder groups (boxplots) N = 24 Commercial fishers; N = 17 Recreational fishers, N = 24 Tourism operators, N = 275 Marine recreation users.

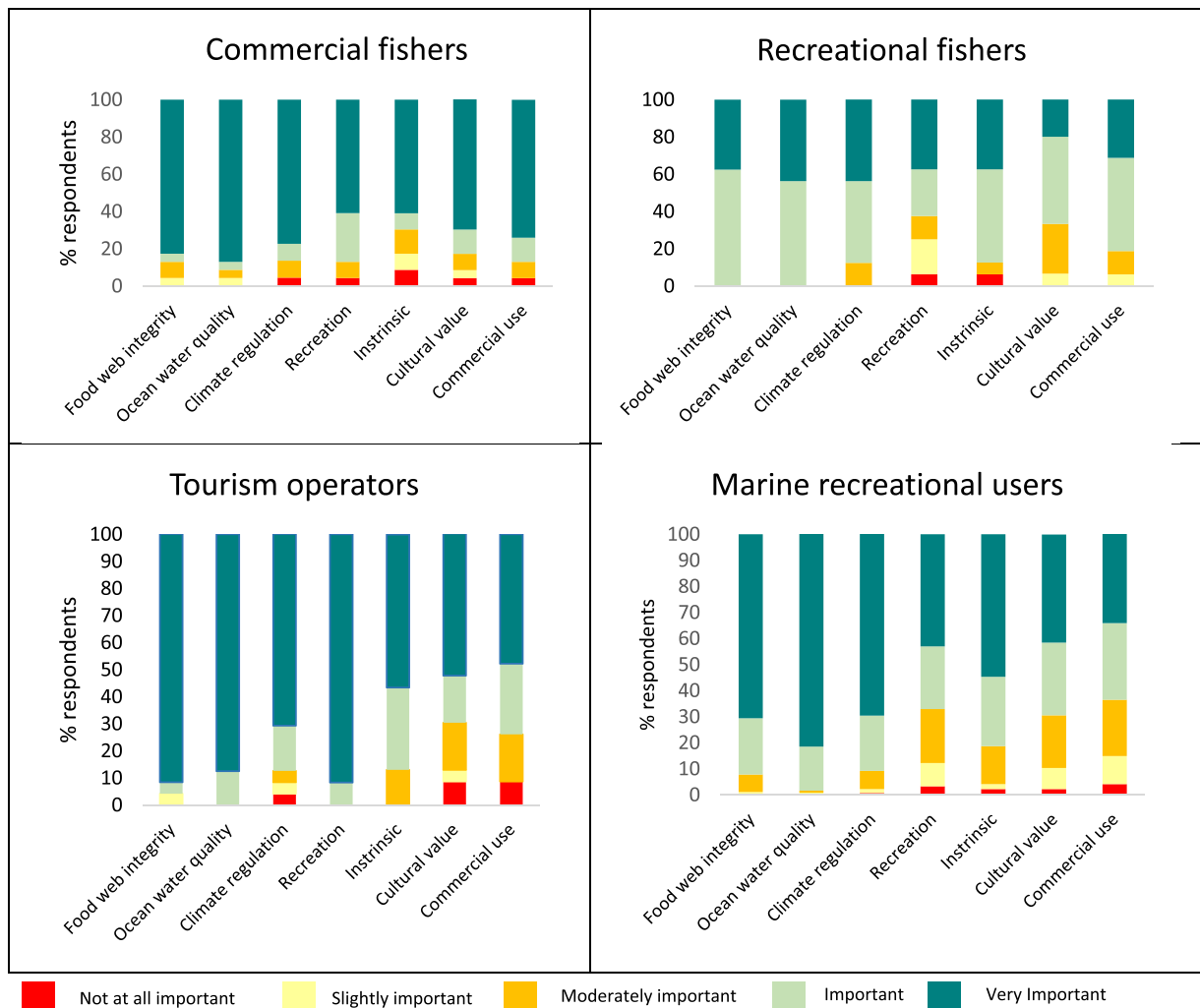


Fig. 4. Importance of ecosystem services across stakeholder groups (% of respondents in each group).

different marine user groups might be affected by MPA management strategies that affect specific ecosystem services [36].

Findings in this study show that most ecosystem services are highly important to coastal communities adjacent to the National Marine Sanctuary. We found that local stakeholders rated supporting and regulating ecosystem services that are not easily observed and experienced as more important than provisioning and cultural ecosystem services. This result differs from findings in studies on stakeholder ecosystem priorities in developing nations that identified provisioning services as most important to local communities [26,27].

The high importance of supporting and regulating services in our study could be related to the unique environment in Monterey Bay, as the area has one of the deepest submarine canyons in the US [20]. Submarine canyons typically provide a range of supporting and regulating services such as sustaining marine food webs [37] as well as the removal of pollutants and climate regulation [38], which were all highly important to stakeholders in Monterey Bay. The importance of specific ecosystem services thus might also depend on the local marine environment and the way people connect to specific places, e.g., based on their sense of place, which has been found to increase the importance of provisioning services [29].

The high importance of regulating and supporting ecosystem services in our study further suggests that there could be a greater focus on protecting more intangible ecosystem services in MPA management, which are often not at the forefront of marine conservation efforts. The current MBNMS management, for example, focuses on resource

protection, including ecological and cultural resources, education, and research [30], with an emphasis on reducing human impacts on these values. Supporting and regulating services could feature more prominently in MPA management actions. Monitoring activities, for example, could include more indicators on supporting and regulating services [39] to demonstrate how effective marine conservation efforts are in providing services that are less easily observable. In addition, these services could feature more prominently in the selection and design of new protected areas that are being established, for example as part of the 30 × 30 initiative that is being discussed in California as well at the national and international scale [40]. While systematic planning of new protected areas often focuses primarily on the protection of specific habitats and species [41], the inclusion of regulating and supporting services could be included for the selection of conservation priority areas.

