Plan Bleu, UNEP/MAP activity center

Final Report

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Assessing the costs and benefits of protection measures in two French marine protected areas

OFB OFFICE FRANÇAIS DE LA BIODIVERSITÉ

Réserve Naturelle CERBERE-BANYULS

Parc national de Port-Cros

ONU programme pour l'environnement

Plan d'action pour la Méditerranée Convention de Barcelone

Plan Bleu

Director of Publication
François Guerquin, Plan Bleu

Authors
Gloria De Paoli, Cloé Rivière, Laura Bastide, Youssef Zaiter (ACTEON)

Coordinator
Constantin Tsakas, Plan Bleu

Design
Pauline Simon, Plan Bleu

Plan Bleu
UNEP/MAP Regional Activity Centre
www.planbleu.org

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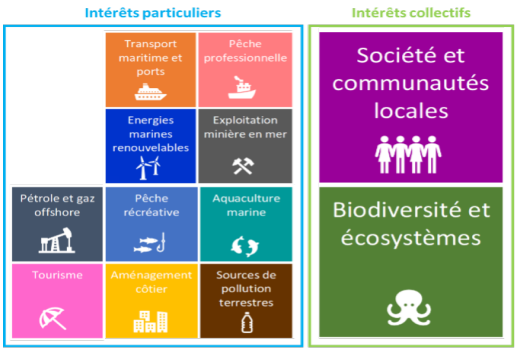
Executive Summary

Presentation

As part of its two-year work programme and a partnership agreement with the Office Français de la Biodiversité (OFB), Plan Bleu launched a socio-economic study of the costs and benefits generated by different levels of protection in two marine protected areas in France: Port-Cros National Park and the Cerbère Banyuls marine nature reserve.
In particular, the work carried out as part of this service provided answers to the following questions:
- What is the socio-economic importance of MPAs? What sectors and activities are found in and affected by MPAs? And what ecosystem services do MPAs provide - and to whom?
- What are the socio-economic impacts (direct, indirect or generated, short- and long-term costs and benefits) of implementing MPAs? And
- What impacts (observed or potential) are associated with different levels of protection?



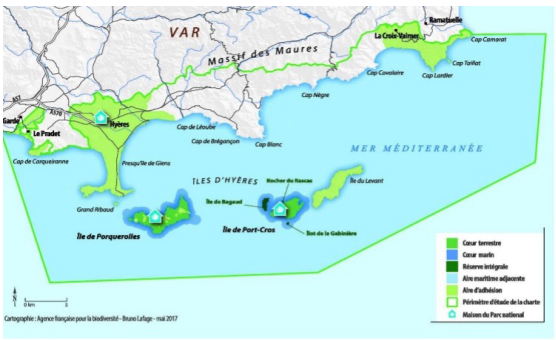
This study distinguishes between economic sectors of collective interest and those of specific interest. Since the creation of a marine protected area was originally intended to pursue the collective interest of protecting ecosystems, this distinction was essential in guiding the study's findings.
The aim of the study was to further investigate the relationship between levels of protection, the impacts of measures and the associated costs and benefits. However, in previous studies, defining protection levels has been described as one of the main challenges of the study. To overcome this obstacle, this study focuses instead on protection measures, trying to establish the relationship between measures, impacts on economic sectors and the associated costs and benefits. This relationship was established beforehand, to guide the assessment, and was tested throughout the assessment.
Costs and benefits were assessed in monetary terms in all cases where data was available. Three main assessment methods were applied, depending on the available data: market price, value transfer and qualitative methods. The socio-economic assessment was based on focus groups with protected area managers, interviews with representatives of economic sectors, available documents and reports on the two case studies, and a review of existing literature on the costs and benefits of marine protected areas.

Case study

Cerbère-Banyuls Nature Reserve (RNMCB):

Cerbère-Banyuls Marine Nature Reserve is part of the Gulf of Lion Marine Nature Park. 585 of the 650 hectares that make up Cerbère-Banyuls Reserve are designated as a partially protected area (PPA), where activities are regulated, and 65 hectares are under enhanced protection (EPA), where all activities are prohibited.
The economic sectors affected by the Reserve area, in order of importance, are biodiversity and ecosystems, society and local communities, tourism (particularly underwater diving, boating, swimming), commercial fishing, recreational fishing, and winegrowing as a source of land-based pollution. The CB marine reserve (6.5 km²) is included in the perimeter of the Gulf of Lion Marine Natural Park created in 2011 which extends over 4,000 km² from the Spanish border to Leucate, integrating off the plateau 3 heads of canyon (see map). The manager of the reserve remains the department of Pyrénées Orientales, while the marine natural park is managed by the French Biodiversity Office (OFB). The management of the Vermeille coast where the Reserve is located is therefore carefully coordinated by the Park. The consultation carried out by the OP Department for the project to extend its perimeter was carried out in close collaboration with the Park. The complementarity between these two "nested" MPAs increases their mutual effectiveness in terms of protection and integration of present activities, however the study will concentrate its work on the socio-economic benefits of the reserve including the age and high level of protection make it a much more demonstrative example.

The following scenarios are considered for the socio-economic assessment:
Baseline scenario: no protection measures, i.e. situation before 1974
Protection scenario: current level of protection.



Executive Summary

The economic sectors represented in the national park, in order of importance, are biodiversity and ecosystems, society and local communities, tourism (particularly underwater diving, boating, swimming), commercial fishing, recreational fishing, land-based sources of pollution (sulphur, waste) and maritime transport. The following scenarios are considered for the socio-economic assessment:

- Baseline scenario: lower level of protection, i.e. the level of protection before regulatory changes between 2016 and 2020;

- Protection scenario: current level of protection, after implementation of the 2016 Charter and the Bagaud mooring area (ZMEL) in 2020, taking into account the various stages in developing the Park's regulations since that date.

Direct costs and benefits of protection measures

Direct or financial costs and benefits are the costs associated with managing the MPA and the income generated by management of the national park (e.g. entry tickets to certain sites, car parks and other services managed directly by the park management body).

The direct costs and benefits in the two case studies are summarised below, on the basis of available information. For example, income for the Cerbère-Banyuls Nature Reserve is not available, while for the Port-Cros National Park, which also includes a land area, it has not been possible to distinguish the portion of revenue relating solely to the marine area. However, the annual income for the Bagaud ZMEL was calculated.

Cerbère Banyuls Nature Reserve

Annual average costs of management actions:

420,000 EUR/year

Range: from 400k to 450k

Average significance in the total budget compared to other activities

Port Cros National Park

Annual budget of PNPC dedicated to protection:

Between 600,000 and 660,000 EUR

Annual revenue of the ZMEL of Bagaud: Around 100,000 EUR

Indirect costs and benefits of protection measures

Indirect costs and benefits correspond to the monetary value of negative and positive impacts on the economic sectors - including ecosystem services and the benefits derived from the associated socio-economic activities.

The results of the assessment are summarised in the table below. As the assessment was highly dependent on the available data, in some cases it was not possible to assess the same costs and benefits at both sites, as in the case of visitor-related costs and benefits, as the data was only available at Port-Cros. The table only includes the economic sectors for which it was possible to assess the costs or benefits for at least one case study. For other sectors (boating, commercial shipping, tourism/swimming, land-based sources of pollution), the analysis could not go beyond impact assessment, either because the available data did not allow for the monetisation of costs and benefits, or because the impact of protection on these sectors is not obvious. Furthermore, for two sectors (professional fishing and diving), an even more comprehensive analysis would be necessary to study the impacts. As this would require more research in several MPAs, the table states "impact requires further study".

Executive Summary

Indirect costs and benefits of protection measures in the two case studies

n/a = non available

Sectors	Measures	Impacts	Costs and benefits	
			Cerbère-Banyuls Nature Reserve	Port-Cros National Park
				Collective interests
Biodiversité et écosystèmes	All measures	Improved biodiversity and ecosystems	**€21.6 million per year** (non-commercial)	**€48.7 million per year** (non-commercial)
Société et communautés locales	Anchoring bans, organised mooring	Increased carbon sequestration	**Between €1.3 and €1.4 million per year** (non-commercial)	**€22.5 million per year** (non-commercial)
				Specific interests
Pêche professionnelle	Fishing restrictions (quotas, bans, tools, etc.)	Better catches	**€35,000 per year** (income attributable to the MPA)	**between 21,000 and 76,000** (catch values related to the MPA)
		Impacts on fishers: requires further study	n/a	n/a
Pêche récréative	Fishing restrictions (quotas, bans, tools, etc.)	Better catches	**€14,800 per year** (willingness to pay)	n/a
		Fewer fishers	n/a	n/a
Tourisme Underwater diving	Underwater diving restrictions (limited access, prohibited areas, etc.)	Change in the number of divers: requires further study	n/a	n/a
		Increased enjoyment in underwater diving	**€6.2 million per year** (economic spin-offs)	n/a
Tourisme Visitors	All protection measures	Tourists attracted by the MPA	n/a	**€154 million per year** (expenses related to the presence of the MPA)
		Well-being through interaction with nature	n/a	**€513 million per year** (non-commercial)
	Restriction on tourist numbers	Fewer visitors	n/a	3,6 million per year (loss of income) 3% of the profits estimated above

Executive Summary

Key messages from the socio-economic assessment

The impacts of MPAs

- "It is evident that Marine Protected Areas (MPAs) play a significant role in local economic dynamics by generating an overall positive impact. The protective measures implemented in these areas substantially contribute to the tourism sector. Concerning fishing, the impact of MPAs is diverse and complex to precisely evaluate. Nevertheless, feedback from fishermen suggests an overall satisfaction.

- The main goal of marine protected areas is to improve biodiversity and the status of ecosystems, by contributing to collective well-being. The results of this analysis clearly show that this goal is fully achieved, as the most important benefits of protection measures are those associated with biodiversity and ecosystems, and those associated with society and local communities - or, in other words, benefits of collective interest.

- The positive impacts and associated benefits are often the result of all protection measures, which have a cumulative impact on the quality of ecosystems.

- To deepen our understanding of the impact of different MPAs, it is recommended to conduct further studies. Firstly, exploring mechanisms to better quantify the overall economic benefits of MPAs by assessing direct and indirect outcomes, such as induced jobs and long-term improvement in economic productivity, is recommended. Simultaneously, studies on adaptation to protective measures are crucial to understanding how local communities and industries adjust their practices, providing insights to anticipate future needs and maintain long-term economic viability. Lastly, a comparative approach between different MPAs would enable the evaluation and identification of the most effective management practices for preservation while supporting sustainable economic activities, thereby offering transferable recommendations for improving conservation policies in other marine regions."

CONTENTS

ABBREVIATIONS

AMA Adjacent Marine Area

CDPM Comité Départemental des Pêche et des élevages marins (Departmental committee for fisheries and marine farming)

EBQI Ecosystem-Based Quality Index

EFESE Evaluation Française des Ecosystèmes et des Services Ecosystémiques (French assessment of ecosystems and ecosystem services)

EPA Enhanced Protection Area

ES Ecosystem Services

HPA Highly Protected Area

IFREMER Institut Français de Recherche pour l'Exploitation de la MER (French Institute for Ocean Science)

MEDREGION Project to support Mediterranean Member States towards implementation of the Marine Strategy Framework Directive new GES decision and programmes of measures and contribute to regional/subregional cooperation

MPA Marine Protected Area

MSFD Marine Strategy Framework Directive

MUM Multi-Use Management

OFB Office Français de la Biodiversité (French Office for Biodiversity)

PACA Provence-Alpes-Côte d'Azur Region

PLU Local development plan

PNPC Port-Cros Nature Park

PPA Partially Protected Area

SDAGE Schéma Directeur d'Aménagement et de Gestion des Eaux (water development and management master plan)

WFD European Water Framework Directive

ZMEL Zone de Mouillages et d'Equipements Légers (Mooring area)

I. INTRODUCTION

1. CONTEXT

REGULATORY FRAMEWORK

Human activities and associated pressures are threatening the good ecological status of Europe's seas and oceans. Preserving coastal and marine areas is important for conserving biodiversity and keeping ecosystems and the services they provide functioning properly. To achieve this goal, various policies and strategies have been put in place at different levels to protect and sustainably manage marine ecosystems.

At a European level, the European Union's (EU) Biodiversity Strategy for 2030 is an essential part of the European Green Deal. It aims to restore European biodiversity, including marine biodiversity, particularly by expanding protected areas to cover 30% of European territory (land and sea), including 10% with a high level of protection by 2030. These additional protection measures will be part of the process of implementing the Marine Strategy Framework Directive (MSFD), the goal of which is to achieve good ecological status for all marine ecosystems in Europe. At a Mediterranean level, the Barcelona Convention is the main legally binding regional multilateral agreement for the protection of the marine environment and coastal areas. There are currently several types of Marine Protected Areas (MPAs) in the Mediterranean region, with different levels of protection, and on very different geographical scales. More specifically, Claudet et al. (2020)[1] identified 1,062 MPAs covering around 6% of the total marine area, of which only 5% (i.e. 0.23% of the Mediterranean Sea) is under high or full protection.

In France, the government adopted the new National Strategy for Protected Areas (SNAP - Stratégie Nationale pour les Aires Protégées) in 2021[2]. The strategy echoes the EU's biodiversity strategy in its protection targets (30% of national territory and marine waters by 2030, including 10% under enhanced protection). Significant progress has been made in designating new MPAs as part of the Natura 2000 network and through additional national designations to comply with environmental legislation, including the obligations of the MSFD concerning the establishment of MPA networks. As of February 2022, 33% of French waters are covered by at least one MPA, exceeding the recommended target of 30%, but well short of the target of 10% under enhanced protection (only 1.8% under high protection in 2021). Note that high protection prohibits certain activities: « *pressures generated by human activities likely to compromise the conservation of ecological issues are absent, avoided, eliminated or significantly limited in a sustainable manner through the implementation of land protection or appropriate regulations, combined with effective control of the activities concerned* ».

THE SOCIO-ECONOMIC ROLE OF MPAS

MPAs play an essential role in protecting coastal and marine ecosystems. By protecting biodiversity, MPAs contribute significantly to the good status of marine ecosystems and, consequently, to providing ecosystem services. It is widely recognised that MPAs generate significant benefits. They play an important role in the economy and development through their contribution to multiple economic sectors (tourism, fishing, etc.) with a potential multiplier effect for the entire local economy. A critical analysis of studies that have assessed the socio-economic impacts of MPAs shows that, even though the benefits they generate are increasingly recognised, analysis of these benefits, and the costs that protection rules can generate, remains difficult :

- The relationship between protection levels and socio-economic impacts has yet to be fully established. It is assumed that socio-economic added value increases with the protection effort, although this hypothesis has not been verified by existing studies and data, which are often difficult to compare;
- The positive impacts on fishing, tourism, recreational activities and biodiversity have generally been well identified and studied, unlike the impacts on regulating ecosystem services, such as the benefits associated with protection against erosion and carbon sequestration.
- The analyses carried out often focus on the benefits that MPAs bring to society, without giving due consideration to the assessment of costs, including investment, maintenance or monitoring costs, and the potentially negative impacts on economic sectors.

COSTS AND BENEFITS OF PROTECTION MEASURES

To obtain a comprehensive assessment of the costs and benefits associated with protection measures, it is necessary to consider:

1 Claudet J., Loiseau C., Sostres M., Zupan M. (2020). Underprotected Marine Protected Areas in a Global Biodiversity Hotspot. One Earth 2, 380–384. https://hal-univ-perp.archives-ouvertes.fr/hal-02934371/document

2 https://www.ecologie.gouv.fr/sites/default/files/DP_Biotope_Ministere_strat-aires-protegees_210111_5_GSA.pdf

- Direct costs and benefits of protection (in financial terms), i.e.: (i) direct costs associated with managing the reserve; and (ii). income generated by management of the national park (e.g. entry tickets to certain sites, car parks and other services managed directly by the park management body).
- Indirect costs and benefits, i.e. the monetary value of negative and positive impacts on the economic sectors - including ecosystem services and the benefits derived from the associated socio-economic activities.

Cette étude s'occupe donc d'estimer les deux catégories de coûts et bénéfices associés à la protection, qui seront présentés séparément au cours de ce rapport.

2. OBJECTIVES OF THE STUDY

The aim of the project is to conduct a socio-economic study and publish a report examining the costs and benefits associated with different levels of protection. Based on the analysis of two MPAs, Port-Cros National Park and the Gulf of Lion Marine Nature Park, work carried out under this project has answered the following questions:

- What is the socio-economic importance of MPAs? What sectors and activities are found in and affected by MPAs? And what ecosystem services do MPAs provide – and to whom?

- What are the socio-economic impacts (direct, indirect or generated, short- and long-term costs and benefits) of implementing MPAs? And what impacts (observed or potential) are associated with different levels of protection?

3. CASE STUDIES

In this context, a socio-economic analysis of different MPAs according to their level of protection should shed new light on some of these issues, particularly as regards the socio-economic implications of different levels of protection. The study will focus on two French Mediterranean case studies whose main characteristics are summarised in the boxes below.

Gulf of Lion Marine Nature Park

Within the Gulf of Lion Marine Nature Park (4,010 km²), the Cerbère-Banyuls Marine Nature Reserve (650 ha) enjoys a high level of protection, and activities are highly restricted (diving along the underwater trail and recreational fishing requiring permits). Since January 2022, a project to expand this area has mobilised public and scientific stakeholders around a consultation process, the results of which were presented on 6 June 2023, with the aim of expanding the highly protected area to 1,680 ha.

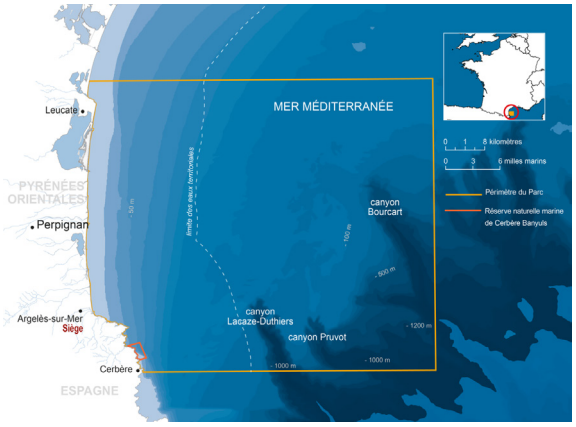


Figure 1 Gulf of Lion Marine Nature Park

Port-Cros National Park

Port-Cros National Park has a coastal zone with a high and low level of protection and three islands: Le Levant, Port-Cros and Porquerolles, which have "National Park core" status and highly protected MPA status, and a coastal zone with varying levels of protection. In this coastal zone, the Corniche Varoise, with a marine area of 286 km², is a Natura 2000 coastal zone, but with a lower level of protection and developed tourism-related economic activities (boating, recreational and commercial fishing, underwater diving, maritime traffic, water sports and leisure activities). Some well-known activities, such as the Pampelonne marine trail, have a very positive economic impact.

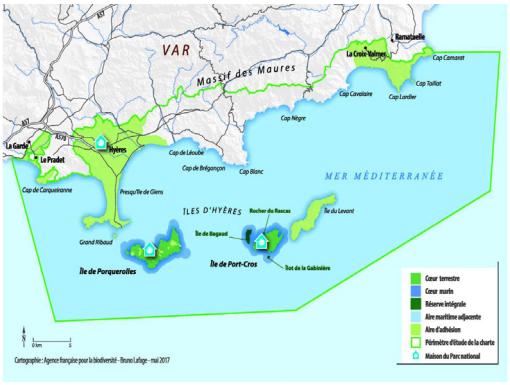


Figure 2 Port-Cros National Park

4. THE APPROACH

The tasks involved in producing this report are shown below :

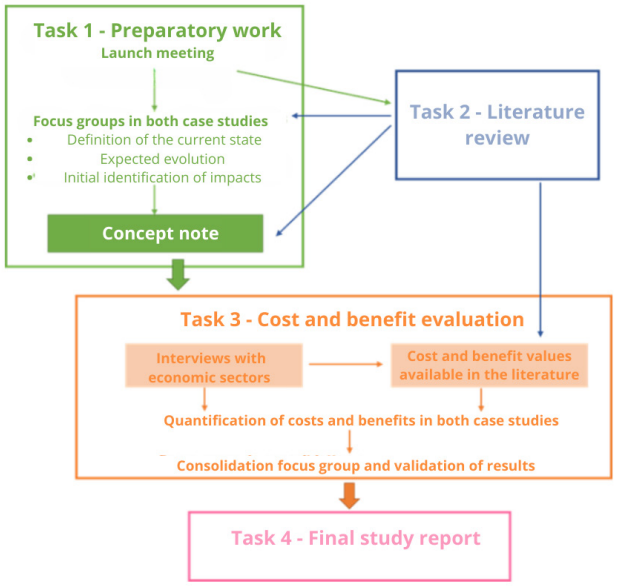


Figure 3 Proposed approach

More specifically:

- The aim of Task 1 was scoping the activities carried out throughout the project, in order to provide detailed knowledge of the specific features of the two case studies and to select the most appropriate methods for assessing the costs and benefits of protection measures. Task 1 included organising two focus groups (one per case study) with MPA managers, Plan Bleu and key stakeholders;
- Task 2 was to carry out a literature review of existing socio-economic studies on MPAs in the Mediterranean region and, where relevant, outside the region. The contents of the database are described in Appendix 2;
- The aim of Task 3 was to assess the costs and benefits of protection measures in the two case studies through: (i) collection and analysis of existing data and studies on the two sites; (ii) semi-structured interviews with key stakeholders in the two case studies, identified in collaboration with the managers of the two MPAs; (iii) values collected during the literature review. The preliminary results of the assessment at the two sites were discussed and approved with the managers of the two MPAs during a focus group to consolidate and approve the results;
- The aim of Task 4 was to write the final report of the study..

5. REPORT

This report presents the final results of the study and is structured as follows:

- Section 2 describes the assessment methodology applied for the two case studies;

- Sections 3 and 4 present the results of the analysis of the two case studies;

- Section 5 summarises the results;

- Section 6 draws conclusions from the socio-economic analysis in the two case studies.

II. CASE STUDIES: ASSESSMENT METHODOLOGY

The socio-economic assessment in both case studies had four stages, shown in the Figure below and described in detail in the rest of this section.

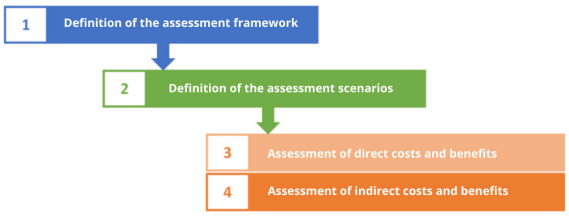


Figure 4 Stages in the socio-economic analysis of the two case studies

1. DEFINITION OF THE SCOPE OF ASSESSMENT

The study framework was defined with the managers of the two MPAs during two preparatory focus groups (one for each case study). The general aim of the focus groups was to define the system covered by the socio-economic assessment in the two case studies.

- The current state of the coastal and marine environments for the case studies, as well as the state of environments before the implementation of protection measures (when possible);

- Management and protection activities, including their geographical location;

- The physical scope of the area under assessment;

- The economic sectors operating within this scope, as well as those whose activities have been potentially displaced as a result of the protection measures, and the location of their pressures;

- An initial identification of the observed impacts of protection measures.

The information gathered during the focus groups was supplemented by short "catch-up bilateral meetings" with protected area managers, interviews with economic stakeholders (see below) and available bibliographical resources.

The economic sectors considered in the assessment were selected from among marine economic sectors as defined by the MEDTRENDS project[3] and included in the MEDREGION study [4], presented below. The figure also distinguishes between economic sectors of collective interest and sectors of specific interest. This distinction is not made in the MEDREGION study, but it is a key observation that emerged from the MEDREGION approval workshop. Since the creation of a marine protected area was originally intended to pursue the collective interest of protecting ecosystems, this distinction was considered essential in guiding the study's findings.

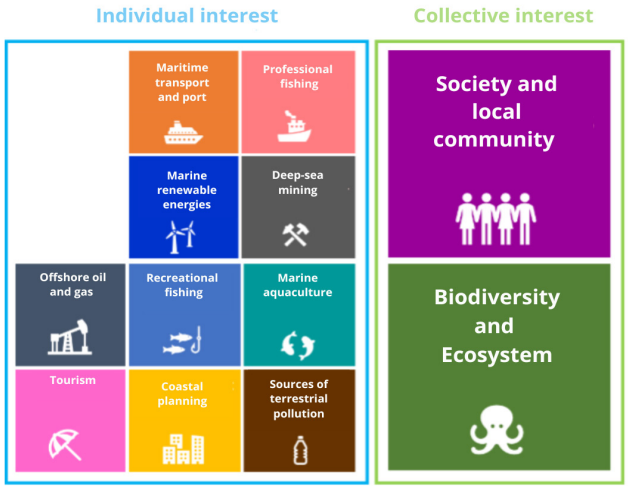


Figure 5 Marine economic sectors defined by the MEDTRENDS project

2. DEFINITION OF ASSESSMENT SCENARIOS

The assessment scenarios need to be defined to ascertain the effect of protection on the system under assessment, by comparing two different situations. To assess the economic added value of levels of protection, the benefits and costs of the prolonged implementation of regulations and protection measures needs to be identified in comparison with a baseline situation in which these measures are not implemented, such as the situation before the protected area was created, or an area not under protection measures in the vicinity of the protected area. This baseline scenario serves as a benchmark for comparison with the scenario where protection measures are in place.

3 https://www.medtrends.org/

4 https://medregion.eu/ - Voir par exemple le rapport : Plan Bleu, 2021. Socio-economic analyses of MPA development in the Mediterranean: investigating protection levels.

The calculated costs and benefits correspond to the difference between the level of costs and benefits in a baseline situation and the current level of costs and benefits resulting from the protection measures, as defined in the protection scenario. The level of benefits depends on the state of the environment. For the analysis, strong assumptions need to be made that:

- The state of the environment is due to the protection measures. In this specific case, the report specifies as precisely as possible what is an impact of the protection measures and what may be due to external factors (economic situation, health crisis, etc.).

- Benefits or constraints on economic activities are an impact of the state of the environment and protection measures. For each impact on economic activities, substantiated assumptions are made about the proportion that is actually attributable to the state of the environment in the MPA. In each case, uncertainties are made transparent.

Ideally, the scenarios assessed in the two case studies should be similar (e.g. a scenario without protection and a scenario with protection in both case studies). However, in both case studies, the scenarios were defined on the basis of the information available, leading to different assessment scenarios on the two sites.

3.ASSESSMENT OF DIRECT COSTS AND BENEFITS

Les catégories de coûts directs à prendre en compte dans l'évaluation sont listées et décrites dans le tableau ci-dessous ; comme il s'agit de coûts standard liés à la mise en œuvre des mesures de protection, ces catégories de coûts sont applicables aux deux cas d'études. Data for these costs are normally public and available on protected area websites as part of the annual reports published by the management bodies.

Type of measure	Measure	Type of associated costs
Administrative management		Payroll cost
Site monitoring	Land monitoring Sea monitoring 24/7 telephone hotline	Monitoring costs (labour costs)
Scientific monitoring	Weather data Water quality data Water temperature monitoring data Observation of passing wildlife Fish stock monitoring Acoustic monitoring Visitor traffic survey Other scientific monitoring	Cost of external studies (cost of outsourcing to research organisations) Costs of in-house studies (payroll cost)
Educational and other activities and events	Educational activities for students (secondary schools, kindergartens, universities) Summer activities on the beach Educational documents, news stories, etc.	Cost of interpretive staff
Visitor reception, facilities and maintenance	Information point Underwater trail Mooring area (26.5 hectares) - 32 buoys available Signs Beach upkeep Boat upkeep	Costs of facilities (investment, running costs), payroll and maintenance/upkeep costs
Use management	Assessment of site traffic Number of commercial fishers authorised (5 in 2022 in Banyuls) Fishing quotas for recreational fishing (fishers must apply for permits) and obligation to submit a catch register (number of catches, catch method, etc.) Professional underwater diving permit (Mooring equipment)	Monitoring costs (payroll) and cost of facilities

Table 1 Protection measures and their costs

Direct benefits were not identified during the focus groups, or more generally, during the scoping phase of the study.

4. ASSESSMENT OF INDIRECT COSTS AND BENEFITS

The assessment path: from measures to impacts and from impacts to costs and benefits

In the Plan Bleu study for the MEDREGION project in 2021, the definition of levels of protection was described as one of the main challenges in the study. Often, the level of protection was not sufficiently defined within studies on the costs and benefits of MPAs. Moreover, many different definitions of levels of protection were found (for example, no-go, no-take, no-go and no-take, but also a list of activities, or a combination of levels of protection within the same MPA). In conclusion, the study was unable to identify a clear relationship between levels of protection and the associated costs and benefits.

Despite these challenges, this study has the aim of continuing to investigate the relationship between levels of protection, the impacts of measures and the associated costs and benefits, by circumventing the obstacles encountered in the previous study. As the concept of “level of protection” has shown these limitations, this study focuses instead on protection measures, by trying to build the relationship between

:

Measures
Impact on economic sectors
Associated costs and benefits

This relationship was established as a preliminary step, before beginning the socio-economic assessment of the two case studies, on the basis of focus group discussions. This preliminary identification served as a guide during the assessment, helping to target the right stakeholders and sources of information.

Table 2 summarises this preliminary identification of the relationship between protection measures, impacts and associated costs and benefits.

It is important to emphasise that the table above provides a preliminary identification of the relationships between measures, impacts, costs and benefits, and requires that:

- This initial framework be further developed and fine-tuned for each case study;

- Not all measures and impacts are the same in both case studies.

Assessment techniques

Costs and benefits were assessed in monetary terms in all cases where data was available. Three main methods were applied :

- Market price, for example, recreational fishers' spending to assess whether fishing enjoyment has increased as a result of protection measures, or loss of income experienced by commercial fishers;
- Value transfer, which uses the values of costs and benefits evaluated in other studies, and adapts these values to the specific case of the assessment. The data to be used in this study are those collected in the Excel database created for the MEDREGION project and supplemented in Task 2 of this study. The main results are provided in the following section, and the database can be found in the Appendix to this final report;
- Qualitative methods: If no quantitative or monetary information was available, a qualitative cost-benefit assessment was carried out.

