BIODIVERSITY IN ENCLOSED SEAS

Stakeholder perceptions regarding the environmental and socio-economic impacts of the Algarve artificial reefs

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Abstract The artificial reef (AR) complex of the Algarve (Southern Portugal), deployed for the purpose of restoring and enhancing fisheries resources, is currently the largest structure of its kind in Europe, extending for over 43.5 km^2. Such a structure can be expected to have had both positive and negative impacts. To evaluate the overall perception of the effects of deployment, a survey of stakeholders' opinions was undertaken based on a set of questions addressing various dimensions (environmental, social, and economic). The survey covered 44 key-stakeholder representatives distributed in six groups: commercial fishermen associations, anglers associations and clubs, diving schools and clubs, fisheries and environmental administrators, natural and social scientists, and local council representatives in the fisheries and/or environmental sectors. The opinions of stakeholders were measured using summated rating scales. The results obtained reflect the most important issues be impacted and the possibility of using them as indicators of relative success or failure. From a total of 12 factor-sets of impacts, the results showed that in general the environmentally related were the ones having had the most positive results. The overall perception of the environmental factor-sets specified as the 'deployment area use' revealed that the artificial reefs were an incentive to users and that the structures were perceived as a satisfactory tool to support the fishery and its management. In both cases divers were the strongest supporters. A closer look at the results presented in the form of an AMOEBA plot showed that there were other factor-sets perceived as impacting positively in other dimensions. Such examples are the factor-sets 'opinion' and 'production and benefits' lying respectively in the social and economic dimensions. The latter factor-set was even the only one having the support of five out of six stakeholder-types. As expected, in general different stakeholder-types take somewhat different positions and attitudes towards AR impacts: usually scientists are the most optimistic, whereas fishermen take the most sceptic view.

Keywords Artificial reefs (ARs) · Impact analysis · Fisheries · Indicators for management

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Introduction

The Algarve (southern Portuguese coast) is a region that has been highly impacted by a multi-purpose active fleet exploiting fisheries resources (Moniz et al., 2000). These resources attain on average some of the best market prices in the country for many fish species as reported by the Fisheries and Aquaculture Directorate (DGPA, 2002), a feature which acts as an incentive to keep fishermen employed in the activity. A socio-economic characteristic of the region is that a high proportion of people depend on fishing for their livelihoods (Moniz, 1997; Moniz et al., 2000). In 2003, over 3,500 fishermen were engaged in sea-fisheries in the region (DGPA, 2004), the majority of whom fished all year round. A survey by DGPA (2000) revealed that fishing tends to be a very erratic activity, with many fishers taking advantage of other economic activities linked with tourism in order to provide an additional or substitute source of income during the summer season. Apart from commercial fishing there are many other activities in the Algarve region that are directly dependent on fish resources, notably angling and diving. The former is practised by enthusiasts from local clubs all year round, but particularly by the end of the summer and fall; whereas the latter is practised mainly during warmer months, i.e., April to September.

In recent years a number of strategies have been developed to address the misuse of fish resources that has occurred in the past. Artificial reefs (ARs) represent one such approach, and indeed have become commonly used world wide to aggregate fish species in the marine environment (Aabel et al., 1996). In the Algarve, after a successful experience with pilot ARs (Santos & Monteiro, 1997, 1998), it was decided that reefs should be deployed on a larger scale throughout the region, but particularly in the windward area (Monteiro & Santos, 2000). The main reason was that in this area there is less abundance of rocky bottoms, having instead, muddy or sandy bottoms, the latter being a prerequisite for AR deployment decision. The deployment of the main program structures started in 1996 and was concluded by summer 2003. The Algarve's ARs were created with traditional small-scale fishing use in mind (Santos & Monteiro, 2001). The initial objectives of the program were to: (a) promote bio-diversity; (b) protect juveniles of commercial species; (c) manage coastal resources; (d) reduce fishing exploitation costs; (e) recover fishing resources; (f) create fishing zones; and (g) adapt gear and fishing strategies to resources availability. The program scope was wide, encompassing both economic and social objectives, but having in mind mainly an environmental focus.

