

Ecosystem-Based Management for More Effective and Equitable Marine Protected Areas: A Case Study on the Faial-Pico Channel Marine Protected Area, Azores



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Abstract Marine Protected Areas (MPAs) are increasingly employed as a tool to protect Europe's swiftly declining marine biodiversity. However, despite increasing coverage, MPA effectiveness and equity is considered highly variable. Concurrently, Ecosystem-Based Management (EBM)—that is, management that aims to protect, restore, or enhance the resilience and sustainability of an ecosystem to ensure sustainable flows of ecosystem services and conserve its biodiversity—is growing in prominence. We applied EBM in the Faial-Pico Channel, a 240 km² MPA in the Azores, Portugal, to assess whether EBM can protect biodiversity whilst meeting diverse stakeholder and policy goals. Collaborating with local stakeholders and policy-makers, this chapter documents the steps of EBM: identifying integrative policy and stakeholder objectives, understanding the social-ecological system, scenario development, and identification and evaluation of EBM measures and policies. We find that stakeholder co-creation and collaboration is a key strength of EBM and should be strengthened in the Faial-Pico Channel. We find that local stakeholders support effective and equitable EBM of MPAs by clearly identifying challenges and priorities, co-creating solutions, providing low-cost knowledge and expertise, and

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through ongoing monitoring, enforcement, and evaluation of the impact of management.

Lessons Learned

- Stakeholder engagement and participation supports long-term sustainable protection of biodiversity and equitable and effective management of MPAs
- Stakeholders can contribute at each stage of EBM: identifying social objectives, understanding the social-ecological system, identifying an EBM plan, and evaluating impact
- Stakeholders contribute by clearly identifying challenges and priorities, co-creating solutions, and generally by providing low-cost knowledge and expertise, as well as increasing societal acceptance.
- EBM is an appropriate framework for increasing effectiveness and efficiency of MPAs

Needs to Advance EBM

- Clear guidance on how to effectively engage stakeholders at each stage of the EBM process
- EBM has high environmental and socio-economic data demands. Guidance on how to apply EBM in low-data environments would support uptake.

1 Introduction

Globally, marine biodiversity declined by 49% between 1970 and 2012 (Tanzer et al. 2015). This rapid decline threatens the resilience of marine ecosystems and their ability to sustainably produce ecosystem services that humans depend on to survive and thrive (Cardinale et al. 2012). Policy makers have turned to Marine Protected Areas (MPAs) as a key tool to reverse marine biodiversity loss (Gill et al. 2017). Indeed, globally, the Convention of Biological Diversity's Aichi Target 11 and the UN Sustainable Development Goal 14 aim to "efficiently and equitably" protect 10% of coastal and marine areas within MPAs (UN 2016; Secretariat of the CBD 2011). However, the efficacy and equity of MPAs is questioned and considered highly variable (Gill et al. 2017).

Researchers, policy-makers, and environment managers are increasingly interested in the ecosystem-based management concept as a promising approach to more effectively, efficiently, and equitably manage aquatic ecosystems (see, e.g., Delacámara et al. 2020). Ecosystem-based management (EBM) is a principle-based management approach that aims to protect, restore, or enhance the resilience and sustainability of an ecosystem to ensure sustainable flows of ecosystem services and conserve its biodiversity (see Gómez et al. 2017; Rouillard et al. 2017). While

there is increasing interest in ecosystem-based management, there are still relatively few practical examples worldwide, especially as applied to Marine Protected Areas.

This chapter presents a summarised excerpt from the more detailed AQUACROSS project case study report (McDonald et al. 2018), documenting the application ecosystem-based management (EBM) in the richly biodiverse Faial-Pico Channel, a 240 km² Marine Protected Area in the Azores, Portugal. We include it in this book as it illustrates in an integrated manner how each of the concepts developed in the AQUACROSS project can be combined to practically apply EBM to manage biodiversity. To apply ecosystem-based management, we collaborated with local stakeholders and policy-makers and follow the AQUACROSS Assessment Framework (Gómez et al. 2017). The chapter aims to: (1) demonstrate how the AQUACROSS Assessment Framework can be followed to practically apply ecosystem-based management; (2) identify how ecosystem-based management can protect biodiversity and improve social welfare in the specific context of the Faial-Pico Channel social-ecological system, and (3) understand how ecosystem-based management generally can support existing MPAs to become more effective and equitable.