Protection measures	Impacted sectors	Impacts	Costs and benefits
Fishing quotas and bans on fishing for certain species or at certain times of year	Recreational fishing	Fewer catches per fisher	Decline in income
		Fewer fishers	
		Greater enjoyment in fishing because morefish, greater diversity and bigger size.	Increased recreational value of the experience
	Commercial fishing	Decreased activity in the MPA	Decline in income
		Increased fish size, weight and density	Increased income for fishing professionals
	Biodiversity and ecosystems	Increasing fish populations (species diversity and quantity)	Increased non-use value of biodiversity
Restricted access to the sea for boating	Recreational boating	Some people may sell their boats	Decline in income in the sector
		Improved quality of the boating experience (fewer people, better quality of environments and landscapes)	Increased recreational value of the experience, increased income
	Commercial shipping/boating	Changes to routes, or slower routes	Potential loss of income
Limitation of cruising speed	Commercial shipping/boating	Longer sailing times	Potential loss of income
Underwater diving restrictions	Underwater diving	Increased enjoyment of underwater diving, increased number of divers	Increased income from underwater diving
		Decrease in the number of divers due to restrictions	Decreased income from underwater diving
All protection measures	Winegrowing (source of land-based pollution)	Reduction in the use of pesticides by certain farmers (winegrowers) who have taken this step since the existence of the nearby reserve and have used it as a label	Product more appreciated by some consumers, price increase, sales increase
		Reduced production ?	Additional costs ?
	Biodiversity and ecosystems	Better biodiversity	Increased non-use value of biodiversity
		Increasing fish populations (species diversity and quantity)	
		Better seabed diversity, greater biodiversity (in terms of diversity and quality)	
		Increase in biodiversity and the number of heritage species (high trophic level, extinct outside the MPA)	
		Better water quality	
	Society and local communities	Increased capacity of ecosystems to sequester carbon	Increased tourist numbers and therefore higher revenue in the sector

KEY : **Negative impact** **Positive impact**

Table 2 Initial identification of relationships between protection measures, impacts and costs/benefits to guide socio-economic analysis in the two case studies

III. CASE STUDY - CERBÈRE BANYULS NATURE RESERVE

1. SCOPE OF ASSESSMENT

The Cerbère-Banyuls Marine Nature Reserve is located in the Gulf of Lion Marine Nature Park. 585 of the 650 hectares that make up Cerbère-Banyuls Reserve are designated as a partially protected area (PPA), where activities are regulated, and 65 hectares are under enhanced protection (EPA), where all activities are prohibited (Figure 6). The reserve was created in 1974 after researchers from the Arago Laboratory noted the disappearance of the grouper population in the reserve due to underwater fishing. The original intention was to prohibit spearfishing and regulate socio-economic activities on the reserve.

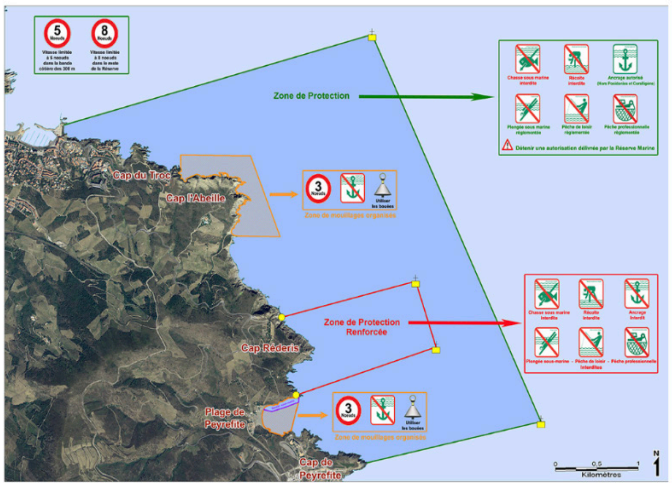


Figure 6 Current protection status of the Cerbère-Banyuls Reserve

Since January 2022, a project to expand this area has mobilised public and scientific stakeholders around a consultation process, the results of which were presented on 6 June 2023, with the aim of expanding the highly protected area to 1,680 ha (Figure 7). The expansion process is about to begin.

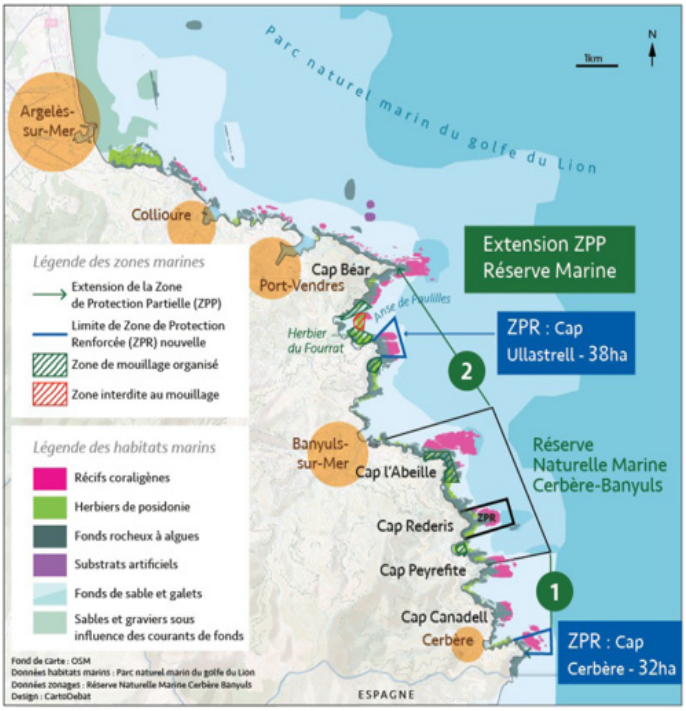
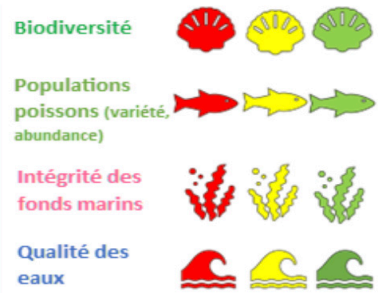


Figure 7 Expansion process for Cerbère-Banyuls Reserve

The status of the natural environment prior to protection and today has been assessed according to the criteria of biodiversity, fish populations, seabed integrity and water quality, and is represented by expert opinion [5] in Figure 9 below from red (poor status) to green (good status). The absence of water quality monitoring networks in the initial period means that there is no way of establishing the state of water quality prior to protection.



5 Virginie Hartmann, Responsable scientifique de la Réserve naturelle de Cerbère Banyuls, lors du focus group préparatoire du 25 juillet 2023

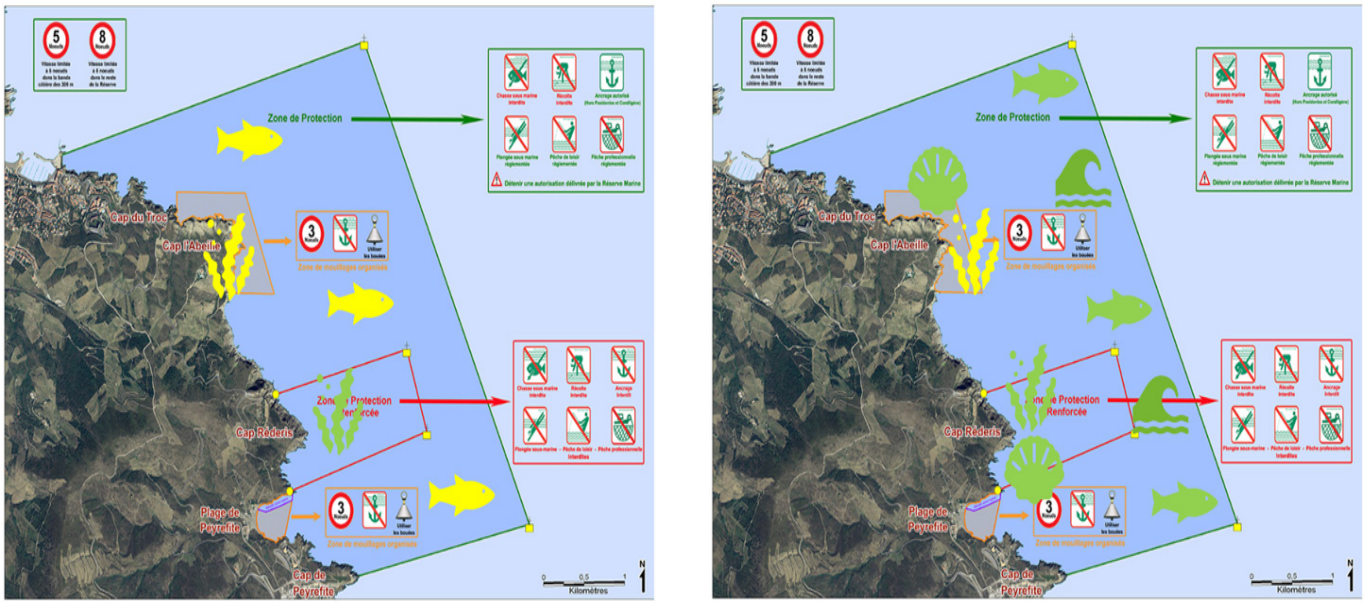


Figure 9 Status of the natural environment in Cerbère-Banyuls Reserve before and after protection measures

Although no projections were made concerning the future status of the environment when the reserve was expanded, the aim after this expansion is to achieve a high quality status (shown in green) everywhere. The challenge ahead will be to maintain (or continue to implement) restrictions on access to underwater diving, recreational fishing and commercial fishing, while preserving economic activities. Furthermore, by better protecting this area, it becomes more attractive, which will increase visitor numbers.

By expanding the reserve, the goal is also to spread the number of visitors over a larger area, while maintaining the same environmental quality over the next ten years as the current protected area.

The figure below shows the economic sectors linked to the Reserve area, in order of importance. In addition to the economic sectors, it is important to note that the Banyuls observatory is very active in the Reserve for scientific research activities.

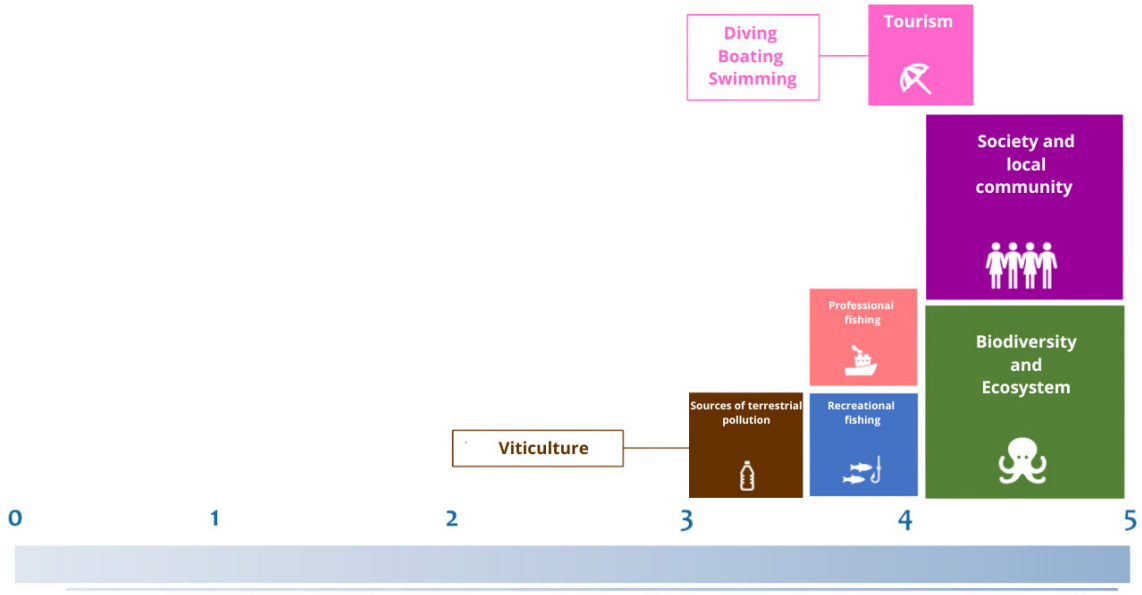


Figure 10 Economic sectors operating in the Cerbère-Banyuls Nature Reserve area, in order of importance

2. THE SCENARIOS

The following scenarios are considered for the socio-economic assessment:

- Baseline scenario: no protection measures, i.e. situation before 1974

- Protection scenario: current level of protection.

The two scenarios correspond to the two situations shown in Figure 9.

Consideration will also be given to the potential impact of the reserve expansion project, which involves expanding the enhanced protection area (from 65 hectares to 135 hectares) and the partially protected area (from 585 hectares to 1,545 hectares). The aim of expanding the area is to achieve good (green) status for all indicators (biodiversity, fish population, seabed integrity and water quality) across the entire area and additional areas in the vicinity. Initially, the expansion project had been considered as a third scenario, but during the course of the assessment, the ex-ante impacts associated with such an expansion proved difficult to anticipate. However, it is possible to make predictions, at least in some cases, and these are provided in boxes at the end of each section.

3. DIRECT COSTS

The activity reports for the Reserve present the budgetary resources allocated to protection actions. An analysis of management costs was also carried out by Biotope during the assessment of the 2015-2019 management plan (Biotope, 2019). The results shown in Figure 12 combine the data collected by Biotope with the latest available data, taken from the 2020 to 2022 activity reports [6].

The average annual cost of management actions for the Cerbère-Banyuls Reserve is around €420,000 per year, ranging from €400,000 to €450,000, depending on the actions planned.

Although the number of violations has fallen over time, enforcement has continued and, as a result, expenditure remains stable. Furthermore, investment costs vary according to requirements, mainly due to the acquisition of ageing equipment such as boat motors, compressors and buoys [7].

In the activity reports, the budget is not broken down by type of action, but this work was carried out by Biotope. Between 2015 and 2019, the reserve's management plan will entail a total cost of €1,908,381, structured as described in the figure below (Biotope, 2021).

Activity management, which is the item most affected by the management measures of interest to this study, is of average significance in the total budget (it is in 3rd or 4th position in terms of expenditure, depending on the year). The biggest expense item each year is visitor services.

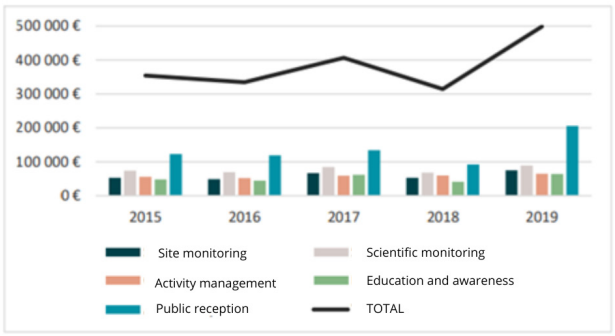


Figure 11 Breakdown of amounts spent on the Cerbère-Banyuls Reserve management plan between 2015 and 2019

On average, over the 2015-2019 period, the State was the main funder (Ministry of the Environment, represented by the DREAL). The Provence-Alpes-Côte d'Azur Region provides occasional funding for actions. The Reserve also once received funding from the Water Agency. Finally, the manager of the Reserve, the Pyrénées-Orientales (PO) Departmental Council, then provides any shortfalls in the budget as and when required. In short, funding varies from project to project, but comes mainly from the Regional Directorate for Environment, Development and Housing (DREAL) Occitanie and the Department of the Pyrénées-Orientales.

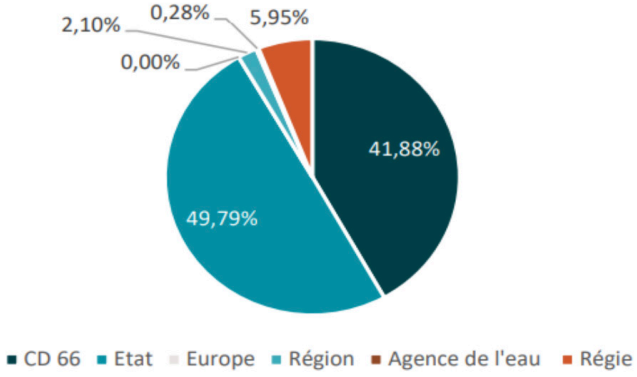


Figure 12 Breakdown of funding for the Reserve's 2015-2019 management plan

6 The latest data are as follows. For 2020, the total cost was €418,458; in 2021, it was €463,503, and in 2022: €558,625.

7 According to Fréderic Cadene, Reserve Manager for the Pyrénées-Orientales Department.

COST OF PROTECTION MEASURES IN THE EVENT OF EXPANSION

According to Frédéric CADENE, the reserve's manager, the expansion of the Reserve will impact costs, and it is obvious that they will increase. The impact on the main expense items could be as follows:

- Site monitoring: Increase due to larger monitoring area

- Activity management: Slight increase

- Visitor services: Slight increase due to development work (signage, etc.)

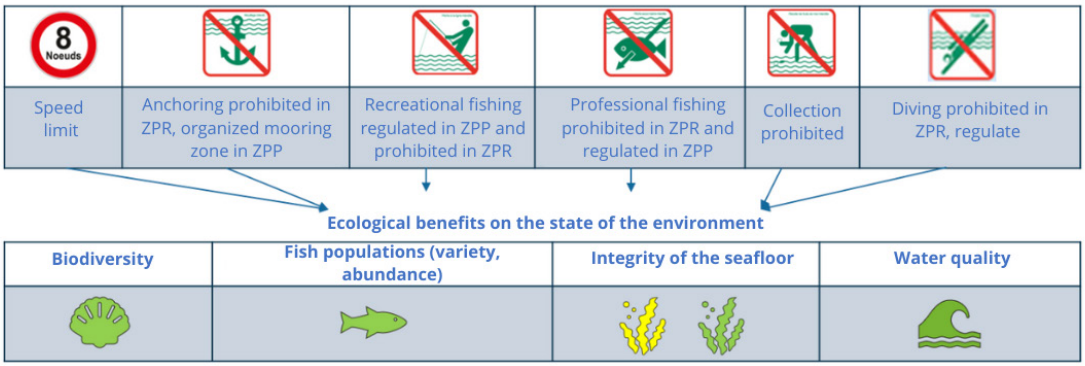
- Scientific monitoring: Stable or a slight increase, because for several years now, the Reserve has been working closely with the Marine Park, which monitors the expansion area. They are members of the Reserve's Scientific Council, which coordinates monitoring.

- Education and awareness-raising: Stable costs, as the visitor capacity is already very good and there are many actions.

The French government has pledged its financial support. Once the expansion has been approved, the Gulf of Lion Marine Nature Park, a key partner in this project, will also support the management of this area, which has yet to be defined.

4. INDIRECT COSTS AND BENEFITS

The figure below summarises the relationships between protection measures, ecological benefits for the state of the environment and the impacts of these measures, as identified in the socio-economic analysis carried out for Cerbère-Banyuls Nature Reserve.



	Recreational fishing	Professional fishing	Diving	Tourist activities: Swimming and boating	Winemakers	Local society and community	Biodiversity and ecosystem
Positive impacts derived from the state of the environment	Increase in catches, Greater enjoyment of fishing	Increase in populations and size -> Better catches	More divers with more enjoyment Improved awareness among divers	Link with protection measures not evident	Link with protection measures not evident	Carbon sequestration	Improvement of biodiversity and ecosystem health
Constraints generated by protective measures	Decrease in the number of fishermen	Fewer fishermen and only small-scale fishing Marine space saturated by other activities	More divers in neighboring sites, Adaptations required				

Figure 13 Summary of results of analysis: relationships between protection measures, ecological benefits for the state of the environment and the impacts of these measures on economic sectors

The following paragraphs provide all the information and data collected to support these relationships, presented by economic sector, as well as the economic assessments of the costs and benefits associated with these impacts. For easier reading, sectors with a minor or insignificant impact have been grouped together in the same section.

5. BENEFITS OF PROTECTION MEASURES FOR BIODIVERSITY AND ECOSYSTEMS

MEASURES

Impacts on biodiversity and ecosystems are attributable to the synergistic action of all protection measures.

IMPACTS

Les impacts sur la biodiversité et les écosystèmes sont attribuables à l'action synergique de l'ensemble des mesures de protection.

Water quality

Water quality is determined by the living processes that regulate the chemical conditions of salt water. The measures put in place under the WFD and the MSFD are helping to protect water quality, but it is still under threat from polluting activities such as winegrowing and industrial discharges. The intermittent nature of the rivers flowing into the Reserve makes it difficult to detect phytosanitary products in marine analyses. However, the Reserve has been participating for many years in the various national monitoring networks that track contaminant concentration levels in coastal water bodies (WFD monitoring, ROCCH-IFREMER network, etc.).

The Cerbère-Banyuls Reserve is part of the "FRDC01 - Spanish border - Racou Plage" coastal water body, and is monitored under the WFD and MSFD.

Between 2006 and 2012, the chemical quality of the water body improved from average to very good, while its biological status has remained stable at average quality since 2006. The physical and chemical and hydromorphological status has been assessed since 2012 and is very good. Consequently, the overall status of the water body in the Cerbère-Banyuls Reserve is considered to be average (Table 3).

Since 2010, bathing waters have been considered to be of excellent quality, and their status is directly linked to wastewater treatment (collection, treatment and discharge into the sea) [8].

During the first scoping interview with the reserve's scientific manager, water quality within the reserve was considered to be good. Outside the reserve, it is considered average. However, due to the lack of information and data prior to 1974, it is impossible to know what the water was like before the protection measures were put in place, or what it would have been like without them.

Furthermore, it is difficult to establish a clear link with protection measures and there is little scientific literature on this case study. Nor was it mentioned much in discussions with the stakeholders interviewed, who focused mainly on the fish population, since the Marine Reserve was not initially intended to restrict water pollution.

		2006	2009	2012
Chemical status	Chemical and other contaminants, heavy metals, pesticides, industrial pollutants	Average	Good	Very good
Physical and chemical status	Dissolved oxygen, transparency	*N/A*	*N/A*	Very good
Hydromorphological status	Hydromorphology	*N/A*	*N/A*	Very good
Biological status	Angiosperm, macroalgae, benthic invertebrates, phytoplankton	Average	Average	Average
Overall status		Average	Average	Average

Table 3: Change in water quality in the Cerbère-Banyuls Reserve

8 According to the 2015-2019 management plan

Due to project deadlines and the large number of factors influencing water quality, it was not possible to search for more detailed information, such as WFD- and MSFD-compliant measures, monitoring data, analysis of MSFD-compliant pressures, etc. The low correlation between protection measures and water quality was confirmed and validated by Reserve managers during the focus group to consolidate and approve the results, based on their knowledge and experience.

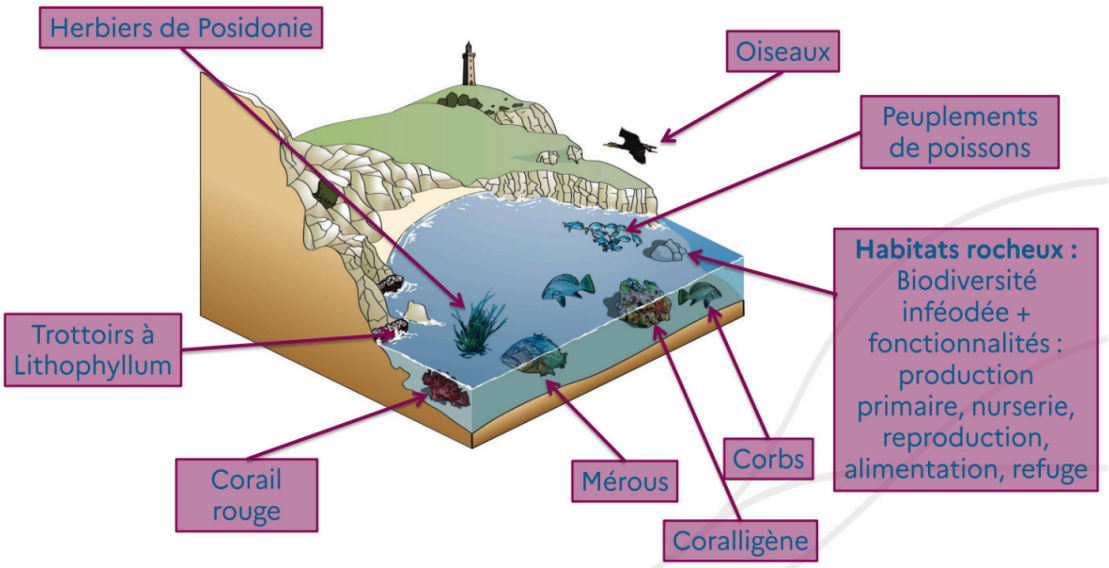
Biodiversity, fish populations and seabed integrity

Biodiversity could be threatened by commercial and recreational fishing (overexploitation of resources), but the regulations in place for these two activities help maintain sustainable practices in the Reserve. These limit fishing catches and ensure that they are consistent with the conservation of the Reserve's fish resources. The strong staff presence in the Reserve significantly limits any poaching activity. The creation of two organised mooring areas in the Reserve has considerably reduced degradation of the seabed (29 buoys are available in the Reserve).

Biodiversity is considered green (good status) everywhere except around Cap Béar (outside the Reserve) according to an interview with the reserve's scientific expert.

The species and habitats that characterise Côte Vermeille[10] are shown in Figure 14 below [11] and are as follows: Posidonia seagrass, fish stocks, rocky habitats, groupers, corbs, coralligenous, red coral and lithophyllum “corridors”.

Monitoring is carried out by staff from the Marine Nature Park and the Reserve. In 2020, monitoring focused on 7 sites, including Côte Vermeille, which is part of the Reserve. These sites share similar habitats, such as Posidonia seagrass, coralligenous areas, sand and rock. A total of 23 fish species and 6 “wild card” species with high heritage value were studied. The counts were carried out by scuba divers, at depths ranging from 0 to 20 metres.



Graph 14 Species and habitats at stake on the Côte Vermeille

10 Côte Vermeille is the name given to the coastline that begins at Argelès-sur-Mer and extends to the Spanish border at Port-Bou, passing through Collioure, Port-Vendres, Banyuls-sur-Mer and Cerbère (i.e. through the study area).

11 Source: Bruno Ferrari - Deputy Director and Head of Operations for the Gulf of Lion Marine Nature Park (PNMGL). The figure is taken from a presentation given in Webinar 8 on “Highly protected areas in the PNMGL: Ecosystem health in relation to various activities”. This webinar series was produced as part of the LIFE Martha project

The results of these studies were used to compare the status of species and habitats in the Reserve with other sites studied outside the Reserve along Côte Vermeille. Analyses reveal that the "Reserve effect" is real for the Posidonia seagrass, the rocky infralittoral with photophilic algae (rocky substrates) and the coralligenous. In particular:

- For Posidonia seagrass, the results show a significant increase in fish populations in the enhanced protection area (where no fishing, underwater diving or freediving is permitted). For example, Pin Parasol, in the EPA Reserve, is an area with a lot of fish and has "good" status. The further away from the Reserve, both south and north, the indicators decrease (number of species, sizes and proportion of carnivores), which could indicate higher fishing pressures.

- For rocky substrates, Cap Rédéris, in the EPA, contains rocks with "very good status", whereas in the PPA they have a good or average status.

- For the coralligenous, the findings are similar. The density of red coral has been decreasing since 2012 in the sites studied (inside and outside the Reserve) but the results show that the coral colonies located within the EPA are doing significantly better than those located outside the Reserve[12].

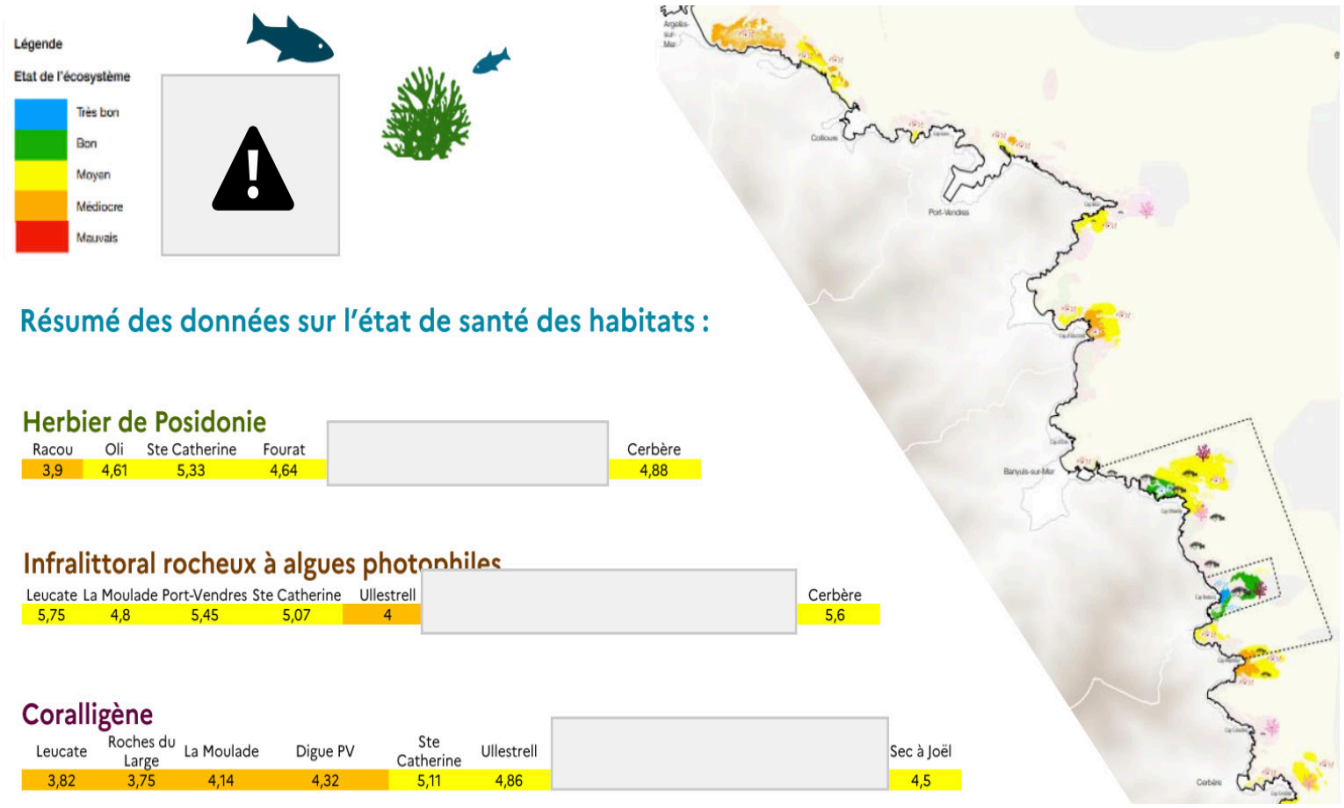


Figure 15 Summary of data on the health of habitats, including those inside the Reserve.

12 https://parc-marin-golfe-lion.fr/editorial/connaitre-les-especes

Example of the grouper population

The grouper is a predatory species, and its presence in large numbers indicates that it is finding all the food it needs to thrive, i.e. all the fish it feeds on. According to Pastor & Payrot[13], the increase in grouper numbers is due to management efforts in the Reserve over many years (1,200 hours of monitoring each year, changes in recreational fishing regulations, collaboration with commercial fishers, consultation meetings with underwater divers, etc.). The Gulf of Lion Marine Nature Park website agrees, explaining that "the difference between the numbers [of groupers] in the Reserve and outside the Reserve can be attributed to major efforts to protect and monitor activities implemented in 1974, as well as the presence of a favourable habitat" [14] .

Outside the Marine Reserve, the grouper is rather rare. Only 2 brown-marbled groupers were counted outside the reserve between 2011 and 2014. None were seen in the years prior. The grouper population outside the Reserve is estimated at less than ten.

Year	1974	1986	2001	2006	2011	2014	2017	2023
Number of groupers found	10	10	190	202	363	429	628	700

According to various sources[15]

Table 4: Number of groupers counted between 1974 and 2017

Expected impact of the expansion project on biodiversity and ecosystems

The aim of expanding the Reserve is to maintain good status throughout the Reserve, and to achieve it at Cap Béar, where biodiversity currently has an "average status".