To date, scientific evidence shows that there has been an increase in abundance of economically-important fish species on the pilot ARs surveyed since their deployment in the early 1990s (Santos & Monteiro, 1997, 1998; Whitmarsh et al., 2004). Over this period, users have been accumulating greater empirical knowledge of the effects of ARs, and this has undoubtedly influenced both their behaviour (e.g. fishing patterns) and attitudes towards the reef programme as a whole. These attitudes may, of course, be negative as well as positive. Experience suggests that ARs typically give rise to a range of impacts, not all of which may be perceived as beneficial by users. For example, while CPUE and incomes may be enhanced, at least in the short term, the attraction of more vessels is likely to increase user conflict (Milon, 1989; Samples, 1989; Galvez, 1991; Murray & Betz, 1994). The aim of this paper is to investigate the local community's perceptions of the Algarve artificial reefs, and to see to what extent people regard the reef programme as having been successful. We contend that the opinions of stakeholders are crucial in this context. When there is a consensus amongst key individuals and groups over the objectives of ARs, it becomes easier to establish whether these objectives have been adequately addressed and how close they are to being reached. By contrast, lack of consensus makes it more difficult to derive a clear and unambiguous indicator for evaluating performance. Stakeholder opinions towards socio-economic as well as environmental objectives need to be considered, and this sort of data typically has to be collected via surveys (Milon et al., 2000). Such information is important to fish managers since they would like to know which impacts are

acceptable and which are not. To carry out this sort of study it is important to consult properly all the local stakeholders and interest groups. Studies which have examined the impact of artificial reefs, particularly as they involve stakeholders, have commonly concerned the 'rigs-to-reefs' conversion of obsolete oil platforms to other uses (Reggio et al., 1986; McGurrin & Fedler, 1989; Reggio, 1989; Cripps & Aabel, 2002).

In this paper we have undertaken a simple analysis of perceived impacts by consulting a panel made up of different key-stakeholders involved in the AR deployment process and its use. The panel's overall perception of the effects resulting from AR deployment in the Algarve south coast may help resource managers to use achieved results in order to find out trade-offs between policy objectives.

Materials and methods

Though the reef deployment programme was only completed in 2003, the presence of artificial habitats since the early 1990s is acknowledged

to have had a biological impact. While it is essential to explore the economic implications of this, particularly in respect of measurable quantities such as catches and incomes, it is important also to find out how far people regard the reef programme as successful along a wide spectrum of performance criteria. A number of techniques may potentially be used to measure stakeholder attitudes (Robson, 2002), and the particular approach adopted here is outlined below.

Questionnaire survey

As a first step in the study, three dimensions expected to be impacted by reef deployment were selected: environmental, social, and economic. For each dimension, factors likely to be affected by deployment were identified, from which an item-pool was constructed (Bell, 1987; Robson, 2002) which included all the perceived predefined impacts. The item-pool consisted of 54 ambiguous-free relevant items to be included in the survey of respondents' opinions (Table 1). The item-pool was then adapted to a specific questionnaire addressed to a range of people with

Table 1 Brief description of each of the 12 factor-sets and the number of impacts addressed to the key-stakeholders