2 The Faial-Pico Channel Marine Protected Area: Case Study Context

The Faial-Pico Channel is rich in biodiversity, and its complex of habitats, species, and ecological processes is recognised as one the most diverse and representative complex of habitats in the Azores archipelago (MarBEF Data System 2006; OSPAR Commission 2016). However, despite a 30 year history of increasing international, Azorean, and local protection for the area (Abecasis et al. 2015), biodiversity in the MPA continues to be lost, as indicated by falling population indices of target coastal species in the channel (Afonso et al. 2014).

Numerous human activities in the Channel place pressure on the ecosystem, especially fishing and tourism. Fishers and tourism operators (including diving operators) value the biodiversity hotspots within the Channel, but have different objectives for how they should be managed. It is important to balance these objectives, as both tourism and fisheries are important local industries for the 30,000 people who live on Channel's neighbouring islands. Commercial fisheries are a historically important driver of the local economy, and still employ 1.5–3.2% of the total working population (Ojamaa 2015; Statistics Portugal 2017).¹ Tourism has swiftly become central to the local economy, with the number of tourist nights in the Azores tripling from 1995–2015; in 2016, tourists spent 228,000 nights on the islands (SREA 2017). As one indicator of the sector's importance, in 2015, the

¹Statistics Portugal: own calculations, Fishermen registered at 31 December 2015 in Azores. This compares to a rate of 0.6% for Portugal.

accommodation sector directly employed 2% of the total Azorean workforce.² This has supported economic growth, with GDP per capita growing at 2.7% per year since 2000 (currently at €16,000).³

The increased demand by tourists (and tourism providers) for eco-tourism in the Channel and declining biodiversity is leading to conflict between commercial fishers and other stakeholders as to how the Channel should be managed (AQUACROSS 2017). Managing the Channel is complicated by multi-level and overlapping responsibilities, with policy development and enforcement split across the local-level Nature Park of Faial and Nature Park of Pico, both under the mandate of the Regional Directorate for the Environment (Direcção Regional do Ambiente, DRA). Other relevant managing authorities include the Azores-level Regional Directorate for Sea Affairs (DRAM) and the Regional Directorate for Fisheries (Direcção Regional das Pescas, DRP), all who must consider local (i.e., Faial and Pico Island), Azorean, Portuguese, and EU policy targets.

In response to falling local biodiversity and to balance stakeholder competition for space, local authorities have extended Marine Protected Area to cover the Faial-Pico Channel. Parts of the Channel have been protected under local policy as a MPA since 1980, with this extended under NATURA 2000 protection in 1995, and OSPAR coverage in 2006, and consolidated under new Azorean Island National Park regulation in 2007 (Abecasis et al. 2015).

Dovetailing this government push for increased biodiversity protection, bottom-up stakeholder demands have driven Faial-Pico Channel management, resulting in an increase in stakeholder participation in MPA management. An early, nearby example was the Condor Seamount, which in 2010 following a stakeholder participatory process was designated a temporary MPA to facilitate marine research (Ressurreição and Giacomello 2013; Ressurreição et al. 2017). Following this and other Azorean examples, local government and scientists supported Faial-Pico tourism operators when they published an open letter calling for an extension of MPA coverage in the Channel to promote non-extractive recreational activities, instigating two stakeholder meetings to gather input on MPA management revisions. While these workshops lacked sufficient representatives from the tourism sector and no recreational fishing representatives, they represent more inclusive management of the MPA by local authorities and the resulting change in law (Ordinance 53 2016) increased protection for some of the high biodiversity zones in the Channel. Within this context—of falling biodiversity, increased competition for the Channel, and at the same time more inclusive MPA management—our application of ecosystem-based management aims to build on previous policies and approaches and identify how local authorities and stakeholders can increase the effectiveness and equity of Faial-Pico Channel MPA management.

²Eurostat: own calculations, SBS data by NUTS 2 regions and NACE Rev. 2 (2014–2016). This compares to a rate of 2.3% for Portugal.

³EUROSTAT: GDP at current market prices by NUTS2 region.