It also aims to protect fish populations by limiting pressures from fishing.

In short, the results point to a general improvement in the status of species and habitats, and the studies show that there is indeed a "Reserve effect". The change is slow, but 40 years after the implementation of protection measures, the results are quite good compared with other less protected areas.

This effect was also confirmed by a scientific expert from the Banyuls oceanological observatory. During the semi-structured interview, he explained that protection measures have an effect on species diversity and abundance, and even more so in enhanced protection areas than in partially protected areas. The model chosen works particularly well because it is a concentric circle where the effects are seen in areas close to the Reserve's boundaries.

Costs and benefits

Economic assessment

The proposed approach to assess the benefits of biodiversity within the MPA was to do a value transfer, by adapting values estimated in other contexts to the current context. The following steps were taken to achieve this:

Step 1: Literature search for studies highlighting the existence of biodiversity within MPAs

The value transfer method was applied based on a study carried out in a very similar context to the Cerbère-Banyuls Nature Reserve, and in particular a study carried out by Parcs nationaux de France in 2014, which estimated the heritage value of the protected areas of Port-Cros National Park. The study used a willingness-to-pay approach for residents of the PACA region to assess their preference for maintaining the protection and management of nature areas in Port-Cros National Park. The estimated value of the benefits was €40 per person per year (2014). At the same time, other studies on valuing the existence and protection of biodiversity within MPAs were identified during Task 2 of this project.

Various studies in the literature have estimated the benefits of restoring marine ecosystems using different approaches. However, most of these studies do not reflect the benefits attributed to the existence of biodiversity, but rather the benefits of restoring ecosystem services and landscapes in marine reserves[16]. Elles ne sont donc pas adaptées au contexte de notre étude de cas. They were therefore not appropriate for our case study.

13 Pastor Jérémy & Payrot Jérôme - La Réserve Naturelle Marine de Cerbère-Banyuls, un sanctuaire pour les

Mérous bruns : évolution des populations de 2001 à 2014.

14 https://parc-marin-golfe-lion.fr/editorial/connaitre-les-especes

15 «Pastor Jérémy & Payrot Jérôme - La Réserve Naturelle Marine de Cerbère-Banyuls, un sanctuaire pour les Mérous bruns : évolution des populations de 2001 à 2014.» & https://www.radiofrance.fr/franceinter/podcasts/le-zoom-de-la-redaction/le-zoom-de-la-redaction-du-mercredi-14-septembre-2022-4693397 & https://france3-regions.francetvinfo.fr/occitanie/pyrenees-orientales-des-zones-de-mouillages-ecologiques-entre-cerbere-et-banyuls-pour-sauver-la-mediterranee-2259706.html & dire d'acteurs lors du focus group

16 For example, O'Connor et al. (2020) estimated the willingness to pay for the restoration of a deep-sea marine resource using the contingent valuation method. The study showed that people were willing to pay €34.69 per person per year for the restoration of Dohrn Canyon in the Bay of Naples. In addition, McCartney (2006) showed that the average amount people were willing to pay for seascape protection in Jurien Bay Marine Park was NZ$52.39 per person per year. In another study (McCartney, 2009), he estimated that people were willing to pay an average of NZ$207.60 per household per year for a modest set of ecological improvements in Ningaloo Marine Park in Western Australia.

However, other research has focused on the value of the existence and protection of biodiversity within MPAs. In particular .

- Rojas-Nazar et al. (2022) assessed the benefits of marine reserves in two areas of New Zealand: Taputeranga Marine Reserve and Kapiti Marine Reserve. Their study highlighted people's preferences for protecting and preserving biodiversity within these marine reserves. The benefits were estimated at NZ$54.79 per household per year for Taputeranga Marine Reserve and NZ$30.44 per household per year for Kapiti Marine Reserve.
- Börger et al. (2014) estimated the benefits of the conservation of an offshore sandbank in British waters (Dogger Bank). The results showed that people were willing to pay an average of £5.975 per person per year for a 10% to 25% increase in species diversity on the Dogger Bank.

As these studies estimated the value of maintaining the marine reserve and preserving biodiversity, they can be used for the value transfer.

In principle, because of the socio-economic differences between different contexts (between the different countries: France, New Zealand, and the UK), the best approach would be to only use the values estimated in the French context, reducing uncertainties related to:

- Socio-economic differences;

- Environmental contexts: Port-Cros National Park is located close to the Cerbère-Banyuls Reserve, so it can be assumed that the environmental context is the same.

Finally, it was helpful to conduct the assessment using both the values obtained from the Port-Cros National Park, and the values obtained in New Zealand and the United Kingdom, to have a point of comparison and a range of values that seems more realistic given the uncertainties associated with the value transfer method.

Step 2: Adapt case study values

Applying the estimated value for Port-Cros to the Cerbère-Banyuls context only required adapting into 2022 Euros. The values were simply adjusted for inflation . In Rojas-Nazar et al. (2022) and Börger et al. (2014), the information taken from the various studies was provided in the currency of the country and for the year in which the study was carried out. It was therefore necessary to adapt these values. All values have been updated to 2022 using the consumer price index for the reference country (New Zealand and the UK). The values were then converted into 2022 Euros using the average exchange rate for that year. The values were then adjusted to the French context, based on the consumer price indexes of the different countries. This meant that the values obtained from the different contexts could be adjusted and transferred to France, so as to accurately reflect local purchasing power and socio-economic differences.

Calculations were made to estimate the benefits per person per year, and are provided in Table 5.

Study	Country/Context	Benefit per capita per year (in EUR 2022)	Consumer Price Index 2022 - Initial study	Consumer Price Index 2022 - France	Transferred benefit per capita per year (in EUR 2022)
National Parks of France (2014)	**FR - Port-Cros National Park**	**44,9**	**118,3**	**118,3**	**44,9**
Rojas-Nazar et al. (2022)	NZ - Taputeranga Marine Reserve	12,24	129,4	118,3	13,38
Rojas-Nazar et al. (2022)	NZ - Kapiti Marine Reserve	6,80	129,4	118,3	7,44
Börger et al. (2014)	UK - Dogger Bank	8,47	133,70	118,3	9,57

Table 5 Value transferred for the presence of biodiversity in MPAs

Based on the estimated values for Port-Cros, we obtain a value of €44.90 per person per year. Based on the values estimated in New Zealand and the UK, the average transferred value could be estimated at €10.13 per person per year - a value that can be considered a minimum threshold for benefits.

Knowing that the Cerbère-Banyuls Reserve has an average population of 481,691[18], the average value can be applied, and the benefits from the existence of biodiversity could be estimated at €21.6 million per year, with a minimum threshold of €4.9 million [19] per year.

The benefits transfer process involves adapting the benefits obtained from other studies or contexts to the Cerbère-Banyuls context. However, these benefits must be used with caution. Although the values have been adjusted, they may not accurately reflect the current situation and may over- or underestimate benefits in the current context. The socio-economic and environmental conditions vary from one country to another. Values estimated in one country may not be fully transferable to another. The value transfer method is also based on the assumption that people's preferences and values are similar from one context to the next, which may not be the case. The perception of the presence of biodiversity can differ from one country to another. This difference in perception can lead to changes in the way people perceive the value of biodiversity and, consequently, may be willing to pay more or less to protect/preserve it.

6. SOCIETIES AND LOCAL COMMUNITIES

MEASURES

Enhanced protection area:

- No mooring.

Partially protected area:

- Organised mooring area.

IMPACTS

Societies and local communities (residents) benefit from a specific place for recreational activities, as demonstrated in the previous sections. In addition, the characteristics of the marine protected area's environment can play a role in climate regulation.

No study has yet quantified the impact of the Cerbère-Banyuls Reserve's protection measures on carbon sequestration, but the issue is very important in the context of climate change. The presence of Posidonia seagrass plays a major role in carbon sequestration, since it is capable of fixing and storing impressive quantities of carbon (up to 1 tonne of CO2 per m²) [20].The Reserve currently has 23 hectares of Posidonia[21].

COSTS AND BENEFITS

ASSESMENT

The value of carbon sequestration in the MPA has been estimated through a value transfer from estimates/studies in other contexts. Two steps were also followed in this case:

Step 1: Literature search for studies highlighting the existence of biodiversity within MPAs.

The information taken from the literature review for Task 2 of this project included information on carbon sequestration assessment.

Mangos and Claudot (2013) [22] provided estimates of carbon sequestration benefits for three different MPAs in the Mediterranean. Estimates were provided for each MPA according to three protection scenarios: business-as-usual scenario (S1), enhanced protection scenario (S2), and reduced protection scenario (S3) between 2010 and 2030 (20 years). The following table shows the average annual benefit estimated in the study.

18 The entire population of the Pyrénées Orientales Department was chosen as the target population for applying the willingness-to-pay principle, as it represented a good average between the population of Cerbère and Banyuls, and the population of the entire Occitanie region.

19 More precisely: from €21,627,926 to €4,880,124 per year

20 https://www.portcros-parcnational.fr/sites/portcros-parcnational.fr/files/available_docs/3.4.8_carbone_bleu_fr.pdf

21 https://www.reserves-naturelles-catalanes.org/les-reserves/reserve-naturelle-de-cerbere-banyuls/

22 https://www.oieau.fr/eaudoc/system/files/documents/45/226158/226158_doc.pdf

MPA	S1 – Business-as-usual scenario	S2 – Enhanced protection scenario	S3 – Reduced protection scenario
Kuriat Islands – Tunisia	140,450	145,650	130,000
PNCC – Spain	593,900	598,850	586,950
Kas Kerkova – Turkey	4,600,200	5,400,450	4,271,050

Table 6 Estimated average annual benefit for carbon sequestration (in Euros per year) - adapted from Mangos and Claudot (2013).

This information will be used to estimate the benefit of carbon sequestration in the Cerbère-Banyuls Reserve.

Step 2: Adapt case study values

The values provided by Mangos and Claudot (2013) were calculated over a 20-year period. They were therefore converted into average annual values (see table below).

In addition, the values were estimated for three different contexts/countries in the Mediterranean basin and for three different protection scenarios. Certain calculations were therefore necessary to adapt the values to the French context.

First, all values were adjusted to 2022 Euros using the consumer price index (2010 - 2022) for each country (Tunisia, Spain, Turkey). The values were then adjusted to the French context, based on the consumer price indexes (2022) of the different countries. This meant that the values obtained from the different contexts could be adjusted and transferred to the French context, so as to reflect socio-economic differences.

The following table shows the average annual benefit of carbon sequestration per hectare for the different scenarios transferred to the French context.

MPA	Average benefits associated with carbon sequestration transferred to the French context – EUR per ha per year		
	S1 – Business-as-usual scenario	S2 – Enhanced protection scenario	S3 – Reduced protection scenario
Kuriat Islands – Tunisia	1,395	1,447	1,291
PNCC – Spain	55	55	54
Kas Kerkova – Turkey	4,434	5,205	4,116

Table 7 Estimated average annual benefit per hectare (in Euros per year per ha for carbon sequestration, transferred to the French context).

Secondly, the values were provided for three protection scenarios, which made it necessary to select the values used for the current study. Two cases are considered here:

- Case 1: the benefits estimated in the study do not differ significantly for each context. For example, for the MPA in Spain, the variation in benefits is less than 1%, while in Tunisia it is around 5%, and in Turkey it is almost 10%. Consequently, no significant difference in carbon sequestration benefits are observed between the scenarios. The average carbon sequestration benefit can therefore be estimated at €2,066 per year per hectare. Given that the Cerbère-Banyuls Reserve covers 650 hectares, the benefit of carbon sequestration in the reserve could be valued at around €1.3 million per year.

- Case 2: in this case, only the values of the second scenario with enhanced protection are taken into account. The average carbon sequestration benefit can therefore be estimated at €2,236 per year per hectare. Applying this benefit to the context of the Cerbère-Banyuls Reserve, the benefit of carbon sequestration could be estimated at €1.4 million per year.

The estimated benefits do not differ significantly between the two cases (7%). This is because no significant differences were found in the literature regarding the benefits of carbon sequestration for the different levels of protection.

The estimated benefit of carbon sequestration for Cerbère-Banyuls could therefore be between €1.3 and €1.4 million per year.

7. COMMERCIAL FISHING

MEASURES

Enhanced protection area:

- No commercial fishing

Partially protected area :

- A maximum quota of fifteen vessels may be authorised within this area (with a maximum length of 9 meters – "small-scale" boats);
- The fishing gear must be marked and identified;
- Restrictions on the size of fishing gear;
- No fishing inside the mooring area between sunrise and sunset in July and August;
- Fishers must keep a catch register;
- The catch can be sold directly to wholesale fish markets and/or producer organisations.

IMPACTS

Impact on the number of fishers

Since 2007, the number of permits has varied significantly, with a fairly steady decline between 2011 and 2022 (Figure 16). However, this variation cannot be entirely attributed to protection measures, as it is also influenced by the economic situation and, in particular, the gradual closure of large fishing operations. As a result, commercial fishing has been in constant decline. Currently, only 6 fishers have one of the 15 available permits, and only 3 regularly come into the reserve.

Stakeholder opinions differ as to the role of the Reserve in reducing the number of fishers: one commercial fisherman interviewed said that in 2001, there were 13 boats in Banyuls, compared to just 3 today, and suggested that the Reserve has contributed to this decline. At the same time, Saint-Cyprien's first fishers' association representative believes that the Reserve helps maintain this activity. [23]

Research shows that the Reserve has a positive influence on small-scale fishing (2022)[24] has shown that commercial fishers in search of the best catches turn to the areas surrounding the reserve, as there are significantly more fishing vessels on the edge of the reserve. She also shows that areas near the reserve offer better catches and higher incomes.

However, these results are contrasted by the account of a commercial fisherman, who revealed that the heavy use of the Reserve by other activities (underwater diving, recreational fishing, boating) often prevents them from working. The areas most suitable for fishing are saturated by other activities. This causes some fishers to move to areas outside the Reserve, which are less attractive for recreational activities due to the low abundance of fish. As a result, these areas are also less attractive for fishers, causing their yields to drop.

The impact of the Reserve on the number of commercial fishers is complex and multi-factorial. The change in the number of fishers is due to multiple influences, and the connection with the Reserve remains subject to debate and external factors.

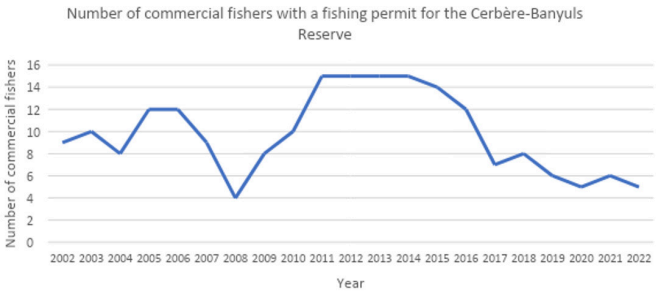


Figure 16 Number of commercial fishers with a fishing permit for the Cerbère-Banyuls Reserve [25]

COSTS AND BENEFITS`

Effect on fishers' income

Protection measures may tend to slow down investment among commercial fishers. According to the fisherman interviewed, his yields have fallen sharply since the creation of the Reserve, with losses estimated at 50%. In addition, investments made by fishers, such as traps, may become obsolete, as they are prohibited in the reserve although authorised outside it. As a result, commercial fishers often turn to areas north of the Reserve.

In the short term, fishing quotas can lead to a drop in income for fishers, as they are restricted by catch limits. At the same time, fish size, weight and density increase, which can have a positive impact on the long-term income of fishers.

As the income assessment for commercial fishers is highly uncertain, two steps were combined to assess the monetary impact of protection measures on commercial fishing.

23 According to Manu Martinez, Saint-Cyprien's first fishers' association representative (Report for Workshop 5 for the expansion of the Reserve): "The Marine Reserve has not prevented the development of commercial fishing, quite the contrary."

24 https://www.ledepartement66.fr/wp-content/uploads/2022/01/3-Pr%C3%A9sentation-scientifique-M-Jarraya.pdf

25 Source: Data from 2002 to 2016 are from the 2015-2019 management plan and from 2017 onwards, from activity reports

1. Calculation of annual income for commercial fishers in the Reserve between 2010 and 2022

Annual income was calculated on the basis of the following available data:

- Number of fishers authorised to fish in the Reserve each year (data available between 2008 and 2022) - Figure 16

- The species most heavily fished in the Reserve in kilograms of biomass per year (data available between 2010 and 2022) - Figure 17

Market prices of each species in Euros per kilogram according to sales prices observed on the market in the study by Morel et al, (2019) - Table 8.

The annual incomes of commercial fishers are obtained by multiplying the kilograms of biomass of each species by the market prices per kilogram. These are shown in Figure 18. This estimate does not capture the impact of protection measures on commercial fishing, but it does give an idea of the economic importance of the Reserve between 2010 and 2022 for commercial fishers. Between 2010 and 2022, the average income from fishing in the Cerbère-Banyuls Reserve was around €84,000 per year.

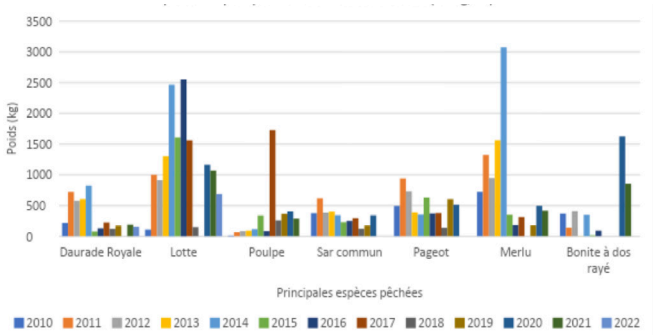


Figure 17 Most-fished species per year (kg per year)

Source : Based on fishing from January to November for the Reserve's 3 most active fishers. The data take into account a wider area than the Reserve, but still provide trends for the most heavily fished species in and around the Reserve. Detailed data for each species are provided in a table in Appendix 3.

	Average price per kg 2023
Sea bream	€19.33
Rascasse_sp	€12.75
Striped red mullet	€21.51
Cuttlefish	€12.72
Common monkfish	€16.88
Forkbeard	€11.83
Octopus	€11.29
Sago	€12.84
Common two-banded sea bream	€12.26
Red scorpionfish	€12.75
Common pandora	€12.03
European hake	€11.70
Brown wrasse	€13.26
Spiny lobster	€53.29
Atlantic bonito	€17.21
Other	€15.85

Table 8 Market prices of species caught in the reserve

Sources : : According to Morel et al (2019) [26] adapted consumer price index 2019 = 110 and 2022 = 118.3 [27]

2. Weighting of average income between 2018 and 2022 based on the abundance of fish for commercial fishers

Based on the EMPAFISH 2005-2006 field survey (Figure 19), Roncin (2013) identifies the three main criteria used by commercial fishers to select a fishing site. Fish abundance is the no. 1 factor for around 24% of commercial fishers, and the no. 2 factor for 18% of them.

26 MOREL M., LAPIERRE B., GOOSSENS A., DIEUDONNÉ E., BEDROSSIAN C., LENFANT P., & VERDOIT-JARRAYA M., 2019. Final report on the cooperation agreement on "Monitoring and data analysis of small-scale commercial fishing" in the Gulf of Lion Marine Park (Rapport final de la Convention de coopération relative au "Suivi et analyse de données dédiés à la pêche professionnelle "petits métiers" dans le Parc naturel marin du golfe du Lion) (Acronym: PechProParc1920). Final report UMR 5110 CNRS-UPVD CEFREM for the Office français de la biodiversité, manager of the Gulf of Lion Marine Nature Park; 84pp + 30 p. appendices

27 https://data.worldbank.org/indicator/FP.CPI.TOTL?locations=FR

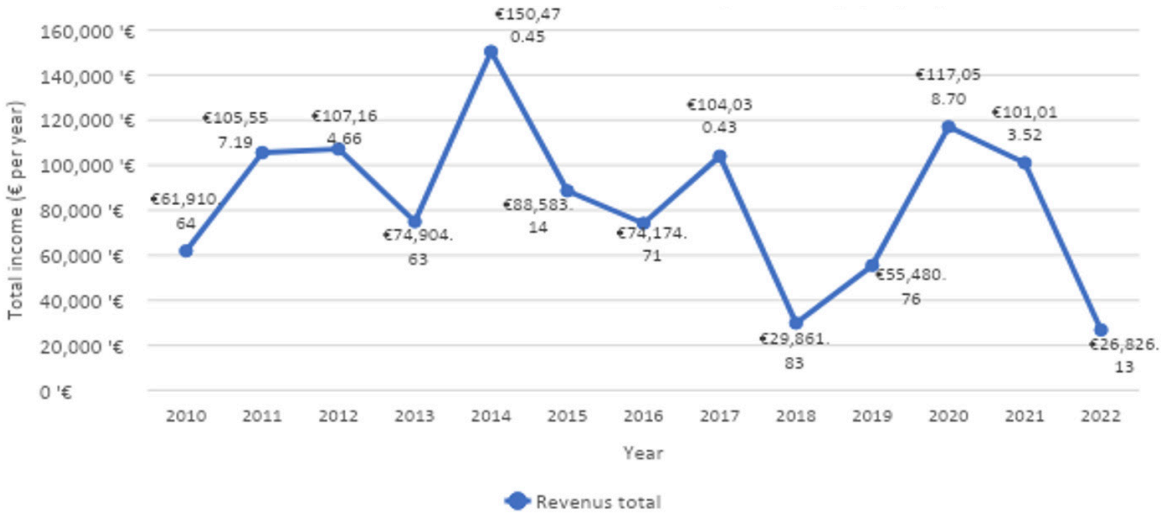


Figure 18 Total income of commercial fishers in the Cerbère-Banyuls Reserve

It can therefore be deduced that within the annual income of €56,000, 42% of this sum comes from the importance attached to fish abundance, which is a factor that depends exclusively on the Reserve, as opposed to weather conditions, i.e. around €35,000 per year.

To improve the economic analysis, it would be necessary to obtain detailed data referring to the situation prior to 1974 or without the reserve and compare it with the current situation. Further research into short- and long-term effects is needed.

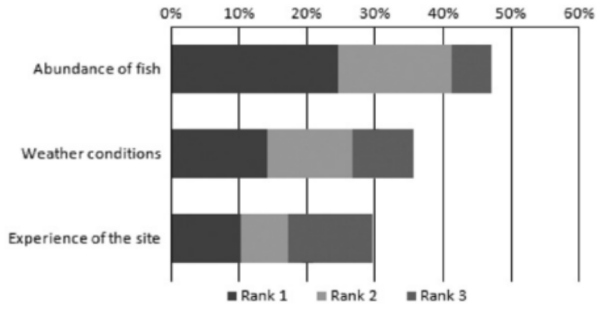


Figure 19 Three main criteria for commercial fishers in selecting a fishing site. Data source: EMPAFISH field survey 2005-2006

8. RECREATIONAL FISHING

MEASURES

Enhanced protection area:

- No commercial fishing.

Partially protected area:

- The activity requires an annual permit. A maximum of 1,000 permits can be issued each year;
- Recreational fishing is only permitted between sunrise and sunset;
- Restrictions on the types, number and size of fishing gear;
- Quotas and no-take periods have been introduced for certain marine species;
- Fishers must keep a catch register.

IMPACTS

Impacts on the number of fishers

Current protection measures have had significant effects on recreational fishing, particularly with the introduction of fishing quotas, and since 2016, by limiting the number of fishers in the area to 1,000. This authorised limit is reached every year (see activity reports from 2018 to 2022), which has certainly reduced the number of fishers.

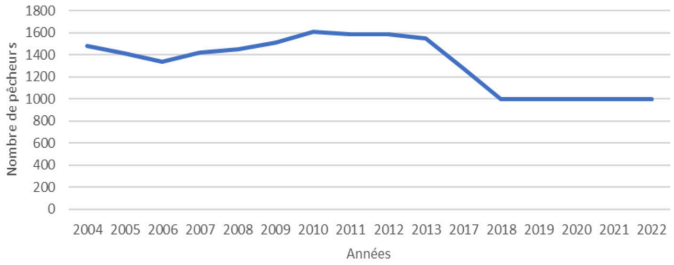


Figure 20 Number of fishers in the Reserve per year [28]

Impact of measures on catches (diversity, number, weight, etc.)

A presentation by Jarraya (2022)[29] to argue for the expansion of the Reserve, discusses recreational fishing and the effects of the measures on this activity. Figure 21 shows the interest of shore-based and boat-based recreational fishers in the Reserve, while Figure 22 shows that the best catches in the Reserve were in spring and autumn. With the exception of summer, when the situation is more contrasted, catches per unit effort for boat-based fishing are systematically higher in partially protected areas than in unprotected areas.

On average, over all seasons, it is estimated that there is 1200g per unit effort per hour more in the partially protected area than in the unprotected area.

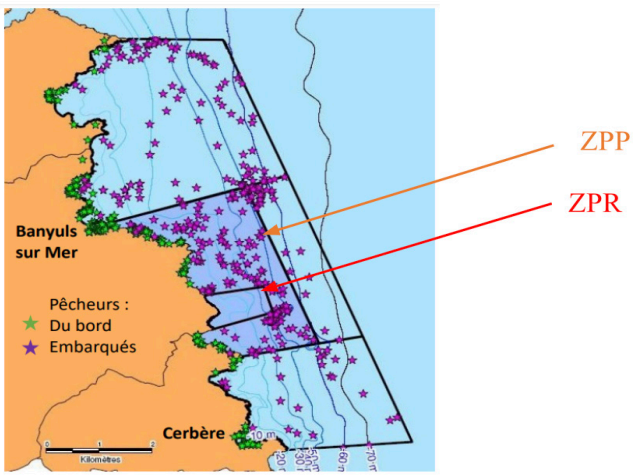


Figure 21 Location of fishing boats and shore-based fishers

As far as catches by target species are concerned, better catches are observed in the Reserve (Figure 23) and there are significant differences between areas inside and outside the Reserve. The catch per unit effort (CPUE) is nearly twice as high in areas inside the Reserve than outside [30]. For the comber and sargo, the average weight in the enhanced protection area is well above weights in the partially protected area and outside the Reserve.

28 Sources: Between 2004 and 2013 data were taken from the 2015-2019 Management Plan, and from 2018 to 2022 from the Reserve's activity reports. There are no data between 2014 and 2017.

29 https://www.ledepartement66.fr/wp-content/uploads/2022/01/3-Pr%C3%A9sentation-scientifique-M-Jarraya.pdf

30 PLAN DE GESTION 2015-2019_SECTION A_corrigé_definitif (Management Plan)

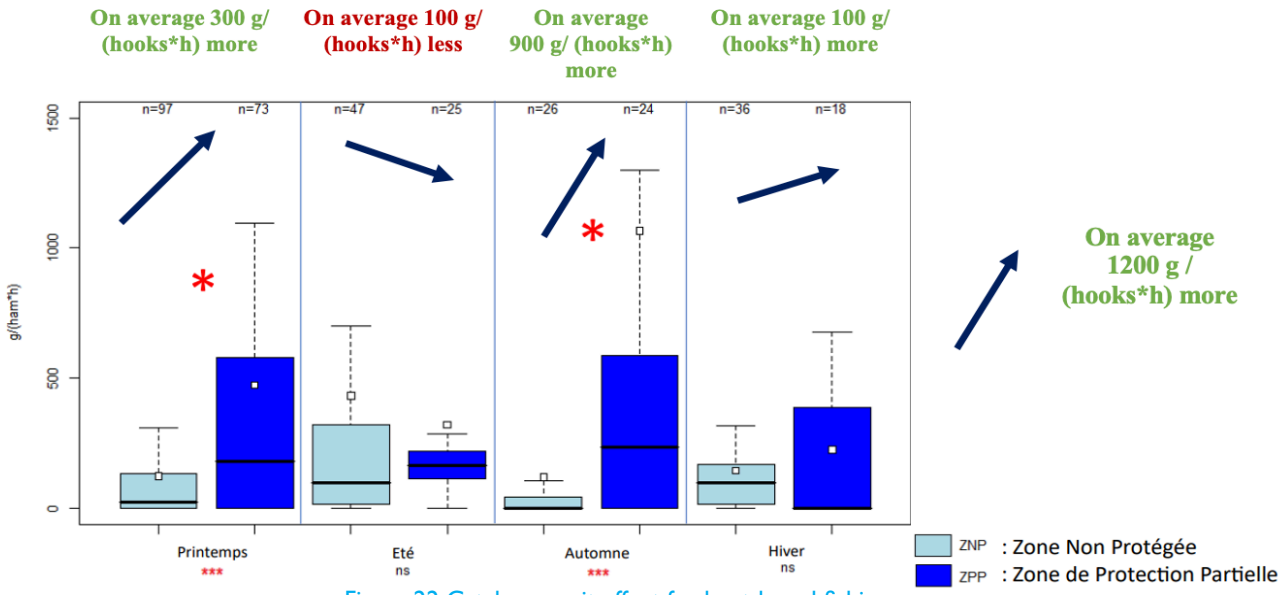


Figure 22 Catch per unit effort for boat-based fishing

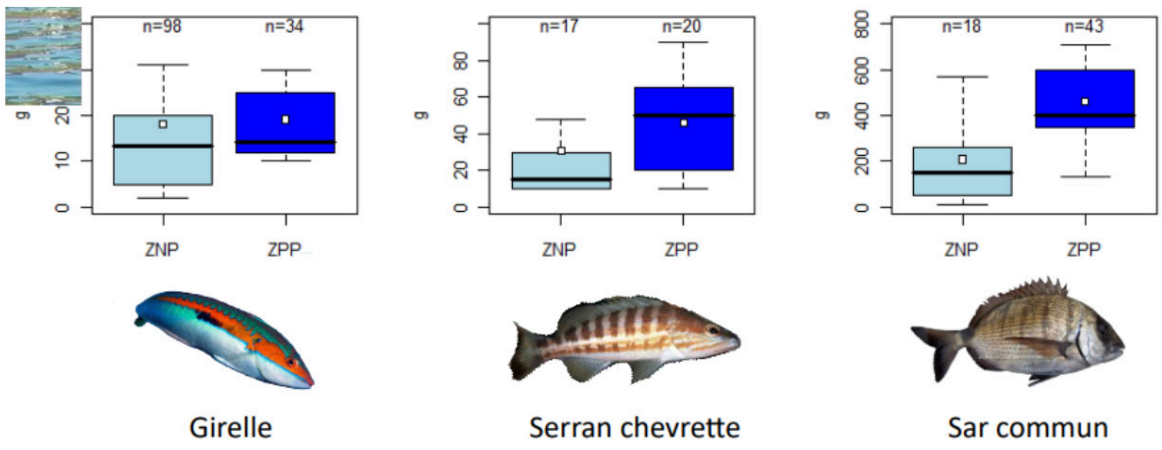


Figure 23 Effect on catches of main species

COSTS AND BENEFITS

Economic benefits of protection measures

For the 1,000 recreational fishers, the fishing enjoyment is increased thanks to a greater diversity of fish of higher weight. Around 21% of fishers consider the abundance of fish to be the primary criterion for selecting a fishing spot (Figure 24).

