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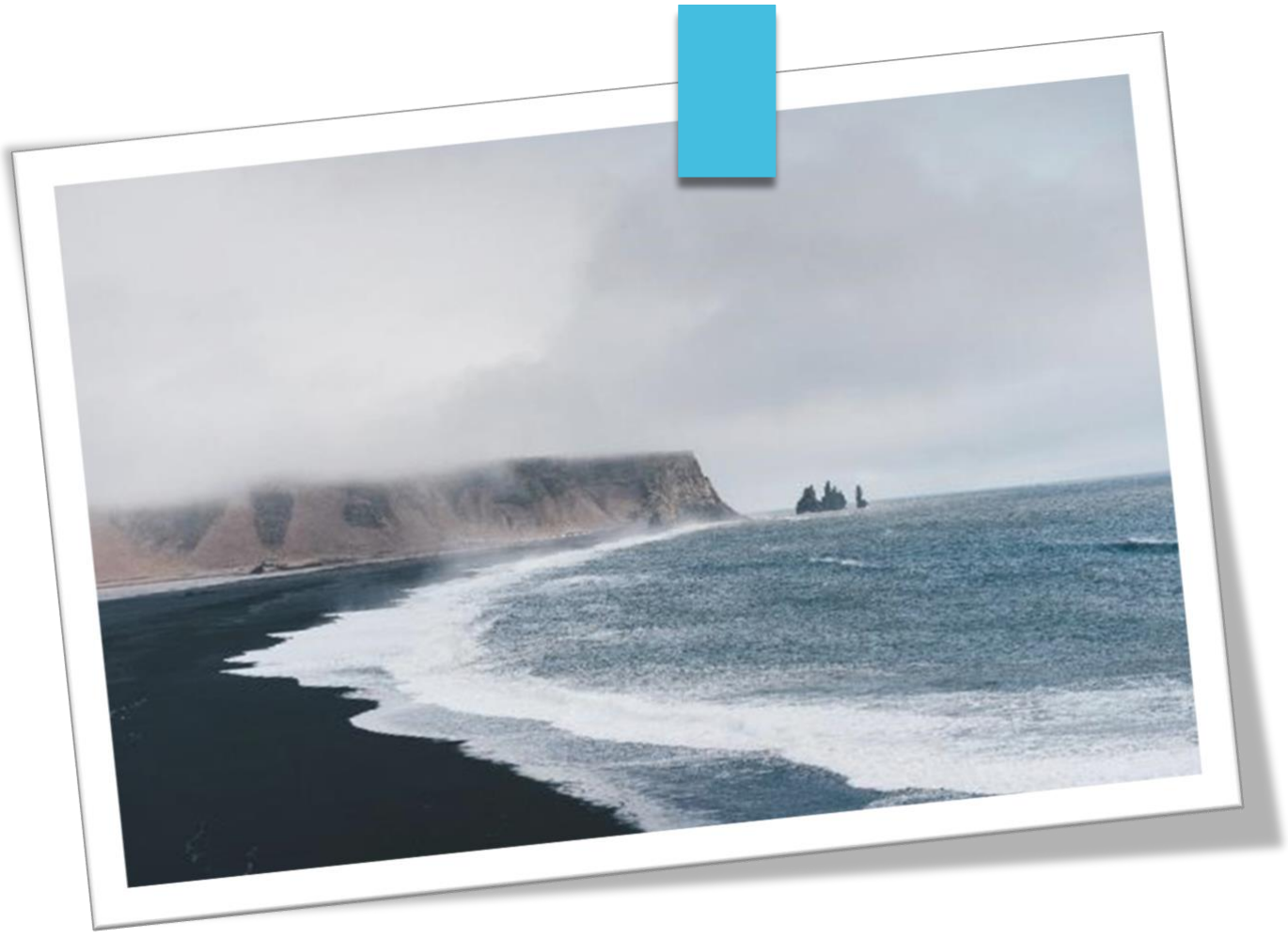
PROcoast

A PROactive approach for COmmunities
to enAble Societal Transformation

D 5.1 Definition of case studies, including baseline status, assessment criteria, and socio-ecological goals

DATE OF DELIVERY – DUE Month 12

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SUMMARY OF CHANGES

A new section 2.4.3 has been included to document the clarifications introduced in this revised version.

BACKGROUND: ABOUT THE PRO-COAST PROJECT

The PRO-COAST project was launched to address the issue of biodiversity loss in European coastal ecosystems. Around 40% of Europeans live within 100km of the coast, relying directly on ecosystem services that are threatened by both quantitative and qualitative losses. Groups already facing socioeconomic vulnerabilities are likely to be disproportionately affected. PRO-COAST aims to empower local communities to support the restoration and maintenance of biodiversity and ecosystem services across Europe, integrating local knowledge into practice and policy making. The project is now underway, coordinating the efforts of 20 partners across 14 countries working on 10 diverse case studies. These case studies cover multiple conservation approaches across various coastal ecosystems, testing different governance models and social incentives to engage local actors in adopting technologies and actions for biodiversity conservation.

An important element of PRO-COAST is its holistic, interdisciplinary approach, based on a conceptual framework that treats social-ecological systems as interconnected. By mapping relationships between ecosystem components and uncovering feedback dynamics, the project seeks to identify leverage points for transformative change. PRO-COAST promotes integrated bottom-up decision-making, recognizing that environmental issues cannot be separated from social, economic, and political factors. Through extensive citizen engagement, guided by state-of-the-art conservation science, the project aims to build community capacity for biodiversity management, providing scalable solutions that balance conservation needs with local socio-economic priorities. Now in its initial stages, PRO-COAST hopes to inform adaptive, participatory approaches to governance that avoid biodiversity losses and ensure sustainable, equitable access to coastal resources.

EXECUTIVE SUMMARY

In this deliverable, readers will find a comprehensive assessment of ten coastal case studies across Europe, each facing specific socio-ecological challenges and cross-cutting concerns. The report outlines the current baseline status of these ecosystems, identifying key issues such as biodiversity loss, habitat degradation, effects of pollution and invasive species, overfishing and over-tourism, and governance gaps. It provides an analysis of the social, economic, and environmental drivers affecting these coastal areas/regions and offers targeted recommendations for sustainable management practices. The document also details the methodologies used for data collection, stakeholder engagement, and socio-ecological assessments, including field surveys, stakeholder consultations, literature reviews, and socio-economic data analysis.

Each case study requires a baseline of knowledge, tailored actions and strategies to ensure long-term sustainability and resilience. Through this deliverable, readers will gain insights into the proposed actions to mitigate ecological pressures, enhance community involvement, and ensure the long-term resilience and sustainability of these diverse coastal areas. The following are the key challenges, focal actions, and strategies identified for each CS:

Comino Island, Malta is experiencing severe degradation due to mass tourism, invasive species, and a lack of sustainable management practices. Actions focus on controlling visitor numbers, managing invasive species, and enhancing community engagement through citizen science initiatives. Strategies

include revising the NATURA 2000 Management Plan, strengthening environmental regulation enforcement, and promoting sustainable tourism practices.

Aquatina di Frigole, Italy faces high tourist influx, marine litter, lagoon litter, climate change and non-indigenous species. Key actions involve strengthening the Joint Task Force for Aquatina di Frigole Protected Area (NATURA 2000) to engage local communities and institutions in developing common strategies and best practices for conservation efforts and habitat restoration. The strategy will mainly focus on a deeper assessment of biodiversity by using innovative tools of investigation, citizen science initiatives to mitigate the impact of marine/beached litter and non-indigenous species (e.g., beach and lagoon plastic standardized cleanup, control of NIS) and developing community-based conservation programs (e.g., eco-visitors).

Strunjan, Slovenia is a the model ground which serves as a framework to study the influence of ecological restoration on both natural and agricultural habitats, as well as human-wildlife conflict (including issues related to game and invasive species), with an emphasis on the interconnectedness of biodiversity and disease interactions. The recommended actions are habitat restoration, eco-tourism promotion, and strengthening local community involvement. Strategies will focus on reinforcing sustainable game management and integrating local communities into the decision-making process for conservation efforts.

Boka Kotorska Bay, Montenegro, a UNESCO World Heritage site, is threatened by overfishing, pollution, and unregulated tourism. Actions target stricter pollution control measures, sustainable tourism aligned with UNESCO guidelines, and enhancing stakeholder engagement. Strategies involve implementing stricter governance frameworks and promoting sustainable development in the tourism sector.

Sreedagh beach, Sligo, Ireland faces sand dunes erosion, agricultural runoff, and urban development pressures. Restoration of sandy shores and grasslands, and the promotion of sustainable land-use practices are critical actions, along with engaging local communities in conservation. The strategy emphasizes sustainable land-use planning and community-driven conservation efforts to restore and maintain ecological health.

Arne Parish, UK is under pressure from recreational activities, agricultural runoff and invasive species. Addressing invasive species management and, to an extent, sustainable recreational practices are practical actions for protecting the region’s biodiversity. The strategy includes developing recreational guidelines and implementing robust invasive species control programs to enhance local ecosystems.

Bergen, Norway is renowned for its coastal and marine biodiversity, but faces challenges from ghost fishing, pollution, and climate change. Actions include reducing ghost fishing, promoting sustainable fishing practices, and increasing community-based marine conservation efforts. Strategies focus on enhancing local marine conservation initiatives and retrieval programs to improve ecosystem resilience.

Kloogaranna-Laulasmaa, Estonia is impacted by coastal erosion, tourism, and invasive species. Coastal erosion management and sustainable tourism practices are the primary actions required. The strategy involves developing long-term erosion mitigation solutions and involving local communities in conservation activities to safeguard the region's natural assets.

Corbu Beach, Romania, part of the Danube Delta Biosphere Reserve, faces challenges from pollution, overfishing, and unregulated tourism. Actions include implementing pollution control measures, sustainable fisheries management, and greater stakeholder involvement in conservation. The strategy

emphasizes strengthening governance frameworks and engaging local communities in monitoring and conservation activities.

Eidsvika-Kildn, Norway is facing increasing development pressures due to a proposed cruise ship terminal that threatens local coastal habitats, including bogs, rocky outcrops, and nesting sites for seabirds. The area is a key recreational space for the local community and holds cultural and ecological value. Actions focus on opposing habitat degradation, promoting biodiversity monitoring, and enhancing community engagement through citizen science and stakeholder dialogues. Strategies centre on strengthening local governance processes, ensuring transparent land-use planning, and safeguarding the ecological integrity of this sensitive coastal area.

The benchmarking of the ten case studies reveals several common themes. Coastal ecosystems across Europe are under pressure from habitat degradation, pollution, and over-exploitation of natural resources. Governance challenges, including weak enforcement and fragmented management, are prevalent in many regions. Effective stakeholder engagement is critical to addressing these issues, and local communities must play a more active role in conservation efforts. The benchmarking also highlights that tailored, context-specific strategies, along with adaptive management frameworks, are essential for achieving long-term sustainability. A cross-cutting recommendation is the need for better education and participation initiatives to enhance community involvement in coastal conservation and policy-making. These findings underscore the importance of integrating environmental, social, and governance dimensions into all case study actions and strategies to ensure scalable and replicable solutions across Europe's coastal regions.