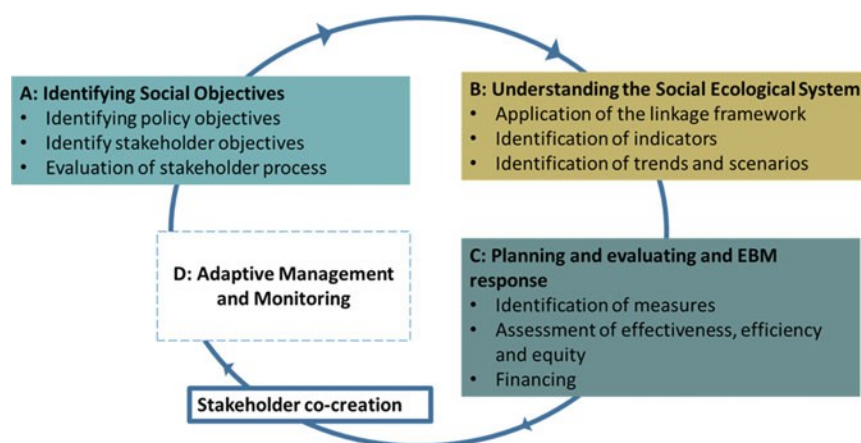


Fig. 1 AQUACROSS Assessment Framework, as applied in this case study

3 Methodology

To apply ecosystem-based management, we followed the AQUACROSS Assessment Framework (Gómez et al. 2017). As shown in Fig. 1, we applied this in three overlapping steps.⁴ Below, we describe the different methodologies applied at each step, as well as how stakeholder co-creation supported the whole process.

3.1 Stakeholder Co-creation

Common to our methodology at all steps was co-creation with local stakeholders. Given EBM's ambition to reflect the complexity and multifunctionality of the Faial-Pico Channel, diverse representative stakeholder participation was required. We mapped stakeholder interest and influence, using snowball sampling to identify and recruit diverse stakeholders (following Reed 2008). Through phone and in-person semi-structured interviews and small meetings we gathered input and feedback from all key stakeholders including recreational and commercial fishers, diving operators, environmental NGOs, scientists, and representatives of all relevant policy ministries and departments (Regional Directorates). Stakeholders also identified issues, shared their views, and provided input and feedback at two workshops: (1) Stakeholder workshop 1—Horta—3rd of October, 2017: 31 local stakeholders discussed the current and future management of the Faial-Pico Channel MPA, and how science and local knowledge can support policy (AQUACROSS 2017);

⁴Due to the timing of the case study, we did not progress to applying the fourth step of adaptive management and monitoring.

(2) Stakeholder workshop 2—Horta—23rd of May, 2018: 18 local stakeholders collaborated on a concrete plan for stakeholder-based management of the Faial-Pico Channel MPA, and prioritised and developed measures to managed the Channel (AQUACROSS 2018).

(A) Identifying Policy and Stakeholder Objectives

To understand *policy objectives* we applied at a local level Rouillard et al.'s (2017) approach and reviewed relevant Faial-Pico and Azores regulations, laws and strategies related to the environment, fishing, and tourism, i.e., the sectors driving pressures on local biodiversity. We assessed key features, implementing measures, and governance of the most important local policies, and applied the Driver-Pressure-State-Impact-Response model to identify the expected pathway through which the management measures impact biodiversity in the Faial-Pico Channel, i.e., how the policy affects ecosystem state, pressures, or drivers. Finally, we identified synergies, conflicts, and gaps in relation to how local management and policy affects biodiversity in the Channel, and how biodiversity protection could be improved. To understand *stakeholder objectives* we relied on stakeholder interviews and the two workshops. To understand *stakeholder processes* and to identify how current stakeholders could better support MPA management, we used the development of a recent relevant policy Fishing Ordinance no. 53/2016 as a case study, evaluating how existing stakeholder processes could be adapted to the requirements for EBM.

(B) Understanding the Social-Ecological System

We applied the AQUACROSS Linkages Framework to understand the current Faial-Pico Channel socio-ecological system (Robinson and Culhane 2020). We mapped marine habitats present in the Channel and then used expert judgement, local scientific reports and economic and environmental data, and interviews with local scientists and regulators to identify drivers and activities, the pressures these place on habitats, and link these habitats to ecosystem-services production. Having identified key elements in the Channel's simplified social-ecological system (see Fig. 2), we then identified indicators and collected data on state and trends. We presented this to stakeholders at workshop 2 and co-developed future scenarios to identify future trends that would require integrative management and to identify potential trade-offs associated with different approaches for managing fishing, tourism, and biodiversity within the MPA.

