






## Article

# Stakeholders' Attitudes about the Transplantations of the Mediterranean Seagrass *Posidonia oceanica* as a Habitat Restoration Measure after Anthropogenic Impacts: A Q Methodology Approach

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**Abstract:** Anthropogenic impacts on *Posidonia oceanica* meadows have led to a decline of this ecosystem throughout the Mediterranean. Transplantations have often been prescribed as a compensation measure to mitigate the impacts caused by coastal maritime works. Here a Q methodology approach was used to investigate the stakeholders' attitudes in four case studies of *P. oceanica* transplants realized in Italian waters. Twenty-two respondents were asked to score 37 statements, and the resultant Q-sorting was analyzed via an inverse PCA using the KADE software. Four discourses, corresponding to the significant axes in the factorial analysis were identified: science and conservation (F1), oriented at a rigorous scientific approach; engineering and industry (F2), oriented at the economic development; environmentalism and participation (F3), oriented at the conservation of seagrass meadows; and transplantation-oriented (F4), oriented at the realization of transplants as compensation measures. The main conflicts and agreements between discourses are assessed and discussed, based on the analysis of the distinguishing statements that contributed to consensus or disagreement among discourses. The benefits of the Q methodology in the identification and mediation of conflicts in the four case studies are discussed, and its potential as a powerful aid in the development of a good environmental governance is acknowledged.

**Keywords:** compensation measures; stakeholders' perception; environmental impact; environmental governance; conflict resolution

## 1. Introduction

Coastal zones are characterized by highly diverse geomorphological features and climatic conditions that provide a wide variety of valuable habitats and ecosystem services

and are among the most productive areas in the world [1]. Due to the frequent presence of human settlements, coasts are often subject to intense anthropogenic pressures that risk to transform coastal landscapes and lead to biodiversity loss, habitat destruction, coastal erosion as well as to conflicts among users [2]. The European Union provides legislative tools aimed at achieving a sustainable development and use of coastal and maritime resources in an attempt to balance environmental, economic, social, cultural, and recreational objectives [3]. Anyway, light and shade emerge from the EU legislation as regards the actions against the effects of the growing human pressures on marine ecosystems [4].

Seagrasses are among the most valuable ecosystems in the shallow waters of all oceans [5] and are particularly threatened by human impacts [6,7]. In recent years, an enormous effort has been put in place to counter the effects of such impacts. In addition to conservation programs, seagrass transplantation has been indicated as a possible measure to compensate for the destruction of this ecosystem caused by human activities along the coasts.

The Mediterranean endemic seagrass *Posidonia oceanica* (L.) Delile forms littoral meadows that are widely distributed from very shallow waters to about 40 m depth [8]. These meadows characterize vast coastal areas and play an important ecological role related to the high biological diversity supported [9], and to the ecosystem services provided, which include oxygen production, carbon sequestration, nutrient recycling, protection against coastal erosion and provision of fisheries resources [5,7,10,11].

“*Posidonia* beds” are listed as a priority natural habitat type of Community interest for conservation under the Habitat Directive (92/43/EEC) and have a dedicated action plan in the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, under the “Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean”. *P. oceanica* is also one of the four biological quality elements in accordance with the Water Framework Directive (2000/60/EC) requirements and a target for good environmental status monitoring in the Italian implementation program of the Marine Strategy Framework Directive (2008/56/EC). Despite the protected status, local and global stressors have led to a general decline of *P. oceanica* meadows [12,13], with an estimated 34% regression in the last 50 years [7]. This trend should be reversed in compliance to the EU Biodiversity Strategy for 2030 (COM (2020) 380 final), which prescribes the restoration of degraded ecosystems and at least no further net regression in the short term.

Infrastructural coastal works such as, e.g., harbor constructions and extensions or pipeline deployments are among the many activities that may severely impact *P. oceanica* meadows. In the European Union, such works are subject to environmental impact assessment (EIA) or strategic environmental assessment (SEA) according to the Impact Assessment Directive (2014/52/EU), and to national laws that provide for compensation when maritime works are expected to damage the meadows. In particular, transplantations of *P. oceanica* shoots have been prescribed often in Italy as a suitable compensation measure [14], although their effectiveness is still debated [15].