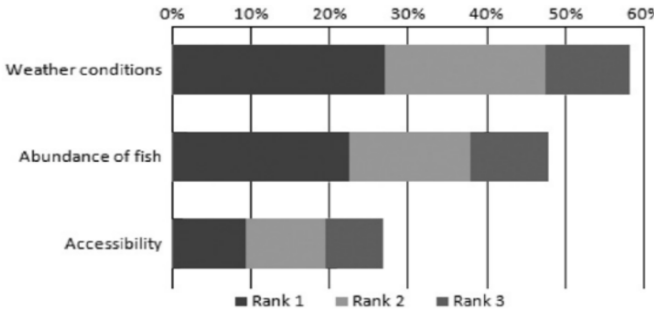


Figure 24 Three main criteria for recreational fishers in selecting a fishing site. Data source: EMPAFISH field survey 2005-2006

Collected in Roncin et al, 2008

The Reserve is visited by some 1,000 recreational fishers. Around 21% prioritise the abundance of fish as a criterion for choosing their fishing spot. Moreover, according to Jarraya (2022), each fisher in the Reserve manages to catch an average of 1.2 kg more fish than in unprotected areas.

Using these figures, it can be demonstrated that there are 210 fishers in the reserve who value the abundance of fish and are willing to pay €71 each [32] to enjoy an extra 1.2 kg each.

As a result, there are 210 fishers who value the Reserve's benefits and are prepared to pay a total of €14,910 per year to enjoy an extra 1.2 kg of fish.

9. UNDERWATER DIVING

MEASURES

Enhanced protection area:

- No underwater diving.

Partially protected area:

- Regulated activity (equipment, dive centre);
- Activity requires an annual permit;
- No physical contact with the substrate or species, no taking or destroying species, no feeding animals; a stabilising jacket must be warn to avoid finning, which has an impact on flora and fauna;
- Up-to-date diving logbook.

IMPACTS

Overall, the Reserve has had a positive impact on the underwater diving sector. There is more enjoyment for divers thanks to a greater variety of fish species, and habitats and species are in better condition, resulting in increased visitor numbers and significant economic benefits for dive centres and the region. Divers are more aware and adopt more environmentally-friendly practices.

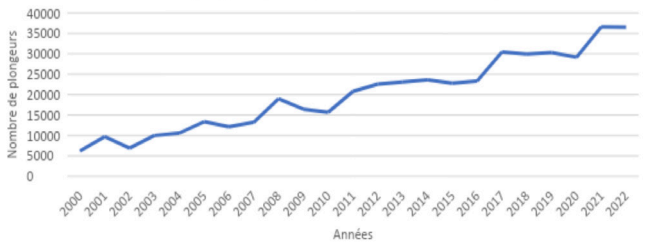
Divers are more aware of the impact of their practices on environments and species

The impact of underwater diving on the environment is well documented. The high concentration of divers in a specific area increases interactions with marine flora and fauna. A diver's impact on marine ecosystems depends on a number of factors, including the number of divers visiting a site, their environmental awareness, knowledge and skills. Protection measures such as the Charter of Best Practices [33] nfluence one of these factors: environmental awareness and knowledge for divers. By educating divers about the importance of preserving the marine environment, they change their behaviour and are less inclined to do harmful actions, such as coming into contact with living organisms, turning over rocks, capturing octopus, producing excessive noise or frequently shining lights in holes[34]. One significant observation in Cerbère-Banyuls corroborates this finding: despite the number of divers doubling in 8 years, the average number of contacts with organisms has decreased "no doubt due to greater awareness among divers" (Rouannet et al, 2017).

Increased visitor numbers...

Scuba diving is booming. In 1974, just five professional dive centres were operating in this area, compared with eighteen in 2013. The number of divers from April to November is available in the Reserve's activity reports, sometimes with details about the dive centres they used (professional dive centres, associations or private individuals). In general, 91% of divers came from professional dive centres, 7% from associations and 2% were private individuals. This upward trend in the number of divers has been constant since the 2000s (Figure 25). The increase in the number of divers is not only a result of the protection measures, but also of the buoys installed. In the MPA, the quality of biodiversity and the fish population have a good status, providing a service to divers. Some fish are seen more now, such as the ornate wrasse, which has been observed for the past 5 years. Caulerpa Racemosa and rays can also be seen.

Figure 25 Number of divers who visited the Reserve between 2000 and 2022 [35]



The Reserve has attracted many divers, who ask to dive exclusively in the area. Professionals sometimes charge extra for diving in the Reserve[36], demonstrating divers' willingness to pay more for an experience in this area.

32 According to the study by Pierre Scemama, Charlène Kermagoret, Alexia Rivallin - Ifremer, Univ Brest, CNRS, UMR 6308, AMURE, Maritime Economics Unit

33 Signing the Information Charter is compulsory for access to a diving area or to use fixed moorings.

34 Source: Section 5.3.3 of ROUANET E., BELLONI B., ASTRUCH P., MONBRISON D., GOUJARD A., LETEURTOIS M., BERTHIER L., 2017. Etat des connaissances des activités de plongée subaquatiques sur la façade méditerranéenne et appui à l'élaboration d'une stratégie de gestion durable des sites de plongée. Contrat d'étude Agence Française pour la Biodiversité – Direction Interrégionale de la Mer Méditerranée & GIS Posidonie – BRL ingénierie, GIS Posidonie publ., FR.: 1 – 184 + 12 annexes + 2 volumes annexes

35 Source: 2000 to 2017 data were taken from the 2015-2019 Management Plan, and 2018 to 2022 data are from the Reserve's activity reports.

36 An additional €8 per person for diving in the Reserve is charged by the dive centre interviewed for the study. Some facilities charge up to an additional €15, also due to the distance of the dive centre from the Reserve.

COSTS AND BENEFITS

...which generate economic spin-offs...

To assess the benefits of protection measures for divers, the calculation method consisted in calculating the economic spin-offs of this activity and deducting the share due to MPA protection measures (Figure 25).

The economic spin-offs of diving are assessed by taking into account the number of people who dive in the Reserve and the amount they are willing to pay for it. Several factors need to be taken into account:

- The total number of divers
- The proportion of divers who are not residents
- The proportion of divers who are residents
- Expenses incurred by residents to go underwater diving
- Expenses incurred by non-residents for a stay including accommodation, food and diving

Next, a percentage needs to be assigned to non-residents to obtain the number who have come specifically to dive in the Reserve (Roncin, et al 2008). Then, to estimate the added value of protection measures in underwater diving, a qualitative approach illustrated in Figure 26 helps to understand the criteria used by divers to choose a dive site.

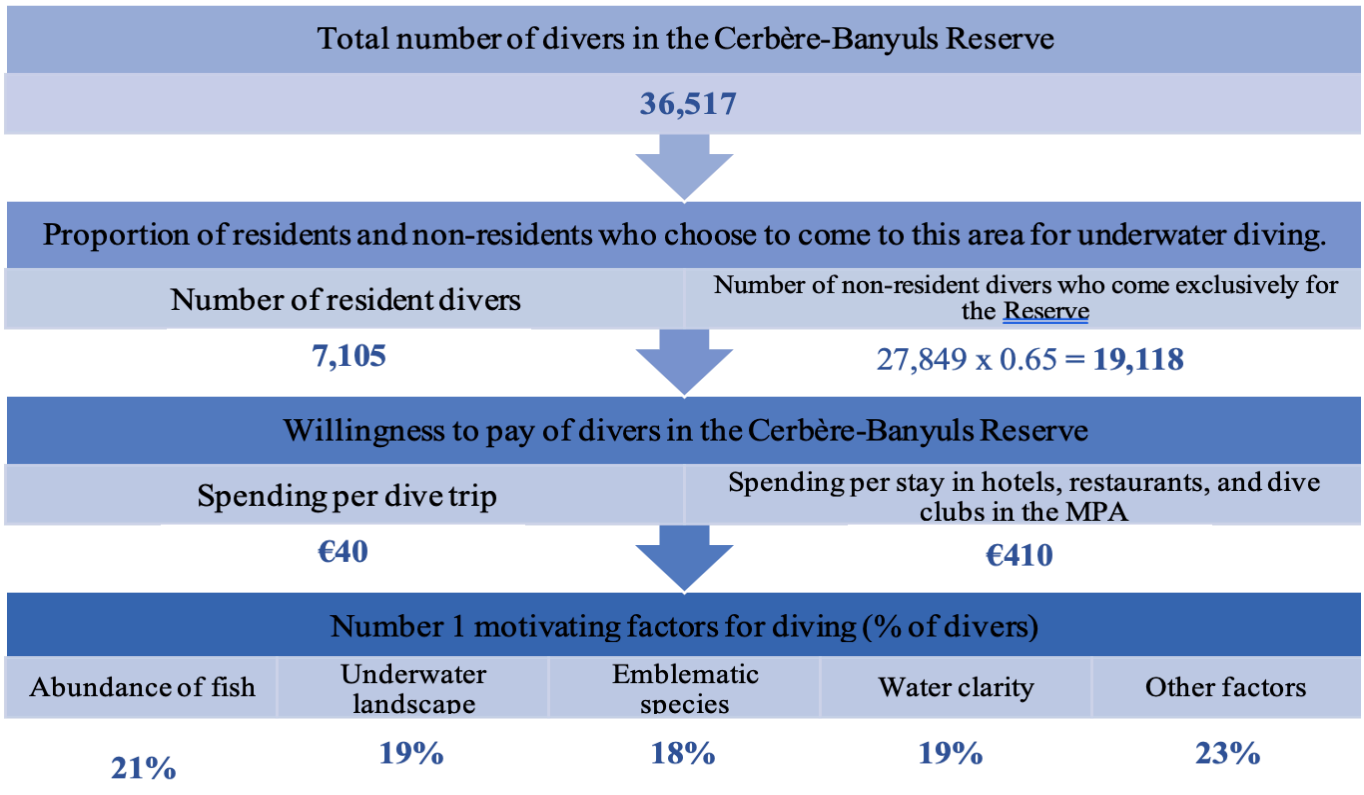


Figure 26 Process for calculating the benefits of protection measures for Cerbère-Banyuls divers

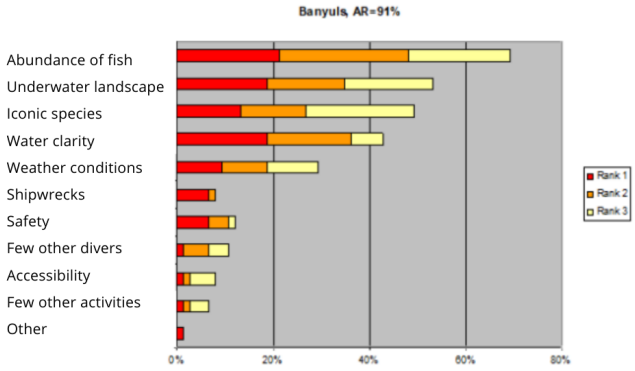


Figure 27 Motivating factors for divers in the Cerbère-Banyuls Reserve [37]

There were 36,517 divers in 2022, according to the Reserve's 2022 activity report (Figure 25). The number of residents can be estimated as the average number of divers who visited the Reserve between November and April. This gives 7,105 residents and 27,849 tourists, 65% of whom (19,118 tourists) chose their holiday destination based on their diving activity. According to the 2015-2019 Management Plan: "65% of divers who have visited the RNMCB and who don't live in the department chose their holiday destination based on their diving activity". Diving operators working in the Reserve[38] charge between €30 and €50 per excursion, depending on the distance from the centre to the Reserve and the type of activity (autonomous, supervised, etc.), with an average of €40 chosen.

The study by Roncin et al, 2008 showed that each diver spends an average of €350 on a stay (accommodation, food, diving). Adjusting for inflation in 2022, this gives a price of €410 per person. The same [39] study provides insight into the motivations of divers in order to assess the real economic impacts of the protection of a marine area (Pendleton, 1995). The abundance of fish, the underwater landscape, emblematic species and water clarity are all environmental factors that motivate people to dive (Figure 27).

The results of the assessment are provided in the table below.

Tourists who were mainly attracted to the Reserve by diving, were willing to spend a total of €7.8 million in 2022. 6 million (77%) of this sum is directly attributable to the benefits of protection measures (fish abundance, underwater landscape, emblematic species, water clarity), while 1.8 million is attributable to other factors (safety, weather conditions, visitor numbers, etc.).

Residents generate €284,200 in economic spin-offs. 76% of this sum is directly attributable to the benefits of protection measures (fish abundance, underwater landscape, emblematic species, water clarity).

	Tourists	Residents	Total
Number of divers	19,118	7,105	36,517
Costs related to diving activities (including tourist stays)	€7,838,298	€284,200	€8,122,498
Willingness to pay to dive to enjoy the abundance of fish	€1,646,043	€59,682	€1,705,725
Willingness to pay to dive to enjoy the underwater landscape	€1,489,277	€53,998	€1,543,275
Willingness to pay to dive to enjoy emblematic species	€1,410,894	€51,156	€1,462,050
Willingness to pay to dive to enjoy water clarity	€1,489,277	€51,156	€1,540,433
Willingness to pay to dive for other reasons (safety, weather conditions, visitor numbers, etc.)	€1,802,809	€65,366	€1,868,175

Table 10 Results of the benefits assessment for diving activitiesCerbère Banyuls

37 Source: Result of the study by Roncin et al 2008, based on the results of the EMPAFISH 2005-2006 surveys

38http://www.plongeebleue.com/plonger-a-banyuls/plongee-exploration/plongee-exploration-reserve-marine-de-cerbere-banyuls.html

https://www.plongee-cap-cerbere.com/boutique-en-ligne-cap-cerbere

https://www.aquablue-plongee.com/copie-de-brevets-d-encadrements

https://aquatile.fr/explorer/

39 Adapted and reused in: EMPAFISH field survey 2005-2006, collected in presentations made during Webinar 4 on the socio-economic benefits of highly protected areas as part of LIFE MARTHA (2022)

...but must be managed

The creation of the enhanced protection area in 1981 led to a ban on diving at an emblematic site (Sec de Rédéris). This had a negative effect, as divers adapted by moving to other nearby sites, particularly Cap l'Abeille, where there are many divers. Although divers are more aware of the environment, there are still a lot of them, which can scare fish away.

At the same time, the growth in the number and high concentration of divers can have negative repercussions on dive centres, which have to adapt and adjust their schedules. During our survey, one of these centres reported that it now dives only twice a week within the Reserve, at different times (8:00 instead of 8:30) and over a longer period to avoid the crowds (particularly boaters). To offset this, the dive centre travels to other areas in the vicinity, which also offer very rich diving experiences in terms of coralligenous and rock formations (Collioure, Port Vendre).

Potential impact of the expansion: Stable

With the expansion of the Reserve, other areas will be developed, which raises hopes of thinning out visitor numbers in other places. Expanding the Reserve could thin out the number of divers, but only to a limited extent as the most remarkable species will always be more visible in the same places (at least in the short term).

In return, the "Reserve label" will be effective over a wider area, reducing the distance covered by certain dive centres that previously had to take divers further afield to access the Reserve.

The expansion of the Reserve will probably have no effect on divers' enjoyment, but more of them will see the benefits of the measures.

10. OTHER FACTORS

Boating

MEASURES

Navigation and speed limits :

- Three knots in the mooring area (ZMEL);
- Eight knots beyond the 300-metre coastal strip;
- Five knots within the 300-metre coastal strip.

Mooring

- Prohibited in the EPA;
- In the ZMEL, only mooring to buoys is permitted;
- Vessels of 24 metres or longer are prohibited from mooring;
- Mooring only authorised outside Posidonia seagrass meadows and other areas with protected species and habitats.

To reduce the impact on the environment, 29 "eco-moorings" have been installed in the Reserve. Boat speed is limited to 5 knots within the 300-metre strip, 3 knots in organised mooring areas and 8 knots in the rest of the reserve.

IMPACTS

The moorings make boating easier, and users are made aware of them. Boating is also more enjoyable in an attractive natural environment with good environmental status, offering the chance to observe the landscape and see unique marine species. Speed limits and bans on anchoring in certain areas in the EPA and mooring areas also limit activity. According to some stakeholders, some have sold their boats as a result of the restrictions, although this remains a minority.The number of recreational boats using the moorings since 2011 is shown below.

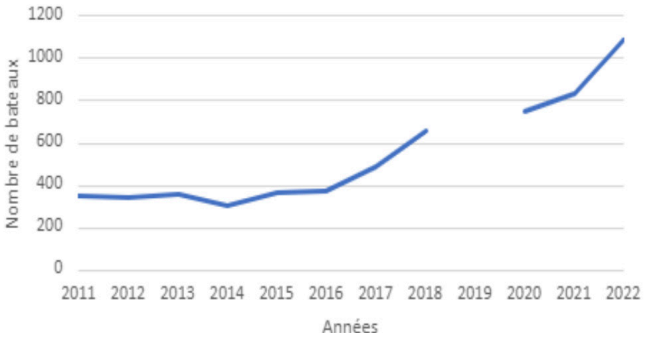


Figure 28 Number of recreational boats annually since 2011

The expansion of the reserve will bring additional moorings and improvements in the southern part of the reserve, but there will still be bans on mooring in certain areas.

With the available data, it was not possible to estimate the monetary values of the positive impacts.

Swimming

MEASURES

No restrictions.

IMPACTS

Protection measures aim to preserve the health of ecosystems, including water quality. Better water quality can make bathing more enjoyable and safer, by reducing pollution and health risks. Bathers therefore benefit entirely from improved water quality. Episodes of heavy pollution could lead to restrictions, or even swimming bans. In addition, poor quality, less clear water affects the quality of the bathing experience. However, there are no real incidents to prove this. Furthermore, protection measures are not intended to protect water quality.

In addition, access to certain areas is restricted (notably in EPAs) to protect marine flora and fauna. This could restrict bathing options in specific areas and be an inconvenience during busy periods. However, areas closed to swimming were not suitable areas for this activity (inaccessible cove). The protection measures therefore had no negative impact on bathers.

Since 2011, visitor data for the Reserve's beaches, in particular Peyrefitte beach, have been available for July and August. In 2022, the Reserve beach welcomed 32,195 bathers, increasingly attracted to the area (Figure 29). According to the stakeholders interviewed, tourists who come to the Reserve perceive the awareness-raising activities in a very positive light. They are very grateful for the visitor information points and the availability of reserve staff (by telephone in winter and in summer). These are even points that can attract visitors.

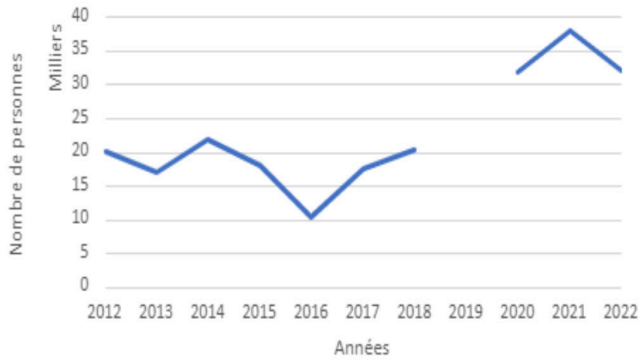


Figure 29 Summer visitors to the Reserve's beaches

With the available data, it was not possible to estimate the monetary values of the positive impacts.

Impact
The expansion will not likely impact this activity, which is already little affected by protection measures. However, in the future, it will be essential to protect pebbles on beaches, which are important areas for the reproduction of small fish.

Winegrowing

MEASURES

No measures: the presence of the Reserve could influence the behaviour of winegrowers.

IMPACTS

Winegrowing is an economic activity that takes place all around the Cerbère-Banyuls Marine Reserve [40]. The geographical proximity between the vineyards and the reserve creates a context where decisions made by winegrowers can potentially be influenced by the presence of the reserve. On the other hand, the behaviour of winegrowers can lead to pressures on the status of the MPA environment (use of phytosanitary products in particular). What's more, this sector is increasingly exposed to extreme phenomena caused by climate change, such as drought and erosion. This interdependent relationship between the Reserve and winegrowing raises questions about the impact of the MPA on this sector.

During the first scoping interview, the reserve's scientific manager mentioned that the Cerbère-Banyuls Reserve could have an impact on the behaviour of winegrowers. They have reportedly reduced their pesticide use accordingly, and are using the Reserve as a label.

However, analysis of Banyuls winegrowers' websites[41] did not show any mention of "Reserve", "marine protected area" or "protection measure". It is not clear that winegrowers use the reserve as a label. However, the label "les vignerons sur mer" (seaside winegrowers) [42] appeared on the Côte Vermeille in 2022, with the aim of consolidating this ailing sector by organising events on the theme of vineyards and the sea[43]. Although the Cerbère-Banyuls Reserve is not explicitly mentioned on the websites or Facebook accounts of the label, the fact that the label connects the vineyards and the sea undoubtedly reinforces their relationship. This confirms that the sea is being used to revitalise the sector. Good environmental status can therefore have a positive impact on the profession. However, the benefits of the Reserve for winegrowers cannot be quantified.

40 The area is renowned for its sweet (Banyuls) and dry (Collioure) wines.

41 https://www.banyuls-sur-mer.com/tourisme/decouvrir/un-vignoble-dexception/sejourner-vignerons/toutes-les-caves-et-producteurs/

42 https://lesvigneronssurmer.com/

43 L'association des vignerons sur mer a été contactée, sans réponse.

The figures on the use of phytosanitary products do not prove the reserve's effect on winegrowers' behaviour. The BNVD database (French database of sales by phytopharmaceutical product retailers) reveals no difference in the purchases and sales of phytosanitary products in Banyuls compared with other surrounding municipalities (Figure 30). The quantity of phytosanitary products purchased in Banyuls-sur-Mer and Cerbère has always been above 5 kg per ha of UAA from 2015 to 2021.This quantity, described as "very high", does not differ significantly from the national average in the winegrowing sector.

In short, while the direct influence of the Cerbère-Banyuls Reserve on the behaviour of winegrowers cannot be proven quantitatively, the appearance of the "les vignerons sur mer" (seaside winegrowers) label underlines the growing awareness of a relationship between vineyards and marine environments. More precise data on the presence of phytosanitary products in the marine environment could help to better qualify the impact of the reserve on winegrowing.

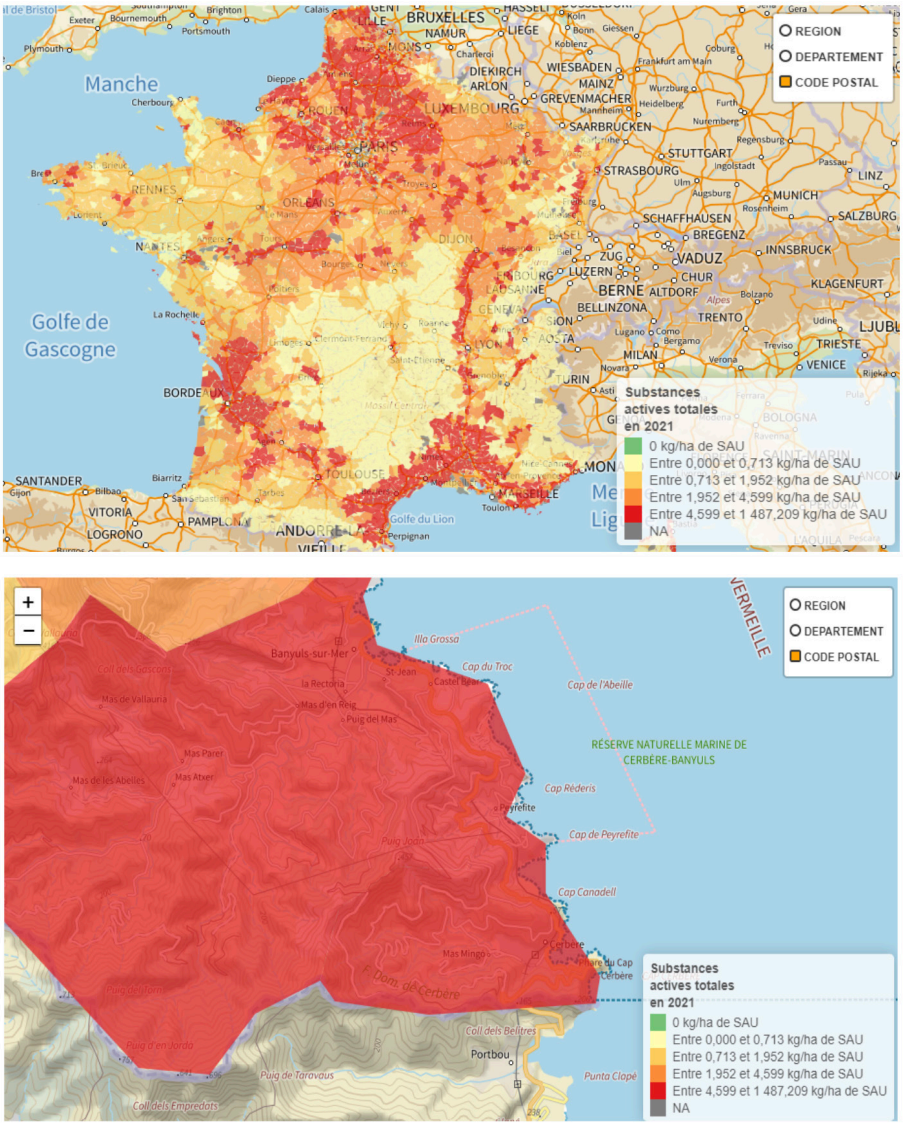


Figure 30 Total active substances purchased in 2021 in France and around Cerbère-Banyuls

Research and education activities

Education for children

The Banyuls Observatory and members of the Reserve carry out awareness-raising activities to bring knowledge to different audiences and improve their understanding of environmental issues. Every year, the reserve welcomes many schoolchildren to help them discover the diversity and fragility of this area. An education manager is responsible for welcoming them and leading activities. A special education service, supported by a Life and Earth Sciences teacher, provides activities and educational worksheets. The themes covered include discovering the Reserve, biodiversity, human-sea interactions and the food chains within the marine ecosystem. Thanks to these efforts, the Reserve will help future generations to gain better knowledge and understanding of the marine environment. The Department covers the cost of the activities, provides free school transport and covers entrance fees. In some cases, other funding is provided by the DREAL.

Between 2007 and 2022, an annual average of around 1,000 pupils, students and teachers were reached thanks to these actions [45].

Visitor awareness

Information points are available in the reserve. Between 2007 and 2022, there were an average of 5,500 visitors per year, rising to 6,500 in 2022 [46]. In addition, Reserve staff organise educational activities in the summer, welcoming an average of 2,500 people per year.

Research activities

The MPA creates opportunities for research by offering scientists the chance to study and observe species and habitats in a specific marine environment. Scientists can study the impact of human actions on marine ecosystems, or study the right level of protection to adopt. The Banyuls observatory carries out studies on biodiversity, seabed integrity and fish populations. Laboratory activities tend to increase as a result of the presence of such a space. For example, the creation of the Reserve initially placed a heavy workload on research institutes, the CNRS and the University of Perpignan. These bodies then contributed to the description of biodiversity and ecosystems. Since the expansion project, numerous studies have been carried out to demonstrate the benefits of such an area. Since the creation of the reserve, a marine ecology unit has been set up to work on connectivity and sea current circulation problems.

Between 2007 and 2014 the reserve took part in 55 conferences (an average of around 6 per year) [47].

Protection measures also entail restrictions on access to certain areas, which can limit researchers' ability to carry out their activities. Requests for access to the Cerbère-Banyuls Reserve must be made to the scientific council, with very precise justification of the purpose of the research. In addition, no sampling requests are accepted in the EPA.

Underwater trail

The underwater trail also aims to raise visitor awareness. Since its creation in 2000, it has welcomed an increasing number of visitors. Since 2007, it has welcomed an average of 24,000 visitors per year.

Figure 31 Key figures for research and education activities

45 These data come from the reserve's management plan and activity reports.There are no data between 2014 and 2017

46 These data come from the reserve's management plan and activity reports.There are no data between 2014 and 2017

47 Source: the reserve's management plan and activity reports

IV. CASE STUDY - PORT-CROS NATIONAL PARK

1. SCOPE OF ASSESSMENT

Port-Cros National Park is located in the Var department of France, around the Hyères Islands. The park core covers 1,700 ha of land and 2,900 ha of sea. There are also 5 land member areas (aires d'adhésions terrestres), covering 11,911 ha spread over 5 municipalities (Hyères-les-Palmiers, la-Croix-Calmer, Le Pradet, Ramatuelle and La Garde). The adjacent marine area (AMA) is 123,000 ha (Figure 31).

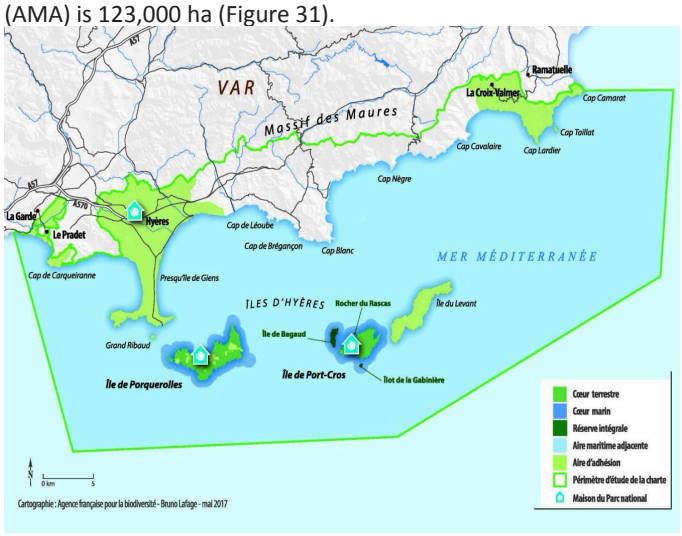


Figure 32 Port-Cros National Park charter perimeter 2016

The current configuration is the result of a series of steps taken since the Park was created, in particular:

- Port-Cros National Park (PNPC) was created in 1963. It was the first marine nature park in Europe.
- In 1999, the Conservatoire du Littoral acquired the eastern part of Port-Cros Island, making almost all of the original island territory public and permanently protected, with part of it allocated as military land.
- The island of Porquerolles only became part of the Park in 2010, after a long process.
- In 2016, the Park's level of protection was increased with the adoption of the PNPC Charter. The Park's area of influence was also expanded to include the adjacent marine area.
- In 2020, the Bagaud ZMEL (mooring area) was created and the number of visitors began to be restricted.

This difference between the years of full membership to Port-Cros National Park explains some of the disparities in the development of economic activities (there is a port and built-up areas on the island of Porquerolles) and in the quality of ecosystem preservation.

In addition, in 2021 a study [48] was launched by PNPC to expand the highly protected area to certain areas of economic and ecosystem interest in the adjacent marine area. This initiative was carried out in consultation with local stakeholders, and should create HPAs around the Posidonia seagrass meadows and the 10 underwater trails. The challenge of protection is twofold [49] : to reinforce the HPA around the island of Porquerolles through effective protection (only 10% of the island is currently covered by a HPA) and to develop protection in areas of interest in the adjacent marine area.

Numerous scientific studies have been carried out by the National Park Observatory, which regularly publishes a scientific journal, and are bolstered by the PNPC's scientific strategy, which identifies the priority areas for research [50].