(C) Identifying an EBM Plan

To identify the combination of management measures and implementing policies that make up the EBM plan, we collaborated with local stakeholders and policy-makers. They suggested a long list of potential measures/policy instruments in interviews and at stakeholder workshop 1 (AQUACROSS 2017). At stakeholder workshop 2, stakeholders selected priority management measures and implementing policies and developed how these should be implemented in the Channel (AQUACROSS 2018). We then ensured the workability of these individual measures and policies and combined them into an EBM plan. Finally, we evaluated this EBM plan relative to a baseline of current management using three criteria:

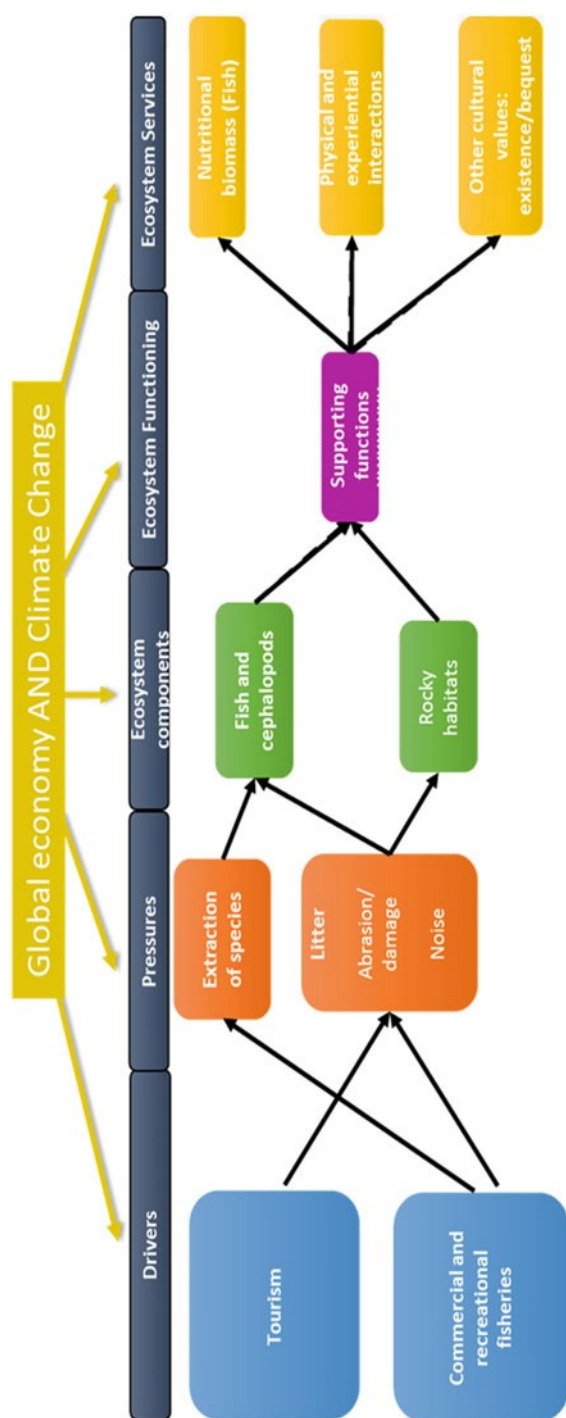


Fig. 2 Simplified linkage framework for Faial-Pico Channel, showing key drivers, pressures, ecosystem-components, ecosystem functioning, and ecosystem services

effectiveness, efficiency, and equity. Here, we drew on stakeholder and expert input and the AQUACROSS Linkage Framework to qualitatively assess direct and indirect impacts. To assess how the direct costs of the EBM plan could be financed, we interviewed participants and quantitatively assessed tax and levy impacts (following European Commission et al. 2017).