LINKS WITH OTHER PROJECT ACTIVITIES

This task has used a lot of the information collected in other WP:

- WP2 provided the State-of-the-Art Literature Reviews (further details in D2.1) and the common research design, methods and tools (further details in D2.2), used here to fix the final methodologies regarding aspects of biodiversity loss such as drivers, governance and communities affected. It has also provided an overview of multi-scale approaches to coastal biodiversity, which are relevant in assessing biodiversity in CS when creating the theoretical framework for understanding the role of Transformative Communities. To do so, this task is compiling "population ecology" datasets and drivers (political, economic and social). Some of them are used in this deliverable.
- WP3 helped to identify ecological levels matching human dimension in coastal management practices, monitoring and sustainable use of resources (see D3.1 - Coastal ecosystem management practices).
- WP4 did the variable selection and literature review for the provision of the framework design used in this deliverable (D4.1). It also helped to **identify stakeholders and sources of information on each CS** analysed here.
- WP6 mapped the change agents and leads the interaction with stakeholders in the CS. Participatory practices, such as interviews and workshops with change agents, have helped to frame the directions chosen in this deliverable.

Also, this task will feed directly into the following tasks and deliverables for PRO-COAST.

- WP2: D2.3

- WP5: T5.2 to provide the Integrated Assessment Methodology (IAM) with Key Performance indicators (KPIs) for the CS; also T5.3
- WP6: (eg. Task 6.2 needs the identified barriers in the workshops (M11).

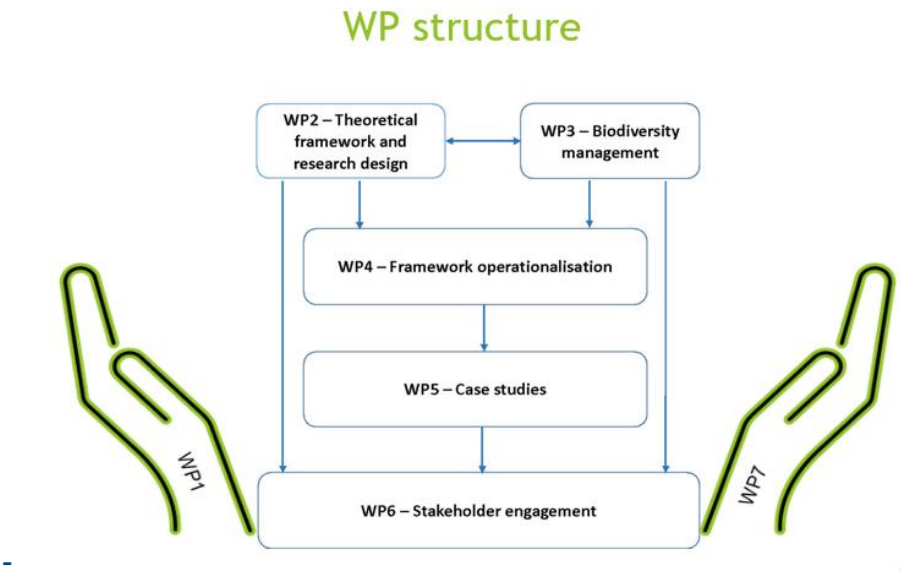


Figure 1 PRO-COAST Work Package structure.

As a result, this deliverable links with the Deliverables listed in Table 1.

Table 1: PRO-COAST Deliverables linked to this D5.1 Case studies baseline information report

Deliverable number	Deliverable name	WP number	Diss. Level*	Delivery date
D2.1	State of the art review on transformative change and biodiversity	WP2	PU	M6
D2.2	Project research methodology	WP2	PU	M15
D2.3	The role of existing stakeholders and their governance structures in biodiversity conservation	WP2	PU	M36
D3.1	Coastal ecosystem management practices	WP3	PU	M12
D3.2	Coastal ecosystem management data	WP3	PU	M16
D4.1	Meta-theoretical operational framework for the study and analysis of complex SES	WP4	PU	M6
D4.2	Supporting guidelines for the PRO-COAST framework application in the case studies	WP4	PU	M12
D4.3	Case studies research tools	WP4	PU	M19
D5.2	Case studies Integrated Assessment Methodology (IAM))	WP5	PU	M24
D5.3	Case studies implementation report	WP5	PU	M34
D6.1	Mapping change agents to case studies	WP6	PU	M8

*SEN – sensitive, PU – public.

This Deliverable is directly linked to the Milestones listed in Table 2, especially Milestone 4.

Table 2: PRO-COAST Milestones related with this deliverable

Milestone Number	Milestone name	WP number	Delivery date
3	Change process initiated	WP6	M11
4	Case studies definition	WP5	M14
5	Open dataset to be used in WP4 and WP5	WP3	M16

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Figure 1: PRO-COAST Work Package structure

1. INTRODUCTION

The PRO-COAST project aims to enhance the understanding and management of coastal socio-ecological systems (SES) in Europe. Coastal regions are vital for biodiversity, cultural heritage, and key economic activities such as tourism and fisheries. However, these areas face increasing threats from climate change, pollution, invasive alien species, over-exploitation, and unsustainable development. To address these challenges, the project employs the Social-Ecological Systems Framework (SESF), which integrates ecological, social, economic, and governance dimensions to provide a comprehensive analysis of coastal systems.

This document, Deliverable D5.1, establishes the baseline status, identifies key drivers of change (both direct and indirect acting at different spatial-temporal scales), and sets socio-ecological goals for the sustainable management of ten diverse case studies (CS) located across Europe. These case studies have been selected for their ecological and socio-economic significance, as well as their potential for demonstrating scalable solutions.

1.1 Scope of the document

The primary objective of this deliverable is to define the baseline status, assessment criteria, and socio-ecological goals for each of the ten case studies under the PRO-COAST project. It provides a diagnostic analysis of each case study's social-ecological profile, including benchmarks for ecosystem health, governance structures, and community engagement.

The deliverable also outlines key indicators and methodologies for future monitoring and management, with the aim of fostering sustainable practices that balance biodiversity conservation with local economic and social needs. This document is linked to several work packages within PRO-COAST, including WP3, WP4, WP5, and WP6, as part of a broader effort to support sustainable coastal management across Europe.

This document aids in identifying and framing Focal Action Situations (FAS). It supports the SES diagnostic procedure and helps develop engagement strategies for each CS. Establishing biodiversity baselines is crucial for assessing ecosystem services and understanding how changes in biodiversity affect these services. These baselines reflect the state of biodiversity (e.g., species richness, ecosystem services) at specific points in time and can be used to track trends. Adaptive management strategies will depend on accurate, up-to-date biodiversity baselines for informed decision-making. Local stakeholders must monitor improvements in these baselines to demonstrate the effectiveness of efforts and maximize impacts in the future.

PRO-COAST's 9 CS are representative case studies that allow for applying findings to similar contexts, supporting scalable and transferable conservation strategies. The approach was developed by PRO-COAST partner IBE and distributed to each CS partner, who conducted the analysis according to guidelines, capacities, and specific conditions, largely through the use of a) consortium meetings (virtual and face-to-face meeting in Brussels and Bergen); b) a questionnaire (included as annex of this document), as well as c) refining and contributing to this document. This method supports PRO-COAST 's broader goal of creating a framework applicable beyond the project's scope, based on the specific conditions and feasibility of each step in the project taken by each CS.

Given the unique conditions of each CS (such as intervention maturity and data availability), the biodiversity baselines provided here support adaptive management, stakeholder involvement, and sustainable use of coastal ecosystems. **Verification and Dissemination:** The document's accuracy and completeness will be verified through peer review by project partners and external experts in biodiversity conservation, ecosystem management, and integrated assessment methodologies. Feedback will be incorporated to ensure quality and relevance. The final document will be available on the PRO-COAST project website (https://www.pro-coast.eu/en/c) and shared with stakeholders, policymakers, and the scientific community.

1.2 About SESF

The **Social-Ecological Systems Framework (SESF)** serves as the conceptual foundation for these deliverable and different tasks of the PRO-COAST workplan. SESF helps to identify variables affecting outcomes in **social-ecological systems (SES)**, with a focus on understanding the complex interactions between ecological systems and human societies. The framework incorporates factors such as **resource systems**, **governance structures**, **actors**, and **external ecosystems**, offering a structured approach for assessing the health and sustainability of coastal areas. This framework is being applied consistently across all case studies to provide an integrated analysis of environmental, social, and governance challenges. It identifies variables affecting outcomes in social-ecological systems (SES)[1]. The SESF is organised into tiers of nested concepts and variables, including Resource Systems (RS), Resource Units (RU), Governance Systems (Gov), Actors (A), Social, Economic, and Political Settings (S), Interactions (I), External Ecosystems (Eco), and Outcomes (O). It is useful for advancing collective action theory and diagnosing the sustainability of SES. Each first-tier component is divided into second-tier variables (Ostrom 2009).

The framework provides a common vocabulary and a conceptual organisation of interactions but does not prescribe specific methods for investigation. Here, we adopt the methodological guide proposed by (op.cit.) Partelow, Stfefan with some guiding questions.

As a result, the **SESF** provides a useful lens through which we can understand the complex interactions between ecological systems and human societies, and how these interactions impact conservation efforts, sustainable development, and biodiversity management. It is applied in all the analyses performed in the following sections.

1.3 Why this document?

This document serves as a baseline assessment report for the ten case studies selected under Task 5.1 of the PRO-COAST project. The purpose is threefold:

1. Define Baseline Status: Establish the current biodiversity and socio-ecological conditions for each case study, highlighting the key environmental, social, economic, and governance factors that influence biodiversity and ecosystem health.

[1] Partelow, Stefan. "A Review of the Social-Ecological Systems Framework: Applications, Methods, Modifications, and Challenges." *Ecology and Society*, vol. 23, no. 4, 2018. *JSTOR*, https://www.jstor.org/stable/26796887. Accessed 14 Mar. 2024 (https://doi.org/10.5751/ES-13493-270439).

2. Establish Assessment Criteria: Develop and apply criteria for evaluating socio-ecological health and sustainability, focusing on key indicators such as biodiversity, community resilience, and policy coherence.
3. Set Socio-Ecological Goals: Define long-term goals to guide future management strategies and policy recommendations, aiming to promote ecosystem resilience, community engagement, and sustainable economic practices.

Structure of the Document

- Section 2 presents the overall methodology applied across all case studies, including stakeholder engagement, data collection, and the application of the SESF framework;
- Section 3 provides a detailed analysis of each case study, outlining their specific baseline status, assessment criteria, and socio-ecological goals;
- Section 4 compares the ten case studies, highlighting key differences and commonalities in their governance, ecological health, and human impacts;
- Section 5 concludes with key findings, recommendations, and next steps for ensuring the sustainable management of Europe's coastal SES.

2. GENERAL APPROACH

The methodology applied in PRO-COAST integrates **qualitative and quantitative approaches** to capture the complex socio-ecological dynamics of coastal systems. The Social-Ecological Systems Framework (SESF) ensures our assessments capture ecological, social, economic, and governance dimensions across multiple scales. This adaptable framework addresses specific challenges in PRO-COAST's case studies and provides a replicable model for sustainable coastal management in diverse contexts. By applying a systematic and adaptable methodology this approach can support the sustainable management of coastal areas across diverse socio-ecological contexts, ensuring its relevance for both the PRO-COAST initiative and beyond.

This approach will be **continuously updated and refined** throughout the lifespan of the PRO-COAST project, adapting to new data, stakeholder input, and evolving socio-ecological conditions in each case study area. These steps are presented in the following sections.

2.1. Approach to Data Collection and Analysis:

This assessment uses a multi-method approach that includes both qualitative and quantitative data, collected through field surveys, remote sensing, stakeholder consultations, and literature reviews. The Social-Ecological Systems Framework (SESF) guides data collection and analysis, ensuring a comprehensive understanding of each case study's socio-ecological dynamics. The multi-level analysis considers local, regional, and EU-wide perspectives to capture the diversity and complexity of each case study.