Dimension	Factor-set	Brief description	No. items
Environmental	A. Deployment area use	To assess stakeholders' perception on the use that can be found in the area.	4
	B. Ecological impact and bio-diversity	Effects caused on the species, namely their aggregation and protection after reef deployment.	5
	C. Pollution	The contribution of the structures as a factor of pollution to the environment (water or sediment).	3
	D. Fishery and management	ARs as a management tool for fisheries (traditional fishing, off-shore aquaculture, etc).	6
Social	E. Demography and employment	Signs of changes in social aspects (people migration, employment, and social benefits).	3
	F. Enforcement and communication	The need to establish sea use rules and communication between the different players.	4
	G. Opinion	How is the AR' deployment perceived by stakeholders and the public in general.	5
	H. Conflicts	Possibilities of conflicts occurrence between the different stakeholders involved.	6
Economic	I. Production and benefits	To evaluate the chances of extra catches and returns after reef deployment.	4
	J. Costs to society	Awareness of the costs involved in the reef deployment process.	5
	K. Changes in local economy	Signs of changes in the local economy in all the sectors of activity after reef deployment.	5
	L. Safety at sea	Reefs contribution to promote safer fishing activities in their deployment area.	4

different perceptions and educational levels. The questionnaire was pre-tested and adjusted. Prior contact was established both by post or e-mail. This was accompanied by an introductory letter explaining the objectives of the proposed work, and an informative memorandum including the purposes of the ARs and their structure, organisation and location along the south-coast. The questionnaires were sent directly to each representative by hand or via post mail, and were addressed to the highest representative of each body/institution, or to the person used to work with fisheries or environmental issues. The survey was carried out approximately one year after the conclusion of the deployment phase, during a period of forty-five days (from the middle of May to the end of June 2004).

Conceptual framework and stakeholders

Though the consultation was principally a retrospective assessment of the performance of the established in situ reefs, the responses given to the questions also give an indication of the expected effects of the newly-established reefs and how far they are likely to meet the needs of stakeholders. Indeed, the attitudes of affected parties regarding the acceptability of ARs should be an element in any decision regarding future reef deployment, particularly as regards design and location. In choosing respondents to take part in the survey, individuals were pre-selected from a key-stakeholder database created from the regional yellow pages and from a fisheries events invitation list. The panel was constructed from key-stakeholders based on their agreement to take part in the survey.

The survey was addressed to representatives of: (a) fishermen associations; (b) anglers clubs and associations; (c) divers clubs; (d) environmental and fisheries administrations; (e) natural, social and economic scientists; and (f) others as borough council representatives in the environmental and/or fisheries areas. The key-stakeholders panel consulting approach was similar to the one described by McKinnon & Forster (2000), where: (i) items were kept simple, and averaged member's views encouraging a consensus within the same institution; (ii) information was col-

lected by questionnaire, without using interviews or subject discussion; and, (iii) anonymity was guaranteed to the members of the panel.

Each one of the six stakeholder-types presented six to eight representatives. In order to understand stakeholders' involvement with the ARs, representatives were divided into two groups: those who knew the structures either by using them or by being involved since the pre-deployment process, and the others whose knowledge was solely by other means (e.g. by the media). The first three types of panel members represent the direct or potential users, whereas the other three are usually involved in the ARs process but mostly as institutional representatives.

The impact assessment validation

Key-stakeholders used 5-point Likert scales to state their positions about impacts (Murray & Betz, 1994; Cripps & Aabel, 2002; Kennish et al., 2002). Perceptions/attitudes were then measured using summated rating scales. Items were graded accordingly to the probable perturbations in the marine system caused by reef deployment as well the effects on the fishing communities nearby. After collecting all questionnaires, impacts of the AR deployment were defined according to their scores and the analyses carried out by dimension, stakeholder type, factor-sets, and the most meaningful items. To evaluate the level of the impact it was important to define a priori what constituted a 'positive impact', since this underlay the whole concept and measurement of success in policy terms.

The survey made use of an AMOEBA plot, which is a graphical device that uses a 'radar' diagram. Though the approach is simplistic it has the advantage of representing to respondents (usually managers and policy makers) the impact of an intervention in a clear and easily understandable manner (Ten Brink et al., 1991). In the current study an AMOEBA plot was used consisting of three areas: inner (negative impacts), middle (no evident impact), and outer (positive impacts). The AMOEBA reading shows that the perception on the AR complex impact assessed over 12 factor-sets is not expressed as a function of others (discrete variables). In this way we can

obtain a visual impression of whether an impact on any one dimension or factor has been positive or negative.