The existence of economic activities that have an impact on an ecosystem of pivotal importance, raises important questions all the more so because seagrass restoration is a highly debated topic at European level [16]. The raised questions regard a number of related issues, such as the selection of the most appropriate transplantation technique and of suitable recipient sites, the availability of propagules, the importance of monitoring, the sharing of and access to collected data and the availability of the results about the effectiveness of the transplant. The issue of public engagement and awareness in environmental matters in Europe is regulated by Directive 2014/52/EU and by the Aarhus Convention and is a crucial element in the realization of good environmental governance and instrumental to the success of environment-related initiatives [17–19]. The benefits of stakeholder involvement in environmental decisions are multiple and include the possibility of preventing or resolving conflicts and of increasing the social acceptability of initiatives [20,21].

Public participation may also lead to an overall improvement of the whole process through the contribution of local knowledge. For these reasons, the governance process in environmental matters should always be appropriately set and should provide the framework for adequate involvement of all the parties directly and indirectly concerned.

The SEPOSSO (Supporting Environmental governance for the *Posidonia oceanica* Sustainable transplanting Operations) project investigated the governance structure in three *P. oceanica* transplants realized as compensation measures and in one experimental transplant along the Italian coast. Drawing from the project activities and tasks, the objective of this paper is to evaluate for the first time the views and attitudes of selected stakeholders about the objectives, characteristics, and results of *P. oceanica* transplantations, and the benefits or detriments originated. To fulfil this task, the Q methodology, an exploratory semi-quantitative tool originally developed to investigate subjectivity in psychology studies [22] but later applied to many other fields of research including environmental conservation [23], was adopted. The Q methodology allows to identify stakeholders' visions (or discourses) that develop around a topic, and the points of agreement or disagreement among them [24]. Despite the high level of subjectivity and the heterogeneity of approaches used in the presentation of results [25] the output of a Q-based study may allow the evaluation of environmental policies [26], assist in conflict resolution and lead to the realization of a good governance structure, paving the path to effective, shared and socially acceptable management actions [20].

## 2. Materials and Methods

### 2.1. Case Studies Selection

Four *P. oceanica* transplantation initiatives realized between 2004 and 2014 along the Italian coast—three in the Tyrrhenian Sea and one in the SW Ionian Sea—were selected as case studies to investigate the attitudes of the stakeholders directly involved in the initiatives. The Tyrrhenian transplantations were realized to compensate for damage caused to native *P. oceanica* meadows by infrastructural works, while the Ionian transplantation was an experimental initiative [27]. Table 1 lists the case studies and their main characteristics.

**Table 1.** Main details and characteristics of four *Posidonia oceanica* transplantation case studies along the Italian coast (WGS84 coordinates).

Locality	Date of Transplantation	Coordinates	Surface	Motivation	Technique
Piombino (northern Tyrrhenian Sea)	Jun 2014	42.944295° N 10.612316° E	1360 m <sup>2</sup>	Dredging works in the harbor	Clod of seagrass <i>matte</i>
Civitavecchia (central Tyrrhenian Sea)	Aug 2004–Mar 2005	42.034567° N 11.890633° E	10,000 m <sup>2</sup>	Dredging works in the harbor	Grids of concrete and steel wire
Ischia (southern Tyrrhenian Sea)	Nov 2008–Feb 2009	40.746826° N 13.949514° E	1600 m <sup>2</sup>	Trench excavation for pipeline deployment	Grids of concrete and steel wire
Priolo (southwestern Ionian Sea)	Jun–Nov 2014	37.160970° N 15.220278° E	2500 m <sup>2</sup>	Experimental transplant	Bio-plastic support modules

### 2.2. Q Methodology

A Q methodology approach was followed to investigate the attitudes of selected stakeholders about *P. oceanica* transplantations in the four case study localities. A standard approach consisting of five steps was followed [28,29]: (1) creation of a collection of statements, *concourse*; (2) extraction of a selected sub-set of statements, *Q-set*; (3) definition of the set of participants asked to score the statements, *P-set*; (4) rank-ordering of the statements and statistical analysis, *Q-sorting*; (5) interpretation of the *discourses*, i.e., the stakeholders' visions stemming out from interviews to stakeholders, critical reading of the statements, case studies' EIA reports and from the academic and grey literature. A final

*Q-set* of 37 statements was extracted after a process of refinement based on the elimination of duplicate or unclear statements, and considered broad and diverse enough to cover the full spectrum of policy, science, and management aspects of the investigated topic (Table 2).