The data collection strategy:

- **Field Surveys**: Biodiversity assessments, habitat mapping, and ecological monitoring are conducted for each case study. Assessments are made of species diversity, habitat quality, and the state of ecosystem services;
- **Remote Sensing**: Satellite imagery and GIS tools are used to track land use changes, habitat fragmentation, and the presence and spread of NIs and invasive species;
- **Stakeholder Consultations**: Engaging with local communities, policymakers, NGOs, and private sector actors to understand socio-economic activities, governance structures, and community interactions with the ecosystem;
- **Literature Reviews**: Existing studies, reports, and databases at the local, national, and EU levels are consulted to complement primary data collection. Socio-Economic Databases provide insights into the local economic drivers (e.g., fishing, tourism, agriculture) and demographic trends. Additionally, existing reports from regional and national environmental authorities offer additional data on ecological conditions and biodiversity;
- **WP5 Partners' Questionnaire**: Data from the WP5 Partners' Questionnaire (a copy of which is found in the Annex in this document) on socio-ecological conditions, governance, and environmental challenges serve as a cornerstone for this deliverable, framing the research and reinforcing our participatory approach. We opted not to include the completed questionnaires within the main document. Instead, they have been formatted and made publicly available as an annex

on the Zenodo platform. This approach ensures transparency and convenient access to supplementary data. The annex can be accessed through the **DOI: 10.5281/zenodo.14012469**[2].

About Social Networks Analysis

Despite the original DoA of Pro-Coast mentioning the use of social network analysis, this task has been rendered unfeasible and less relevant due to significant changes in major social media platforms. Given the recent constraints of modern social media platforms—such as restricted data access, fragmented user bases, and geolocation challenges—shifting to direct, participatory engagement methods ensures more meaningful stakeholder involvement and actionable insights.

While these techniques were useful and applied in the past (e.g., the study analysing the structural dynamics of the 15M movement in Spain was performed by the authors of this deliverable), they are no longer considered useful for the current project due to a combination of technical, practical, and representational factors. Platform restrictions (e.g., changes in Twitter's API and increased limitations from platforms like Facebook) have drastically reduced access to reliable and comprehensive datasets. Additionally, concerns about the representativity of social media users and the increasingly fragmented nature of online communities diminish the relevance of such analyses for gaining broad insights into socio-ecological dynamics.

Moreover, geolocalization issues limit the ability to accurately track information at the local level, as most platforms no longer provide precise location data for analysis. Time constraints and the fast-evolving nature of social media make it increasingly difficult to obtain timely, meaningful results that align with the project's goals. Finally, given the shifting financial and pay-per-use landscape of social media, the opportunity cost of focusing on these methods outweighs their potential benefits, making other forms of direct or indirect stakeholder analysis more valuable and effective.

[2] https://doi.org/10.5281/zenodo.14012469

2.2 Identification of Key Indicators and Assessment Criteria

The following indicators and criteria ensure consistent assessment of socio-ecological health across all dimensions:

Dimension	Key Indicators	Assessment Criteria
Ecological/ Environmental	Biodiversity: Species richness, presence of endemic/threatened species,presence of non-indigenous species.	Species diversity, analysis of ecological indicators, presence of endemic species, presence of threatened species (IUCN red list of species), presence of NATURA 2000 priority species (habitat and birds directives), presence of non-indigenous species
	Habitat Quality: Habitat diversity, habitats conservation status, habitats connectivity, habitats ability to support biodiversity.	Habitats composition and mapping, ecosystem integrity analysis, presence of NATURA 2000 priority habitats (habitats directive), analysis of habitats fragmentation and mapping
	Ecosystem Services: Ecosystems provide provisioning (e.g., food, water, raw materials), regulating (e.g., climate regulation, carbon sequestration, water purification), cultural services (e.g., recreation, aesthetic enjoyment, education), and supporting services (e.g., photosynthesis, nutrient cycling, soils creation, water cycle), all of which contribute to local livelihoods and human wellbeing	Evaluate the health, value and availability of ecosystem services. Evaluate ecosystem services contribution to local livelihoods (e.g., fisheries and tourism) and the community's reliance on these services. Evaluate the ecosystem services equal availability among all social levels and their relation to human dimension.
Social	Community Engagement: Level of local involvement in conservation efforts and decision-making processes.	The level of participation in management activities and equitable distribution of benefits.
	Economic Activities:depend on natural resources through industries like tourism, fisheries, agriculture, and renewable energy.	Evaluates the sustainability of these economic practices, their impact on natural resources, the level of dependence on ecosystem services, and the capacity of local economies to adapt to environmental changes without degrading the ecosystem.
	Cultural Heritage Preservation: protection and continuation of cultural practices, traditional knowledge, and historical landmarks linked to coastal ecosystems,	Evaluates the integration of cultural heritage into conservation efforts, the engagement of local communities in maintaining traditions, and the preservation of cultural landscapes and historical sites amidst environmental changes.
Economic	Tourism and Fisheries: Role of these industries in supporting local economies and impact on ecosystem health.	Evaluates the sustainability of these economic activities, their impact on ecosystem health, the level of economic dependence on natural resources, and the capacity of local economies to adapt without degrading environmental assets.

	Economic Resilience: Community capacity to sustain activities without degrading natural resources, ensuring long-term sustainability of livelihoods and industries such as tourism, fisheries, and agriculture.	Evaluates the capacity of communities and industries to adapt to external shocks (e.g., climate change, market fluctuations), the diversification of income sources, and the balance between economic activities and ecosystem health.
Governance	Governance Systems: Effectiveness of local/regional policies and regulations for sustainable development.	Evaluates the coherence of policies, the capacity for adaptive management, stakeholder collaboration, enforcement of environmental regulations, and the inclusion of local communities in decision-making processes.
	Stakeholder Collaboration: Cooperation and partnership among government bodies, local communities, NGOs, businesses, and other stakeholders	Assesses the inclusiveness of decision-making processes, the effectiveness of multi-stakeholder partnerships, communication channels, and the capacity for joint action and conflict resolution in governance structures.

Table 3: Identification of Key Indicators

2.3 Identification and Engagement of Stakeholders

In line with social science and humanities (SSH) principles, stakeholder engagement should ideally occur before interventions are planned, ensuring that strategies are co-created with input from those most affected. This enhances the social acceptability, economic feasibility, and contextual relevance of the actions taken. However, in real-world settings, certain actions must begin before full engagement is possible. Flexibility and ongoing feedback loops are therefore critical. SSH experts, particularly from ethnography and participatory research, also emphasise the need for before-and-after assessments to understand the social impact of interventions and ensure strategies are refined based on community needs. Through the Social-Ecological Systems Framework (SESF), PRO-COAST integrates biodiversity research with SSH to engage a wide range of stakeholders, ensuring that strategies are not only scientifically sound but also socially inclusive, contributing to long-term sustainability.

Stakeholder identification and engagement are key components of the project, helping to ensure that the perspectives of local communities, businesses, and policymakers are integrated into the decision-making process. Early and iterative stakeholder engagement is essential for crafting solutions that reflect local needs. Involving stakeholders throughout—from identifying issues to co-designing strategies—ensures the relevance, inclusivity, and sustainability of actions. Engagement activities include workshops, online platforms, and meetings that build trust and foster collaboration among stakeholders.

Further work on these aspects is being conducted under Work Package 6, and its outputs have been utilised in this deliverable.

Categories of Stakeholders to be Engaged (5-Q helix)

- **Public Institutions**: Government agencies and local authorities involved in policy-making, environmental management, and urban planning. These stakeholders are crucial for regulatory support and facilitating community engagement;
- **Non-Governmental Organisations (NGOs)**: Environmental and social NGOs focused on biodiversity conservation, climate action, and community-based initiatives. These stakeholders provide expertise, local knowledge, and a network for grassroots engagement;
- **Academic and Research Institutions**: Universities and research centres that contribute scientific expertise, data analysis, and monitoring support. These stakeholders are key for evidence-based decision-making and innovation in SES management;
- **Local Communities and Citizens**: Residents, local businesses, and community groups who are directly affected by or dependent on coastal resources. Engaging these stakeholders ensures the inclusivity and social sustainability of project initiatives;
- **Private Sector Entities**: Businesses and industries, particularly those related to tourism, fisheries, and agriculture. These stakeholders are integral for aligning economic activities with sustainable practices and contributing resources and support for conservation efforts.

The stakeholder identification process aims to map out all relevant organisations, entities, and individuals involved in or affected by coastal management. This process should consider key interests, topics of concern, and the level of engagement stakeholders are willing to commit to.

Process of Stakeholder Identification - 5-Q Helix model

1. **Mapping Key Interests and Issues**: Stakeholders need to be categorised based on their key interests and issues that are significant to them. These could include areas such as climate adaptation, biodiversity conservation, climate mitigation, urban planning, and citizen science. Understanding these interests helps in aligning project objectives with stakeholder priorities and identifying areas of mutual benefit;
2. **Identifying Relevant Topics**: Each stakeholder needs to be assessed for their relevance to specific topics that are critical to the project. Topics may include climate adaptation, biodiversity, climate mitigation, urban planning, and citizen science. This assessment helps determine which stakeholders should be prioritised for engagement based on their potential to contribute to or benefit from the project outcomes;
3. **Engagement and Contact Strategy**: Stakeholders need to be contacted through various channels, including email, phone, and in-person meetings. This step aims to establish initial communication, gauge interest, and discuss potential roles and contributions to the project. The position of the contact person within each organisation also needs to be recorded to ensure the right level of engagement and decision-making capacity;
4. **Assessing Stakeholder Issues and Solutions**: Key issues affecting and affected by stakeholders need to be identified, along with their potential solutions and benefits. This step involves understanding who or what is affecting or being affected, and how this dynamic plays out in the socio-ecological landscape. It provides insights into stakeholder motivations, concerns, and potential areas of conflict or collaboration;
5. **Determining Levels of Interest and Participation**: Stakeholders need to be assessed for their level of interest in participating in the project. Levels of participation could range from non-involvement to active roles in awareness, information sharing, consultation, deliberation, co-design, and co-decision making. This assessment should align stakeholder capacities and interests with suitable roles within the project.

Each of these sectors contributes unique perspectives and resources to the collaborative process. Following the methodology outlined in the DoA, the PRO-COAST engagement strategy for each coastal case study adopts the Excites and Bristol Approach, structured into six iterative steps:

1. **Identification of Issues:** Engage with local communities to identify key environmental and societal issues and motivations for engagement. Establish a community protocol based on informed consent and mutual understanding;
2. **Framing the Issue**: Study the identified issues in detail to evaluate their significance and feasibility for resolution;
3. **Designing the Use Case**: Collaboratively develop tools (e.g., apps, data collection kits) tailored to community needs and capabilities;
4. **Testing the Tools:** Deploy and test tools in real-world conditions with community involvement.
5. **Sharing**: Promote tool usage and extend the network to include new stakeholders and communities;
6. **Outcome Assessment:** Evaluate the results, share knowledge, and plan next steps.

Remarks:

- No one left behind. Find open, collaborative and adaptable ways to manage the 'commons'. It is about bridging gaps and including people who are normally excluded from this kind of initiatives because of educational or technical barriers;
- Transformative communities comprise civil society organizations, biodiversity policy makers, social partners, financing, industry, education institutions, business leaders, retailers, cultural and gender institutions, local authorities, fishers, farmers, processors, NGOs, youth organisations, tourists, experts, migrants… to ensure complete representation of the local population;
- Participants can be involved at all stages of the process – including problem definition, data collection and analysis – for issues that matter to them and which they decide they want to tackle;
- Engagement is mostly initiated and run by the local communities themselves with the key support of the local ambassador. Communities are encouraged to lead discussions, and particular care is taken to ensure that everyone feels encouraged to express their views without any criticism or judgement;
- Focus on people rather than technology because technology helps but never works alone. All skills are needed beyond data, software or hardware. These initiatives rely heavily on a participatory design approach methodology;
- Think global, act local. Actions are situated taking local needs, practices and cultures into account, and make positive transformations in the world;

Run as many meetings as needed in each phase ensuring that 'everyone' can join with ideas, skills and opportunities to engage. Meetings can be practical workshops, 'hack-days' and making sessions. It is encouraged to improve the meetings by inviting artists and creative technologists to facilitate them. Try to avoid specialist language.