The current status of ecosystems varies between the HPA and the adjacent marine area. According to the EBQI index[51], Posidonia seagrass meadows have good or very good status, while fish populations have very poor status, except to the north of Port-Cros Island, where they have good status.

The figure below shows the economic sectors relevant to the PNPC area, in order of importance.

48 Focus Group on Port-Cros National Park, 4 September 2023.

49 Focus Group on Port-Cros National Park, 4 September 2023. 5

50 Port-Cros National Park Scientific Strategy 2023-2032, https://www.calameo.com/books/0003183633ac5b7f3295a

51 Data provided by the scientific managers of Port-Cros National Park

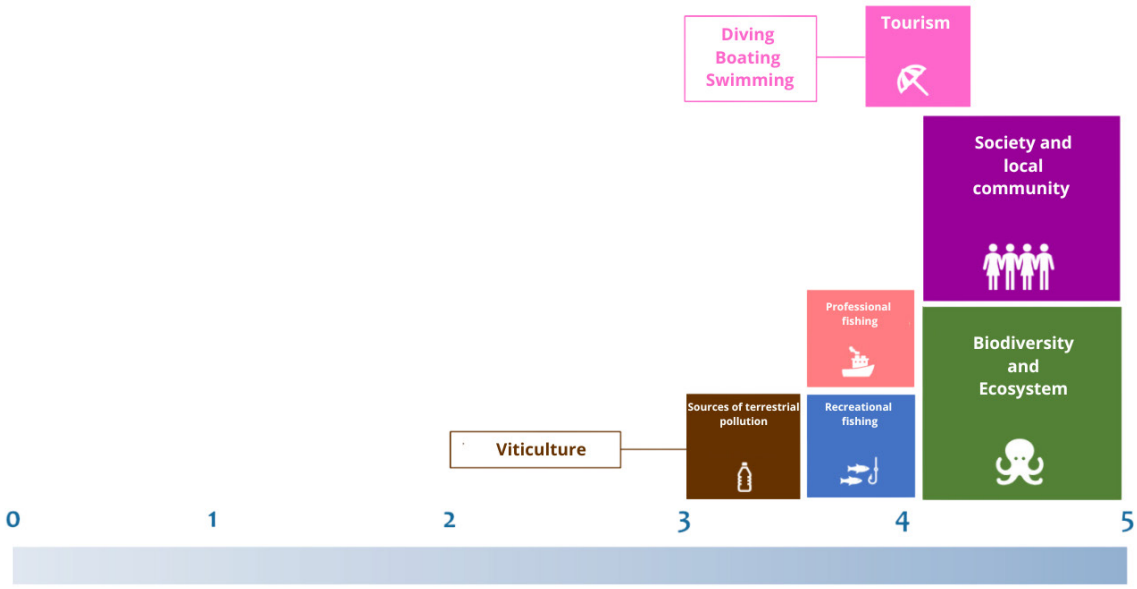


Figure 33 Economic sectors relevant to the PNPC, in order of importance

2. SCENARIOS

The following scenarios are considered for the socio-economic assessment:

- Baseline scenario: lower level of protection, i.e. the level of protection before regulatory changes between 2016 and 2020;
- Protection scenario: current level of protection, after implementation of the 2016 Charter and the mooring area in 2020, taking into account the various stages in developing the Park's regulations since then.

The scenarios are shown in Figure 34.

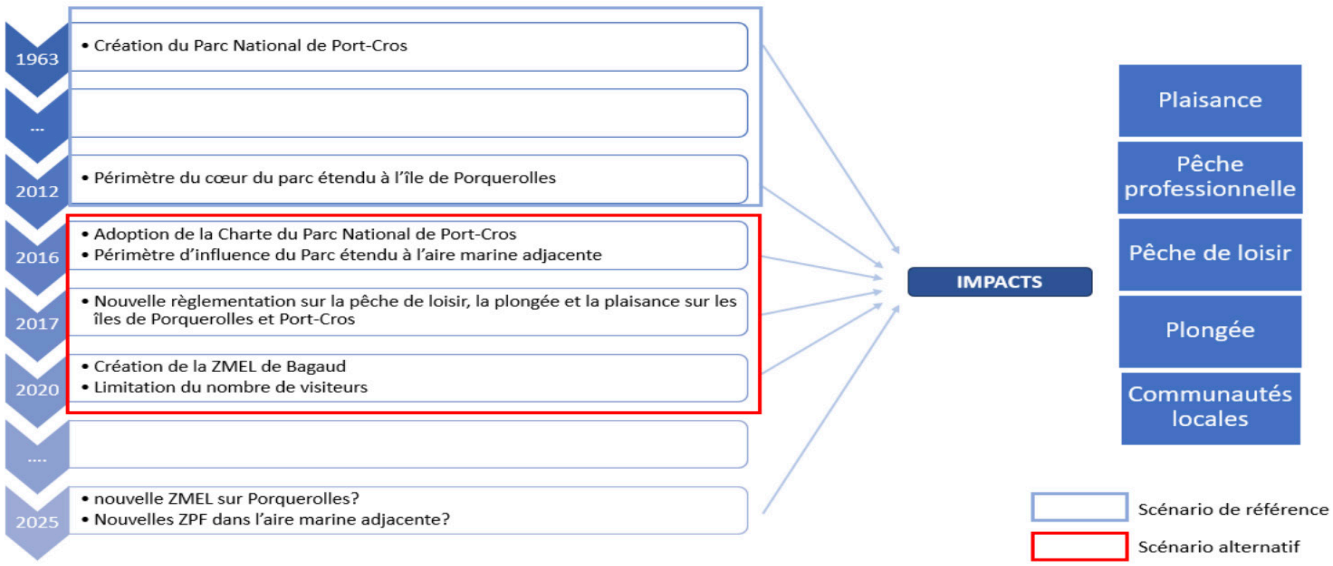
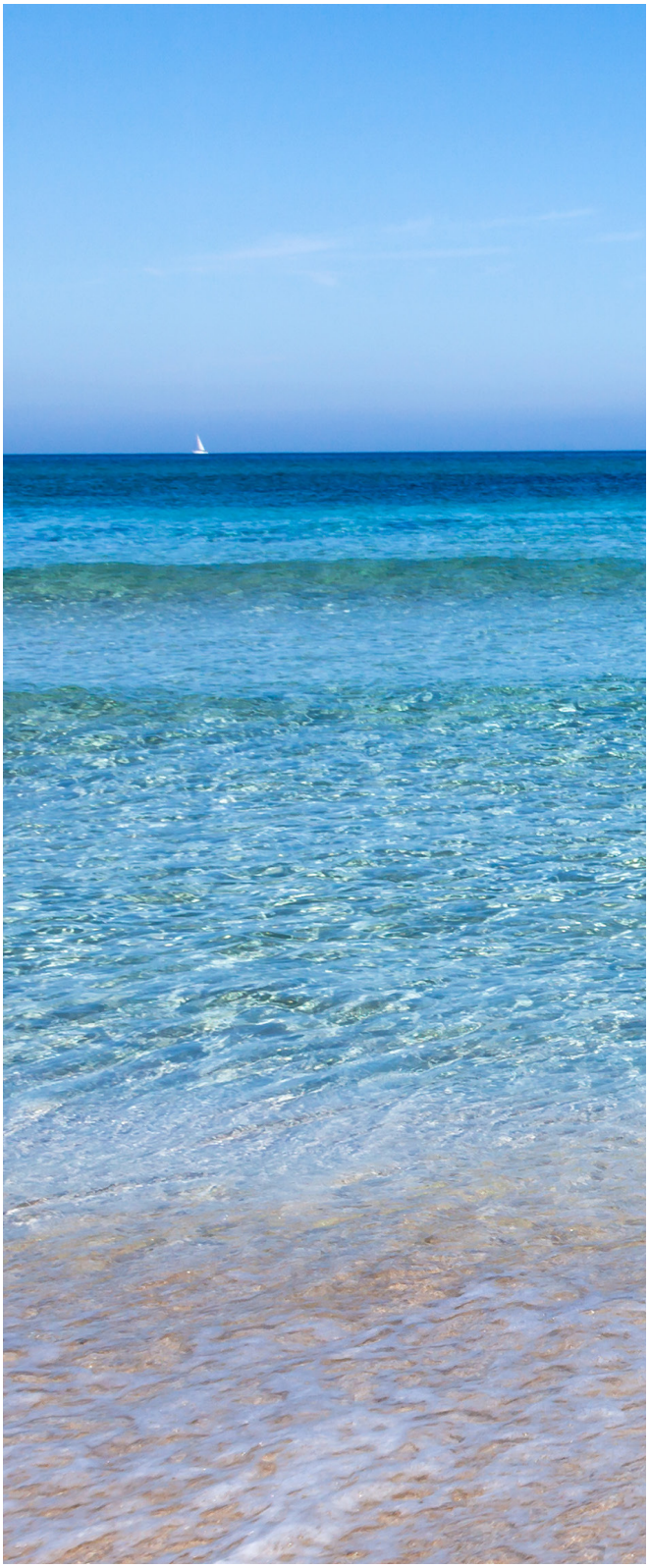


Figure 34 Analysis framework for the PNPC study

In addition, two very one-off studies will be included in the analysis:

- The impact of the mooring area on the economic sectors;
- Expected impacts of the implementation of new highly protected areas in the adjacent marine area.

The analysis is based on documentation provided by PNPC and semi-structured interviews with economic stakeholders whose activities are located in PNPC core. Most of the documents and interviews concern three areas: the island of Porquerolles, the island of Port-Cros and the Bagaud mooring area. Very little information was collected on the adjacent marine area. The adjacent marine area has only been in existence since 2016, and PNPC does not impose any specific regulations in this area. Very recent studies have begun to be carried out, in particular a consultation study on economic activities in the adjacent marine area, which began in 2020 [52], but which has not produced reliable results since the consultation part was not carried out due to the Pandemic. Results on both the ecology and potential management costs of this area, which is more than 10 times the size of the PNPC cores, would be useful to compare HPA and non-HPA areas, to help PNPC in its process of establishing new HPAs in PNPC.



3. DIRECT COSTS AND BENEFITS

Management costs

Overheads

PNPC expenditure has been rising steadily since 2001 (Figures 35 and 36). This can be explained by a number of factors:

- Inflation and wage increases
- The integration of Porquerolles into the park core in 2012
- Inclusion of the adjacent marine area in 2016
- Development of restricted income (subsidies after calls for projects: European programmes, funding for local authorities for environmental protection or education, etc.). This restricted income accounted for around 40% of the PNPC budget in 2023.

52 Usage planning in the adjacent marine area of Port-Cros National Park, study by Indivisible (consulting firm)

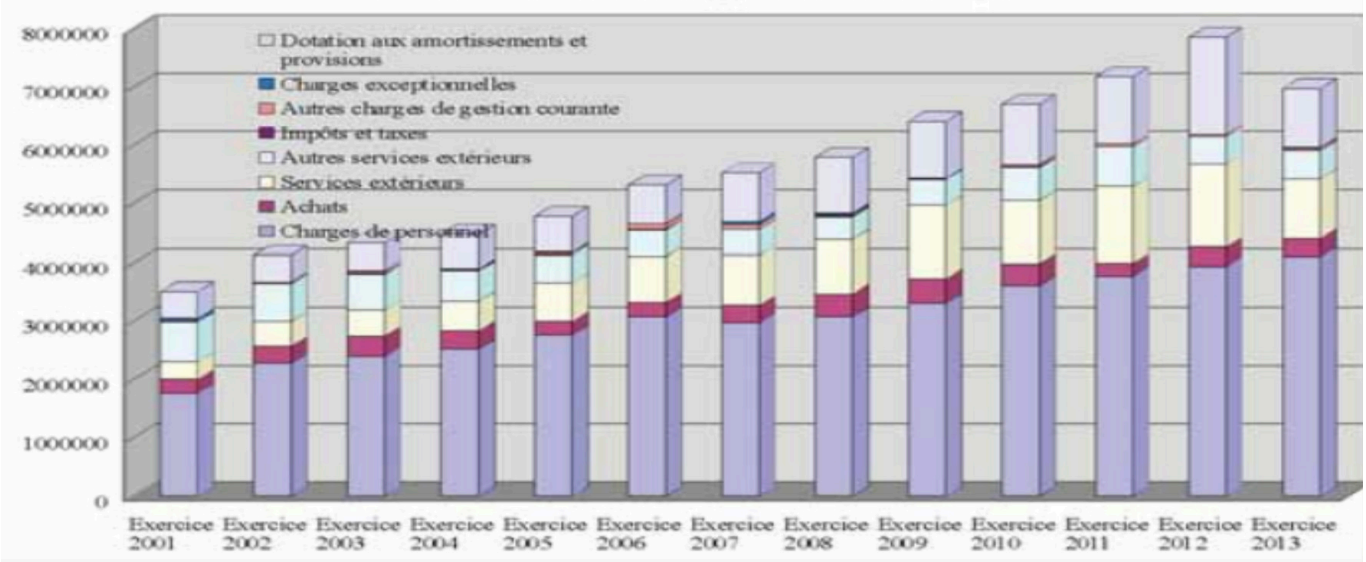


Figure 35 Change in overheads from 2001 to 2013 for PNPC [53]

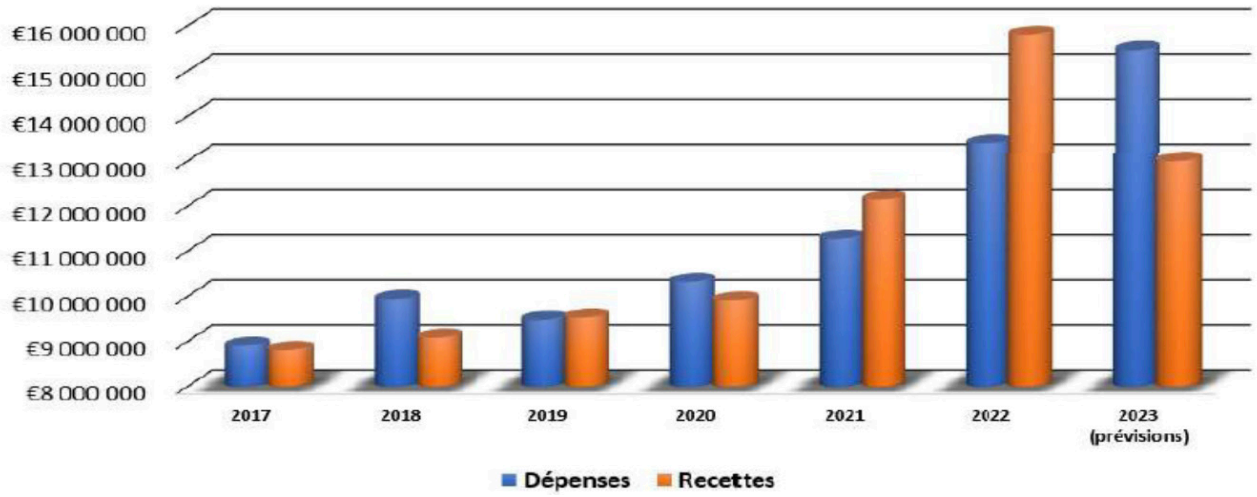


Figure 36 Change in overheads for PNPC from 2017 to 2023

53 Compte-rendu d'activité du PNPC de 2013

Total overheads for PNPC, which provide data for the baseline scenario and the alternative scenario, are difficult to compare between the years prior to 2016 and post-2016 (2016 being the year of transition to the new standard), as the presentation has changed since the transition of public institutions to a presentation subject to French public accounting rules known as GBCP. As indicated by the PNPC's CFO, data will generally be difficult to compare between 2001 and 2022.

PNPC income

Income for PNPC is mainly from public funding, with the OFB (formerly AFB) accounting for the vast majority. There has been a decline in French public funding since 2013 (from 72% in 2013 to around 60% in 2019). European funding now accounts for a larger share of PNPC's operating income.

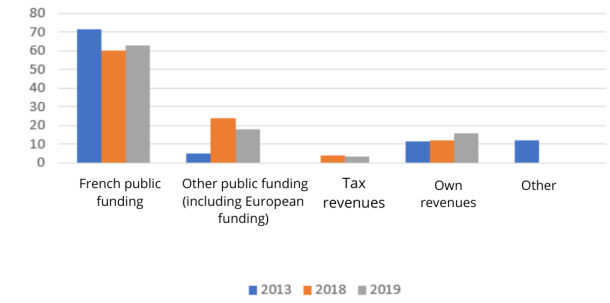


Figure 37 Comparison of PNPC income in 2013, 2018 and 2019

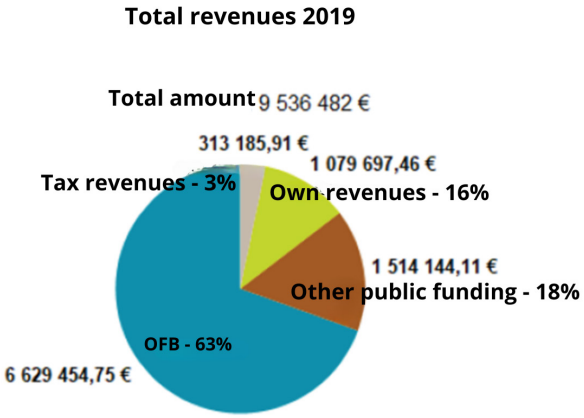
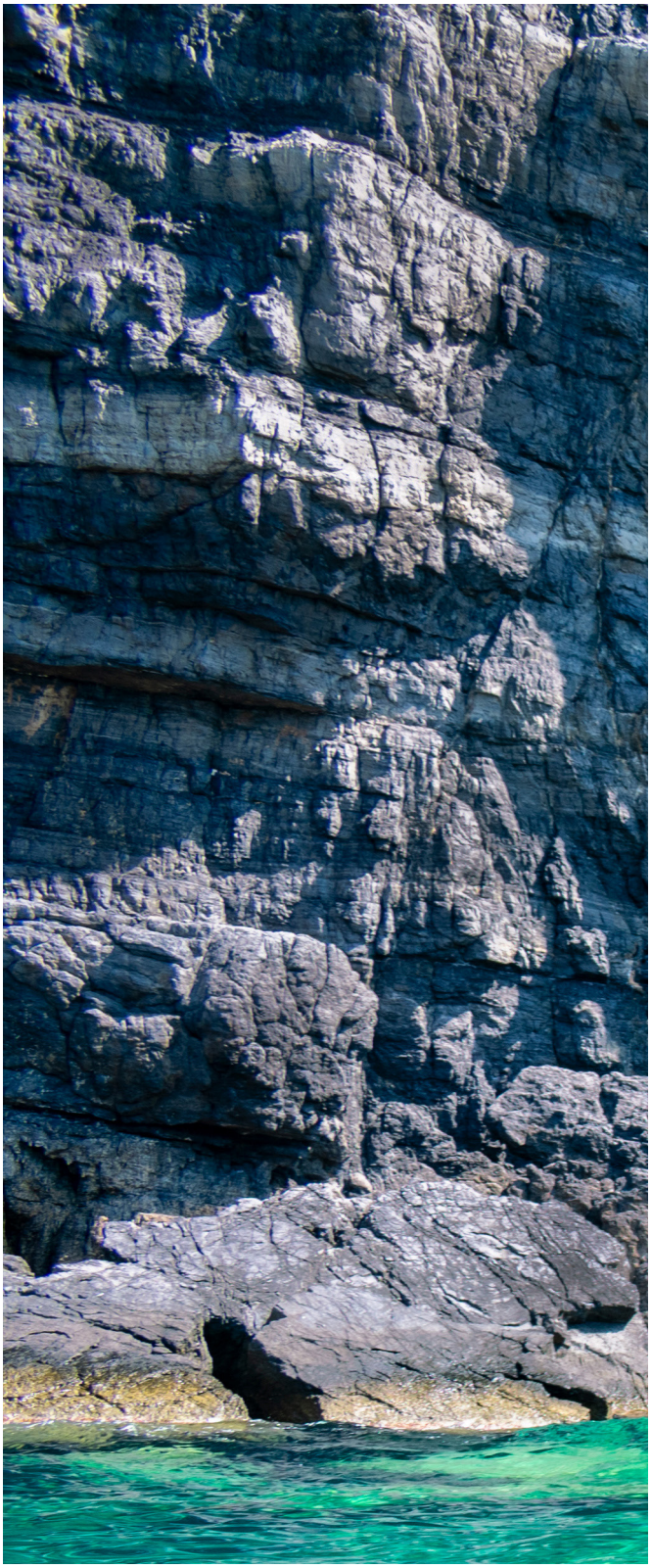


Figure 38 Breakdown of income by source in 2019



A detailed description of the source of PNCP income was found in the 2018 activity report and is provided in the box below.

Description of PNCP expenses in 2018

Subsidies from AFB (formerly OFB) accounted for 60% of the park's operating income. By its very nature, it is an annual operating subsidy intended to cover the operator's payroll and overheads without distinction. In 2018, the park received €5.45 million, the same amount as in 2017.

Other government funding accounted for 14% of income. This was mainly income received for capital expenditure programmes: Fort du Moulin, Fort du Pradeau. CBNMed also provided annual operating subsidies in the amount of €200,000 (DREAL) and €500,000 (MTES).

Other public funding accounted for 10% of the institution's income. It consists of restricted income granted by public institutions, local authorities, etc. Some of the CBNMed income is paid by local authorities in the form of grants. These amounted to €0.92 million in 2018, compared to €1.19 million in 2017.

Tax revenue accounted for 4% of the institution's income. This was from the French "Barnier" tax, payable by public maritime transport companies. It was introduced by French Act no. 95- 101 of 02/02/1995 on the reinforcement of environmental protection. It is based on the number of passengers travelling to sensitive areas, and is collected at the time of embarkation. In 2018, it amounted to €332,000 compared to €323,000 in 2017, an increase of 3%.

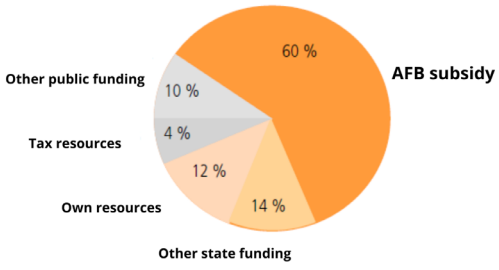
The park's own resources accounted for 12% of its income. They relate to income earned through the institution's 3 companies (€342,000): the Port-Cros boutique, the Port de Port-Cros office and the Porquerolles boutique, which include cash services, port fees, publications, merchandise sales, overnight stays and entrance fees. These resources also include Port-Cros harbour dues paid by carriers (goods/passengers) which come into the Port-Cros harbour, income from leases and other rentals (royalties from winegrowers' leases, permits for temporary occupation of the public domain in Port-Cros, various rents, etc.) and miscellaneous income (reimbursements from CPAM or civil pensions, etc.). Income from offsetting measures connected to CBNMed projects is also included under this item.

Expenses related to the protection of marine ecosystems

It is difficult to establish the operating budget of the PNPC dedicated to the marine protected area and the protection of marine ecosystems. Most of the Park's activities, such as awareness-raising and monitoring, also include activities carried out on the islands of Port-Cros and Porquerolles.

Since 2020, the PNPC has been involved in producing the "Maritime Policy" Cross-cutting Policy Document, which is an appendix to the French Finance Act. For this purpose, "sea-based" expenditure was taken from the overall PNPC budget. No such data are available for earlier years. These data dos not include payroll expenses. The budget for management of the marine protected area was the same in 2021 and 2023, but lower in 2022.

Nature of operating revenues of the institution



	2021		2022		2023	
Catégorie	AE	CP	AE	CP	AE	CP
transport naval	61 796 €	61 796 €	65 559 €	65 559 €	72 000 €	72 001 €
Renouvellement de la flotte	77 287 €	- €	77 956 €	155 243 €	110 000 €	110 000 €
plongée	17 068 €	17 068 €	14 766 €	14 767 €	15 500 €	15 500 €
études scientifiques	240 176 €	115 562 €	218 797 €	215 000 €	220 000 €	220 000 €
gestion des aires marines protégées	220 385 €	240 612 €	186 065 €	163 368 €	183 000 €	239 966 €
	616 712 €	**435 039 €**	**563 143 €**	**613 937 €**	**600 500 €**	**657 467 €**

Table 11 PNPC "sea-based" expenditure [54]

KEY:

AE: "Commitment authorisations" (AE, for autorisations d'engagements) are "the upper limit of expenditure that can be committed"

CP: payment appropriations (CP, for crédits de paiements) are "the upper limit of expenditure that can be scheduled or paid during the year to cover commitments entered into within the framework of commitment authorisations"

The PNPC annual budget for the protection of the marine protected area is therefore between €600,000 and €660,000.

Income generated by PNPC: focus on the Bagaud mooring area

The Bagaud mooring area (ZMEL) is one of PNPC's flagship measures for preserving Posidonia seagrass. The current mooring area covers 176 ha and has 68 buoys. Anchoring outside this mooring area is prohibited from 15 April to 15 October, and booking is mandatory. Its implementation cost €670,000 EUR, two-thirds of which was financed by public funding. Rates depend on the number of nights.

The cost of buoy maintenance (€400-500 per year per buoy), replacement and personnel costs must be deducted from the income generated. At the feedback workshop, it was pointed out that the mooring area's overnight rate was enough to cover operating costs, but that there was no profit for PNPC.

Nombre de nuitées consécutives	1	2	3	4	5
TB x m²	TB x m² x 1	TB x m² x 2	TB x m² x 4	TB x m² x 8	TB x m² x 16
Exemple : navire de 10m (30m²)	17,40€	34,80€	69,60€	139,20€	278,40€

Table 12 Rates for overnight stays in the Bagaud mooring area [55]

Income can estimated from the data on the mooring area visitor numbers provided in the table below.

	2021	2022
Visitor numbers to the mooring area		
15/04 - 15/10	33%	30%
01/07 - 31/08	59%	66%
Average number of vessels (night)		
15/04 - 15/10	21	19
01/07 - 31/08	38	42
Number of overnight stays booked		
15/04 - 15/10	3,780	3,420
01/07 - 31/08	2,228	2,438
Number of bookings	1,977	2,219
of which 1 night	*1,769*	*2,023*
of which 2 nights	*173*	*175*
of which 3 nights	*27*	*19*
of which 4 nights	*8*	*2*
of which 5 nights (maximum)	*0*	*0*
Average vessel size (July-August)	11.93 m	11.97 m
of which 0 - 10 m	*428*	*557*
of which 10 - 15 m	*1332*	*1423*
of which 15 - 24 m	*196*	*212*
of which 24 - 30 m (maximum)	*21*	*27*
Number of nights with wind > 4 Beaufort (July-August)	10	5
Income generated	€94 k	€98.4 k

Table 13 Visitor numbers for the Bagaud mooring area in 2021 and 2022

54 Figures provided by PNPC CFO

55 https://www.portcros-parcnational.fr/fr/des-decouvertes/sejourner/la-zmel-de-bagaud

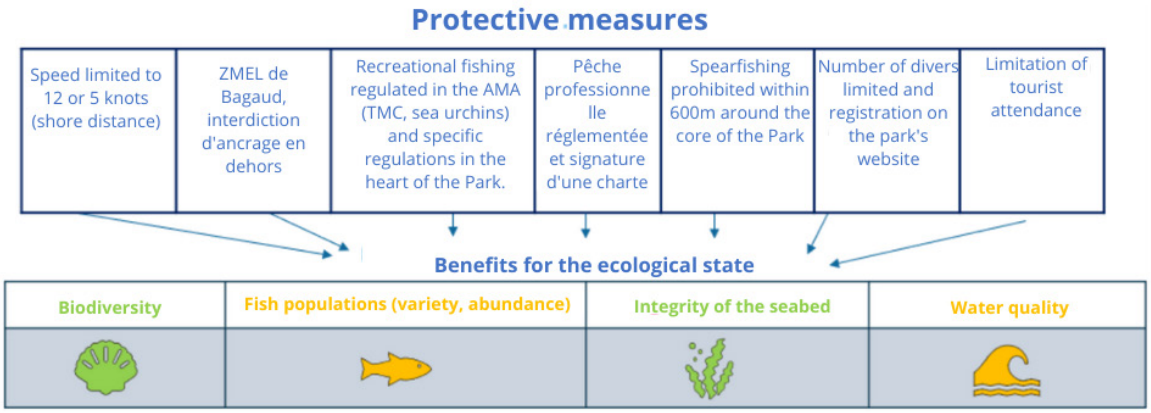
In particular:

- 60-70% of bookings are concentrated in July and August;
- Visitor numbers were slightly down in 2022 across the whole season, but higher in summer than in 2021 (+12%). The number of nights when the wind was less than 4 on the Beaufort scale may explain this phenomenon;
- 9 out of 10 bookings were for a single night;
- 99% of vessels stay less than two nights;
- No vessels stayed for 5 nights (maximum allowed by the regulations);
- The average size of vessels using the mooring area at night is 12 meters. Around 65% measured between 10 and 15 metres. A quarter were under 10 metres. 1 in 10 vessels measured more than 15 metres. 1 in 100 vessels was over 24 metres (and under 30);
- The average cost per overnight stay is between €25 and €30.

Given the figures for visitor numbers in 2021, the economic estimate mentioned earlier in the document, which estimated the number of occupied buoys at 90% rather than 60%, should be qualified. With this occupancy rate, an average length of 12m, an average cost of between €25 and €30 per night, 19 vessels on average in the low season and 42 in the high season, annual income for the mooring area would be around €100,000.:

4. INDIRECT COSTS AND BENEFITS

The figure below summarises the relationships between protection measures, ecological benefits for the status of the environment and the impacts of these measures, according to the socio-economic analysis carried out for the Port Cros National Park.



Impacts des mesures de protection et de l'état des milieux sur les activités socio-économiques

	Recreational fishing	Professional fishing	Diving	Boating	Education and research	Tourist activities and swimming	Society and local communities
Benefits derived from the state of the environment	Greater enjoyment of fishing (more and larger fish)	Increased catches per unit effort, benefit from the reserve zone	More divers with more enjoyment	Greater pleasure and more tourists wanting to see the benefits	Increased opportunities for research, education, and awareness of users and tourists	Improved water quality for bathing	Carbon sequestration
Constraints generated by protective measures:	Fewer catches per fisherman and fewer fishermen, online registration	Obligation to register, no additional license for gangui fishing	Very high attendance, online registration	Obligation to moor in ZMEL, ZMEL night rate		Loss of ZMEL restaurant customers, limitation of the number of tourist transfers	Tourist overuse

Figure 39 Summary of analysis results: relationships between protection measures, ecological benefits for the status of the environment and the impacts of these measures on economic sectors

The following paragraphs provide all the information and data collected to support these relationships, presented by economic sector, as well as the economic assessments of the costs and benefits associated with these impacts. For easier reading, sectors with a minor or insignificant impact have been grouped together in the same section.

5. BENEFITS OF PROTECTION MEASURES FOR BIODIVERSITY AND ECOSYSTEMS

MEASURES

Impacts on biodiversity and ecosystems are attributable to the synergistic action of all protection measures.

IMPACTS

Water quality

Water quality is determined by the living processes that regulate the chemical conditions of salt water. The measures put in place under the WFD and the MSFD are helping to protect water quality, but it is still under threat from polluting activities such as agriculture and industrial discharges.