The results obtained concerning ARs' impacts after deployment have particular significance for stakeholders. The analysis was undertaken by separating the panel of stakeholders according the group of interests. To demonstrate the differences in stakeholders' positioning, hypotheses were tested for the whole impact using a simple *t*-test (Zar, 1996). The *t*-test was carried out for the analyses on dimension, factor-set, and stakeholder-type. It was decided to work on a percentage basis where the overall score had three critical thresholds: scores over 66.7 implied that the effect was positive, those falling between 33.3 and 66.7 signified that the impacts were largely neutral, while those below 33.3 were interpreted as negative. For each item individually summated rating scales were also defined showing the top and bottom impacted ones.

Results

Key-stakeholders' characteristics

The total number of contacted stakeholders representing regional entities was 53. Of these, 9 stakeholders explicitly declined to collaborate, did not answer the calls, did not fill the questionnaire during the stipulated time, or simply filled the questionnaire in an invalid way (Table 2). The final panel consisted in 44 respondents, where 28

Table 2 The key-stakeholders contacted and its relationship with the ARs

Contacted (*n* = 53)				
Stakeholder type	Denied	Agreed		
		Total	AR experience	
			Heard	Known
Fishermen	2	7	0	7
Anglers	2	7	2	5
Divers	1	6	1	5
Administrators	2	8	2	6
Scientists	1	8	5	3
Others	1	8	6	2
Total	9	44	16	28

knew already the structures, and 16 were just somewhat familiarised with artificial reefs built off the Algarve's coast. The most familiarised group was fishermen, and the least one was the group of borough council representatives.

Key-stakeholders' perception

In terms of impact perception, the majority of stakeholders were positive concerning the environmental impact caused by ARs. Stakeholders who had first-hand experience of the structures were even more optimistic than those who had simply heard about them. Concerning the environmental terms, around 60% of the answers showed that reef deployment had made a positive contribution, against 20% believing the impact was negative. By contrast, for social and economic effects both types of stakeholders were more cautious in making statements about the potential impacts. The areas corresponding to the neutral position reflected in some way stakeholders' difficulty in formulating judgements. Around one third of the social and economic dimensions remain in this position (Fig. 1). For the economic and social dimensions, less than 50% of the answers were accounted as positive and more than 20% negative.