2.4 Baseline Establishment and Diagnosis of Case Studies

2.4.1. Baseline Status

Baseline data forms are the reference point for assessing changes in biodiversity and socio-ecological conditions, tracking progress towards sustainability goals, and guiding adaptive management. The process of baseline establishment involves several key steps, as detailed below:

- **Data Integration**: As stated in section 2.1, combining qualitative and quantitative data from field surveys, remote sensing, historical records, socio-economic databases, and environmental monitoring reports and literature;
- **Validation with Local Knowledge**: Collaborating with local stakeholders, including communities, policymakers, and researchers, to validate baseline data and align it with local realities;
- **Baseline Reporting**: Documenting the baseline status for each case study area, outlining relevant initial ecological conditions, socio-economic activities, governance structures, and community involvement;
- **Diagnosis and Contextual Understanding:** Analysing the political, social, and ecological dynamics within each case study area, recognising challenges, and identifying key drivers of biodiversity loss, providing a clearer picture of future risks and opportunities.

An essential aspect of baseline establishment is the validation of data with local knowledge. Collaboration with local stakeholders, including communities, policymakers, and researchers, ensures that the baseline data reflects on-the-ground realities. This participatory approach aligns the assessment with local priorities and fosters trust among stakeholders, which is critical for successful project implementation. Local knowledge provides valuable insights into historical environmental changes, social dynamics, and policy challenges that may not be captured in quantitative data alone.

For identified stakeholders, engagement activities linked to the Baseline establishment should include:

- Workshops and Consultations: Participatory workshops are organised in each case study area to co-design strategies, identify key challenges, and prioritise actions;
- Collaborative Platforms: Online and in-person platforms foster continuous dialogue between stakeholders to share knowledge, monitor progress, and refine management strategies;
- Local Ambassadors: Designated local representatives play a key role in facilitating stakeholder engagement, ensuring inclusive participation, and leading community-driven initiatives.

For each case study, a detailed baseline report is developed, documenting the initial conditions across key socio-ecological dimensions and indicators presented in section 2.2. This baseline report outlines a) Ecological Conditions: Including relevant biodiversity, habitat quality, and ecosystem services; b) Socio-Economic Activities: The role of industries such as tourism, fisheries, and agriculture, and their interaction with natural resources; and c) Governance Structures: Analysis of local governance systems, policies, and stakeholder engagement. These reports serve as the foundation for assessing progress and also serve as a foundation for monitoring progress and assessing the impacts of project interventions over time.

To sum up, to establish a baseline status for each case study, the PRO-COAST project employs a systematic approach that combines ecological, social, economic, and governance data to capture the current conditions of coastal socio-ecological systems (SES). This approach helps in understanding the

initial state of biodiversity, ecosystem services, and socio-economic factors, serving as a reference point for future assessments and management actions. It serves as a benchmark to measure changes in biodiversity and ecosystem health. Moreover, it provides a foundation for developing adaptive management strategies and it helps in setting realistic and achievable socio-ecological goals. The steps are compiled in the following table:

Steps to Establish Baseline Status:

1. Data Collection and Integration: Gather existing data from multiple sources, including field surveys, remote sensing, historical records, socio-economic databases, and environmental monitoring reports. Integrate new qualitative and quantitative data to develop a comprehensive baseline that reflects the complexity of each SES.
2. Identification of Key Indicators: Define key indicators for ecological, social, economic, and governance dimensions. For example:
    - Ecological Indicators: Biological assemblages or taxa that by their presence or condition indicate something about the environment. SMART ecological indicators (e.g., species diversity) will be calculated and compared;
    - Social Indicators: Community engagement, socio-economic dependence on natural resources;
    - Economic Indicators: Economic activities linked to natural resources (e.g., tourism, fisheries);
    - Governance Indicators: Effectiveness of management practices, stakeholder involvement.
3. Historical Analysis and Trend Assessment: Analyze historical data to identify trends and changes in key indicators over time. This helps to understand the trajectory of ecosystem changes and potential future challenges.
4. Validation with Local Knowledge: Engage with local stakeholders, including communities, policymakers, and researchers, to validate baseline data and ensure it aligns with on-the-ground realities. This step enhances the credibility and relevance of the baseline status.
5. Documenting Baseline Conditions: Create a comprehensive report that details the baseline status for each case study, highlighting the initial conditions, identified trends, and key challenges.

This comprehensive approach to establishing baselines ensures the strategies developed are context-specific, measurable, and adaptable, laying the groundwork for achieving PRO-COAST's long-term sustainability objectives.

2.4.2. Diagnosis of Case Studies

The diagnosis of each case study area goes beyond data collection, providing a holistic understanding of the **political, social, and ecological dynamics** at play. This includes identifying key drivers of biodiversity loss, resource depletion, and socio-economic pressures. Understanding these dynamics is critical for developing tailored strategies that address the unique challenges of each area/region.

The general approach, aligned with the project's broader goal of providing a framework applicable beyond PRO-COAST, includes the following steps:

1. **Application of SESF**: SESF helps address biodiversity challenges in marine systems with complex, vaguely defined boundaries. It integrates systems thinking, archetypes, and Ostrom's SES framework to support resilience and sustainability.
2. **Understanding the Context**: Analyse political, social, and ecological processes that cross social boundaries, property systems, and political districts. Recognize the diverse values and scales of ecosystem services that challenge management of these "new commons."
3. **Performing the Analysis**: Conduct analyses based on specific guidelines, capacities, and conditions. Understand research questions, methodologies, and the interdependencies of various tasks.
4. **Data Gathering and Identifying Gaps**: Collect data, identify gaps, and determine challenges and drivers of biodiversity loss. This helps focus on identifying focal points and key stakeholders and analysing socio-ecological profiles.
5. **Proposing Research Questions**: Develop research questions to guide further investigation.
6. **Engagement Methodologies**: Develop methodologies to engage stakeholders effectively, using approaches like the Bristol model

Table 4: Examples of SESF Variables and Data Sources used in this deliverable.

Dimension	Variable	Data Sources
Social, Economic, and Political Settings (S)	S1 Economic Development	Regional economic statistics, reports on fisheries, tourism, coastal economic activities, and household income surveys.
	S2 Demographic Trends	Local demographic studies, census data, migration patterns in coastal communities, age distribution, and household sizes.
RS1 Sector	RS1 Sector	Reports on fisheries, agriculture, and tourism management; marine research on ecosystem services.
	RS2 Clarity of System Boundaries	Marine Protected Area (MPA) regulations, coastal zoning laws, and land-use policies.
Governance Systems (GS)	GS1 Government Organizations	Policy and regulatory documents on coastal resource use, national and regional coastal management plans.
	GS2 Nongovernmental Organisations	NGO reports on community-based projects, biodiversity conservation, coastal development monitoring.
Resource Units (RU)	RU1 Resource Unit Mobility	Marine biology studies, reports on migratory species (e.g., fish, birds) and coastal ecosystem connectivity.
	RU2 Growth or Replacement Rate	Fisheries stock assessments, reports on coastal habitat recovery (e.g., coral reefs, wetlands).
Actors (A)	A1 Number of Relevant Actors	Surveys on local communities, fishers' cooperatives, tourism operators, conservationists, and local governance bodies.

	A2 Socioeconomic Attributes	Socioeconomic surveys focusing on income, education levels, employment in tourism, fisheries, and agriculture.
Interactions (I)	I1 Harvesting	Fisheries management data, seasonal catch records, agriculture yield reports, forest resource extraction.
	I2 Information Sharing	Community consultations, citizen science data platforms, local radio and media outreach, participatory workshops.
Outcomes (O)	O1 Social Performance Measures	O1 Social Performance Measures
	O2 Ecological Performance Measures	O2 Ecological Performance Measures
Related Ecosystems (ECO)	ECO1 Climate Patterns	Meteorological data, climate change impact reports (e.g., sea-level rise, coastal erosion), adaptation strategy reports.
	Meteorological data, climate change impact reports (e.g., sea-level rise, coastal erosion), adaptation strategy reports.	Water quality monitoring, marine plastic pollution studies, local sewage and industrial waste reports.

In future socio-ecological assessments beyond PRO-COAST, analysing all the SESF variables and data sources independently for each case study may be challenging. However, existing regional strategies and global frameworks—such as the Sustainable Development Goals (SDGs) and NATURA 2000 Directives—offer a more practical approach by requiring documentation to address these variables holistically. These frameworks inherently interlink variables such as economic development, biodiversity conservation, and governance systems, enabling future case studies to leverage existing literature and global databases to integrate diverse dimensions efficiently. Instead of isolating variables, practitioners can analyse cross-cutting issues like socio-economic resilience or ecosystem service management through the lens of interconnected frameworks, ensuring a more cohesive and manageable evaluation. This approach not only reduces the complexity of independent analysis but also aligns future case studies with internationally recognised standards, fostering more effective management strategies at both local and global scales.

2.4.3. Future data collection and quantitative monitoring

To ensure a comprehensive understanding of the socio-ecological dynamics across the case studies, quantitative data will be progressively collected throughout the lifespan of the PRO-COAST project. This data will be integrated into future deliverables, providing a measurable foundation for assessing progress and evaluating the impact of project interventions.

Key actions for quantitative data integration:

1. Quantitative data collection by Case Studies: Each case study will gather quantitative data relevant to biodiversity, ecosystem health and socio-economic factors within their specific areas. These data will be used to establish baseline conditions and measure changes over time, with a focus on key performance indicators (KPIs) for each area.

2. KPIs for biodiversity monitoring: Case studies will enhance biodiversity monitoring by integrating quantitative data, such as the abundance and diversity of species, habitat quality (e.g., area of protected habitats), and the presence of key ecological drivers (e.g., invasive species). These quantitative metrics will allow for an evidence-based assessment of conservation strategies and the project's impact on biodiversity.

3. Citizen Science for data enhancement: To strengthen the collection of quantitative data, each case study will implement citizen science initiatives. These will involve local communities and stakeholders in data collection, expanding the scope of monitoring and improving data accuracy. Participants will be trained to gather standardized data on biodiversity and environmental conditions, which will be integrated into the case studies for analysis.

4. Adaptive monitoring framework: The project will adopt a dynamic approach to data collection, with continuous monitoring and updates to the datasets. Regular reports will outline progress in quantitative data collection and its integration with other research methods. This adaptive framework will allow for adjustments in strategies based on the most current and accurate data, ensuring that the project's objectives remain relevant and impactful.

5. Revisions to deliverables: The quantitative data collected will be incorporated into future deliverables, improving the depth and robustness of the case study assessments. These revisions will provide a clearer and more detailed picture of the socio-ecological conditions across the project's case studies, facilitating more effective and evidence-based decision-making for sustainable management.

This approach ensures that while the initial baseline provides qualitative insights, the future analysis will evolve to include robust quantitative data. The continuous collection and integration of this data will enable the project to provide a comprehensive, evidence-based understanding of the socio-ecological changes in the case study areas, supporting adaptive management strategies and enhancing the overall impact of the project.

2.5. Fixing the focal action

Focal Action Situations (FAS) are specific scenarios or issues within each case study that require targeted management and interventions. These actions are central to addressing the most pressing threats to coastal socio-ecological systems, such as biodiversity loss, resource over-exploitation, or ecosystem degradation. Directly addressing the FAS is the "final step" in the SESF with all the previous analysis converging into targeted management actions. It is essential for aligning management efforts with the local realities of each case study, ensuring that the interventions are not only scientifically informed but also contextually appropriate and supported by stakeholders.