In PNPC, the main sources of water pollution are nitrogen from land-based sources [56] from towns like Hyères, pollution from pleasure boats based in the AMA and the Bagaud mooring area[57] and, more occasionally, pollution from marine sources (e.g. the 2018 oil spill)[58].

The PNPC 2023-2032 Scientific Strategy highlights the role of PNPC in various aspects of pollution, including: recording pollution impacting the Park core, particularly large-scale chronic pollution (e.g. macro-waste), facilitating (rather than managing) accidental pollution (hydrocarbons), noise pollution (through regulations), light pollution, acoustic pollution with scientific studies, health pollution with the implementation of the mooring area and the "clean boat" policy. This strategy is detailed in the table below.

Marine Area pollution	Role of the park	Management cost	Cost of degradation
Large-scale chronic pollution	Records	Monitoring activities	n/a
Accidental pollution (hydrocarbons)	Facilitation	Provision of personnel on an occasional basis	Loss of tourists, beach closures, cost of ecosystem rehabilitation
Noise pollution	Scientific monitoring	Costs of studies and equipment	n/a
Health pollution	Enforcement	Implementation of a "turn-over" policy for the Bagaud mooring area	Potential loss of tourists

Table 14 PNCP 2023-2032 Scientific Strategy in relation to different sources of pollution

56Focus Group with Port-Cros National Park managers, 4 September 2023.

57 Interview with André de Marco from the association Les Amis de Porquerolles

58 Interview with André de Marco from the association Les Amis de Porquerolles

As far as water quality is concerned, Port-Cros National Park is part of the "FRDC07H - îles d'Hyères" coastal water body, and is monitored in accordance with the WFD and the MSFD.

The status of water quality [59] is presented in Table 15, illustrating the good status of water compared to neighbouring bodies of water (Alpes-Maritimes and Bouches-du-Rhône).

		2017
Chemical status	Chemical contaminants, heavy metals, pesticides, industrial pollutants	Very good status
Physical and chemical status	Dissolved oxygen, transparency (please note that specific pollutants and nutrients that describe pollution of agricultural origin have not been taken into account)	Very good status
Hydromorphological status	Hydromorphology	Very good status
Biological status	Angiosperm, macroalgae, benthic invertebrates, phytoplankton	Good status
Overall status		Good status

Table15: Water quality in Port-Cros National Park

In addition, bathing waters are an essential indicator given the importance of tourism in PNPC. They are considered to be of excellent[60] quality, with the exception of the north-east of Porquerolles Island (where the port is located). This is a matter of concern for local residents[61] who have noticed a deterioration in water quality, particularly in terms of health, due to the increasing number of pleasure boats in the park cores. PNPC has sought to tackle the issue, which led to the creation of the Bagaud mooring area and ongoing consultations to expand its perimeter around the island of Porquerolles.

In this sense, it can be said that the Bagaud mooring area has a positive impact on water quality, even though this impact cannot be quantified.

However, it is difficult to establish a clear link with protection measures and there is little scientific literature on this case study. It was also not mentioned much in discussions with the stakeholders interviewed.

Due to project deadlines, and given the large number of factors involved in determining water quality, more detailed information was sought from monitoring data available online (WFD and MSFD measurements, monitoring data, MSFD pressure analysis, etc.). The weak link between protection measures and water quality was confirmed and validated by PNPC managers during the focus group to consolidate and approve the results, based on their knowledge and experience.

Conservation status of Posidonia seagrass

Protecting Posidonia seagrass is one of the major ecosystem challenges facing PNPC (and the Mediterranean in general). They play an essential role in protecting against erosion and stabilising the seabed. They are also oxygen-producing carbon sinks and habitats for many species that indicate good water quality. Numerous studies are carried out by both PNPC and all players involved in Mediterranean ecosystems (Rhône-Méditerranée-Corse Water Agency, DIRM Méditerranée 2020 call for projects, etc.).

As early as 1983 [62], the degradation and protection of this seagrass became one of PNPC's priorities. Regular monitoring is carried out across the entire Adjacent Marine Area. The last two studies, dating from 2012 and 2019, show seagrass beds generally have a good status. However, the seagrass beds around the islands of Port-Cros and Le Levant had a worse status in 2019 than in 2012. It would be interesting to study the Port-Cros area in 2024 to assess the impact of the Bagaud mooring area on seagrass beds.

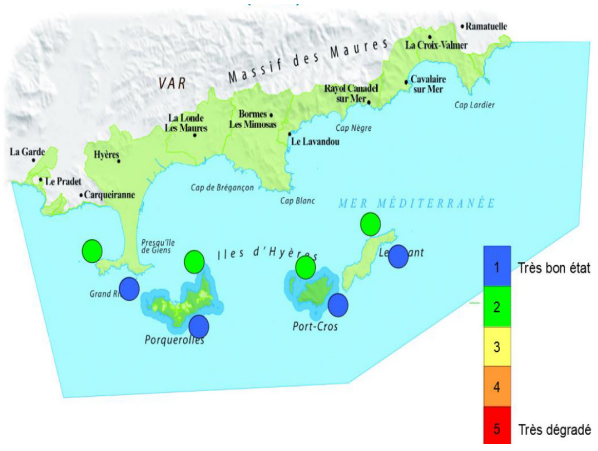


Figure 40 Conservation status of Posidonia seagrass in 2012

59 https://atlas-dce.ifremer.fr/map

60 https://baignades.sante.gouv.fr/baignades/homeMap.do#a

61 Interview with André de Marco

62 Robert (1983), degradation of Posidonia seagrass beds in the organised mooring area of the island of Port-Cros, PNPC scientific review.

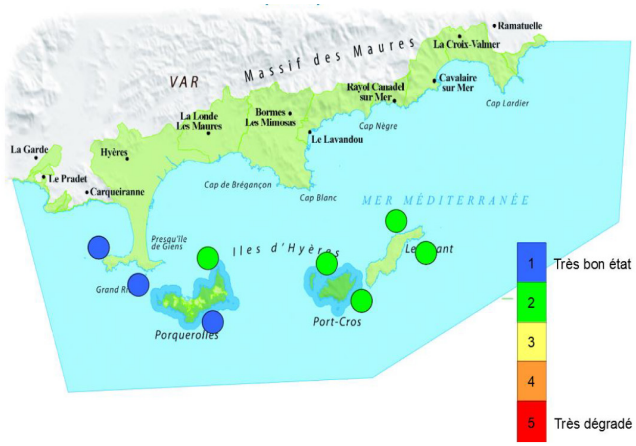


Figure 41 Conservation status of Posidonia seagrass in 2019

The status of the seagrass beds is impacted both by nautical activities (see section on socio-economic impacts) and by human activities on the mainland [63]. Indeed, as Figure 42 shows, the seagrass beds are in better condition on the south side than on the north side of the island. Several factors may explain this status, such as moorings closer to the mainland to avoid a longer journey, but also potential pollution.

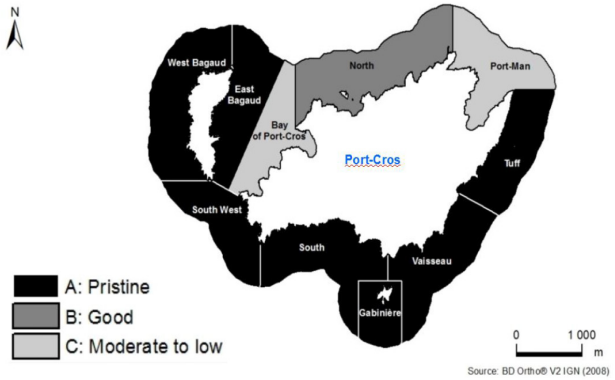


Figure 42 Conservation status of Posidonia seagrass around the island of Port-Cros

Fish stocks

Monitoring of the various species is carried out by the PNPC OBI1 observatory and university laboratories like at Aix-Marseille. The high value-added species found in the waters of PNPC include: fan mussel, lithophyllum byssoides, violescent and yellow sea whip, white gorgonian, deep Cystoseira forests, grouper, corb, spider crab, and red lobster, etc.

PNPC is also well known for numerous marine mammals and cetaceans, making it a popular spot for underwater divers while also highlighting the importance of monitoring noise pollution. PNPC also boasts a number of remarkable formations and habitats, such as biogenic and rocky habitats, marine or strong birdlife (special geomorphological structures, rocky and biogenic habitats and spawning grounds).

Regular monitoring by PNPC provides reliable data on fish populations. These populations have good status around the island of Port-Cros, but have a fairly critical status in the rest of the AMA (Figure 43). This highlights not only the positive impact of HPAs in protecting marine species, but also the time it takes for a HPA to have a positive impact on fish stocks. The island of Porquerolles became an HPA in 2010, and 6 years later, the status of fish stocks was still very poor

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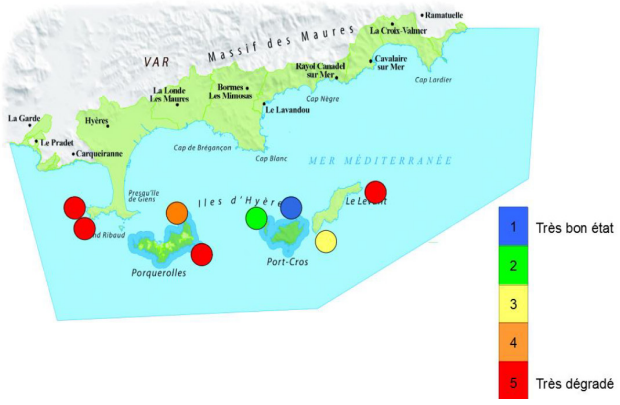

Figure 43 Conservation status of fish stocks in PNPC in 2016

GIS Posidonie carries out more detailed studies on the biomass of the islands of Porquerolles and Port-Cros by analysing their EBQI (ecosystem-based quality index). This ecosystem assessment work provides more in-depth scientific knowledge to improve MPA management with users. For instance, this makes it possible to justify catch quotas.

63 Focus group du 4 septembre 2023.

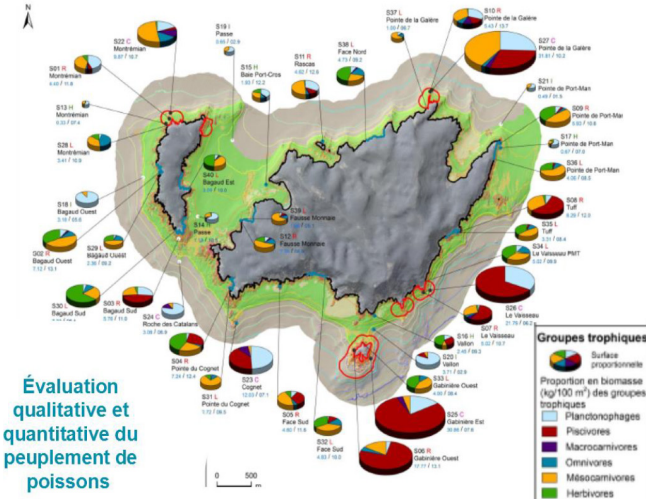

Figure 44 Port-Cros EBQI in 2021

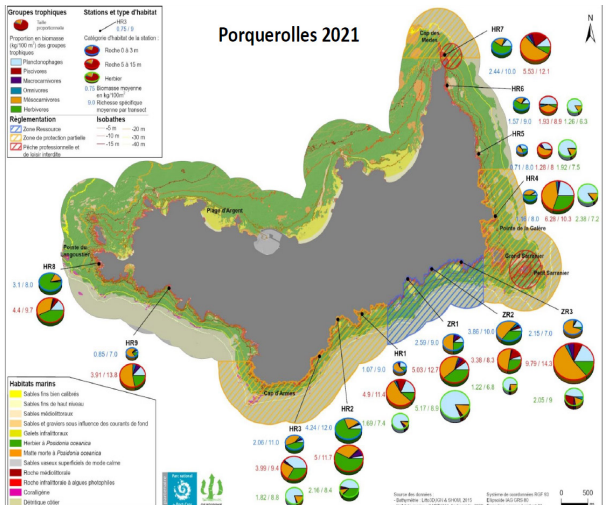

Figure 45 Porquerolles EBQI in 2021

Focus on grouper numbers

As a leading species for activities such as underwater diving, grouper stocks are carefully monitored. Grouper biomass increased slightly between 2012 and 2019 around the various islands in PNPC.

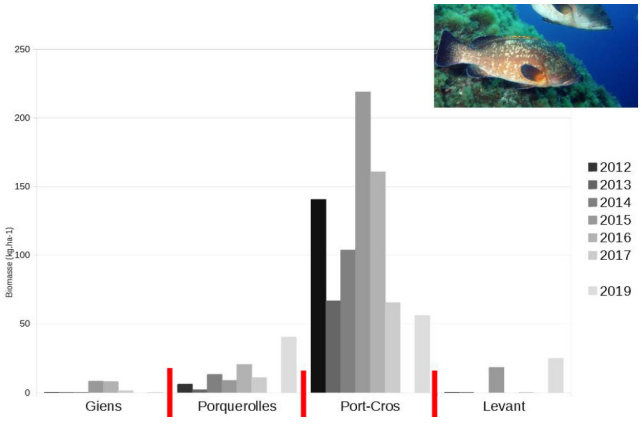

Figure 46 Dusky grouper biomass (2012-2019)

However, in examining the increase in biomass over a longer period (1970 - 2020 for Port-Cros in Figure 47), a very sharp increase in the species' population is observed, demonstrating the beneficial effects of MPAs. This has positive effects on certain economic activities, and underwater diving in particular (see next section on socio-economic impacts).

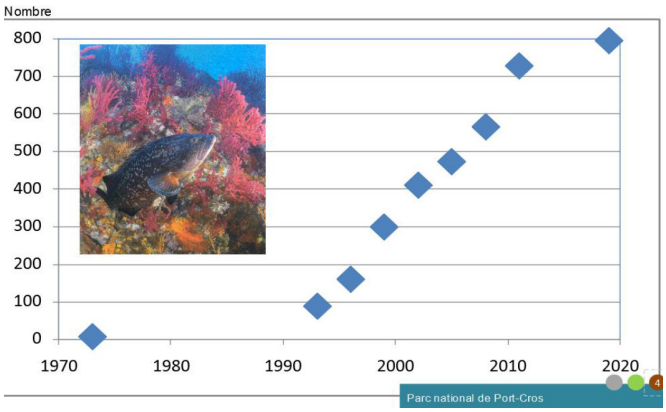

Figure 47 Dusky grouper numbers around Port-Cros (1972-2020)

Focus on corb numbers

Just like for the grouper population, corb numbers have risen significantly since the 1990s, showing the positive impact of MPAs on biodiversity.

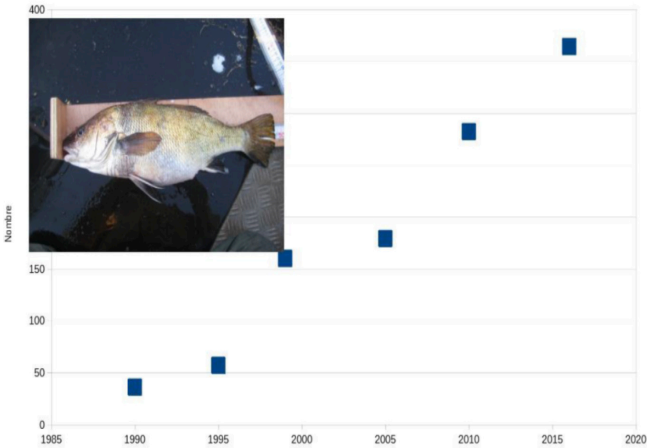

Figure 48 Corb numbers around Port-Cros (1990-2020)

The status of fish populations in the assessment scenarios and one-off studies

- Before and after 2016: comparing the figures showing changes in corb and grouper numbers in Port-Cros shows that the regulations on commercial and recreational fishing in the AMA will have a positive impact on fish biomass and populations. Figures 9 and 10 on the EBQI also illustrate the importance of creating a reserve (with a ban on fishing or other activities).
- Creation of the Bagaud mooring area: not applicable.
- Creation of other HPAs in the AMA: the impact of creating other HPAs in the AMA is essential for species protection, since regulations similar to those in the Park core would be applied (tight control of commercial and recreational fishing and catches).

COSTS AND BENEFITS

Economic assessment

The assessment of the benefits linked to biodiversity was able to draw on a study carried out by Parcs Nationaux de France in 2014, which estimated the heritage value of the protected areas in Port-Cros National Park. The study used a willingness-to-pay approach for residents of the PACA region to assess their preference for maintaining the protection and management of nature areas in Port-Cros National Park. The estimated value of the benefits was €40 per person per year (2014).

At the same time, it was considered useful to repeat the assessment exercise carried out for the Cerbère-Banyuls Nature Reserve, where the value transfer method was applied using the values obtained at Port-Cros in 2014, and the values identified in the literature and, in particular, the studies by Rojas-Nazar et al. (2022), conducted in New Zealand, and Börger et al. (2014), conducted in the UK.

Please recall that, in Rojas-Nazar et al. (2022) and Börger et al. (2014), the information taken from the various studies was provided in the currency of the country and for the year in which the study was carried out. It was therefore necessary to adapt these values. All values have been updated to 2022 using the consumer price index for the reference country (New Zealand and the UK). The values were then converted into 2022 Euros using the average exchange rate for that year. The values were then adjusted to the French context, based on the consumer price indexes of the different countries. This meant that the values obtained from the different contexts could be adjusted and transferred to France, so as to accurately reflect local purchasing power and socio-economic differences.

Calculations were made to estimate the benefits per person per year, and are provided in Table 16.

Study	Country/Context	Benefit per person per year (in EUR 2022)	Consumer price index 2022 - Initial study	Consumer price index 2022 - France	Transferred benefit per person per year (in EUR 2022)
Parcs nationaux de France (2014)	**FR – Port-Cros National Park**	**44.9**	**118.3**	**118.3**	**44.9**
Rojas-Nazar et al. (2022)	NZ - Taputeranga Marine Reserve	12.24	129.4	118.3	13.38
Rojas-Nazar et al. (2022)	NZ - Kapiti Marine Reserve	6.80	129.4	118.3	7.44
Börger et al. (2014)	UK - Dogger Bank	8.47	133.70	118.3	9.57

Table 16 Value transferred for the presence of biodiversity in MPAs

Based on the estimated values for Port-Cros, the value is €44.90 per person per year. Based on the values estimated in New Zealand and the UK, the average transferred value could be estimated at €10.13 per person per year - a value that can be considered a minimum threshold for benefits. Knowing that the Port-Cros Reserve has a population of 1.09 millions [64], the average value can be applied, and the benefits from the existence of biodiversity could be estimated at €48.7 million per year, with a minimum threshold of €11 million [65] per year.

Please recall that the benefit transfer process involves adapting the benefits drawn from other studies or contexts to make them applicable to the Port-Cros context. However, these benefits should be used with caution. Although the values have been adjusted, they may not accurately reflect the current situation and may over- or underestimate benefits in the current context. Perceptions of biodiversity can vary from one country to another, which can influence the way in which individuals assess the value of biodiversity and, consequently, their willingness to pay for its protection and preservation.

6. SOCIETY AND LOCAL COMMUNITIES

MEASURES

- Bagaud mooring area: The Bagaud mooring area (ZMEL) is one of PNPC's flagship measures for preserving Posidonia seagrass. The current mooring area covers 176 ha and has 68 buoys.
- No anchoring outside of this zone: Anchoring outside this mooring area is prohibited from 15 April to 15 October, and reserving a buoy is mandatory.

IMPACTS

Posidonia seagrass beds are one of the most important ecosystems in the Mediterranean, as they have a strong capacity to sequester carbon. Posidonia seagrass plays a major role in carbon sequestration, as one hectare of this plant currently stores up to 20,000 tonnes of carbon over 20 years.

Posidonia seagrass in PNPC covers the following area:

- Porquerolles: 876.72 ha
- Port-Cros: 448.37 ha
- AMA: 1,345.5 ha.

The status of seagrass conservation in the assessment scenarios and one-off studies

Before and after 2016: implementation of the Charter has had a positive impact on seagrass beds in the Park core and the AMA, as there have been increased regulations and controls on nautical activities.

Creation of the Bagaud mooring area: no scientific study has yet been carried out to quantify the impact of the Bagaud mooring area. However, as anchoring is the main threat to Posidonia beds, the impact on the seagrass beds is positive.

Creation of other HPAs in the AMA: the impact of the creation of other HPAs in the AMA is essential for the protection of Posidonia seagrass, since the project aims to establish these new HPAs around the main seagrass beds in the AMA.

64 Population of the Var department, - 2020 figures, and more precisely: 1,085,189 residents - https://www.insee.fr/fr/statistiques/2011101?geo=DEP-83

65More precisely: €48,724,986 per year, minimum threshold of €10,992,964 per year

COSTS AND BENEFITS

Assessment

The economic assessment carried out in Port-Cros in 2014 (Parcs nationaux de France, 2014) estimated the benefits of carbon sequestration at €22.4 million per year (figure adjusted to 2022 Euros).

However, to obtain comparable results for the two case studies, the value transfer method used in Cerbère-Banyuls was also applied to the Port-Cros case study, following the same steps.

Please recall that the values provided by Mangos and Claudot (2013) were used, converted into average annual values (see table below) and updated to 2022 Euros using the consumer price index (2010 - 2022) for each country (Tunisia, Spain, Turkey). The values were then adjusted to the French context, based on the consumer price indexes (2022) of the different countries. This meant that the values obtained from the different contexts could be adjusted and transferred to France, so as to reflect socio-economic differences.

The following table shows the average annual carbon sequestration benefit per hectare for the different scenarios transferred to the French context.

MPA	Average benefits associated with carbon sequestration transferred to the French context – EUR per ha per year		
	S1 – Business-as-usual scenario	S2 – Enhanced protection scenario	S3 – Reduced protection scenario
Kuriat Islands – Tunisia	1,395	1,447	1,291
PNCC – Spain	55	55	54
Kas Kerkova – Turkey	4,434	5,205	4,116

Table 17 Estimated average annual benefit per hectare (in Euros per year per ha for carbon sequestration, transferred to the French context).

Secondly, the values were provided for three protection scenarios, which meant that a decision needed to be made regarding the values used for the current study. Two cases are considered here:

- Case 1: the benefits estimated in the study do not differ significantly for each context. For example, in the case of the MPA in Spain, the variation in benefits is less than 1%, while in Tunisia it is around 5%, and in Turkey it is almost 10%. Consequently, there is no significant distinction in carbon sequestration benefits between the different scenarios. The average benefit of carbon sequestration could therefore be estimated at €2,066 per year per hectare. Given that the Port-Cros Reserve covers 4,600 hectares, the benefit of carbon sequestration in the reserve could be valued at around €9.2 million per year.
- Case 2: in this case, only the values of the second scenario with enhanced protection are taken into account. The average carbon sequestration benefit can therefore be estimated at €2,236 per year per hectare. Applying this benefit to the context of Port-Cros Reserve, the benefit of carbon sequestration could be estimated at €10.2 million per year.

The estimated benefit of carbon sequestration with the value transfer to Port-Cros is therefore between €9.2 and €10.2 million per year.

These estimated benefits are less significant than the benefit of carbon sequestration estimated in the study for Port-Cros (Parcs Nationaux de France, 2014). This difference could be linked to the various uncertainties involved in value transfers from one context to another, such as socio-economic, environmental and methodological variations.

7. COMMERCIAL FISHING

MEASURES

The commercial fishing sector is heavily impacted by the implementation of an HPA, since it changes practices by limiting the number of catches, restricting types of fishing gear, or the number of licenses, etc. However, PNPC has been careful not to negatively impact the small number of commercial fishers through overly strict regulations. While no new fishing licenses have been issued, licenses have been maintained for fishers who previously fished in the PNPC core.

Since 1999, a charter has been in place between PNPC and commercial fishers [66], setting limits on the number of vessels, net size, the authorised period for certain techniques, and the closure of certain areas reserved for other activities such as swimming, underwater diving or underwater trails. Under the charter, fishers are also required to declare catches in a fishing logbook, which must be submitted to PNPC every year.

66 Laurence Le Diréach, Charles-François Boudouresque, Patrick Bonhomme, Gwenael Cadiou, Melanie Ourgaud, et al.. Exploitation des ressources halieutiques par la pêche artisanale dans et autour des aires marines protégées : socio-écosystème, conservation et gouvernance.

In addition, commercial fishing in the Port-Cros National Park core is regulated by the Prefectoral Order of 20 December 2013 concerning commercial fishing in waters within Port-Cros National Park around the islands of Port-Cros and the Order of 4 June 2019 regulating commercial fishing in waters within Port-Cros National Park around the island of Porquerolles and the surrounding islands. These two orders set out restrictions on use and the issuing of commercial fishing permits.

IMPACTS

Impact on the number of fishers

PNPC's policy on commercial fishing is not restrictive, since "maintaining fishing activity in the Park core on Porquerolles is compatible with the preservation of heritage provided that these activities are monitored and organised". The 2016 Charter notes a shrinking fleet, with around 62 vessels registered in 2014. On Port-Cros, fishing is only authorised for trolling, so little impact has been recorded.

One of the impacts is the creation of a fishing resource area on Porquerolles, but this was created in collaboration with commercial fishers. The Park submitted several proposals to fishers for areas of ecological interest, and the one in the south of the island was selected. The number of commercial fishers is not measured in the AMA. However, in 2021, the Var department had 223 registered fishers [67].

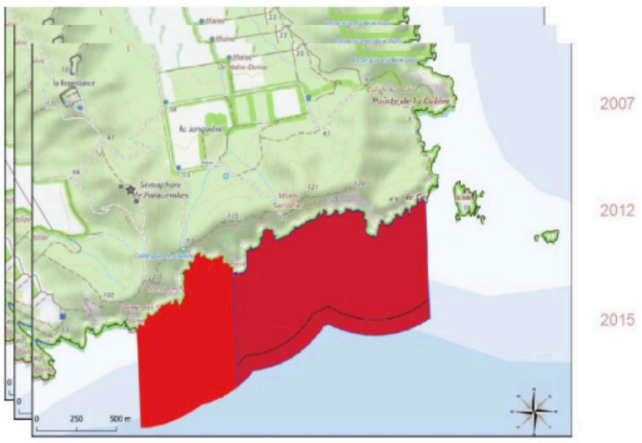

Figure 49 Porquerolles resource area

There are very few commercial fishers on the islands. There were 10 on Port-Cros and 14 on Porquerolles (down slightly from previous years, Figure 49).

This decrease can be put into perspective using the figures for the PACA region, where there was a 4.4% reduction in the number of "small-scale" commercial fishers in 2019 and a 4.6% reduction in 2020, from 670 to 640 [68].

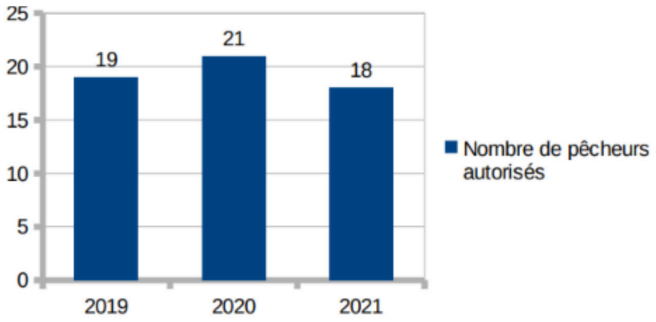

Figure 50 Number of licensed commercial fishers on Porquerolles

Impact on fishing yields

However, despite the implementation of the 2019 charter, questions are being raised about the effectiveness of the measures adopted, since the average yield of certain species is falling sharply on the island of Port-Cros after 15 years of implementing the charter[69]. The causes may be exogenous, such as the inflow of pollutants from the Bay of Hyères and Toulon, fishing and human activities in areas bordering PNPC, and chemical pollutants of agricultural and plastic origin. To ensure the effectiveness of a tool such as the PNPC Charter, it would be useful if marine environment protection policies (freshwater and marine) were designed and implemented with coherent objectives (bay contracts, DSF, SDAGE, for example).

67 https://eos.debatpublic.fr/wp-content/uploads/EOS-CA-CRPMEM-PACA.pdf

68 https://www.ocapiat.fr/wp-content/uploads/Dossier-Observatoires-Peche-chiffres-2020.pdf

69 Laurence Le Diréach, Charles-François Boudouresque, Patrick Bonhomme, Gwenael Cadiou, Melanie Ourgaud, et al.. Small-scale fishing in and around marine protected areas: socio-ecosystem, conservation and governance

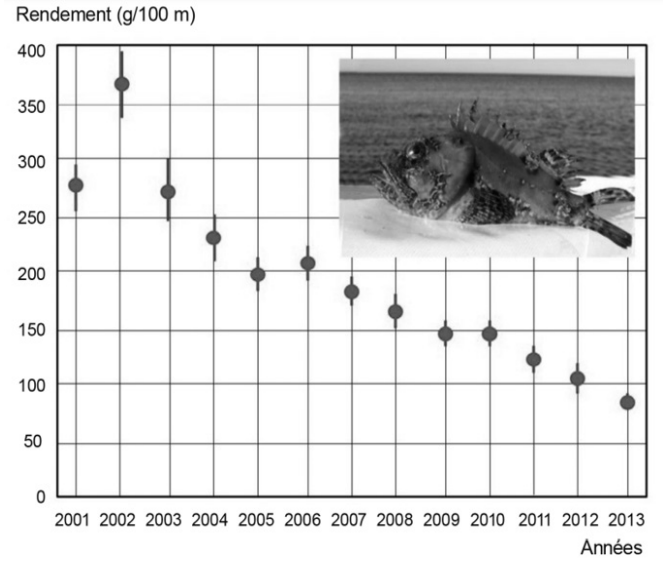

Fig. 7 – Évolution du rendement moyen (CPUE, grammes de MH par 100 m de filet) du chapon *Scorpaena scrofa*, entre 2001 et 2013, autour de l'archipel de Port-Cros. Données issues des carnets de pêche remplis par les pêcheurs artisanaux, dans le cadre de la charte de la pêche (données déclaratives). Barres : écart-type. D'après P. Bonhomme *et al.*, 2014, redessiné.

Figure 51 Change in average yield of red scorpionfish between 2001 and 2013 around the Port-Cros archipelago

More generally, there was a decline in the biomass fished from net fishing between 2016 and 2018 by commercial fishers (Figure 52). This can be explained by a decline in the number of fishers. However, if examined over a longer period (2000-2018), the quantity recorded is about average. Nevertheless, there has been a change in the species fished, with a sharp decline in cephalopods (squid, cuttlefish, etc.).

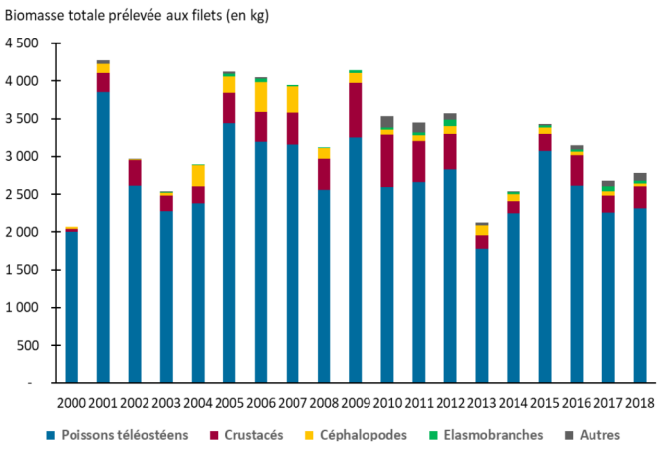

Figure 52 Total biomass fished using net

Analysis of catches per unit effort shows a sharp increase in the profitability of fishing trips since 2016 (Figure 53).