4 Results

4.1 Identifying Policy and Stakeholder Objectives

Policy Objectives

Biodiversity in the Channel is protected by environmental policies. However, as described in Rouillard et al. (2017), the positive impact of these policies can be undermined by sectoral policies, which support drivers (fishing, tourism) that place pressures on biodiversity. Together with local policy-makers and stakeholders, we concluded that, while local policy already targets sustainability, there are three policy gaps that should be priorities for improving MPA management:

- *Lack of coordinated management of the Channel limits synergies*—The current dispersion of responsibilities and management between environmental directorates (Faial and Pico Island Nature Parks, DRA, DRAM, and DRP) hinders integrated and coordinated management, implementation, monitoring, and evaluation of the Faial-Pico Channel. Leaders of the Island Nature Parks have reported lacking expertise and interest in non-terrestrial protected areas (AQUACROSS 2017). DRAM has the expertise and the mandate for coordinating and regulating the MPAs but is currently lacking operational means to implement monitoring or enforcement.
- *Issues of scale of marine resources not reflected in policy or governance*—The current split of the Channel into two separate Faial and Pico management units fails to recognise the Channel's interconnected ecosystem, and its links to the wider Azores marine ecosystem. A key benefit of MPAs are the potential positive spillover effects: MPAs elsewhere have been shown to increase species richness and catch rates in neighbouring waters (Russ and Alcala 2011). Negative spillover effects can also occur, where closure of one area increases fishing effort in boundary or neighbouring zones (Murawski et al. 2005). Managing the Channel as one integrated unit could help balance these competing spillover and network effects to meet local and Azorean biodiversity goals. In this way, the most recent MPA management regulation (Ordinance 53 2016) suggests a way forward: it was developed by DRAM in collaboration with DRP, who also manage the Azores Marine Park, thus better reflecting ecosystem scale.
- *A lack of monitoring data limits target setting and adaptive management*—Ecosystem-based management requires decision-makers to monitor policy impact and regularly revisit management tools if objectives are not being met

effectively, efficiently, and equitably (Rouillard et al. 2017). This requires monitoring and data at the appropriate spatial scale (i.e., Faial-Pico Channel), as well as clearly defined and spatially consistent policy objectives and targets. Ideally, this should include both ecological data (i.e., measures of biodiversity state, such as fish stocks) and socio-economic data (benefits and costs for society, e.g., fishing income, MPA visits). This data challenge is compounded by the issue of scale: policy objectives are set—and existing biodiversity and economic data collected—at the national (or, in some cases, island) scale, rather than at the Faial-Pico Channel-level. This makes it difficult to set and evaluate quantitative local targets. Additionally, Channel monitoring data is currently insufficient to manage biodiversity.

Stakeholder Objectives

EBM aims to maximise overall social welfare. Accordingly, it is important that as well as existing policy objectives, MPA management must consider other stakeholder goals. In the Faial-Pico Channel, there was considerable overlap between policy objectives and stakeholder priorities, but we did identify additional stakeholder objectives, some of which all stakeholder groups shared, and others where different groups were in conflict.

- *Shared stakeholder objectives:* Stakeholders all recognised that they share the Faial-Pico Channel MPA and come from the same community. Accordingly, all stakeholder groups share four central objectives: long-term sustainability, simplified and holistic management of the Channel, regular monitoring, and ongoing participatory management. (AQUACROSS 2017, 2018).
- *Conflicting stakeholder objectives:* The major stakeholder groups within the Channel also have conflicting objectives (AQUACROSS 2017, 2018). Additionally, as the Channel consists of many distinct habitats, stakeholders also place different value on different parts of the Channel (Schmiing et al. 2015; Afonso et al. 2014). For example, commercial fishers prioritise access to fishery grounds, which can be in conflict with recreational fishers wish for extended catch limits and tourism operators' desire for expansion of the MPA to protect biodiversity and restrict extractive uses.

Enhancing cooperation and managing these conflicts relies on transparent and inclusive governance, which stakeholders believe could additionally decrease conflict, increase knowledge, and motivate greater environmental protection (AQUACROSS 2018).