**Table 2.** List of the 37 selected statements included in the *Q-set*.

No.	Statement
1	A transplantation technique that is considered the most appropriate to the transplant site should be adopted
2	The information that leads to choose the transplantation as a compensation measure should be clear and easily accessible
3	A mismatch between administrative and technical terminology exists in the EIA prescriptions that impose the transplantation
4	The choice of the transplantation technique should be based on an accurate environmental study of the transplant site
5	A marine protected area should be established in addition to the transplantation to assure the full restoration of ecosystem functions lost due the infrastructural works
6	<i>P. oceanica</i> transplantations are not a priority for the country
7	Among compensation measures, public meetings should be held to awaken the public opinion to conservation and environmental issues
8	The choice of the transplantation technique should be based on the most recent scientific knowledge
9	Social acceptance of the infrastructural works and of the compensation measures is a prerequisite to a good governance of the transplantation initiative
10	<i>P. oceanica</i> should be protected, not transplanted
11	<i>P. oceanica</i> is a waste
12	A transplantation initiative should involve local skills, abilities, and cultural heritage
13	Pilot transplantations should be realized in the identified transplant site before the start of the infrastructural works
14	Monitoring outputs should be made public in an easily accessible and understandable format
15	A transplantation should produce easily accessible new knowledge and data
16	Maritime infrastructural works are necessary to the economic growth of the country
17	Priority habitats as defined by the EC Habitat Directive should never be impacted by infrastructural works
18	The environmental effects of a transplantation should be made public
19	EIA prescriptions should be drawn up by a multidisciplinary expert team
20	Transplantations should be bound to the stakeholders' acceptance
21	The main aim of EIA should be ecosystem protection
22	Transplantations should always be realized by an experienced team
23	A transplant alone cannot warrant all the ecosystem functions originally provided by the damaged seagrass meadow
24	The restoration of lost ecosystem functions is more important than economic convenience in the choice of transplantation technique
25	Tenders for the allotment of a transplantation initiative should not be based solely on a lowest-bid contract
26	Economic development should not be subject to extreme conservation logics
27	The citizens should be fully informed about objectives, techniques, and costs of a transplantation initiative during its early stages, not merely after its completion
28	Links and synergies among the stakeholders directly involved in a transplantation initiative are insufficient
29	Transplantation initiatives should be fully regulated
30	The governance of a transplantation initiative should be adapted to the local socio-economic context
31	Transplant monitoring should be carried out by an external scientific team rather than by the one who realized the transplant
32	The creation of centers for the collection and storage of beach-cast rhizomes and seeds of <i>P. oceanica</i> is a priority
33	Transplant monitoring should be a long-term activity
34	The data collected before and after realized transplantations are not adequately organized, shared, and exploited
35	The loss of <i>P. oceanica</i> meadows is an inevitable cost of modernization
36	To avoid tensions, transplantation initiatives should be based on the agreement of all (national, regional, local) political actors
37	All steps of a transplantation initiative should be traceable, clear, and accessible



### 2.5. Discourse Analysis

Q-sort data, i.e., the distribution of Q-SV scores given to statements by *P-set* respondents, were analyzed with the KADE software (KADE (Ken-Q Analysis Desktop Edition v.1.0.6 is a free software available at <https://shawnbanasick.github.io/ken-q-analysis/>, last access on 15 September 2021) [30]. KADE analysis started with the correlation of each participant's Q-sort with those of all other participants. A principal component analysis was performed on the resulting correlation matrix to produce statistically significant factors that suggested similar perspectives on the matter of study. Four meaningful factors were then selected based on an eigenvalue >1 and on the percentage of explained variance. A Varimax rotation applied to the selected factors as suggested by Zabala [31], produced a table with factor loadings by participants. Participants' loadings were auto-flagged in the factors with a 95% confidence level. The subsequent steps produced a series of tables with the Z-score ranking of each statement and the distinguishing statements in each factor. These tables were used by the software to build a series of reconfigured Q-sorts (one for each factor) based on the composite and weighted Z-scores from all the participants who define a particular factor, called *composite Q-sorts* (Table S1).

### 3. Results

The principal component analysis conducted on the 22 Q-sorts highlighted four significant factors that explain 67% of the total variance (Table 3).

**Table 3.** Characteristics of the four significant factors (discourses) selected from the analysis. s.e.: standard error.