Steps to Fix the Focal Action:

- **Identify Focal Issues**: Based on baseline data and assessment criteria, identify key issues that pose significant risks to the socio-ecological health of each case study. These could include

specific threats such as invasive species, overfishing, pollution, or habitat loss. These focal issues represent the most urgent challenges that need to be addressed to improve sustainability in each case study.

- **Prioritise Actions**: Rank the identified issues based on their urgency, potential impact, and feasibility of intervention. This prioritisation helps focus resources and efforts on the most critical challenges. Priority is given to actions that can provide the greatest benefit for both the ecosystem and the local community, and those that align with existing regional and global strategies.
- **Develop Targeted Strategies**: For each prioritised issue, develop a set of targeted strategies that address the root causes and mitigate the impacts. Strategies should be specific, measurable, achievable, relevant, and time-bound (SMART).
- **Engage Stakeholders**: Involve relevant stakeholders in the development and implementation of focal action strategies. This ensures that actions are context-appropriate and have the support of local communities and decision-makers. Their input ensures that actions are locally adapted, culturally relevant, and have the necessary support for long-term success.
- **Monitor and Adjust**: Continuous monitoring is key to evaluating the effectiveness of the focal actions. By tracking progress against predefined criteria, the strategies can be adjusted as needed, ensuring an adaptive management approach that remains responsive to changing conditions in the coastal systems.

Summary of Key Points, Aspects, and Remarks of the Definition of a CS

1. Data Collection and Analysis:
    - Mixed-method approach combining qualitative and quantitative data from field surveys, remote sensing, and consultations.
    - Multi-level analysis from local to EU-wide perspectives.
2. Stakeholder Engagement:
    - Mapping key stakeholders from local communities, NGOs, government agencies, and private sectors.
    - Methods of engagement: workshops, surveys, participatory mapping, and continuous collaboration.
3. Data Sources and Tools:
    - Use of GIS, remote sensing, and statistical software.
    - Integration of environmental, social, economic, and governance data.
4. Assessment Criteria:
    - Ecological: Species diversity, habitat quality, and ecosystem services.
    - Social: Community engagement, social equity, and cultural heritage preservation.
    - Economic: Economic dependence on natural resources and sustainable practices.
    - Governance: Policy coherence, stakeholder collaboration, and adaptive management.
5. Diagnosis of Case Studies:
    - Application of SESF to understand cross-boundary socio-ecological challenges.
    - Identification of drivers of biodiversity loss and knowledge gaps.
6. Engagement Approach:
    - Iterative engagement process emphasising inclusivity, community leadership, and participatory design.
    - Emphasis on inclusivity, local community leadership, and participatory design.
    - Stakeholder engagement ensures that strategies developed are socially acceptable and economically feasible.
7. Baseline Status:
    - Combines multiple data sources and identifies key ecological, social, economic, and governance indicators.
    - Validates baseline data through local stakeholder input.
8. Fixing the Focal Action:
    - Identifies critical socio-ecological challenges within each case study and prioritises actions based on urgency, feasibility, and impact.
    - Stakeholders are involved in the co-development and monitoring of strategies, ensuring that actions are contextually relevant and adaptive to local needs.

While this general approach provides a comprehensive framework for addressing socio-ecological challenges in coastal regions, it serves as an overarching recommendation for both PRO-COAST and other similar initiatives. However, it is important to recognize that the specific realities and complexities of each case study area will require tailored strategies and adaptations. The diversity in ecological conditions, governance structures, and stakeholder dynamics across case studies means that a one-size-fits-all solution is not feasible. Therefore, while this methodology offers valuable guidance, its application must be flexible, allowing for localised adjustments to meet the unique needs of each socio-ecological system.

3. DEFINITION OF CASE STUDIES

The general approach developed in Section 2 provides a comprehensive framework for understanding and managing the socio-ecological complexities of coastal systems. This framework has been initiated and adapted to each specific case study, ensuring that the methodology reflects the unique environmental, social, economic, and governance challenges present in each context. By applying the general steps of data collection, stakeholder engagement, and baseline establishment to the concrete realities of each case study, we ensure that the analyses are locally relevant and actionable.

We emphasise the need for flexibility and responsiveness to the specific socio-ecological dynamics of each case study area, a core objective of this deliverable. This tailored approach allows for the identification of critical socio-ecological drivers and supports the development of adaptive management strategies, grounded in both global frameworks and local insights. In the following sections, we present the results of this adapted methodology as applied to each case study, enabling the formulation of effective and sustainable actions.

3.1. CS1: Comino Island, Malta

3.1.1 CS Situation and Baseline

Comino Island, part of the Maltese archipelago, is a small but crucial biodiversity reserve known for its rocky coastlines, Mediterranean shrublands, and cliffs. It plays a key role in the protection of endemic plant and seabird species, such as the Yelkouan Shearwater and the Maltese Wall Lizard. Despite its ecological significance, the island faces significant degradation due to the pressures of mass tourism and inadequate governance. Mass tourism is exerting growing pressure on Comino's environment, particularly in the Blue Lagoon. Visitor numbers and management practices are key areas where improvements could mitigate pollution, protect sensitive habitats, and preserve biodiversity. While there are only two people currently residing on Comino (elderly residents who have grown up and always lived there) around 5000 visitors arrive daily in the summer season. The high density of boats around Comino, particularly in the Blue Lagoon area, is contributing to seabed damage and marine habitat destruction. Implementing stricter anchoring restrictions is critical to protecting sensitive habitats such as *Posidonia oceanica* meadows and coral reefs. Additionally, noise and light pollution from boats are impacting both marine life and the visitor experience.

Ecological Baseline:

- Comino Island is a NATURA2000 Site, both terrestrially and for the surrounding marine areas, designated for its diverse habitats, such as vegetated sea cliffs and marine plant *Posidonia oceanica*. Its biodiversity includes endemic species of flora like *Linaria pseudolaxiflora*, as well as key fauna like the *Puffinus yelkouan* seabird and *Caretta caretta* turtles, which are protected under the EU Habitats and Birds Directives. Coastal cliffs and rocky habitats dominate the landscape, while human pressures are exerted primarily through tourism and recreational activities.
- *Linaria pseudolaxiflora* is listed as one of the key endemic species of flora on the island. The species is part of the island's critical biodiversity, particularly found in the clifftop phrygana and pseudo-steppe habitats. However, these areas face significant threats from tourism pressure, which leads to habitat degradation, especially in terms of trampling on sensitive plant species. The Comino N2K Management Plan and conservation efforts aim to protect such endemic flora, but the need for enhanced protection measures is clear given the impact of tourism on these fragile habitats
- The island's biodiversity is concentrated in cliff-side habitats, garigue, and pseudo-steppe environments. Key endemic species include the *Limonium melitense* and *Matthiola incana* subsp. *melitensis*, while invasive species like *Carpobrotus edulis* threaten local flora.
- Marine biodiversity is also significant, with *Posidonia oceanica* meadows covering approximately 70% of the surrounding marine areas, providing critical ecosystem services like water filtration and carbon sequestration.

Social Baseline:

- Comino has a very small residential population, with only two permanent residents. However, it attracts around 5,000 daily tourists during peak seasons, leading to issues of overcrowding, littering, and strain on local infrastructure.
- Community engagement in conservation activities is limited but there is growing interest in involving both local NGOs and tourists in citizen science efforts. Local groups like Friends of the Earth Malta and BirdLife Malta have been active in advocacy and monitoring.

Economic Baseline:

- Tourism is the main economic activity on Comino, especially concentrated in the Blue Lagoon, which experiences high visitation during the summer. The lack of sustainable tourism management has led to habitat degradation.
- The Comino Hotel development plans, combined with recreational activities such as boating and diving, contribute to ongoing debates about the environmental impact of tourism on the island.

Governance Baseline:

- The management of Comino falls under multiple national and local authorities, including Ambjent Malta[3] and the Environment and Resource Authority (ERA). However, enforcement of environmental regulations has been insufficient, leading to unchecked tourist activities, and habitat damage.
- Efforts to improve governance include plans to revise the NATURA 2000 Management Plan[4] and better coordination between local NGOs, governmental bodies, and private enterprises.
- Key governance stakeholders include Ambjent Malta (AM) and the Environment and Resource Authority (ERA), both responsible for ensuring sustainable practices on the island (rated 5 in relevance). The Malta Tourism Authority (rated 5) plays a crucial role in managing the high tourist influx, while private operators like kiosks, deckchairs, and boat services (rated 4) heavily influence daily activities, particularly around the Blue Lagoon area.

3.1.2 Initial Indicators, Data Sources, and Drivers

This section identifies socio-ecological indicators and key drivers based on available data and stakeholder input. The indicators focus on biodiversity, community engagement, economic activities, and governance structures, providing a comprehensive understanding of the current state of the island. The analysis is based on existing literature, environmental reports, and direct stakeholder feedback gathered through the questionnaire, where biodiversity loss, tourism pressure, and governance challenges were identified as top concerns. These data sources help outline the main environmental, socio-economic, and governance drivers affecting Comino Island, laying the foundation for targeted management actions.

Comino Island faces numerous environmental threats, primarily due to uncontrolled mass tourism and a lack of proper management. Uncontrolled visitation is concentrated in small areas, leading to trampling, waste generation, and noise and light pollution, while the lack of a waste management plan exacerbates the problem. There is a total absence of a management plan for the Marine Protected Area (MPA),

[3] https://ambjentmalta.gov.mt/

[4] https://era.org.mt/topic/natura-2000-management-planning-for-terrestrial-sites-in-malta-gozo/#:~:text=The%20overall%20aim%20of%20this,the%20general%20public%20and%20stakeholders.

resulting in uncontrolled anchoring, potential spills, and damage to the seabed. Local Administration will for implementing carrying capacity measures and conservation initiatives is lacking, and there is insufficient consultation with authorities. The island also suffers from mushrooming unlicensed food stalls, sprawling umbrella operators, and an increasing number of motorised vehicles, all of which negatively impact the environment. There is little funding for conservation compared to the high turnover from tourism, and the island's biodiversity is further threatened by invasive species. There is no environmental education or enforcement on-site, and infrastructural works are often carried out without sensitivity to the site's ecological status.

Initial Indicators:

- **Ecological**: Species diversity (e.g., breeding seabirds, endemic plants), habitat quality (coastal cliffs, marine meadows), and the presence of invasive species (e.g., *Carpobrotus edulis*) and rats;
- **Social**: Community engagement in conservation activities (low involvement of residents, high tourist presence), cultural heritage preservation efforts;
- **Economic**: Heavy dependence on tourism, specifically in peak seasons, with limited alternative livelihood opportunities;
- **Governance**: Collaboration between local NGOs and government, but gaps in policy enforcement and coordination.

Data Sources:

1.National Legislation

- **Government of Malta**: Provides key policy documents on tourism, environmental protection, and sustainable development that are relevant to Comino Island;
- **Planning Authority of Malta (PA)**: Oversees land-use planning, development control, and environmental assessments, with specific relevance to development projects on Comino;
- **Sustainability Malta**: Offers Malta's national sustainability strategy and regulations, covering resource management and environmental sustainability;
- **Energy and Climate Policy (Malta)**: Contains data on Malta's national energy strategies and sustainable energy projects, affecting Comino's sustainability.

2.Questionnaire Responses: Direct feedback on biodiversity, habitat quality, community engagement, and governance challenges.