Stakeholder Processes

Stakeholder processes are central to EBM, and given the gap we identified between policy objectives and stakeholder objectives and the presence of stakeholder conflicts, we evaluated existing stakeholder processes for integrating stakeholders into policy development. We found that while policy-makers' development of a non-technical scientific report (Afonso et al. 2014) and stakeholder workshops were positive steps in enabling stakeholders to contribute to policy design/

development, low participation from two key sectors—recreational fishing and tourism operators—meant the process was not representative. A second conclusion was that stakeholders should be involved throughout the policy cycle, not just in the policy development stage. Such adaptive management requires ongoing monitoring, evaluation, and, if necessary, adaptation of any management measures. This ongoing stakeholder engagement, for example through clear communication or regular workshops, would help ensure that decision-makers have full information on stakeholder objectives and priorities and feedback on whether current management is optimal or needs adjustment.

4.2 *Understanding the Social-Ecological System*

The second step of the AQUACROSS Assessment Framework is to understand the Faial-Pico Channel Social-Ecological System (SES). Effective management requires an understanding of how society affects the ecosystem, and how the ecosystem provides benefits to society, as well as the complex processes within the SES. We used the AQUACROSS Linkage Framework and developed indicators to understand the current state of the SES, and also used co-developed scenarios to identify potential future challenges and trends that would need managing.

Linkage Framework Analysis

Figure 2 presents a simplified social-ecological system for the Channel. We find that biodiversity in the Faial-Pico Channel is affected by the society that surrounds it: human activities like fishing and tourism place pressures on the Channel. These pressures affect the ecosystem's health and its ability to deliver valuable ecosystem services, such as fish and recreational experiences, which drive human activities and responses.

Our analysis shows that both the key sectors of fishing and tourism place many of the same pressures on the ecosystem, such as litter and noise. Unsurprisingly, fishing is most associated with the key pressure of extraction of fauna and flora. The linkage framework also assesses impacts over time: we find that fishing exerts more acute pressures, while tourism is associated with pressures that are more chronic. Accordingly, policies targeting fisheries will more swiftly decrease pressures than tourism-targeted policies.

We also used the Linkage Framework to assess which ecosystem components were most central to the Faial-Pico Channel SES. Fish are highly valued by all stakeholders. We find that rocky habitats support the most ecosystem functions and were associated with the most ecosystem services. This aligns with recent research on values of biodiversity indices around the Faial and Pico islands, which shows that the highest values were linked to rocky habitat, which provide refuge and substrate for various marine species, making rocky habitats important sites for fishing and diving (Schmiing et al. 2014). These insights suggest that management should prioritise protection of these central and valued ecosystem components.

Indicators

Our development and evaluation of indicators suggests that policy-makers can use indicators to understand the system, set quantitative targets, and monitor and evaluate trends and the impact of management measures. However, a key conclusion of this exercise was that a lack of quantitative Faial-Pico Channel data limits ability to apply EBM. The small scale and trans-boundary nature of the case study makes it difficult to use Azores-level data. Ecosystem-based management of the Channel calls for collecting and developing more specific Faial-Pico Channel data, especially to measure the current state of the ecosystem and its biodiversity, and on flows of key ecosystem services (fish for consumption, recreational experiences, and existence/bequest values).

Future Scenario Development

Scenarios are valuable as they provide a vehicle for incorporating diverse information into a comprehensive, actionable vision of the expected future (Gómez et al. 2017). Together with Azorean stakeholders and policy-makers (AQUACROSS 2018), we reflected on the understanding of the current SES, as well as our understanding of policies and stakeholder objectives, to develop identify what 2018–2050 is likely to bring to the Channel:

- **Climate change** will impact all sectors, increasing variability and uncertainty.
- The **global economy** will continue to drive ongoing—but fluctuating—growth.
- **Tourism** will continue to grow economically—with more visitors, income, and infrastructure.
- These changes mean **marine biodiversity** will be under increasing pressure in Faial-Pico Channel.
- **Commercial fisheries** and **recreational fishing** will remain central to local life, but sensitive to uncertain trends in fish stocks and biodiversity.

Developing this scenario clarified the gaps between current management (and the resulting expected future) and the future stakeholders and policymakers and stakeholders desired. Overall, we concluded that all stakeholders depend on a sustainable and resilient ecosystem. Given the large uncertainties and unknowns, stakeholders and policy-makers need to be adaptive—employing regular monitoring, evaluation, and if necessary, management changes.