Factors	No. of Defining Variables	Eigenvalues	% Explained Variance	Average Reliability Coefficient	Composite Reliability	s.e. of Factors' Z-Scores
F 1	7	7.230	33	0.8	0.966	0.184
F 2	6	4.095	19	0.8	0.960	0.200
F 3	4	1.907	9	0.8	0.941	0.243
F 4	5	1.424	6	0.8	0.952	0.219

The list of ranked statements in each factor is shown in Table S2. Statements 21 (the main aim of EIA should be ecosystem protection) and 11 (*P. oceanica* is a waste) ranked 1st and 37th respectively in Factor 1. Due to their ranking, they concentrate maximum agreement and maximum disagreement from the respondents associated to that factor, respectively. The statements that ranked first and last in the other significant factors were: 8 (the choice of the transplantation technique should be based on the most recent scientific knowledge) and 17 (priority habitats as defined by the Habitat Directive should never be impacted by infrastructural works) in Factor 2; 10 (*P. oceanica* should be protected, not transplanted) and 11 (*P. oceanica* is a waste) in Factor 3; 37 (all steps of a transplantation initiative should be traceable, clear, and accessible) and 11 (*P. oceanica* is a waste) in Factor 4. Statement 11 ranked the lowest in three factors and relatively low in Factor 2, which indicates a very strong disagreement by most respondents.



Discourses, which represent the attitudes of *P-set* respondents about the issue of *P. oceanica* transplantations as a compensation tool, correspond to the significant factors that emerged from the principal component analysis. Their characterization and description were based on the composite Q-sorts (Table S1), which allowed us to identify the distinguishing statements of each factor. The four discourses were entitled considering the statements' content and the result of the interviews made to respondents, as follows:

- F1: Science and conservation discourse;
- F2: Engineering and industry discourse;
- F3: Environmentalism and participation discourse;
- F4: Transplantation-oriented discourse.

### 3.1. Characterization and Description of Discourses

#### 3.1.1. F1: Science and Conservation Discourse

This discourse expresses a vision strongly inspired by the importance of nature conservation and by the most rigorous, science-based approach to transplantations. The protection of *P. oceanica* meadows as well as other priority habitats is considered a top priority that should be taken into consideration during the planning of infrastructural works at sea. The demand for seagrass conservation is expressed by agreement with Statement 10 and especially Statement 21, and by disagreement with Statement 26. A high attention is posed on the pre-requisites that are expected to assure a highly successful transplantation, such as the choice of the methodology, the necessity of preliminary studies, and the adoption of pilot transplant experiments. Emphasis is posed in long-term monitoring of transplants to be sure that they are effective in the long run. Agreement with Statements 13 and 33 testifies the confidence placed in a rigorous scientific approach that ensures effective transplantation techniques through the use of pilot experiments and subsequent long-term monitoring. Neutral or negative opinion was expressed instead for Statements 28, 7, 9 and 18, which correspond to different levels of public engagement in the transplantation initiatives. Overall, there is an attention towards sustainable development, as suggested by the disagreement against statements that emphasize the importance of modernization and industrialization (Statements 26, and 35).

#### 3.1.2. F2: Engineering and Industry Discourse

This discourse expresses a vision oriented at granting the economic development of the country (Statement 16) even at the expense of the ecosystem (Statements 17, 21, 24). The importance of sound scientific advice that assures effective transplantations is acknowledged (Statement 8), although monitoring carried out by the actual transplant realizer is preferred over one carried out by an external, independent team (Statement 31). The necessity to avoid non-optimal choices dictated by the mere search for profit is acknowledged (Statement 25). The influence of extreme conservation logics (Statement 26) and an interdisciplinary team that draws EIA prescriptions (Statement 19) are both considered an impediment. An ambivalent attitude is expressed as regards citizens' participation: while social acceptance of infrastructural works and of transplantations is considered an important pre-requisite (Statement 9), as well as the adaptation of governance to the local socio-economic context and the preliminary agreement of political forces (Statements 30, and 36), workshops organized to enhance the awareness of citizens towards conservation issues (Statement 7) are not considered necessary.