Key-stakeholders' general positioning and dimension analysis

Despite the differences found between those stakeholders who knew the reefs from first-hand experience and those that had only heard about them, it can be confirmed that the entire panel thought that the most important positive impacts belonged to the environmental dimension (Fig. 2). The hypotheses tested showed that only fishermen and anglers were not sure about the environmental overall impact of the ARs. By contrast, divers and scientists were the most optimistic (Table 3). Anglers, divers, and administrators considered that economic impacts overshadowed social impacts, whereas scientists and others claimed the opposite. In addition, fishermen representatives were the most sceptical among all concerning to the economic dimension of the reefs, contrasting with administrators who
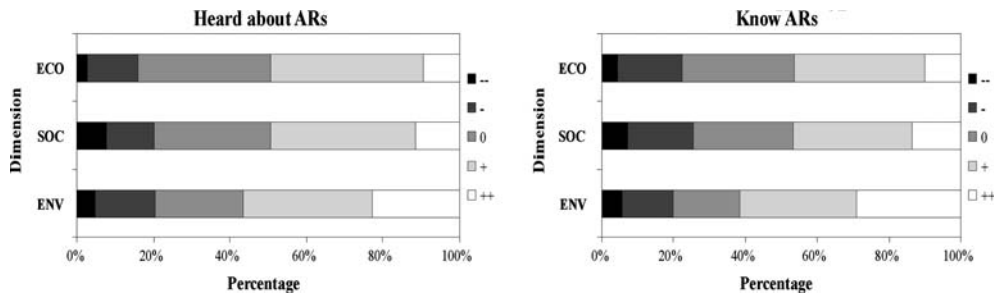
Fig. 1 Stakeholders' perception about impacts: (a) Stakeholders who only heard about ARs (*n* = 864 answers), (b) stakeholders that know ARs (*n* = 1,512 answers). "Minus" signs represent the percentage of impacts perceived as negative. "Plus" signs represent the percentage of impacts perceived as positive. Double minus/plus mean respectively high improbability/probability of occurrence. The "zero" represents answers with no clear position taken or perceived by stakeholders. Legend: ENV, Environmental; SOC, Social; ECO, Economic
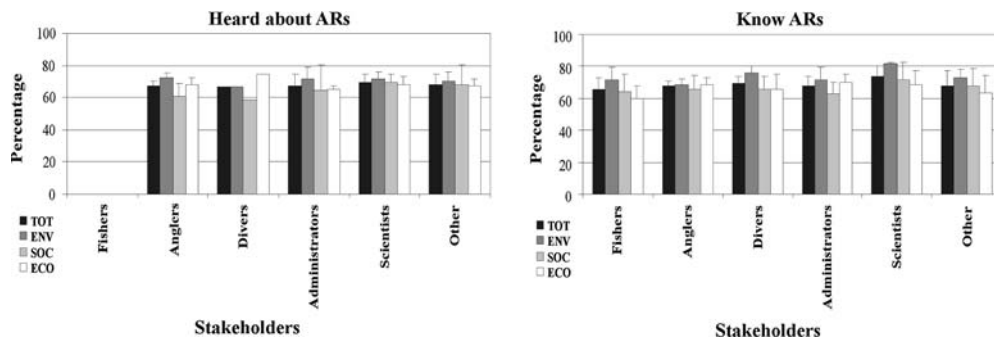

Fig. 2 Stakeholders' positioning about impacts caused in each dimension. Legend: ENV, Environmental; SOC, Social; ECO, Economic; TOT, All previous three dimensions together

strongly supported their economic role. Scientists were the most favourably inclined towards the social role of the reefs.

Factor-sets analysis

By disaggregating each dimension in their factor-sets through an AMOEBA plot, it was possible to perceive important impacts detected by the entire panel of stakeholders (Fig. 3). A refinement of the AMOEBA plot showed that among the 12 factors, only four can be considered as positively significant (Table 4). In the environmental dimension, the only factor not having a visible positive impact is related to 'pollution', whereas all the other factors are positively accepted (however, 'ecological impact and bio-diversity' was rejected by the *t*-test). The social dimension, by contrast, showed only a strong positive factor

related with the 'opinion' demonstrating that these structures were generally welcomed. For its part, the economic dimension seemed to have factor-sets perceived sceptically in terms of some factors (for example 'costs to society' and 'safety at sea') but more favourably in terms of others (e.g. 'production and benefits').

Table 3 Statistical results using *t*-test for impacted dimensions. '++' for p < 0.01, '+' for $P < 0.05$, and the 'n.s.' for non-significant results

Stakeholder	Dimension			
	Environmental	Social	Economic	All
Fishermen	n.s.	n.s.	n.s.	n.s.
Anglers	n.s.	n.s.	n.s.	n.s.
Divers	++	n.s.	n.s.	n.s.
Administrators	+	n.s.	n.s.	n.s.
Scientists	++	n.s.	n.s.	+
Others	+	n.s.	n.s.	n.s.