4.3 Identifying an EBM Plan

Our final steps in applying ecosystem-based management in the Faial-Pico Channel was to reflect on identified objectives and policy gaps, and draw on our understanding of the current and future state of the SES to identify a set of priority management measures and implementing policies (the EBM Plan). We then evaluated the extent to which this EBM Plan would increase effectiveness, equity, and efficiency relative to a baseline of current management. We also investigated how regulators could

finance the EBM Plan, which has important equity affects as well as being crucial for MPA effectiveness (Gill et al. 2017).

EBM Plan

We identified the following measures and policies as priorities for EBM management of the Faial-Pico Channel:

1. **Increased monitoring of biodiversity**
2. **Increased stakeholder participation through a Stakeholder Advisory Group** consisting of representatives of all sectors.
3. **Integrate and coordinate Channel management** through a Marine Protected Area management plan and policy coordination group.
4. **Clear communication and enforcement of existing regulations**—e.g., through simple information panels and surveillance cameras
5. **Implement a sustainability tax**—a tourism tax/diving fee.

Evaluation of the EBM Plan

Effectiveness: Due to data and methodological limitations, we are unable to decisively quantitatively assess how the EBM Plan will affect biodiversity (i.e., its environmental effectiveness). The EBM plan has direct impacts on biodiversity by increasing enforcement and awareness of existing fisheries/biodiversity regulation, which will increase compliance and decrease a key pressure on local biodiversity, extraction of species. The implementation of a sustainability tax will marginally decrease tourism and related pressures. The EBM Plan would also have indirect positive impacts on biodiversity by increasing scientific knowledge and financing to support management, policy integration, and stakeholder cooperation. Stakeholders believe that a stakeholder advisory group would result in greater environmental protection and increases in biodiversity (AQUACROSS 2018).

Efficiency: Assessing economic efficiency of the EBM Plan requires an understanding of its direct and indirect costs and benefits. However, given the indirect, supporting nature of the majority of elements of the EBM Plan, we cannot quantitatively assess this. Using the AQUACROSS Linkage Framework, we find that there is uncertain impacts on the value of fish caught to be eaten; increases in the existence/bequest value of the system; and likely increases in the value of experiential/physical interactions with the ecosystem. Alongside this qualitative assessment, evidence of efficiency is provided by the fact that each of the policy instruments that form the EBM plan were co-created with local stakeholders, whose selection of the plan, who believe that the benefits of the plan will outweigh the costs (AQUACROSS 2017, 2018).

Equity: A key focus of the EBM Plan is to increase stakeholder involvement and ownership of MPA management in such a way that the EBM Plan recognises and balances the costs and benefits to different stakeholder groups, and focusses on synergies and a shared commitment to environmental sustainability. Indeed, all stakeholders prioritised this cooperative, participatory element of the EBM Plan, arguing that it would decrease conflicts between different users and policy entities through better communication, and the promotion of multiple uses of the Marine

Protected Area (AQUACROSS 2018); all evidence of greater equity under the EBM Plan than under current management.

Financing: The first four elements of the proposed EBM plan place costs on fishers (who will face increased enforcement and compliance costs), while tourists, tourism operators, and other local stakeholders benefit (both from exclusive access to diving locations and positive environmental impacts). Financing can be used as a way to share the costs between those who benefit and those who bear cost. Our assessment of two financing options (a per dive fee levied by tourism operators and a per night occupancy tax) suggests that even at low rates of €2 per dive or €0.25 per night, either of these options could cover the likely direct costs of the EBM Plan and share the costs between different stakeholder groups to improve equity.

4.4 Local Policy Recommendations

Overall, our co-development of an EBM plan for the Faial-Pico Channel with stakeholders resulted in the following set of complementary management measures and policy instruments: (1) increase scientific monitoring, (2) implement stakeholder co-management with a Stakeholder Advisory Group, (3) increase integration and coordination of Channel management (e.g., by means of a coordination group of fishing, tourism, and environment Regional Directorates and island national parks); (4) communicate and enforce existing fishing and biodiversity regulations, and (5) finance biodiversity protection and share costs. This plan would better protect Channel biodiversity, whilst also ensuring economic and social sustainability. A key element of this plan is extending the stakeholder participation and policy cooperation that was evident in the EBM process and in existing local government stakeholder engagement efforts. In light of the Azores government's strategic goal of increasing MPA coverage, to ensure their success, we encourage continued engagement of stakeholders in planning, implementation, and evaluation. This, along with increased scientific knowledge and cross-sectoral policy coordination, will enable adaptive management in the Channel, reduce stakeholder conflict, and can improve effectiveness and efficiency of management, delivering benefits to the whole community into the future.