The low importance given to provisioning services in this study might be related to the fact that the study focused on the importance of ecosystem services in a marine sanctuary and stakeholders may place less importance on extractive and commercial use, even though the sanctuary itself does not directly regulate any aspect of commercial fishing and more than 500 fishing vessels make commercial landings in ports in or adjacent to the Sanctuary [32]. Another explanation could be the low livelihood dependency on marine areas in the Sanctuary of most respondents in this study, as previous studies found that people attributed the highest importance to provisioning services if they directly contributed to their livelihoods [42,26,27]. The relationship between

**Table 2**  
Correlation between ecosystem services and socio-economic variables (Spearman's rank).

	Provisioning		Cultural		Regulating		Supporting
	Commercial use	Recreation	Intrinsic value	Cultural value	Ocean water regulation	Climate regulation	Food web integrity
Age	.120*	-.203**					
Livelihood dependency	.205**	.247**					
Education							
Years living in MB	.182**						
Gender		.103*		.119*	.114*		
Commercial fishing	.196**	.130*		.132*			
Recreational fishing	.168**	.180**					
Marine recreation	.109*	.452**		.166**	.270**		.219**
Env. NGO				.128*	.131*	.109*	

\*\* sign. 0.01, \* sign. 0.05

Spearman's rank correlation coefficient

0.400-0.499 0.300-0.399 0.200-0.299 0.100-0.199

Note: see supplement for all correlation coefficients

livelihood dependency and the importance of provisioning services was also evident in this study as a high livelihood dependency was positively correlated with a higher importance of provisioning services. Yet, our study further indicated that livelihood dependency was not the only variable that was significantly correlated to the importance of provisioning as this service correlated with multiple socio-economic variables. Thus, while the importance of provisioning services reflects a higher importance of ecosystem services that contribute directly to the stakeholders' economic wellbeing [26,27], economic variables do not seem to be the only variables that increase the value of provisioning services.

Previous studies further found that the importance of ecosystem services that are less easy to observe, such as supporting and regulating services, can be linked to education assuming that these services need more scientific background to be understood [43,44]. Respondents in our study were indeed highly educated as more than 70% of respondents had a college or graduate degree. Yet, regulating and supporting services did not significantly correlate with formal education in terms of years of schooling in our study, which is different from previous studies [28,26, 43,44]. Our study thus does not confirm that formal education is a stronger factor influencing the value of non-tangible ecosystem services compared to other socio-economic variables [43]. In fact, supporting and regulating services in this study did not correlate with most socio-economic variables suggesting that the importance of these services is less related to the socio-economic profile of MPA users. The exception was environmental NGO membership, which correlated with both regulating services in this study suggesting that more targeted conservation outreach and messaging might shape the importance of less tangible ecosystem services more than formal education.

The integration of stakeholder priorities in MPA design and management is also a potential means of reducing conflict among local communities and MPA policies [45]. As our study demonstrates, there were some differences in the importance of select ecosystem services

among the four stakeholder groups indicating that stakeholders value the marine environment in different ways. Cultural services, in particular recreation, was highly important to people who use the area for recreational activities. Though, there was a difference among different types of recreational users, as recreational fishing use was less strongly correlated with the importance of recreation as an ecosystem service compared to non-consumptive recreational users, even though the NMS has no recreational fishing restrictions in place. Differences were also evident between commercial and recreational fishers indicating that diverse groups have a different understanding of the contribution of the MPA to their well-being. Management actions that target specific ecosystem services thus may benefit or negatively affect specific user groups that depend on MPAs in different ways. Understanding the connection between specific ecosystem services and socio-economic characteristics of marine user groups is therefore critical and might contribute to more equitable management of MPAs.

**5. Limitations**

Our approach has some important limitations. Due to limited resources, we applied a survey-based approach that included a set of pre-defined ecosystem services based on the context of the MBNMS. Using a mixed methods approach that would have included the elicitation of ecosystem services by different stakeholders prior to the survey could reveal additional ecosystem services that we did not capture in this study. In addition, our sample size for some of the stakeholder groups was quite small, in particular for commercial and recreational fishers. Future studies could apply a more targeted sampling approach to reach a larger number of stakeholders in these groups.

**6. Conclusions and outlook**

Ecosystem services are increasingly used to identify the contribution

of marine protected areas to the well-being of local communities. By exploring stakeholders' perceptions of MPA management through the ecosystem service lens, our study demonstrates that local communities value the MPA for multiple services including more tangible ones and those that are less easily observed. Along with an increased emphasis on the integration of ecosystem services in MPA management, marine conservation efforts thus could place more emphasis on protecting ecosystem services that are less easily observed and experienced, which are often not at the forefront of marine conservation efforts and messaging. In addition, we found that supporting and regulating services as well as the intrinsic value was less related to the socio-economic profile of MPA users compared to cultural and provisioning services. More research is needed to further identify and detect which variables shape differences in ecosystem service importance in the context of marine conservation, particularly for regulating and supporting services, that did not correlate with most socio-economic variables in this study and seem to be driven by other factors. Our study also focused only on the perception of marine user groups. Comparing stakeholders' and managers' opinions on the importance of MPA ecosystem services in future studies could be used to detect if local communities and MPA managers share a similar understanding of the contribution of MPAs to local well-being.

#### Data availability

The data that has been used is confidential.

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#### Author statement

The authors of this study declare no conflicts of interest with public or private institutions.

#### Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.marpol.2022.105330](https://doi.org/10.1016/j.marpol.2022.105330).

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