3.Environmental Reports

- **Environmental and Resources Authority (ERA)**: Provides comprehensive environmental monitoring data, including habitat conservation efforts, NATURA 2000 management, and marine monitoring programmes;
- **NATURA 2000 Annex (Kemmuna)**: Specific reports related to Comino Island's NATURA 2000 status and biodiversity conservation strategies;

- **Focus Group Surveys by Friends of the Earth Malta (FoEM)**: Provides insights from stakeholders and local communities on environmental concerns and conservation needs on Comino;

- **Data Sheet from N2K Management Plan**: Essential data from the Natura 2000 management plan, specifically regarding Comino Island's biodiversity and habitat conservation efforts;

- Bees Diversity and Distribution in the Maltese Islands: This initiative focused on bee species that are crucial for ecological health in Malta;

- Ecologica - Malta Biodiversity Survey Project (by Friends of the Earth Malta in partnership with BINCO (Biodiversity Inventory for Conservation). It is designed to monitor species populations and habitat conditions in various ecosystems across the Maltese islands and incorporates citizen science, encouraging the public to participate in biodiversity surveys, and fostering greater environmental awareness.

4.Scientific Literature

- **University of Malta Projects**: Research initiatives focusing on marine ecosystems, biodiversity, and environmental science, with projects such as **Spot the Jellyfish** providing data on Comino's marine biodiversity;

- **University of Malta's Biology and Environmental Science Departments**: Offer scientific data and research studies relevant to biodiversity and habitat management on Comino Island;

- **Environmental Education Projects (University of Malta)**: Involves citizen science initiatives such as the **Wild for Orchids** project, contributing to ecological monitoring and public engagement;

- Studies on coastal erosion, biodiversity loss, and socio-economic impacts of tourism in Malta. For instance, studies on the Romanian Black Sea coastal ecosystems highlight the critical role of dunes and wetlands for biodiversity. Portals like **Web Of Science** and **Scopus.** Literature Review provides valuable insights into CS. Studies[5] suggest that tourism on Comino Island (Malta) negatively impacts biodiversity by reducing species richness, abundance, and habitat availability, and by promoting the spread of non-native invasive species.

5.NGO Reports

- **Din l-Art Ħelwa**: A heritage and environmental NGO involved in the conservation of Malta's cultural and natural landscapes, with a focus on protecting Comino's biodiversity.
- **Nature Trust Malta:** Engaged in wildlife conservation and habitat restoration projects, providing reports on ecological health and biodiversity in Comino.
- **BirdLife Malta:** Active in habitat conservation and monitoring migratory bird species, especially in Comino's protected areas. https://birdlifemalta.org/

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[5] Vogiatzakis, I., Mannion, A., Sarris, D., Sarris, D., & Sarris, D. (2016). Mediterranean island biodiversity and climate change: the last 10,000 years and the future. Biodiversity and Conservation, 25, 2597-2627. https://doi.org/10.1007/s10531-016-1204-9.

Main Drivers:

- **Environmental**: Habitat degradation from mass tourism (ranked 5) and pollution from recreational activities.
    - **Habitat Loss**: Overcrowding results in habitat degradation, trampling of sensitive areas, and increased waste generation. Issues such as **trampling on sensitive habitats** and **pollution from waste on land and at sea** were ranked as critical concerns (ranked 5). The continued degradation of Comino's coastal habitats, including its wetlands and rocky areas, is driven by uncontrolled tourism and human activities, which disturb natural ecosystems and contribute to habitat fragmentation;
    - **Biodiversity Pressures**: Invasive species and human disturbance are pressuring local biodiversity, including rare plant species, and habitats supporting migratory birds, particularly noted in the data from **BirdLife Malta** and environmental assessments from the **ERA**. This was ranked highly in the questionnaire;
    - **Climate Change Impacts**: Rising sea levels and changing weather patterns increase coastal erosion risks, threatening the island's fragile ecosystems. This is supported by reports from **ERA** on climate-related challenges in Malta's coastal areas.
- **Socio-Economic**: Economic reliance on unsustainable tourism practices, contributing to environmental stress (ranked 5).
    - **Tourism Pressure**: Comino Island experiences high levels of seasonal tourism, which leads to habitat degradation, littering, and strain water resources. Comino experiences extremely high human impact, with a minimum of 5,000 daily visitors during the summer season, which now extends over at least six months. This was highlighted in the questionnaire, where **mass tourism** was ranked as highly relevant (ranked 5) among the main uses of the area. The **Malta Tourism Authority** and **Planning Authority** have raised concerns about the island's carrying capacity, indicating that tourism is a major driver of environmental degradation. The lack of sustainable practices is contributing to environmental degradation, particularly through unregulated tourism activities such as boating, mass tourism, and beach usage (ranked 5). While tourism provides economic benefits, its unregulated nature is causing habitat loss, pollution, and overcrowding, which threaten long-term ecological and economic resilience;
    - **Uncontrolled Visitation**: The lack of carrying capacity measures leads to overcrowding, particularly in small areas like the Blue Lagoon. The questionnaire identified **uncontrolled visitation condensed in one small area** as a primary threat (ranked 5). Moreover, the lack of awareness among visitors leads to irresponsible behaviors such as littering and trampling. The questionnaire noted lack of awareness by private tourism operators and visitors as a critical issue (ranked 5);
    - Boat traffic contributes to **pollution**, including **oil spills**, **waste dumping**, and **damage to the seabed** from anchors. These activities degrade the marine environment, affecting the quality and quantity of fish stocks, which in turn impacts the livelihoods of local fishers;
    - The questionnaire also ranked **pollution from waste on land and at sea** as a critical concern (ranked 5), underscoring the environmental degradation caused by heavy boat traffic. **Overfishing and Marine Resource Use**: Fishing activities, though limited around Comino, still impact marine ecosystems. **Nature Trust Malta** has noted concerns over marine resource management around the island;
    - **Comino's population consists of only two residents,** with the majority of human presence being transient tourists during the summer. There is an increasing trend in visitor

numbers, with over 5,000 daily visitors during peak seasons, which stresses the island's ecological balance. Concerns about overcrowding, particularly in the Blue Lagoon area, have led to public protests by NGOs and the local community;
    - **Real Estate Development**: Pressure from real estate development, though limited, has raised concerns about long-term sustainability and impacts on natural resources. Plans for hotel redevelopment and expansion pose threats to sensitive habitats and increase environmental pressures. In the questionnaire, **hotel development and works** were rated as a significant use of the area (ranked 5), indicating real estate development is an issue. Reports from the **Planning Authority** discuss zoning and land-use planning that could impact the island;
    - **Mushrooming Food Stalls and Kiosks**: The proliferation of kiosks and deckchair operators, often with dubious licensing, has led to increased waste, sound pollution, and occupation of public land. This issue was ranked as a significant pressure (ranked 5);
    - **Uncontrolled Anchoring and Boating Activities**: High density of boats causes damage to the seabed, contributes to noise and light pollution, and leads to potential spills. This was identified as a critical threat (ranked 5).
- **Governance**: Lack of enforcement and implementation of management plans for both terrestrial and marine areas (ranked 5).
    - **Weak Enforcement of Environmental Regulations**: Governance gaps and weak enforcement of regulations, particularly concerning tourism management and habitat protection, are noted as major challenges. The **Planning Authority** and **Environmental and Resources Authority** have reported issues with the enforcement of regulations designed to protect Comino's ecosystems. A Natura 2000 management plan exists for the terrestrial areas but lacks full implementation, and there is no management plan in place for the surrounding marine areas. Governance gaps and poor enforcement of existing policies were identified as significant issues (ranked 5) in the questionnaire, particularly concerning mass tourism control and environmental protection;
    - **Weak Enforcement**: The questionnaire highlighted a lack of environmental enforcement on site (ranked 5), leading to uncontrolled activities that harm the ecosystem. For instance, infrastructural projects are often carried out without sensitivity to the site's protected status, leading to habitat degradation (ranked 4);
    - **Fragmentation of Management Competencies**: Multiple authorities with overlapping responsibilities contribute to ineffective management and enforcement;
    - **Stakeholder Conflicts**: The competing interests of tourism, conservation, and development stakeholders create conflicts that hamper effective environmental management. The questionnaire responses highlight governance as an area needing stronger coordination and collaboration among stakeholders.
- **External**: Climate change and the seasonal nature of tourism impacting both the environment and the economy

3.1.3 Diagnosis of Knowledge Gaps and Challenges

This section outlines the key knowledge gaps and challenges that hinder effective management of Comino Island's socio-ecological systems, particularly those related to the main drivers of environmental and socio-economic pressures, such as tourism, governance, real estate development, and boat traffic. These gaps reflect missing data, incomplete understanding of impacts, and insufficient management capacity.

1. Biodiversity Knowledge Gaps

- **Impact of Tourism on Habitats and Species:** Specific data on how tourism activities (e.g., trampling of sensitive habitats, waste generation, and noise pollution) affect biodiversity is missing. Comprehensive assessments are needed to quantify the long-term impacts on species diversity and habitat quality.
- **Marine Ecosystem Degradation:** There is insufficient data on the impact of boat traffic on marine biodiversity, particularly the effects of noise pollution, anchor damage, and pollution from boats on key habitats like seagrass beds and fish populations. Without this, it is difficult to regulate boating activities effectively.
- **Survey on Local Bats**: While Comino is home to various species, including bats, there is a significant gap in understanding the population dynamics and habitat use of these species. A detailed survey on local bat populations would help inform habitat conservation efforts and mitigate the impacts of tourism and other human activities. Example to follow: Bat Monitoring Programme[6]
- **More Detailed Flora Survey**: Existing flora surveys are not comprehensive enough, particularly regarding endemic species like *Linaria pseudolaxiflora*. A more detailed flora survey is essential to understand the distribution, health, and conservation needs of plant species across the island, especially considering habitat degradation due to tourism and development.
- **Rat Population Hotspots**: Although the invasive rat population is recognised as a major threat to Comino's biodiversity, especially to ground-nesting birds, there is insufficient data on rat population hotspots. Identifying these hotspots is crucial for implementing effective and targeted control measures, thereby reducing the impact on the island's ecosystem.

2. Social Knowledge Gaps

- Visitor Awareness and Behaviour: More research is needed on how visitor behavior affects the island's ecosystems and whether current environmental education initiatives are effective. Understanding how tourists perceive their environmental impact is essential for designing more targeted awareness campaigns. Conducting regular visitor surveys would provide data to inform better tourism management strategies and raise awareness about conservation needs.

- A significant knowledge gap exists in the lack of a structured waste management plan, despite the high tourist turnover (rated 5). The proliferation of unregulated food stalls contributes to waste generation and pollution, impacting both land and sea environments. Clear waste reduction strategies are urgently needed, as highlighted by stakeholders.
- Seasonal Visitors and Engagement: There is limited understanding of how to effectively engage seasonal visitors and part-time residents in conservation efforts, given their transient presence. Strategies for their involvement in sustainable practices are underdeveloped.
- Stakeholder Collaboration: A knowledge gap exists in understanding how to facilitate better collaboration between local authorities, NGOs, and private tourism operators to ensure that conservation goals are aligned with tourism practices. The fragmented management of Comino has hindered effective cooperation.

[6] https://eu-citizen.science/project/460

3. Economic Knowledge Gaps

- **Long-term Effects of an Eco-Tax**: There is a gap in understanding the potential **long-term effects of introducing a visitor eco-tax** on Comino Island. An eco-tax could generate revenue to fund conservation efforts, but its impacts on **tourism numbers, visitor satisfaction**, and the local economy have not been studied. Without this data, it is unclear whether such a tax would be sustainable or effective in mitigating tourism pressures.
- **Real Estate Development Impacts**: There is insufficient data regarding the long-term environmental impacts of **real estate development** on Comino, particularly hotel expansion projects. Environmental Impact Assessments (EIA) should provide more robust long-term monitoring to understand how these developments affect sensitive habitats.
- **Fisheries and Local Economy**: There is limited data on the impact of tourism and boat traffic on **local fisheries**. Understanding the relationship between environmental pressures and fish stocks is essential for promoting sustainable fishing practices and protecting local livelihoods.