#### 3.1.3. F3: Environmentalism and Participation Discourse

This discourse is strongly oriented at avoiding any damage to *P. oceanica* at all costs. This translates in a position that stands against transplantations (Statement 10) no matter how sound the scientific background is and how clearly the information about the transplantation is delivered (Statements 1, 22, and 2). In addition, different compensation measures (such as the establishment of marine protected areas) are favored over transplants in order to obtain a full recovery of ecosystem functions (Statement 5). Public information,

social acceptance of infrastructural works and compensation measures and more generally the involvement of citizens are considered important (Statements 9, and 20), and a major role is acknowledged to long-term monitoring activities and to the relevant data produced (Statements 15, and 33). Overall, this discourse is basically against any sort of impact on seagrass meadows, irrespective of the compensation measures proposed and of the diffusion of information about the transplantation.

#### 3.1.4. F4: Transplantation-Oriented Discourse

The last discourse is oriented towards the realization of maritime works also even if they impact sensitive habitats (Statement 17), and subsequent transplantations should be realized even in the absence of a general agreement from all the political bodies involved locally and nationally (Statement 36). Maritime infrastructures are not considered a necessary step towards the economic growth of the country though (Statement 16). Governance mechanisms are deemed faulty, and a more effective administration is considered an important issue (Statement 3). Transparency of the whole transplantation process and access of citizens to the data (Statement 37), and the importance of data quality and accessibility (Statements 15, and 34) are acknowledged.

### 3.2. Differentiation among Discourses

Four statements (Table 4; see also Table S1) are consensus statements and should be interpreted as points of agreement among the discourses: 14 (monitoring outputs should be made public in an easily accessible and understandable format: positive agreement), 27 (the citizens should be fully informed about objectives, techniques, and costs of a transplantation initiative during its early stages, not merely after its completion: neutral agreement), 29 (transplantation initiatives should be fully regulated: negative agreement), and 35 (the loss of *P. oceanica* meadows is an inevitable costs of modernization: negative agreement). While these statements do not help in the differentiation among discourses, they are potential starting points to build consensus among stakeholders around the issue of *P. oceanica* transplantations.

**Table 4.** List of statements that obtained consensus at the Q sorting.

Statement	F1		F2		F3		F4	
	Q-SV	Z-Score	Q-SV	Z-Score	Q-SV	Z-Score	Q-SV	Z-Score
14 **	1	0.36	1	0.499	1	0.502	2	1.02
27 *	0	−0.222	0	−0.187	0	0.372	0	0.318
29 **	0	−0.2	−2	−0.89	−1	−0.74	−1	−0.23
35 **	−3	−1.4	−2	−0.83	−2	−1.01	−3	−1.56

Q-SV: statement value given by the *P-set* respondents. \* = non-significant at  $p < 0.05$ ; \*\* = non-significant at  $p < 0.01$ .

The relation among discourses is visually represented in Figure 2, where the physical distance of symbols on each line of the plot indicates the level of agreement or disagreement among discourses around each statement (closer distance = higher agreement). The four statements at the bottom are the consensus statements already described. The top statements represent the most distinctive ones, i.e., those showing maximum divergence among discourses. Statements 16 and 26 regard the necessity of infrastructural maritime works and the subjugation of economic development to conservation logics. As expected, the F2 discourse stays at one end while F1 and F3 stay at the other end. Statements 17 and 21 regard nature conservation and ecosystem protection, and also in this case discourses F1 and F2 stay at the opposite ends of the Z-score range. Statement 10 expresses a very drastic position that is strongly agreed upon only by discourse F3.





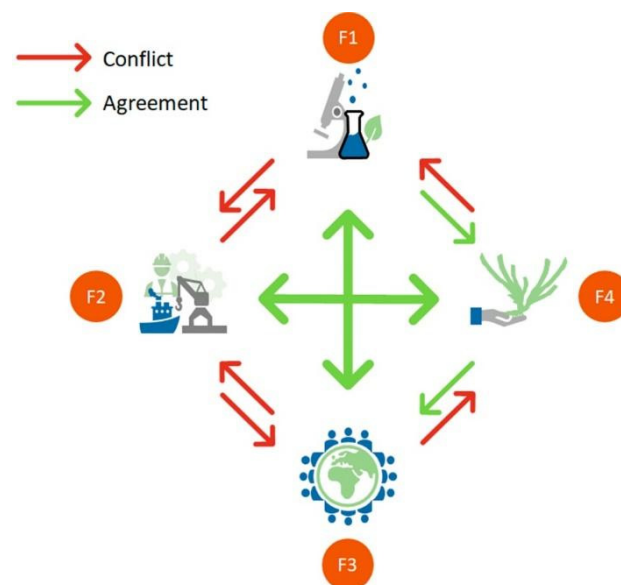
**Figure 2.** Statements and their Z-scores (on the horizontal axis) arranged from the most divergent (on top) to the most consensus-oriented (at the bottom). Each symbol represents a different discourse (see legend).