5 Conclusion and Discussion: How Can Ecosystem-Based Management Support Effective and Efficient Management of Marine Protected Areas?

We conclude that the Faial-Pico Channel case study provides evidence that ecosystem-based management and the AQUACROSS Assessment Framework can support decision-makers to manage Marine Protected Areas more effectively, so that

they equitably meet biodiversity goals, both in the specific case of the Faial-Pico Channel and more generally in existing MPAs.

Our key conclusion is that stakeholder engagement and participation is beneficial for long-term sustainable protection of biodiversity and equitable and effective management of MPAs, and that ecosystem-based management's placing of representative stakeholder participation at the centre of ecosystem management is its key strength. Stakeholder engagement and participation has value in its own right. Reed (2008) reviewed stakeholder engagement literature and found that it promotes active citizenship, increases public trust, empowers stakeholders through co-generation of knowledge, improves public perception of policy, promotes social learning, and can reduce conflict between stakeholders and lead to creative solutions to environmental problems. In addition, stakeholder engagement is one of the defining principles of EBM (Long et al. 2015; Gómez et al. 2017). Stakeholder co-creation within this case study increased the relevance, acceptance, and quality of the management plan, and, as recognised by stakeholders, promotes synergistic solutions that provide multiple benefits, reducing stakeholder conflict, as well as improving knowledge and justifying more biodiversity protection (AQUACROSS 2018). It can be challenging involving stakeholders: for example, we found some stakeholders are harder to involve than others, and the process can be time-consuming, focused on discussion rather than action. However, on balance, we believe that the benefits of stakeholder co-creation outweigh these costs. This conclusion aligns with recent participatory management initiatives within the Azores, such as Condor seamount (Austen et al. 2019) and the Azorean fisheries regulation (Ordinance 53 2016) that increased protection for some high biodiversity areas in the Faial-Pico Channel. Our case study built on these initiatives and underlines the importance of integrated and representative management as a way to cope with the complexity and interlinkages of marine social-ecological systems.

Our experience also identified other strengths and challenges of ecosystem-based management for managing Marine Protected Areas. We found that ecosystem-based management provides a framework for integration of diverse stakeholders and objectives (biodiversity/environmental and sectoral). This integration clarifies the interconnectedness of the social-ecological system, and strengthens understanding of and arguments for collaborative, sustainability-focussed long-term ecosystem management. Key challenges that we faced were that while the interdisciplinary work of ecosystem-based management results in more useful and impactful policy, it requires diverse expertise and sometimes challenging cross-sectoral and cross-disciplinary collaboration and communication. Additionally, the newness and apparent complexity of the interdisciplinary work can make it challenging to get buy-in from sectors and policy makers. Finally, while EBM's emphasis on science-informed management are likely to support effective biodiversity protection, data and methodological limitations were a challenge in our case study.

It is too soon to evaluate the impact of the Faial-Pico MPA EBM process, though we conclude that the process had stakeholders' support and that it contributed to sustainable marine policy development in the Azores. Stakeholders demonstrated their support for the EBM process through their participation and positive comments

in the workshops (AQUACROSS 2017, 2018). In particular, stakeholders supported EBM's commitment to representative stakeholder participation in policy development (AQUACROSS 2018). Alongside concurrent Azores projects and policy development, the case study and resulting EBM plan support ongoing MPA policy development and increasing stakeholder involvement in Azores marine policy, as evidenced by current processes to update Azorean MPA policy.

Overall, The Faial-Pico Channel EBM Plan, and its development and evaluation, provide evidence of how ecosystem-based management can support existing and future marine protected area management. The results are relevant in the Azores, where the government is committed to expanding MPA coverage, and globally to meet international MPA coverage targets. This study provides valuable information on how participatory management can support effective and equitable MPAs through clear identification of challenges and priorities, creative co-creation of solutions, low-cost knowledge and expertise, and ongoing monitoring, enforcement, and evaluation of the impact of management.

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