4. Governance Knowledge Gaps

- **Implementation of Management Plans**: There is a critical gap in the **implementation of the Natura 2000 management plan** for Comino, particularly for the marine protected area, which remains unregulated. The absence of active management and enforcement leaves critical ecosystems vulnerable to unchecked degradation.
- **Environmental Enforcement**: There is a lack of data on the **effectiveness of current environmental enforcement mechanisms**. Understanding where enforcement is failing (e.g., regulating boat traffic, waste management, or real estate development) is essential to improve compliance with existing environmental laws and regulations.
- **Policy Coherence and Stakeholder Engagement**: Limited data exists on how **policies are coordinated between the various authorities** responsible for managing Comino. Better understanding of governance gaps will help in creating a more integrated and efficient management framework.

Challenges

Based on the socio-ecological drivers and knowledge gaps for **Comino Island**, the main challenges are:

- Overcrowding and Tourism Pressure: The high influx of tourists, especially during the extended summer season, exerts immense pressure on Comino's ecosystems. Overcrowding in sensitive areas like the Blue Lagoon leads to habitat degradation, increased waste, and pollution. The lack of clear carrying capacity data and inadequate visitor management exacerbate this issue.

- The results of a previously conducted **carrying capacity study** remain unpublished (rated 5 in relevance), creating a critical gap in understanding the sustainable number of visitors the island can accommodate. Additionally, there is a lack of data on rat populations, waste generation, and vehicle traffic, all of which impact the island's ecosystem health.
- Environmental Degradation from Boat Traffic: Boat traffic causes substantial harm to Comino's marine environment through noise pollution, anchor damage, and pollution from vessels. This impacts both biodiversity and local fisheries. Without robust data on the effects of boating and effective enforcement of anchoring regulations, marine habitats remain vulnerable to long-term damage.

- Weak Governance and Enforcement: There is a critical gap in the implementation and enforcement of the Natura 2000 management plan and other environmental regulations. The fragmented management between various authorities, weak collaboration, and insufficient on-the-ground enforcement allow uncontrolled tourism activities, real estate development, and environmental degradation to continue unchecked. A key challenge identified is the lack of engagement from private tourism operators in environmental conservation efforts. These operators often prioritise profit over sustainability, contributing to environmental degradation. There is limited data on how to incentivize these operators to adopt more sustainable practices. Also, engaging **seasonal tourists and part-time residents** in conservation efforts remains a challenge due to the transient nature of their presence.

3.1.4 Proposed Engagement Methodologies

The following key stakeholders have been identified as crucial for addressing the socio-ecological challenges facing Comino Island:

Stakeholder Mapping:

- Local NGOs (Friends of the Earth Malta, BirdLife Malta, Nature Trust Malta): These NGOs are based on the island of Malta but frequently work on Comino Island, particularly in conservation and environmental education.
- Tourism Operators: Primarily located on Gozo and Malta, but their operations (boat tours, kiosks, etc.) are concentrated around the Blue Lagoon and other key tourist areas on Comino.
- Government Bodies (Ambjent Malta, ERA): These bodies operate both on Comino and Malta, with a focus on land use, environmental monitoring, and the management of Natura 2000 sites.
- Local Residents and Seasonal Visitors: Comino's few local residents and many seasonal visitors typically concentrate around the harbour area and beaches.
- University of Malta plays a critical role in scientific research and environmental conservation on Comino Island. The university contributes through various research projects and educational initiatives that focus on biodiversity, marine ecosystems, and environmental management.

Engagement Approaches:

To effectively engage these stakeholders and address Comino Island's socio-ecological challenges, the following approaches will be employed:

1. **Workshops and Roundtable Discussions**:
    - **Focus**: Engage **local tourism operators** and **government bodies** in discussions around sustainable tourism practices, such as waste reduction, controlled visitor numbers, and eco-certification of tourism services.
    - **University, public administrations or local NGOs** like **Friends of the Earth Malta** and **BirdLife Malta** could facilitate these discussions to align tourism growth with conservation objectives. Workshops should be held on **Gozo** and **Malta**, where tourism operators and government representatives are based. Occasional workshops can be organised on **Comino** (likely near the **harbour** or in the **Blue Lagoon** area) to engage stakeholders on-site
2. **Participatory Biodiversity Monitoring (Citizen Science)**:

- **Approach**: Involve tourists and residents in **biodiversity monitoring** through interactive platforms such as mobile apps and online maps (through projects like Spot the Jellyfish), allowing them to report on wildlife sightings, habitat conditions, and environmental issues (e.g., littering, illegal anchoring).
- **Local NGOs** like **BirdLife Malta** and **Nature Trust Malta** can spearhead these citizen science initiatives, creating community-driven data to complement official monitoring efforts. The Blue Lagoon, Santa Marija Bay, and surrounding coastal paths on Comino are ideal for launching citizen science initiatives. Tourists can use apps to track wildlife sightings and monitor biodiversity while exploring the island.

3. **Community Consultations**:
   - **Focus**: Hold consultations with **local communities**, **NGOs**, and **government agencies** (e.g., **ERA** and **Ambjent Malta**) to co-create policies for managing tourism sustainably and protecting biodiversity.
   - Consultation Topics: Discussions can address the impact of real estate development, coastal restoration projects, and seasonal tourism management. Location: Primarily on Gozo and Malta due to logistical constraints, but consultations should focus on discussing strategies that impact Comino Island directly.
4. **Collaborative Governance Platforms**:
   - **Approach**: Establish a multi-stakeholder platform that brings together **government agencies**, **NGOs**, **tourism operators**, and **local residents** to foster ongoing dialogue and joint decision-making. This will help ensure that different interests are balanced, and that conservation actions have widespread support. In-person meetings can take place in Valletta or Gozo.
   - **Focus**: Topics like **marine protection**, **boat traffic regulation**, and **carrying capacity management** can be co-managed through this platform.

c. Adaptive Strategies

To address Comino Island's environmental challenges, flexible and evolving strategies will be implemented to ensure stakeholder engagement remains responsive to changing conditions:

1. **Seasonal Tourism Caps**:
   - Implementing caps (at key entry points, such as the **harbour**, **ferry docks**, and at **Blue Lagoon**) on tourist numbers during peak seasons, based on carrying capacity studies. Tourism operators could work with the Planning Authority to enforce limits, ensuring that ecological strain is reduced during the busiest months.
2. **Educational Campaigns**:
   - On-site education and outreach campaigns will be launched in collaboration with BirdLife Malta and Friends of the Earth Malta, promoting responsible tourism behavior. Informational materials on waste management, biodiversity conservation, and sustainable tourism will be provided at key tourist points, such as ferry docks and beaches.
   - **Eco-guides**: Trained eco-guides can be positioned at key tourist sites, such as ferry docks, beaches (e.g., Blue Lagoon), and hiking trails, to provide real-time information on Comino's natural environment, wildlife, and proper tourist behaviors (e.g., responsible waste disposal, protection of habitats).
   - Establish an interactive visitor centre or pop-up information kiosks where tourists can learn about Comino's biodiversity, marine ecosystems, and the environmental impacts of human

activities. These centres can provide educational videos, infographics, and interactive displays about the local ecosystems.
    - Partner with local NGOs (such as BirdLife Malta, Nature Trust Malta) to create biodiversity-focused exhibits, explaining how tourism affects habitats and offering guidance on how visitors can minimize their impact.
3. **Eco-Tax for Environmental Conservation**:
    - Proposing the introduction of a visitor eco-tax aimed at funding environmental management and conservation projects. This tax would be implemented in collaboration with tourism operators and government agencies, ensuring that it contributes directly to local conservation efforts.
    - Encourage tourists to sign a visitor pledge upon arrival, committing to responsible behavior such as not littering, staying on marked paths, and respecting wildlife. As part of this initiative, provide tourists with a "Responsible Tourist" badge or eco-friendly souvenir (e.g., reusable water bottles) upon signing.
    - Offer incentives (discounts on eco-tours, souvenir items, etc.) to visitors who participate in educational programs or volunteer for clean-up efforts. This can also help attract more engagement with conservation activities on the island.
4. **Citizen Science Initiatives**:
    - Leveraging tourists' and local residents' participation in biodiversity monitoring and conservation efforts through apps that track species sightings, marine health, and pollution levels. Local NGOs can coordinate this initiative, turning tourists into active participants in preserving Comino's ecosystems.

3.1.5 Fixing the Focal Action

Based on the questionnaire and data sources, and in response to the focal issues raised by the data, the following **action strategies** should be developed.

1. **Tourism Overcrowding and Habitat Degradation**: The high volume of tourists, especially during the summer months, leads to the degradation of sensitive habitats, particularly in areas like the Blue Lagoon. The lack of a clear carrying capacity and effective tourism management exacerbates the strain on these ecosystems.
2. **Real Estate Development and Unregulated Infrastructure Projects**: Hotel developments and other infrastructure projects on Comino pose significant threats to the island's fragile habitats. These developments often proceed without comprehensive environmental impact assessments or long-term ecological monitoring.
3. **Boat Traffic and Marine Ecosystem Degradation**: The large numbers of boats visiting Comino contribute to noise pollution, anchor damage, and marine habitat destruction. This negatively impacts both biodiversity and the livelihoods of local fishers.
4. **Weak Governance and Policy Enforcement**: A fragmented governance structure and lack of enforcement for existing environmental policies, such as the NATURA 2000 management plan, leave Comino vulnerable to uncontrolled development, tourism pressure, and environmental degradation.

Proposed Action Plan

To address these focal issues, the following strategies will be implemented:

1. **Setting Up an Environmental Education Centre on Comino Island**

    - A new Environmental Education Centre on Comino Island would serve as a hub for promoting conservation, biodiversity awareness, and active engagement in ecological protection efforts. It will also function as a catalyst for advocating long-term policy changes. The centre can lay the groundwork for crucial improvements to the Comino N2K management plan, afforestation, and rodent control programs, ultimately contributing to the conservation and sustainable management of the island's fragile ecosystems.

    - Its Implementation Plan should include Site Selection, preferably near the Blue Lagoon or Santa Marija Bay, as these are high-traffic areas for tourists. The location should also provide easy access to key habitats for practical learning experiences (e.g., vegetated dunes, marine ecosystems). The building should reflect the ecological values of the island, maintaining a low environmental impact, and host interactive exhibits focused on Comino's biodiversity, marine life, and current environmental threats. It should use real-time data displays, virtual reality experiences, and multimedia presentations.

    - An Educational and Citizen Science Program could be designed with local educational institutions, such as the **University of Malta**, including courses and fieldwork programs that align with both **secondary** and **university-level education**. Also, regular workshops could provide new platforms to engage with, and train tourists, local communities, and students.

2. **Managing Tourism Numbers and Habitat Protection**:
    - **Tourism Caps**: Introducing **seasonal caps** on tourist numbers should be considered based on a thorough study of Comino's carrying capacity. Limiting the number of visitors during peak times will reduce the ecological strain on the island's fragile habitats. It may require a more specific and tailored approach to managing tourism and environmental pressures. This action must be coordinated with **tourism operators**, the **Planning Authority**, and **Ambjent Malta**. Given the controversial character of this solution, alternative solutions must also be envisaged.
    - **Eco-Certifications for Local Operators**: Promoting eco-certification systems for local tourism operators (boat operators, local guides, equipment rentals) would ensure that activities in these areas meet sustainability criteria, limiting harmful or inappropriate practices.
    - Alternatively, a **reservation system** could be considered for access to particularly sensitive areas, such as certain routes through coastal dunes, wetlands, or protected lagoons. This approach would allow limited access during periods of high environmental pressure, such as breeding seasons for birds or peak tourist times. The Zingaro Nature Reserve in Sicily, Italy, uses a similar system to control access to ecologically fragile areas although it is not a mass tourism destination.
    - **Establish waste management systems.** Enhanced waste management practices, reduced pollution, and improved marine habitat quality e.g. recycling stations and educational outreach for residents and tourists.