#### 4. Discussion

Identifying the discourses developed by selected stakeholders around matters of common interest is a good way to find common grounds, mediate conflicts and proceed towards shared and successful management of complex processes [32]. The knowledge of discourses made about the environment may definitely help to understand if environmental policies are acceptable by specific societal sectors as well as by the wider public [24,26,33]. The Q methodology provides an excellent help in this direction. For this reason, it has been applied often to analyze environmental governance in the field of nature conservation [21,34–36], fisheries management [20,37], ecosystem services [28,29,38] and sustainability [33,39,40].

This study has investigated for the first time the views and attitudes of selected stakeholders about *P. oceanica* transplantations prescribed to compensate the impact of marine infrastructural works on *P. oceanica* meadows and also about an experimental transplant in an area affected by severe industrial pollution. The application of a Q methodology approach allowed us to identify four discourses that represent the visions of stakeholders directly involved in *P. oceanica* transplantations in Italy. The graphical representation of the relationships among discourses (Figure 2) gave us clues to identify the conflicts and the points of agreement between them.

Consensus statements helped to identify shared attitudes. These regard societal, economic, and scientific issues around which there is common agreement, disagreement or even neutrality of opinion. More critical, and more important is the identification of conflicts among visions, which require an effort to be solved [17]. The results of this study illustrate the relationships among discourses and shows how each vision affects the others, as pictured in Figure 3. The engineering and industry discourse (F2) supports a vision that emphasizes the importance and necessity of industrial and economic development, even when it implies a strong impact on the ecosystem. This discourse refuses the constraints imposed by an environmentalist logic but acknowledges the importance of appropriate and competent scientific advice in the realization of the transplants and considers the social acceptance of maritime works and of compensatory transplants a mainstay. The F2 discourse shares some common ground with the Transplantation-oriented discourse (F4), which strongly supports transplantations as a compensation measure and at the same time expresses the need of a more effective involvement of citizens in terms of transparency of the procedures and accessibility to data and knowledge.



**Figure 3.** Relationships among discourses as highlighted by the discourse analysis. F1: science and conservation discourse; F2: engineering and industry discourse; F3: environmentalism and participation discourse; F4: transplantation-oriented discourse.

The science and conservation (F1) and the environmentalism and participation discourses (F3) share a common attitude and tend to set against the previous two. They share a common vision oriented at the protection of the environment, the recovery of lost ecosystem services and the full involvement of local populations, with some peculiar statements such as the emphasis on the role expected by the EIA commission in the protection of the ecosystem (F1), and the firm belief that seagrass meadows should never be impacted, no matter what the compensation measures might bring in terms of habitat recovery (F3).

In some cases, the points of disagreement that we have highlighted could be smoothed out (green arrows in Figure 3). This would pave the way to a more effective governance of transplantation initiatives with positive spin-off on all the parties involved. For example, scientific expertise is necessary to the realization of transplants, hence F1 and F4 are expected to be synergistic on this matter since both of them aim at transplants that are stable in the long run and effective in the compensation of the damage produced by infrastructural works. Another common ground exists between F4 and F3, based on the agreement about the importance of an effective governance that assures fuller involvement of citizens and easy access to data collected and knowledge gained during the transplantation.

Seagrass meadows provide numerous ecosystem services, however, they are widely threatened by anthropogenic pressures that have led to their decline at a Mediterranean [7] and global scale [41]. The management of *P. oceanica* in the western Mediterranean has recently been perceived as inadequate by stakeholders [38], hence an adaptive governance of all initiatives that regard this peculiar ecosystem is needed. This is even more important when it comes to the conflicts existing between economic interests (e.g., infrastructural maritime works) and conservation demands. The Q methodology approach adopted in this paper has highlighted consensus points and, more importantly, conflicts that need to be addressed and resolved in the framework of a suitable governance structure. Our study provides a potential basis for implementing a sustainable governance and assuring high social acceptability in any future initiative concerning *P. oceanica* transplantations.

**Supplementary Materials:** The following are available online at <https://www.mdpi.com/article/10.3390/su132112216/s1>, Table S1: list of the 37 selected statements with the composite Q-sorts and their significance level; Table S2: Z-score of statements and associated ranks.

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