This suggests that the decrease in catches due to a decline in the number of fishers has made sea trips more profitable in 2018 compared with 2013, with a yield of 1.8 kg per 100 metres of net compared with 0.8 kg.

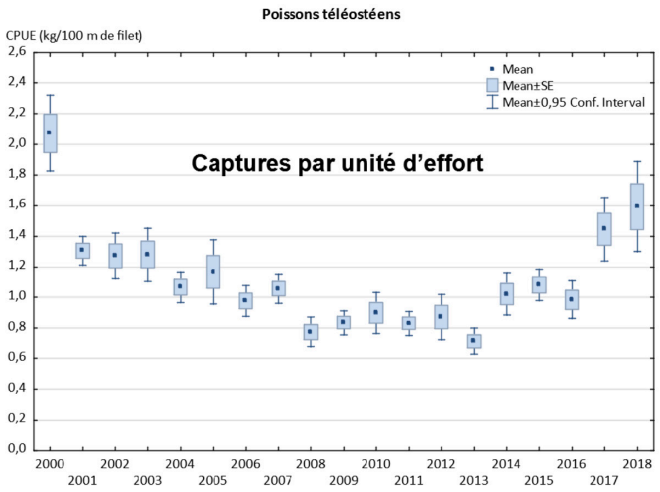

Figure 53 Catch per unit effort from 2000 to 2018

COSTS AND BENEFITS

Effect on fishers' income

As seen in the previous section, the impacts on commercial fishing are not obvious. On the one hand there is a decrease in the number of fishers and in the volumes caught, on the other hand there is a sharp increase in the activity's yield.

Given this uncertainty, and the lack of detailed data referring to the pre-1963 situation and the current situation, it is difficult to capture the impact of the reserve on commercial fishing and to assign it economic value.

However, this exercise was previously carried out by Landrieu (2013). Considering that Port-Cros was of interest to 10 to 20 fishers, he estimated the value fished that was directly linked to the reserve effect at €67,500 per year, which today could be worth around €76,000 per year [70] and constitute the upper range of the economic assessment.

70 Considering the following CPIs: 105 for 2013 and 118.3 for 2022.

For comparison, in 2018, around 2,800 kg of fish were netted and the catch per unit effort was 1.8 kg per 100 m of net, compared to 0.8 kg per100 m of net in 2013, representing a 56% increase. Income from the 2,800 kilograms of biomass fished in 2018 can be estimated and it can be assumed that 56% of this biomass is directly attributable to protection measures.

Considering the species fished in 2022 by recreational fishers (see Table 18) and assuming that the same species are fished by commercial fishers, the distribution of the 2,800 kilograms of biomass can be determined (see Table 20 - Column A). Using the market prices (see Table 19) for each species, the incomes of commercial fishers are obtained (see Table 20 - Column B). This means that in 2022, commercial fishers received a total income of €37,563. If 56% of this income is attributable to protection measures, the annual benefits of protection measures at Port-Cros for commercial fishers amount to €21,000 per year.

In short, the benefits for the commercial fishing industry range from €21,000 to €76,000 per year

Species caught by recreational fishers	2022	Share of total
Bonito	340	27%
Squid	57	5%
Common dentex	84	7%
Sargo	71	6%
Greater amberjack	281	22%
Comber	69	5%
Other	363	29%

Table 18 Species caught by recreational fishers

Species fished	Market price (€ per kg 2023)	Sources
Bonito	8	[1]
Squid	17	[1]
Common dentex	26.5	[3]
Sargo	14	[2]
Greater amberjack	14.74	[4]
Comber	8.2	[1]
Other	14.74	[4]

Table 19 Market prices for species fished

According to Réseau des Nouvelles des Marchés (RNM) de France Agrimer [1], data from Port de Vigo [2], https://moonfish.universita.corsica/article.php?id_site=45&id_menu=0&id_rub=597&id_cat=0&id_art=2544&lang=fr [3] and an average obtained from prices of other species [4]

	(A) Biomass fished (kg per year 2018)	(B) Income (€ per year 2022)
Total biomass	2,800	€37,563
Of which bonito (kg)	752	€6,020
Of which squid (kg)	127	€2,156
Of which common dentex (kg)	186	€4,930
Of which sargo (kg)	156	€2,191
Of which greater amberjack (kg)	622	€9,172
Of which comber (kg)	152	€1,250
Of which other (kg)	804	€11,844

Table 20 Calculation of income for commercial fishers

8. RECREATIONAL FISHING

MEASURES

Current protection measures include:

- The introduction of fishing quotas;
- An annual fishing permit ;
- Restrictions on certain tools and uses;
- Ban on octopus fishing;
- Obligation to declare catches in the PNPC fishing log.

IMPACTS

Impacts on the number of fishers

Permits are issued every year, and many applications are rejected. It can take 4 or 5 years to obtain a permit, which has to be renewed annually[71].

The number of new applications accepted changed from 50 to 25 as of 1 January 2016 (Prefectoral order of 2015). The number of permits for recreational fishing, which used to be around 400-420 per year, has decreased as a result of the new regulations, stabilising at around 320 per year. Many recreational fishing permit applications are rejected (around 150 per year), which is due to regulations (Figure 54).

71 Interview with Gaelle Urvoy.

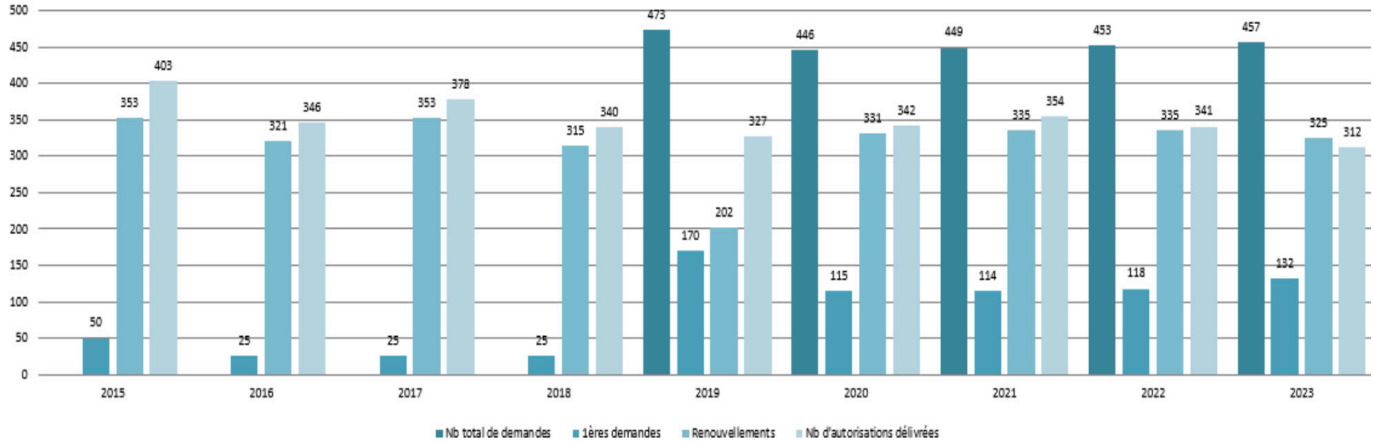

Figure 54 Change in recreational fishing permit applications from 2015 to 2023

The enjoyment of fishers can be observed through the number of fishing excursions per year. Without counting the year of the pandemic (2020), the number of fishing excursions is relatively constant, at around 1.9 excursions per recreational fisher. However, it should be noted that some fishers do not go fishing at all during the year, but renew their permit so as not to lose it.

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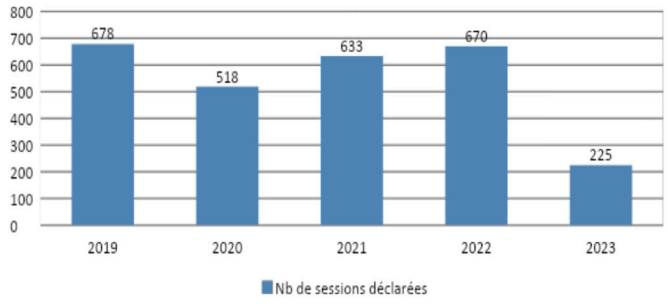


Figure 55 Change in the number of declared excursions

Impact of recreational fishing on fish populations

A drop in the total number of catches has been recorded since 2016, which may be due to the decrease in the number of recreational fishers between 2016 and 2019. The number of species has not increased since 2020, while the number of fishing excursions has.

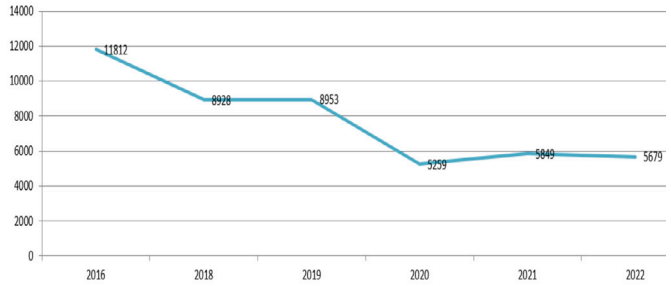


Figure 56 Change in the number of catches 2016 -2022

This decline also applies to the number of catches by species. Species that were most heavily fished in 2016 include the ornate wrasse and comber, as the number of catches decreased by more than half between 2016 and 2022 (Figure 57). On the other hand, the quantity of biomass caught in kilograms increased in 2022 (Figure 58), showing larger catches than in 2016.

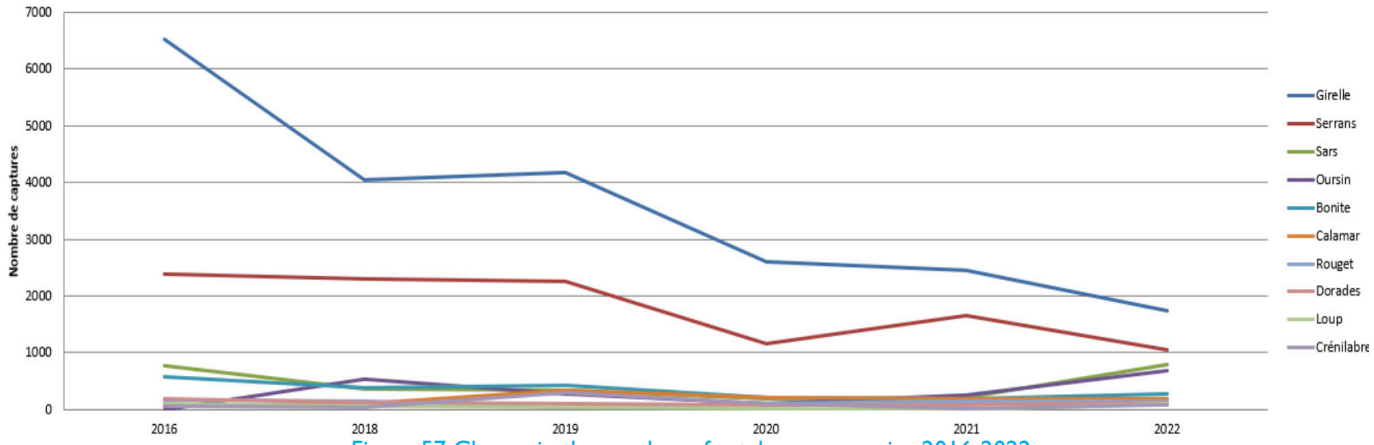


Figure 57 Change in the number of catches per species 2016-2022

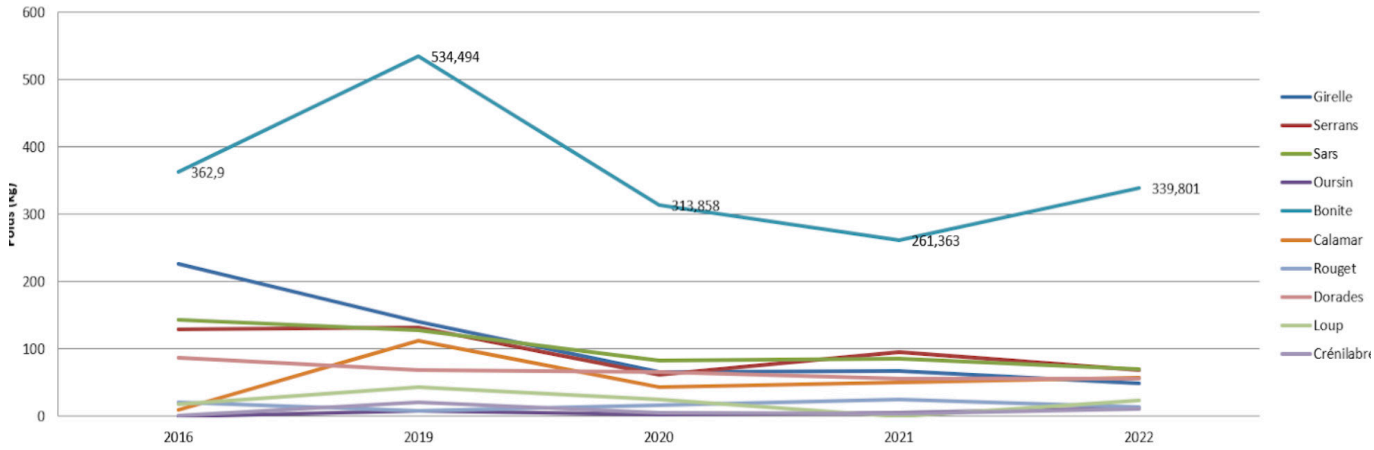


Figure 58 Biomass fished by species in kg 2016-2022

COSTS AND BENEFITS

Economic benefits of protection measures

The impacts of the protection measures on recreational fishing is not clear. While there has been a reduction in the number of fishers and catches (in numerical terms), the number of fishing excursions has remained stable over the years and the quantity of biomass caught increased in 2016.

For this reason, it has not been possible to determine whether protection measures generate benefits or costs.

9. UNDERWATER DIVING

MEASURES

Regulations on the islands are fairly restrictive:

- Only 40 divers are allowed per site;
- Dive centres and divers must register on CAPEL (dive logbook);
- Certain sites are off-limits for first-time beginner diving sessions.

Dives are mainly carried out on the islands of Port-Cros and Porquerolles, but there are other sites, particularly wrecks, in the adjacent marine area close to the coast.

The CAPEL logbook

Since 2016, regulations have required all PNPC underwater divers to register on CAPEL, the online dive logbook, to declare their dives and sign the Park's underwater diving regulations.

In particular, these regulations include:

- no feeding the fish,
- no turning over rocks,
- no coming into contact with the substrate or animal or plant species.

Dive centres must also register. In an interview with the manager of a dive centre, he stated that this did not generate any additional management costs compared to before 2016 and the implementation of CAPEL, since he previously had to record all dives on an Excel spreadsheet and send them to PNPC.

IMPACTS

Change in the number of underwater divers and dive centres

In general, dive centre managers seem to find the measures effective and without any negative impacts on their business, since the regulations limit conflicts (diving areas off-limits to pleasure boats) [72].

The number of dive centres has been relatively stable since 2004 (around 50), but strong growth can be observed in 2022, which may be due to the growing appeal of diving in France in general.

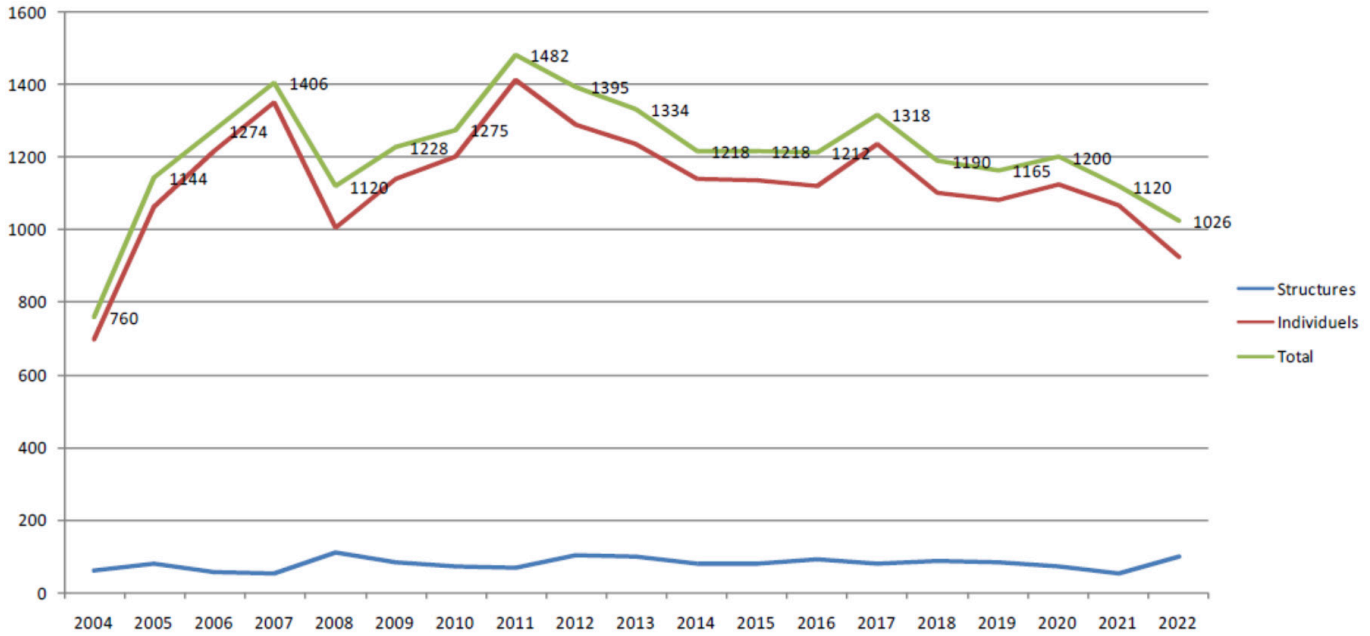


Figure 59 Change in the number of permits issued for underwater diving from 2004 to 2022

However, the number of divers has been falling since 2012. This can be explained by the relatively high cost of supervised diving compared to other sites in France (+/- €40 with private dive centres).

Diving on the Port-Cros sites costs divers around €45-60. AMA dive centres offering dives close to the coast charge more affordable rates (€40). There are many reasons for this difference, such as the cost of fuel to get to the islands and the appeal of diving in the Park core.

One of the Park's negative impacts on these dive centres is the difficulty in finding accommodation. The only diving site on Port-Cros (Sun Plongée) states on its website that it is difficult to organise a "diving holiday" due to the difficulty of finding accommodation on the island.

COSTS AND BENEFITS

Economic spin-offs of diving

Due to the lack of data, it was not possible to carry out an economic assessment of the economic spin-offs of diving.

72 Interview with Mirko Rosman, Manager of Bormes-plongée

10. VISITORS

MEASURES

The status of PNPC means that measures can be taken to limit the number of visitors, both for environmental reasons (pollution) and for the people who live on the islands. Therefore, since 2020, following a study carried out by the Park ("carrying capacity and conservation of the character of the island of Porquerolles" initiative launched in 2016) and a change in legislation, the number of visitors has been limited to 6,000 per day (previously there were peaks of over 10,000).

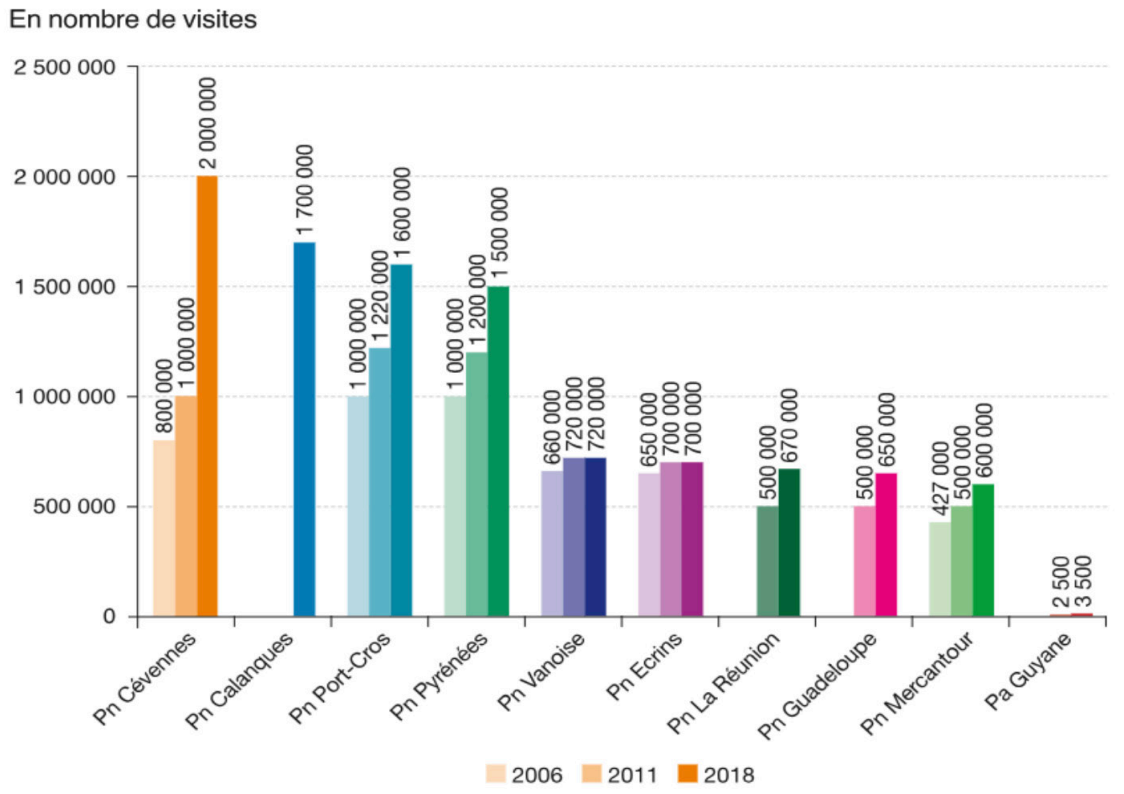
IMPACTS

Tourist numbers

Within PNPC, tourist numbers are strongly linked to beach quality, but as already observed in the Cerbère-Banyuls case study, the links between water quality and tourist numbers (and swimming in particular) cannot be easily demonstrated.

In the case of PNPC, there are no specific data on the number of visitors who come to the islands solely for swimming. However, it is reasonable to assume that most visitors are attracted by the environmental and scenic quality of the islands. Visitor numbers have grown steadily, from 1 million in 2006 to 1.6 million in 2018, largely due to the positive image associated with the ecosystems and distinctive nature of PNPC. Nevertheless, even with restrictions on visitor numbers, the islands are very small, resulting in overcrowding and a lower quality experience for visitors (see Figure 63).

Nevertheless, even with restrictions on visitor numbers, the islands are very small, resulting in overcrowding and a lower quality experience for visitors (Figure 64).



Note : Pn = parc national, Pa = parc amazonien.
Champ : périmètres d'étude de la charte, hors Parc national de forêts.
Source : Atout France, 2018. Traitements : SDES, 2020

Figure 60 Change in visitors numbers to French national parks between 2006 and 2018

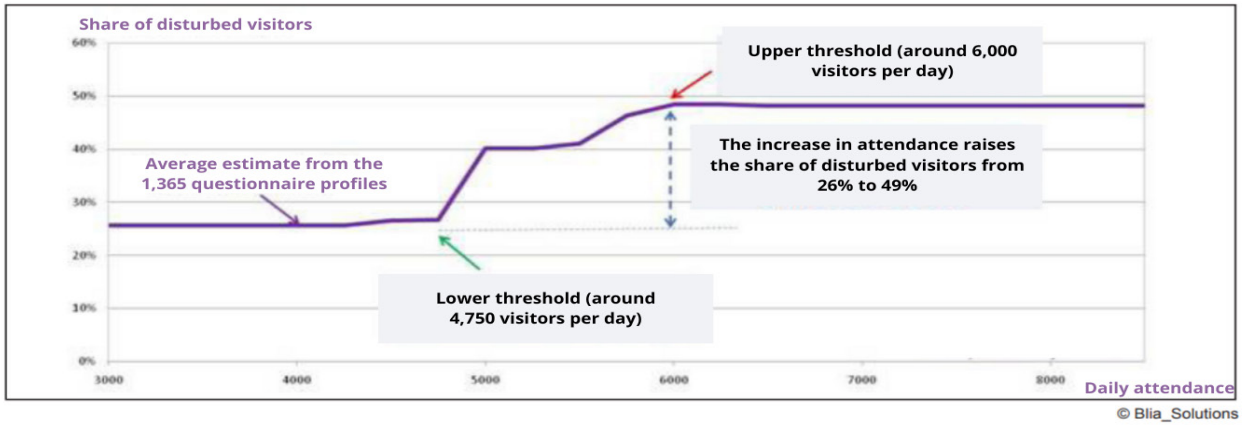


Figure 61 Carrying capacity limits in PNPC

Several impacts were studied during the consultation phases on the acceptable "carrying capacity" for the island of Porquerolles [73]. The positive impacts highlighted are the quality of life for local residents, flows of people in the villages, and the island's character.

COSTS AND BENEFITS

The introduction of a daily limit on the number of visitors, combined with the "protected area effect", has two effects:

- They help to attract visitors and improve the quality of their visit, generating economic spin-offs for tourism stakeholders (hotels, restaurants, recreational activities, etc.) and maximising the well-being of locals (improved quality of life on the island, waste management, flows of people towards the villages, access to drinking water and agricultural water, etc.) ;
- By limiting the number of people, a loss of income is observed for restaurant owners, hotels and maritime transport companies.

The economic assessment consists of two estimates: the commercial benefits linked to the economic spin-offs generated by visitors and the loss of income due to the limited number of daily travellers, and the non-commercial benefits linked to the improvement in visitors' well-being.

Economic spin-offs

In 2010, an economic study [75] estimated total local spending by the 1.1 million visitors to Port-Cros National Park at €106 million per year, estimating that 78% of this spending was attributable to the presence of the protected area [76], i.e. €83 million per year.

Using the same approach[77],it can be shown that in 2018 (the latest visitor figures available), the 1.6 million visitors generated €154 million in economic spin-offs, including €120 million per year directly linked to the presence of the protected area, which, converted into 2023 Euros[78], is equal to €142 million per year (€89 per visitor per year)[79].

At the same time, by limiting the number of visitors to 6,000 per day, a loss of income is observed and calculated as follows. The number of days on which transport is regulated is between 15 and 25 per year, i.e. an average of 20 days per year[80] during which an average of 2,000 visitors [81]are turned away.

73 Charlotte MICHEL et Valérie DELDREVE, La démarche de capacité de charge sur Porquerolles (Provence, Parc national de Port-Cros, France) : de la prospective au plan d'actions, 2019

74 Charlotte MICHEL et Valérie DELDREVE, La démarche de capacité de charge sur Porquerolles (Provence, Parc national de Port-Cros, France) : de la prospective au plan d'actions, 2019

75 https://www.parcsnationaux.fr/sites/parcsnationaux.fr/files/atoms/files/notevaleureconomiquebassedef2.pdf

76 Selon une enquête menée auprès de 600 visiteurs du Parc national de Port Cros, 7.8/10 est le facteur d'influence de l'aire protégée dans le choix de destination de vacances des personnes interrogées.

77 In other words, considering that for 1.1 million visitors the economic spin-offs from the protected area are €83 million, then those for 1.6 million visitors would be €120 million

78 Selon les Indices des Prix à la Consommation de 2010 et 2022 issus de : https://data.worldbank.org/indicator/FP.CPI.TOTL?locations=FR

79 Due to a lack of more precise data, the values presented here mix resident and tourist visitors.

80 Source:According to interviews with stakeholders and the website of the delegated passenger transport company https://metropoletpm.fr/actualites/frequentation-estivale-ile-de-porquerolles-iles-d-or-un-bilan-positif

81 Source: This is an average taken from interviews, the feedback workshop and DELDREVE and MICHEL (2019), showing that there are between 15 and 25 days when there are 8,000 passengers. Considering the 6,000 person limit, 2,000 people are denied access.

Therefore, the number of visitors turned away who will not generate any economic spin-offs can be estimated at 40,000 visitors per year, i.e. a loss of income of €3.6 million per year [82], which is just 3% of the benefits estimated above.

Improved visitor well-being

Visitors feel a sense of well-being as a result of their interactions with nature during their stay, generating non-commercial benefits linked to this experience. Data collected during the surveys carried out for the 2010 study can be used to assign a value to this benefit. Using the travel cost method, the authors estimate the social value of recreational use at €271 per person per visit (i.e. €321 per person per visit in 2023).

Considering 1.6 million visitors in 2018, the non-commercial benefits of visitor well-being are therefore estimated at €513 million per year, almost 4 times more than the commercial benefits.

11. OTHER SECTORS

Boating

MEASURES

Special regulations were put in place by a 2017 prefectoral order[83] with the aim of regulating speeds and prohibiting mooring in certain areas. These regulations aim to protect Posidonia seagrass beds and tourists present on the island to prevent views from being "spoilt by boats »[84]. On Port-Cros, anchoring is prohibited in the Bagaud mooring area, along the 300m strip to the north of the island, and in 7 dive sites. On these sites, speeds are limited to 3 knots, and 6 knots in the 300m strip and 6 knots between 300 and 600m.

On Porquerolles, navigation, anchoring and all pleasure boating activities are prohibited in the resource area and the south-eastern area of the island.

There are no particular restrictions in the AMA.

IMPACTS

Pleasure boating is one of the main challenges of PNPC and one of the main sources of conflicts of use[85] at sea around the islands and in the AMA. Boating is the most frequent use around the island of Porquerolles.

The regulations in place have a very limited impact on economic activities, as they are restricted to certain coastal areas around the islands and dive sites.

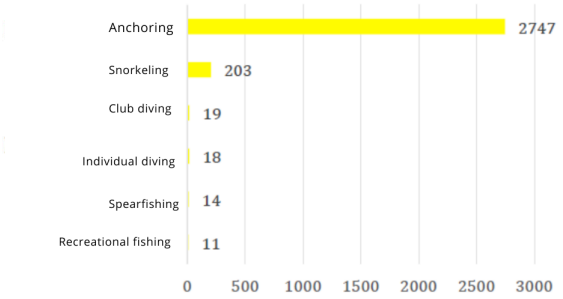


Figure 62 Offshore uses by type of activity in 2018. L. Fraxe, Source: OBi_1, PNPC

Building on its experience with the Bagaud mooring area, PNPC has launched a project, supported by the Rhône-Méditerranée-Corse water agency, to organise moorings in the marine park core around the island of Porquerolles - an area of around 1,500 hectares. Its main objective will be to preserve fragile marine habitats, in particular Posidonia seagrass beds, and to enable visitors to explore the national park territory in safe conditions and with peace and quiet. A consultation process is underway with users (see next section on socio-economic activities). Some 350 buoys, accommodating 750 boats, would be installed over the summer period. This would have a relatively limited impact, since there are only a few days a year when the number of boaters peaks at up to 1,000.