Fig. 3 The AMOEBA plot showing the 12 factor-sets of impacts
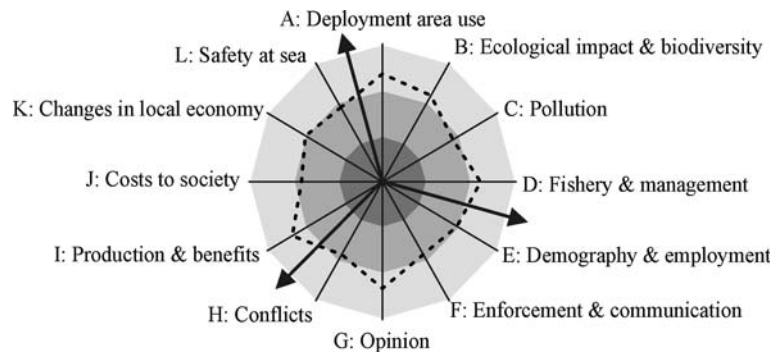
Key-stakeholders by factor-set

The disaggregation of the dimensions by factor-set and the entire stakeholder panel by stake-holder-types shows that groups are not identical in their assessment of the impacts (Table 5). After putting together all stakeholders results by factor-set it appears that fishermen were the most sceptical concerning evident positive impacts. For their part, administrators are positive about just two fundamental socio-economic aspects of the reefs: the structures' acceptance and their role as revenue generators. In contrast to the previous groups, divers are the ones believing that four out of 12 impacted factor-sets are positive.

The most positively impacted factor-set was within the environmental dimension and related to the 'deployment area use', where three of the stakeholder-types supported the suggestion that

Table 4 Simple t-test statistics for the AMOEBA-approach refinement. '++' for $P < 0.01$, '+' for $P < 0.05$, and the 'n.s.' for non-significant results

Dimension	Factor-set	Statistics
Environmental	A. Deployment area use	++
	B. Ecological impact and bio-diversity	n.s.
	C. Pollution	n.s.
	D. Fishery and management	+
Social	E. Demography and employment	n.s.
	F. Enforcement and communication	n.s.
	G. Opinion	++
	H. Conflicts	n.s.
Economic	I. Production and benefits	++
	J. Costs to society	n.s.
	K. Changes in local economy	n.s.
	L. Safety at sea	n.s.

ARs will attract more users to sites. Another factor-set showing favourable results concerned the social dimension, and related to the 'opinion' about AR deployment. Here were found four out of six stakeholder-types with a confident attitude/opinion, while only fishermen and anglers remained unconvinced. The factor-set believed to have had a demonstrated positive effect was the 'production and benefits', with five out of six stakeholder types being strongly favourable to it. Fishermen alone were sceptical or did not reveal their position.

Factor-sets that do not show any significance can also give some clues about AR impact. For instance, environmentally it seems that ARs are not regarded as a source of pollution, since none of the stakeholder-types held a clear position on this aspect. The same situation was found with respect to the role of ARs as a tool to improve 'fishery and management', since apart from divers no other group revealed an attitude that was either strongly positive or negative. Socially it seems that AR deployment is not a significant contributor to 'demography and employment' in the region, a result which is consistent with the belief that ARs will not significantly impact on the local economy.

Key-stakeholders agreed impacts

The survey results enable us to produce a hierarchy of items most significantly affected by the deployment of the reefs (Table 6). Ratings are indicators of stakeholders' sensitivity to impacts.

On the positive side, the overall perception is that: ARs promote a specific habitat enriched with several different species, promoting

Table 5 Simple *t*-test statistics showing stakeholder type by factor-set. '++' for $P < 0.01$, '+' for $P < 0.05$, and the 'n.s.' for non-significant results

Stakeholder	Dimension											
	Environmental				Social				Economic			
	A	B	C	D	E	F	G	H	I	J	K	L
Fishermen	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Anglers	+	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	+	n.s.	n.s.	n.s.
Divers	++	n.s.	n.s.	++	n.s.	n.s.	++	n.s.	++	n.s.	n.s.	n.s.
Administrators	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	+	n.s.	++	n.s.	n.s.	n.s.
Scientists	+	n.s.	n.s.	n.s.	n.s.	n.s.	+	n.s.	+	n.s.	n.s.	n.s.
Others	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	+	n.s.	+	n.s.	n.s.	n.s.

bio-diversity; being also able to aggregate marine fauna, and the structures are more likely to attract local fishermen than other users. The use of local fishing vessels at the reef area was considered an environmental positive impact once it is recogni-

sed as a more sustainable way of fishing, when compared with larger vessels. There are other positive impacts perceived as having the potential to augment catch rates when fishing in the reef area.