Commercial boating: passenger transport

MEASURES

The Park is taking regulatory action by limiting sailing hours (boat schedules in summer since 2020 in order to regulate the number of passengers).

On 6 July 2021, Hyères, Métropole TPM and Port-Cros National Park set up a system to regulate the number of passengers transported to Porquerolles (6,000 per day), based in particular on the new delegation of public service (DSP) for maritime transport on the Îles d'Or 2021-2025 and a charter signed by the

82 €89 per visitor per year * 40,000 visitors

83 Prefectoral Order no. 189/2017 of 5 July 2017

84 Interview with André de Marco, Porquerolles residents' association.

85 Anne CADORET, Conflictualité et capacité de charge au sein du Parc national de Port-Cros. Final report July 2019.

IMPACTS

Passenger transport is a sector closely linked to problems associated with CO2 emissions, accounting for 92% [87] of CO2 pollution on the island of Porquerolles, which comes from maritime transport. Avenues are being explored to transform internal combustion engines into electric motors, but this will entail a major cost.

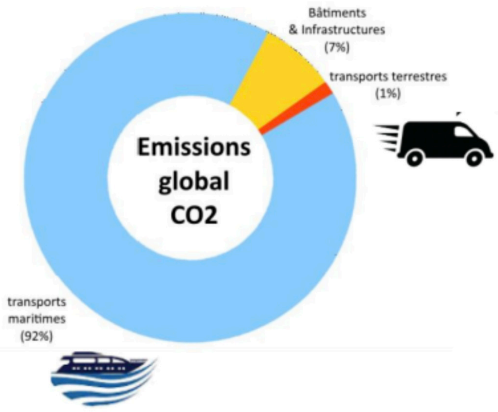


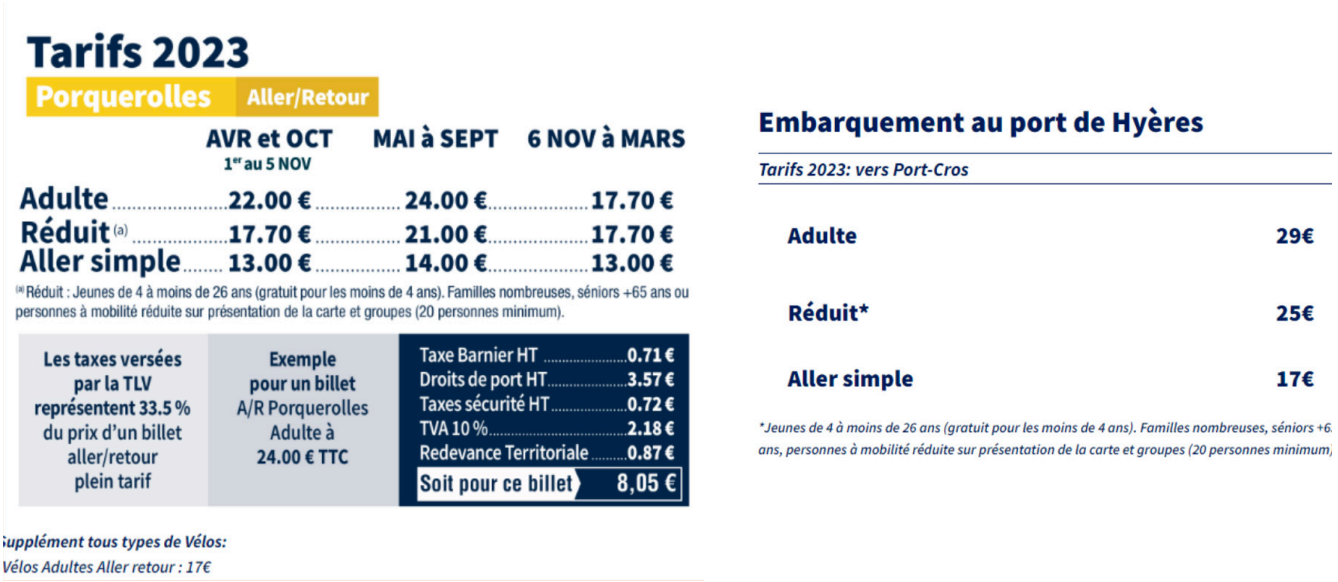
Figure 63 Breakdown of CO2 emissions on Porquerolles

92 https://www.portcros-parcnational.fr/sites/portcros-parcnational.fr/files/available_docs/projet_energie_eolienne_fr.pdf

The economic spin-offs of PNPC on passenger transport

On 6 July 2021, Hyères, Métropole TPM and Port-Cros National Park set up a system to regulate the number of passengers transported to Porquerolles, based in particular on the new delegation of public service (DSP) for maritime transport on the Îles d'Or 2021-2025 and a charter signed by the main private boat operators serving the island (a dozen in summer) 27. This limit only applies to the island of Porquerolles.

TLV-TVM is the main passenger carrier between the mainland and the islands. Fares depend on the month, as listed below.



Tarifs 2023

Porquerolles Aller/Retour

	AVR et OCT (1er au 5 NOV)	MAI à SEPT	6 NOV à MARS
Adulte	22.00 €	24.00 €	17.70 €
Réduit (a)	17.70 €	21.00 €	17.70 €
Aller simple	13.00 €	14.00 €	13.00 €

(a) Réduit : Jeunes de 4 à moins de 26 ans (gratuit pour les moins de 4 ans). Familles nombreuses, séniors +65 ans ou personnes à mobilité réduite sur présentation de la carte et groupes (20 personnes minimum).

Les taxes versées par la TLV représentent 33.5 % du prix d'un billet aller/retour plein tarif

Exemple pour un billet A/R Porquerolles Adulte à 24.00 € TTC

Taxe Barnier HT	0.71 €
Droits de port HT	3.57 €
Taxes sécurité HT	0.72 €
TVA 10 %	2.18 €
Redevance Territoriale	0.87 €
Soit pour ce billet	8,05 €

Supplément tous types de Vélos:
Vélos Adultes Aller retour : 17€

Embarquement au port de Hyères

Tarifs 2023: vers Port-Cros

Adulte	29€
Réduit*	25€
Aller simple	17€

*Jeunes de 4 à moins de 26 ans (gratuit pour les moins de 4 ans). Familles nombreuses, séniors +6 ans, personnes à mobilité réduite sur présentation de la carte et groupes (20 personnes minimum)

Figure 62 Fares for Hyères-Porquerolles (left) and Hyères-Port Cros

The number of people transported between Hyères and Porquerolles by TLV-TVM and boat operators during the regulated summer season (approximately 4 weeks) are as follows:

- 2020 : 317 00
- 2021 : 297 000

This summer season, a ticket costing €23 on average (average of normal fare and reduced fare) represents around €8,533,357 in revenue (of which €6,826,860 for TLV-TVM, the public service delegate). Considering that the majority of tourists (50%, as many arrive by pleasure boats, between 4,000 and 5,000 per day during peak periods) visit the islands from the mainland, and that residents and seasonal workers don't have the same fares, and taking an average annual ticket price of around €20 per round trip, we could estimate the approximate income from passenger transport at €16,000,000 (20x0.5x1,600,000). In 2012, the fare was around €17 per round trip ticket, with an estimated 1,220,000 visitors. Using the same calculation method, income from passenger transport in 2012 was around €10,370,000.

Tourist transport is therefore one of the main sectors to benefit from the reputation of PNPC, and it employs over fifty people year-round for the TLV-TVM, in addition to seasonal contracts.

For PNPC, it is also an important source of income. The "Barnier" tax on maritime passenger transport to protected nature areas is an environmental tax. It makes maritime transport companies carrying passengers to protected nature areas contribute to financing the protection of these areas. The tax has two rates: 3.271% for round trips and 6,542% for one-way trips. In 2019, it amounted to €313,185.91 compared to €332,319 in 2018. In 2023, this tax should amount to between €440,000 and €520,000 (€520,000 for an estimate of 3.27 x 800,000 passengers x €20).

V. SUMMARY OF THE SOCIO-ECONOMIC ASSESSMENT

The results of the socio-economic assessment for the two case studies are summarised in Table 21, which lists the impacts, costs and benefits associated with the protection measures for the most important economic sectors.

In particular, for sectors of collective interest, and particularly the benefits associated with the protection and improvement of biodiversity and the benefits for society and local communities (carbon sequestration), the following points were observed:

- Marine protected areas have very positive impacts on benefits of collective interest: following the implementation of protection measures, there has been a significant improvement in biodiversity and ecosystems (such as Posidonia seagrass beds and fish populations), as well as an increase in carbon sequestration due to the increased surface area and health of Posidonia seagrass beds;

- These benefits were assessed using the value transfer method, based on values available in the literature. One of the studies in particular, was carried out by Parcs Nationaux de France in 2014 for Port-Cros National Park - which made it possible to assess the benefits using baseline data that was very similar to the two case studies;

- The monetary values of the benefits associated with the protection and improvement of biodiversity are €21.6 million per year in Cerbère-Banyuls Nature Reserve, and €48.7 million per year in Port-Cros National Park – i.e. €44.9 per person per year (same value used for both sites);

- The monetary values of the benefits for society and local communities associated with increased carbon sequestration are between €1.3 and €1.4 million in Cerbère-Banyuls. In Port-Cros, using the same methodology applied for Cerbère-Banyuls, with the same values from the literature, the benefits are between €9.2 and €10.2 million per year. However, the assessment conducted by Parcs Nationaux de France in 2014 valued these benefits at €22.4 million per year for Port-Cros National Park.

For sectors of specific interest, the main conclusions are as follows:

- Commercial fishing: in both case studies, there was a clear improvement in catches (in terms of kilos per unit effort). In the Cerbère-Banyuls Nature Reserve, restrictions on the sector have contributed to a decline in the number of fishers and their income over the years, although other external factors may have played a role. In Port-Cros National Park, on the other hand, protection measures have had little impact on fishers. In both case studies, the available data did not allow monetary values to be assigned to the impacts observed.

- Recreational fishing: in the Cerbère-Banyuls Reserve, better catches have been observed following the protection measures, which also generate greater fishing enjoyment, valued at €14,800 per year (willingness to pay for these better catches). Both sites have experienced a decline in the number of fishers since the introduction of protection measures. In Port-Cros, the number of fishing sessions remained stable.

- Underwater diving: an increase in diving enjoyment, due to the improved quality of marine ecosystems, was clearly observed in both case studies. In addition, in the Cerbère-Banyuls Reserve, the available data was used to quantify the economic value of this positive impact at €6.2 million per year in additional economic spin-offs due solely to the environmental improvements generated by the protection measures. Over the years, thanks to protection, the Cerbère-Banyuls Reserve has seen an increase in the number of divers, while in Port-Cros National Park this number has decreased over the years - even though the number of dive centres has remained relatively stable. Due to a lack of data, it was not possible to determine monetary values for the impacts observed in Port-Cros.

In general, the available data was used to estimate certain economic values in the Cerbère-Banyuls case study, unlike the Port-Cros National Park case study.

Economic sectors	Cerbère-Banyuls			Port-Cros		
	Positive impacts	Negative impacts	Monetary values	Positive impacts	Negative impacts	Monetary values
						Collective interests
Biodiversity and ecosystems	Improved biodiversity and ecosystems (seagrass beds, fish populations, etc.)		**€21.6 million per year** (Minimum threshold: €4.9 million per year)	Improved biodiversity and ecosystems (seagrass beds, fish populations, etc.)		**€48.7 million per year** (Minimum threshold: €11 million per year)
Society and local communities	Increased carbon sequestration		**Between €1.3 and €1.4 million per year**	Increased carbon sequestration (Posidonia seagrass)		**€22.4 million per year** With value transfer: between €9.2 and €10.2 million per year
						Specific interests
Commercial fishing	Better catches	Decrease in fishers and income	**€35,000 per year** Portion of income attributable to the Reserve	Catch per unit effort: from 0.8 kg per unit (2013) to 1.8 kg per unit (2018) - more profitable fishing	Low impact on fishers	**Between €21,000 and €76,000 per year** **Fished value linked to the reserve effect**
Recreational fishing	Better catches: + 1,200 kg per unit of effort per year	Fewer fishers	**€14,800 per year (willingness to pay)**	Stable number of fishing sessions	Decrease in fishers and catches	
Underwater diving	Increased number of divers			Number of dive centres relatively stable	Decrease in the number of divers (high cost)	
	Increased underwater diving enjoyment		**€6.2 million per year in economic spin-offs**	Increased underwater diving enjoyment		
Visitors				Tourists attracted by PNPC (spending directly linked to the park's existence)	Decrease in visitors (Restriction on the number of visitors)	**€154 million per year** **Spending directly linked to the park's existence**
						€3.6 million per year **Loss of income**
				Well-being through interaction with nature		**€154 million per year** **Non-commercial benefits**

VI. CONCLUSIONS

Socio-economic analysis of the impacts of protection measures in two marine protected areas in the south of France has identified:

- Protection measures in place at both sites;
- The sectors affected by the protection measures;
- The socio-economic impacts of the protection measures on the economic sectors and;
- The monetary values of the costs and benefits associated with the impacts of protection measures (more or less depending on the available data).

The following conclusions and observations can be drawn from analysis of the case study results:

Marine Protected Areas (MPAs) significantly contribute to local economic dynamics, generating an overall positive impact. The protection measures in these areas notably contribute to the tourism sector. Regarding fishing, the impact of MPAs is varied and complex to precisely evaluate. However, feedback from fishermen suggests a general satisfaction..

These positive results confirm the overall beneficial impact of MPAs on the local economy. They highlight the need for further research to better measure and articulate the specific impact of these protected areas on tourism and fishing, providing more concrete data.

Positive impacts and associated benefits are often the result of all protection measures, which have an accumulative impact on the quality of ecosystems.

The MEDREGION study highlighted the challenges of associating impact levels with various degrees of protection, as well as the more general difficulty of defining levels of protection universally applicable to all Marine Protected Areas (MPAs), given the wide variety of measures and multiple possible combinations within these areas. To overcome these complexities, this study has taken a different approach by associating impacts with individual protection measures, with the aim of producing results that could potentially be transferred to other MPAs. For example, by detailing the impacts of measures to restrict commercial fishing in the two case studies, similar impacts can be expected in other MPAs where these same restrictions are in force.

However, this approach highlights the persistent challenges of establishing a clear relationship between the level of protection or protection measures and socio-economic impacts, particularly with regard to positive impacts.

The main goal of marine protected areas is to improve biodiversity and the status of ecosystems, by contributing to collective well-being. The results of this analysis clearly show that this goal is fully achieved, as the most important benefits of protection measures are those associated with biodiversity and ecosystems, and those associated with society and local communities, or, in other words, benefits of collective interest.

Importantly, applied restrictions like licensing constraints and mooring zones have overall positive implications, significantly contributing to preserving marine ecosystems and fisheries resources. However, divergent results in the professional fishing context highlight the complexity and diverse opinions surrounding this activity, suggesting the need for further specific studies to deepen our understanding.

As mentioned several times throughout this report, it is important to put the results of this study into perspective by taking into account its limitations, including the tight timeframe for completion, the limited availability of data to quantify the impacts, costs and benefits, and the challenges associated with accurately measuring the difference between the assessment scenarios. It should also be noted that some sectors showed diverging impacts between the two sites, and it is difficult to determine whether these variations are due to local specificities or differences in the data used in the calculations.

The study also shows the importance of mobilising funding from a wide range of stakeholders, since 60% and 88% of funding for the Banyuls and Port-Cros action plans, respectively, comes from public funds (State, Region, EU, Water Agency). There is therefore probably (although this study did not prove it) an initial phase requiring considerable effort on the part of managers to identify and secure these funds, to ensure that the actions are actually financed every year. This effort is not yet reflected in the costs of marine protected areas, but it would be interesting to measure it.

In short, this socio-economic study highlights the complexities inherent in understanding the effects of Marine Protected Areas (MPAs) on marine ecosystems, particularly with regard to the different levels of protection. However, despite these challenges, it makes an important contribution to existing knowledge on the subject and paves the way for a better understanding of the interactions between biodiversity conservation and economic activities, which is a positive step forward in our search for sustainable solutions for marine ecosystems.

Future Directions:

- Conducting further studies to deepen understanding of the impacts of different MPAs, especially in measuring tourism's impact and quantifying protection effects on fishing activities. This will provide policymakers with more precise data to evaluate protection measures' effectiveness while preserving marine ecosystems.

- Exploring mechanisms to better quantify overall economic benefits of MPAs, possibly through comprehensive monitoring methodologies. Understanding not just immediate impacts but also long-term effects on local economies, like indirect job creation or long-term improvements in economic productivity, is crucial.

- Studying adaptation to protection measures in MPAs to grasp how local communities and industries react and adjust. This understanding is vital for evaluating the long-term impact on the economic viability of sea-dependent regions.

- Conducting comparative studies of MPAs to distinguish the effectiveness of various preservation strategies. By comparing MPAs with differing protection levels or management approaches, insights can be gained into the most effective practices for conservation and sustainable economic activity.

- These future avenues aim to enhance understanding and optimize the balance between conservation efforts and economic sustainability in marine ecosystems.

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APPENDIX 1 - SEMI-STRUCTURED INTERVIEWS: CONTACTS AND INTERVIEW GUIDE

Interviews with stakeholders play a key role in assessing the costs and benefits of protection measures, as they provide a first-hand understanding of the impacts of MPAs on local economic sectors and help gather additional information. A wide range of stakeholders will be met with to represent the various activities linked to the reserve and the park (fishing, boating, underwater diving, etc.), as well as scientific institutions and environmental protection associations. Contacts identified in the two case studies are listed in the tables below.

Focus group			
People in attendance	**Poster**	**Topics covered**	**Date**
Alain Barcelo	Department Manager, Knowledge for Biodiversity Management	Historical, scientific and legal scoping of the study Status of ecosystems Definition of the main economic sectors impacted	4 September 2023, 10a 12pm.
Louise Freybuger	Marine and Pelagos support		
Giulia Azzolini	Manager, Cooperation and Financial Engineering Division, PNPC		
Observers: Constantin Tsakas (Programme Manager, Socio-economic analysis and blue economy) and Rianne Van Duinen (ACTeon)			

Results workshop (present for PNPC)			
People in attendance	**Poster**	**Topics covered**	**Date**
François Victor	Deputy Director, PNPC	Validation of economic analysis scoping and methodology Discussions on the main impacts found	25 September 2023, 2p 4pm.
Louise Freybuger	Marine and Pelagos support		
Other people in attendance: Constantin Tsakas (Programme Manager, Socio-economic analysis and blue economy, Plan Bleu), Hervé Magnin, (Deputy Director of the Gulf of Lion Marine Nature Park), Frédéric Cadène (Director of the Cerbère-Banyuls Reserve), Gloria Paoli and Rianne Van Duinen (ACTeon)			

People interviewed	**Organisation/Position**	**Topic covered**	**Date of interview**
Marie-Claire Gomez	Natura 2000 and Adjacent Marine Area Project Manager	Economic activities in the AMA and Posidonia seagrass beds	15/09/2023
Anne Cadoret	Vice-president of the Port-Cros human and social science group	Conflicts of use	12/09/2023
Gaelle Urvoy	Marine and Pelagos technician, PNPC	Commercial fishing, recreational fishing, underwater diving, regulations	12/09/2023
Mirko Ronsmans	Director of Bormes Plongée dive centre	Underwater diving	11/08/2023
André de Marco	"Les amis de Porquerolles" residents' association	CO_2 and water pollution Tourism Restaurants Underwater diving and fishing	28/08/2023

Table 6 Interviews and focus groups for the Port-Cros case study

Stakeholders	Contact person	Topics covered	Date of interview
Reserve Scientific Manager	Virginie Hartmann	Scoping interview covering all topics	25/07 (focus group)
Coordinator of the associated local action group for fishing and aquaculture (GALPA)	Géraldine CAPRANI	Commercial fishing	12/09
French national association of recreational diving companies	François Poch	Underwater diving	17/08
Commercial fisherman in Banyuls	Jean-Marc Ségura	Commercial fishing	30/08
Representative of the Banyuls-sur-Mer oceanography observatory, coordinator of the nature reserve's "highly protected areas (2019-2021)" working group and chairman of the reserve's scientific council	Ives Desdevises	Biodiversity and ecosystems	29/08
Reserve custodian	Frederic Cadène	Cost of the MPA	Email exchange 28/08

Table 7 List of interview contacts for the Cerbère-Banyuls case study

The questions asked during the interviews were targeted according to the role of each stakeholder and the specific information sought for each sector and/or activity. The interview guide, containing questions for each sector and/or activity, is provided in Appendix 1.

Generic questions for all socio-professionals

- Your name and position
- History in the area (arrival, previous activities, etc.)
- Type of activity today

Recreational fishing

- How important is your activity in the reserve? (Revenue, number of active fishers in the area, quantity fished)
- What species are fished in the reserve? Is it possible to track fishing catches over a year by species?
- How are they valued?
- What are the average types of annual expenses incurred by a fisher, and how much do they amount to? (Travel, equipment, training, permits, other, etc.)
- Do local jobs depend on fishing?
- Why is the Cerbère-Banyuls Reserve a better place to carry out this activity than any other?
- Have you noticed any changes in recreational fishing in the reserve over time? (More, less, change in location of the activity as a result of measures) and why?
- Which protection measures have an impact on your activity? (cite the measures) How much do you estimate the impact of each measure to be? (provide a range)
- What impacts can you see as a result of these measures? Can you quantify this (decrease, increase in the number of fishers, decrease/increase in quantities fished) and by how much?
- Have you had to adapt your behaviour as a result of these measures? How?
- If the protection area is expanded, will your fishing activities be affected? In what ways? How will you adapt?

Commercial fishing

- How important is your activity in the reserve? (Revenue, number of active fishers in the area, quantity fished)
- What species are fished in the reserve? Is it possible to track fishing catches over a year by species?
- How are they valued?
- What are the average types of annual expenses incurred by a commercial fisherman, and how much do they amount to? (Travel, equipment, training, permits, other, etc.)
- Do local jobs depend on fishing?
- Why is the Cerbère-Banyuls Reserve a better place to carry out this activity than any other?
- Have you noticed any changes in commercial fishing in the reserve over time? (More, less, change in location of the activity as a result of measures) and why?
- Which protection measures have an impact on your activity? (cite the measures) How much do you estimate the impact of each measure to be? (provide a range)
- What impacts can you see as a result of these measures? Can you quantify this and by how much ? (Decrease/increase in number of fishers, decrease/increase in quantities fished, decrease/increase in sales)
- Have you had to adapt your behaviour as a result of these measures? How?
- If the protection area is expanded, will your fishing activities be affected? In what ways? How will you adapt?

Underwater diving

- How important is your activity in the reserve? (Revenue, number of active divers in the area)
- What species are seen in the reserve?
- What are the average types of annual expenses incurred by a diver, and how much do they amount to? (Travel, equipment, training, permits, other. etc.)
- Do local jobs depend on underwater diving?
- Why is the Cerbère-Banyuls Reserve a better place for diving than any other? (Species diversity, easy access, etc.)
- Have you noticed any changes in underwater diving in the reserve over time? (More/fewer people, improvement of ecosystems, change in location of the activity as a result of measures) and why?
- Which protection measures have an impact on your activity? (cite the measures) How much do you estimate the impact of each measure to be? (provide a range)
- What impacts can you see as a result of these measures? Can you quantify this and by how much?
- Have you had to adapt your behaviour as a result of these measures? How?
- If the protection area is expanded, will underwater diving be affected? In what ways? How will you adapt?

Water quality

- Have you noticed any change in water quality since the reserve was created?
  - If so, what area has been affected?
  - Do you think protection measures play a role in this change? Which ones and how?
- Are there any studies that have measured water quality in the area since it was created?
- In the absence of protection measures, what clean-up measures would be required?
  - For what kind of volume?
  - How much would such measures cost?
- In the absence of protection measures, if water quality were to deteriorate, what would be the consequences for users and other socio-economic activities? (Ban or restrictions on swimming, etc.)
- If the protected area is expanded, could water quality be affected? In what ways?

Fish populations (species diversity and quantity)

- Have you noticed any change in fish populations since the reserve was created? (Diversity, quantity)
  - If so, what area has been affected?
  - Do you think protection measures play a role in this change? Which ones?
- What are the impacts for users and other socio-economic activities?

- Have any studies measured the change in fish populations since the reserve was created?
- If the protected area is expanded, could the status of fish populations be affected? In what ways?

Seabed integrity

- **Have you noticed any change in seabed integrity since the reserve was created?**
- **If so, what area has been affected?**
- **Do you think protection measures play a role in this change? Which ones?**
- **What are the consequences for users and other socio-economic activities?**
- **Have any studies measured the change in seabed integrity since the reserve was created?**
- **If the protected area is expanded, could seabed integrity be affected? In what ways?**

For pleasure boaters in Port-Cros:

What impact has the installation of moorings had on your activities?

Has this reduced your activities?

Has the price of moorings increased?

Additional questions specific to the Bagaud (Port-Cros) mooring area (ZMEL) (key player to be interviewed following discussions with Plan Bleu)

- What is the average annual revenue generated by the ZMEL? (boat rental, equipment, associated services)
- How has the installation of the buoys in 2019 affected the revenue of your boating activities? (change in revenue, increase or decrease and by how much)
- What is the annual cost of the ZMEL? (differentiate between cost of buoys, patrolling, management)
- How have the new measures been perceived by the community?
- How has the installation of the buoys affected the revenue of related activities and by how much? (e.g. restaurants, hotels)
- Are you aware of the measure's impact on Bagaud's marine ecosystem and biodiversity? (specifically on Posidonia seagrass)

Capacity of ecosystems to sequester carbon

- Do you know if there has been any change in carbon sequestration since the reserve was created?
- o Do you think protection measures play a role in this change? Which ones? How?
- What are the consequences for society and local communities? (Avoided costs in the climate action plan, etc.)
- Have any studies measured the change in the quantity of carbon stored over time? (Storage rate per hectare)
- If the protected area is expanded, could the carbon sequestration capacity be affected? In what ways?

Winegrowing (source of land-based pollution)

- How important is this activity around the reserve? (Number of hectares, number of winegrowers)
- Does the presence of the Cerbère-Banyuls Reserve impact winegrowing practices?
- Have you noticed any changes in the management of the reserve over time?
- Which protection measures have an impact on your activity? (cite the measures)
- What impacts can you see as a result of these measures?
- Have winegrowers adapted their behaviour as a result of these measures? If so, how? And how many winegrowers have changed their practices?
- Has there been a change in the amount of pesticides used? (Increase, decrease) Can you quantify this?
- If the protected area is expanded, will winegrowers be affected? How?

Construction (Port-Cros)

- What does this activity involve?
- What are the challenges associated with limiting construction on the islands?
- Would there be any impact on the coastline if the area were expanded?
- How many companies would be affected?

How can these companies adapt to these changes? Would this result in a loss of income?

APPENDIX 2 - EXISTING STUDIES ON THE SOCIO-ECONOMIC ASSESSMENT OF MPAS: AN OVERVIEW

Note: this appendix describes the contents of the database, which lists existing socio-economic studies on MPAs, mainly but not exclusively in the Mediterranean region. The database was provided to Plan Bleu in Excel format as a supplement to this report. Initially, the database was developed as part of the MEDREGION project, funded by the European Commission, and in particular in the report "Socio-economic analyses of MPA development in the Mediterranean: investigating protection levels", written in 2021 by ACTeon for Plan Bleu. This appendix includes and updates the description of the database contained in the 2021 report.

The 24 studies are described in the database under 73 entries. There is a difference between the number of studies and the number of entries due to the presence of studies involving the assessment of several MPAs. In these cases, each MPA was its own entry.

The following points can be observed in the database:

- Most entries base assessment on a single MPA (the most suitable unit), either by applying a cost-benefit analysis, or by comparing socio-economic impacts between different studies;
- 10 studies are based on a cost-benefit analysis (8 for a single MPA, 1 at the global level, 1 concerning seven MPAs outside the Mediterranean region), 2 are based on a multi-criteria analysis and 50 are studies classified as "other", a category which includes all other types of socio-economic studies (e.g. studies focusing on (certain) benefits, studies involving expanded areas, studies mixing qualitative and quantitative approaches). No studies based on a cost-effectiveness analysis were found;
- Most studies are based on ex-ante estimates, although a few assess the value of biodiversity in MPAs on the basis of conditions at the time of the study. This is notably the case of the Parcs Nationaux de France study (2014), which includes Port-Cros National Park, and the articles used to conduct this study on the assessment of the benefits associated with biodiversity and ecosystems through value transfer (Rojas-Nazar et al., 2022, and Borger et al., 2014);
- The benefits most commonly assessed in monetary terms are those for the fishing industry (especially commercial fishing), tourism and leisure. The benefits for biodiversity and ecosystems are often assessed, but mainly in qualitative terms - with the exception of the studies used for value transfer, mentioned above;
- The costs and benefits for certain sectors, such as marine renewable energies, coastal urban development and land-based sources of pollution, are very rarely taken into account - and the potential impacts on these sectors are stated in simplified terms;
- Most cost estimates refer to MPA administration and management costs. Estimates of benefits lost due to protection measures are only provided in a few cases, often outside the Mediterranean.

In general, available monetary estimates of the costs and benefits associated with protection measures are difficult to compare from one study to another, as the studies consider different types of benefits and apply different methodologies, valuation techniques, timeframes and discount rates.

APPENDIX 3 - COMMERCIAL FISHING: CATCHES IN CERBÈRE-BANYULS BETWEEN 2010 AND 2022

Most fished species (kg per year)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Sea bream	215	720	575	604	824	76	129	222	121	172		186	155
Rascasse_sp						0		311		361	241	139	231
Striped red mullet	5	91	168	35	305	178	43	384		357	267	407	380
Cuttlefish						288	1						86
Common monkfish	108	1000	911	1,302	2,469	1,606	2,552	1,562	149		1,164	1,066	688
Forkbeard						224	116	336	240	251	370		
Octopus	10	65	82	90	115	337	82	1,728	258	364	403	287	
Sargo	375	617	384	400	341	227	249	294	122	174	339		
Common two-banded sea bream									93				
Red scorpionfish						261	109	175	204	258		347	
Common pandora	494	939	729	388	353	630	370	377	138	603	514		
European hake	721	1,323	946	1,563	3,074	350	180	313		176	496	415	
Brown wrasse						206				315		278	
Spiny lobster						221	107				275	413	
Atlantic bonito	368	140	407	2	348	14	90				1,624	855	
Other	1,904	2,205	2,798	716	2,171	844	439	1,479	775	869	1,307	1,007	0
Total	**4,200**	**7,100**	**7,000**	**5,100**	**10,000**	**5,462**	**4,467**	**7,181**	**2,100**	**3,900**	**7,000**	**5,400**	**1,540**

Source: Based on fishing from January to November for the Reserve's 3 most active fishers. The data take into account a wider area than the Reserve, but still provide trends for the most heavily fished species in and around the Reserve.

Plan Bleu pour l'environnement et le développement en Méditerranée
planbleu@planbleu.org - www.planbleu.org

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