Table 6 The top and bottom impacts due the existence of the ARs. Stakeholders' rating averages are indicators of their sensitiveness to each item. Ratings vary between 1.0 (minimum), and 5.0 (maximum). Legend: CF, Commercial fishermen associations; RF, anglers associations and clubs;

DV Divers clubs; AD, Administration bodies in fisheries, environment, and fisheries funds managers; SC, Natural and social scientists, and OI, Other institutions as local council representatives in the fisheries and/or environment sectors)

Rank	ARs' positive impacts	Dim	Score	Stakeholder rating averages						
Top 10				All	CF	RF	DV	AD	SC	OI
1	To promote bio-diversity	ENV	204	4.6	4.1	4.4	4.7	5.0	4.6	4.6
2	To contribute for the success in fish enhancement actions	ENV	192	4.4	4.6	3.9	4.3	4.3	4.5	4.6
3	To aggregate marine fauna	ENV	190	4.3	4.0	4.1	5.0	4.3	4.1	4.1
4	To increase the numbers of local fishing vessels in the AR area	ENV	188	4.3	4.3	4.3	4.5	4.4	4.1	4.1
5	To increase the numbers of recreational anglers in the area	ENV	187	4.2	4.0	4.3	4.2	4.4	4.4	3.9
6	To protect juveniles from inshore waters	ENV	186	4.2	4.6	4.3	3.7	4.4	4.1	4.3
7	To demonstrate to users that the program is worthy	SOC	182	4.1	4.0	4.1	4.2	4.0	4.3	4.3
8	To augment the catch in the AR area	ECO	181	4.1	4.3	4.0	4.0	4.0	4.1	4.3
9	To protect some marine life species	ENV	178	4.0	3.7	4.1	4.2	3.4	4.5	4.4
10	To increase the numbers of more divers in the area	ENV	175	4.0	4.1	4.0	4.3	3.8	4.4	3.4
10	To attract users to the near area	SOC	175	4.0	4.0	3.6	4.0	4.1	4.3	3.9
Bottom 10	ARs' negative impacts									
1	To increase the need of sea rules accomplishment	SOC	83	1.9	2.7	2.0	1.5	1.6	1.9	1.6
2	To increase fishing pressure over the AR	ENV	94	2.1	2.0	1.9	2.3	2.3	2.3	2.1
3	To augment fishing gears lost near the AR	ENV	109	2.5	1.9	2.1	1.8	2.8	2.9	3.1
4	To contaminate or pollute the water	ENV	110	2.5	3.0	2.7	2.3	2.3	2.8	2.0
5	To increase local authorities enforcement	SOC	115	2.6	2.6	2.6	2.5	2.6	2.3	3.1
6	To cause more fishing gears damages	ECO	116	2.6	2.0	3.1	2.0	2.6	2.8	3.1
7	To find out other less expansive alternatives	ECO	120	2.7	3.1	2.9	2.2	3.3	2.6	2.3
8	To make no contribution to social benefits	SOC	123	2.8	2.6	3.0	3.0	2.3	3.4	2.6
8	To generate conflicts between fishermen and anglers	SOC	123	2.8	2.6	3.0	2.3	2.6	3.3	2.9
8	To realise that there were better sites to deploy ARs	ECO	123	2.8	2.7	2.9	2.8	3.1	2.6	2.6

Negatively, the worst impact perceived is the lack of enforcement measures to keep sea use rules in the deployment area. Other negative impacts relate to the uncontrolled augmentation of fishing pressure on the reefs, associated especially with the activities of non-local boats having more powerful fishing capacity. Other perceived adverse impacts include the belief that ARs cause a loss of fishing gear which in turn entails additional costs in their replacement.

Discussion

This study shows that the deployment of the Algarve's reef structures has resulted in perceived changes. The program can be considered successful since, apart from few sceptic views, in general key-stakeholders do not oppose to it and indeed there is an overall positive attitude. For the purposes of this study key-stakeholders can be considered as licit 'judges' of the AR program by virtue of their experience, use or knowledge of these structures. Among the key-stakeholders panel it is agreed that, compared to the economic or social dimensions, the environmental dimension seems to be the one impacted most positively. The social dimension can be seen as the one that still remains relatively unaffected by reef deployment, either for better or worse. Moreover, it seems that there are no highly adverse (i.e., impacting negatively) factor-sets, whatever the dimension. The negative effects are specific and relate to the risk of losing gears, conflicts between users, and problems of enforcement. Arguably these can all be overcome through awareness campaigns on how to use the ARs. By its turn, as recommended by Murray & Betz (1994). A slightly unexpected result is that, despite the scientific evidence of increased economic abundance, some stakeholders take a cautious position regarding the economic impacts in the belief that there are no strong signs of visible positive results.

Biological findings show that AR structures are intensely colonised and attract fish assemblages. Monitoring data show that there is an average increment on catches (Santos & Monteiro, 1997, 1998). However, some potential users consider ARs' siting to be generally either unknown or of no interest. The latter situation may arise where, even if the underwater structures are detected by vessels, the quantity of harvested fish is deemed inadequate or the species composition unsuitable; consequently, the site fails to be accepted as a 'hot spot' ground amongst other fishermen. A further constraint on the effectiveness of ARs is that their use may be limited to commercial fishermen who use passive gears (as pots, traps, trammel and gillnets, etc.). Eco-tourism based around charter boats and diving is an activity that could take some advantage from reef deployment, and in particular the depth and range once they are additional features to charter boat passengers or to divers. Due the ARs' depth range, the structures can be used for several levels of divers.

ARs are also a tool to manage coastal resources insofar as they can bring about a spatial separation between inshore fishing vessels, which are attracted to the reef areas, and the more powerful commercial fishing gears (such as trawl and pelagic purse-seine) which are in effect excluded. In addition, considering that the catch can be augmented in the reef area and assuming that the access to the resources is facilitated, exploitation costs can be reduced. Economic impacts usually presuppose a change expressed by a multiplier-effect in output, revenues, and employment. However, while catches and income may well have increased as a direct consequence of deploying these structures, key-stakeholders seem unconvinced about employment effects, i.e. ARs are not believed to make a notable contribution to the number of jobs created in the nearby areas. Whether this is the case *de facto* is not clear, since even though the construction of the reefs contributed to an increase on labour for a certain period of time, there is no firm evidence for employment creation within the fisheries. This is consistent with the results of the study by Kovács (2000). Besides, a sustained increase in economic benefits arising from AR deployment depends crucially on how access is managed, and failure to restrict the number of users may result in stock depletion and a cancelling of any long-term economic gains (Whitmarsh & Pickering, 1999).

A joint collaboration between several key-stakeholders is important in order to know to

what extent the impact of the ARs is perceived. A problem that is being faced is the specificity of the AR program. Many stakeholders were consulted before and during the deployment phase, and even after deployment many of the results seem to be based on expectations. This study demonstrates how the key-stakeholders perceptions of the impacts may be empirically measured. By using a summated rating scale and appropriate simple statistics it is possible to make a selection of the most important positive and negative impacts from the entire item-pool. The panel members who took part of the survey emphasised that in the future they would like to be consulted in similar surveys. This is a sign of positive interdisciplinary interest and participation in solving fisheries management problems. Finally, it can be added that these sorts of survey can give some information to fisheries managers about stakeholders' positioning, which can be used as indicators for management. It is important to get more people involved with the reefs use and awareness campaigns towards each user type in particular should be carried out in the future.

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