- Outcome:**No-Go Zones:** Establish no-go zones in the most sensitive ecological areas, such as especially fragile habitats and nesting grounds, to prevent further habitat degradation. These zones will be clearly demarcated, and on-site rangers or eco-guides will monitor tourist compliance.

3. **Relocation of the camping site**, in accordance with the NATURA 2000 management plan to initiate restoration of one rare habitat in one small part of the island. Also, **hotel redevelopment** and expansion plans in the island's two main bays poses threats to **sensitive habitats** and is likely to increase environmental pressures.
4. **Environmental Impact Assessments (EIAs)**: Make **comprehensive EIAs** mandatory for all real estate and infrastructure developments on Comino Island. Ensure that **government bodies**, such as the **Planning Authority**, work closely with **NGOs** to assess the long-term environmental impacts of any proposed developments.
    - **Sustainable Building Practices**: Collaborate with **real estate developers** to promote **sustainable construction practices** and ensure that future developments align with Comino's conservation goals.
5. **Managing Boat Traffic and Marine Protection**:
    - **Anchoring Restrictions**: Implement strict regulations on where boats can anchor, particularly in ecologically sensitive marine areas such as seagrass beds. Designated anchoring zones will help prevent damage to the seabed, and this would need to be enforced by the **Marine Conservation Authority**.
    - **Noise and Pollution Controls**: Establish **noise pollution standards** and **waste management protocols** for boats to reduce their environmental impact. Boats whose engines exceed noise limits or found to be improperly disposing of waste will face fines or restrictions.
6. **Strengthening Governance and Policy Enforcement**:
    - **Unified Governance Platform**: Create a **multi-stakeholder governance platform** involving **ERA**, **Ambjent Malta**, **local NGOs**, and **tourism operators** to coordinate decision-making, policy enforcement, and stakeholder engagement.
    - **Enforcement of NATURA 2000 Plans**: Ensure full implementation and enforcement of the **NATURA 2000 management plan**, focusing on habitat conservation and sustainable land use. Establish a system of regular inspections and monitoring to track compliance with conservation policies.

Monitoring and Adaptation

- **Monitoring Protocols**: Establish clear **monitoring protocols** for each focal action to track progress and effectiveness. This includes regular assessments of tourism numbers, habitat recovery, and the impact of real estate development.
- **Adaptive Management**: Based on the results of on-going monitoring, adjust strategies as needed to ensure continued progress towards the conservation goals. This adaptive approach allows for flexibility in response to new environmental or socio-economic challenges.
- **Stakeholder Feedback**: Gather feedback from stakeholders, including **local residents**, **tourists**, and **NGOs**, to refine and improve the action plans over time.

3.2. CS2: Protected area of Aquatina di Frigole, Apulia, Italy

3.2.1 CS Situation and Baseline

Case Study 2 - Aquatina di Frigole Protected Area is an EU NATURA 2000 Network Site (IT9150003) in Apulia, south-eastern Italy. The coastal lagoon included in the NATURA 2000 Site represents about 3% of the entire protected area. The surface area of the lagoon is about 42 ha, and its length is about 2 km parallel to the dune cordon. The maximum registered depth is about 1.5 m, and the annual maximum registered tidal excursion is about 34 cm.

The coastal lagoon directly connects with the Adriatic Sea through a 400 m long and 15 m wide channel on the southern boundary. On the northern boundary, a lateral ramification of a canal named “Giammatteo canal” represents the freshwater input.

The NATURA 2000 Site is managed by the Department of Biological and Environmental Sciences and Technologies and hosts the Research Centre for Fisheries and Aquaculture of Aquatina di Frigole, University of Salento, which routinely monitors the biodiversity and abiotic gradients of the Aquatina di Frigole lagoon in different surveyed sampling points. This NATURA 2000 Site represents an important ecological zone for biodiversity conservation since it protects a wide range of habitats rich in species biodiversity that face several environmental pressures. Because of that, the Aquatina di Frigole Protected Area represents a pillar for scientific research, biodiversity conservation, and sustainable management practices. The NATURA 2000 Site Aquatina di Frigole protects different Mediterranean NATURA 2000 priority coastal habitats and species included in the Habitat Directive (92/43/EEC). Protected priority habitats include *Posidonia oceanica* meadows (1120)*; Coastal Lagoons (1150)*; and Coastal dunes with *Juniperus* spp. (2250)*. Other habitats are: Mediterranean maquis, beach and freshwaters around the saltmarsh lagoon.

This protected area is integrated into a broader context, represented by the surrounding socio-economic landscape. The small village of Frigole, in which the protected area is integrated, hosts different socio-economic activities, mainly represented by small-scale fisheries, agriculture, beach resorts, bars, restaurants, schools, and cultural and environmental associations. Given the constant involvement of the local citizens towards the conservation actions for Aquatina di Frigole Coastal Lagoon and beach, this protected area represents a highly cultural value site for the local community.

Further to the local initiatives for Aquatina di Frigole conservation, the protected area is subject to regional, national, and international regulations for species and habitat biodiversity conservation. At the local scale, the Aquatina di Frigole Protected Area faces environmental pressures that may originate from the socio-

economic activities directly linked to the NATURA 2000 Site. Such pressures can be generated from the activities related to tourism, agriculture, and small-scale fisheries, which interact with the delicate coastal ecosystems of the whole area.

At the macro-regional scale, the protected area faces wider environmental pressures that extend over the local community and affect the entire Adriatic-Ionian region. These pressures, mainly represented by macro- and micro-plastics coming from the Adriatic and the Ionian Sea through the currents and accumulating on the beach and in the coastal lagoon, can have important impacts on the ecosystems within the NATURA 2000 Site and the surrounding areas. More generally describing, the Aquatina di Frigole Protected Area is influenced by worldwide environmental pressures that extend beyond the regional and local levels. These pressures mainly include non-indigenous species, like the blue crab *Callinectes sapidus*, and the effects of climate change. Such pressures can have strong long-term impacts on the ecosystems within the NATURA 2000 Site and the surrounding areas.

According to the objectives of the PRO-COAST project, to face the threats acting on the Aquatina di Frigole Protected Area and ensure best practices for environmental protection and biodiversity conservation, a proactive, multi-scale approach has to be adopted in order to enhance the integration of scientific research, stakeholder involvement, and innovative monitoring technologies. The objective is to develop sustainable management and conservation practices towards this ecologically important protected area while addressing the needs of the local socio-economic community other than the local, regional, and global environmental challenges.

Ecological Baseline:

Acquatina di Frigole NATURA 2000 Site is characterized by a broad spectrum of ecological habitats and includes a high variety of fauna and flora species, which can be divided into the following groups: plants, algae, zooplankton, macroinvertebrates assemblages, fishes, amphibians, reptiles, birds and mammals. The lagoon is also a staging area for migratory birds and an important nursery for fish.
To improve conservation efforts and facilitate biodiversity monitoring and research, the area is under the management of the University of Salento. Specifically, the Research Centre for Fisheries and Aquaculture under DiSTeBA (Department of Biological and Environmental Sciences and Technologies), located within the protected area, serves as a scientific hub for studying and managing the ecological integrity of the area, as well as developing new biodiversity monitoring and conservation tools and strategies. Traditional methodologies and innovative environmental DNA-based tools are improving the knowledge about biodiversity, structure and functioning of this ecosystem.

Social Baseline:

Case Study 2 - Aquatina di Frigole Protected Area comprehends the broader socio-economic landscape that surrounds the NATURA 2000 Site. The local community includes schools, markets, tourism infrastructures, beach resorts, small-scale fisheries, agriculture, etc.

Furthermore, the socio-economic landscape surrounding the protected area is represented by different cultural and environmental associations often included in initiatives which involve citizens in conservation actions towards the beach and the coastal lagoon ecosystem.

Economic Baseline:

The local community's economy primarily relies on agriculture and small-scale fishery activities.
Generally speaking, the whole Apulia region is well-known for its agricultural-based products, mainly represented by extra virgin olive oil and fine wines.
Also, seasonal tourism represents an important economic opportunity for the socio-economic reality surrounding the Aquatina di Frigole Protected Area.

Governance Baseline:

According to EU Directives 92/43/EEC ("Habitats") and 79/409/EEC ("Birds"), and with the resolution of the regional council (Regione Puglia) of 6 August 2010, no. 1871, the NATURA 2000 Site Aquatina di Frigole (IT9150003) was established, identifying a Site of Community Importance and a Special Protection Area. With a formal agreement established with Regione Puglia, since 1986 Aquatina di Frigole, together with the surrounding territory, has been managed by the Department of Biological and Environmental Sciences and Technologies (DiSTeBA) of the University of Salento, where the Research Centre for Fisheries and Aquaculture was established in order to carry out research and third mission activities, and monitoring. Anyway, the NATURA 2000 Site management body is legally represented by the regional institution.

3.2.2 Initial Indicators, Data Sources, and Drivers

This section identifies initial socio-ecological indicators, data sources, and key drivers impacting the CS2 - Aquatina di Frigole Protected Area.

Initial Indicators:

Ecological:

a. Habitat quality, mainly in the coastal lagoon ecosystem, can be monitored through the most common ecological indicators, such as phytoplankton and macrozoobenthic species. The presence and distribution of non-indigenous species, such as *Callinectes sapidus* (blue crab), are routinely surveyed.

b. Plastic driven by currents from the Adriatic and Ionian Sea accumulating on the beach represents a pressure for ecosystem and biodiversity conservation.

c. In addition to the beach accumulation, plastics and other waste materials can accumulate within the lagoon. This internal accumulation is particularly relevant since lagoons are generally semi-closed ecosystems where pollutants can persist longer, potentially disrupting the delicate balance of such important ecosystems.

Social:

- During the summer season, the area is subjected to a large increase in tourism, in particular concerning beaches and coastal resorts. This increased use of the coastline can lead to coastal pressures and disturbance to wildlife and natural habitats, including the sensitive dune systems and lagoon areas.

- Coastal dunes are mainly subjected to trampling. The dunes play a crucial role in protecting both the lagoon and the beach.

- Agricultural activities occurring in the areas surrounding the lagoon can represent an environmental stress for the coastal lagoon, potentially increasing the nutrient loads and affecting water quality.

- The region is rich in cultural heritage, with traditional small-scale fisheries and family-driven farming practices still visible. Such traditions are under threat due to modernization and declining interest among younger generations. Cultural and environmental associations, through eco-tourism initiatives, often attempt to preserve these practices by offering cultural tours or promoting local products.

Economic:

- The local economy shows a strong link with agriculture, farming, and small-scale fishery activities.

- Seasonal tourism represents an important economic opportunity mainly during the summer season.

Governance:

To improve the conservation efforts and facilitate biodiversity monitoring and research, the area is under the management of the University of Salento. The Research Centre for Fisheries and Aquaculture represents the scientific hub to study and manage the species and habitats biodiversity of the area, as well as develop new biodiversity monitoring and conservation tools and strategies.

Data Sources:

- Local Reports: Apulia Regional Environmental Authority, University of Salento studies.
- National Sources: Italian Ministry of Environment, ISTAT demographic and land-use trends.
- EU Sources: European Environment Agency, Natura 2000 documents, LIFE+ wetland conservation projects.
- Questionnaire Responses: Direct feedback on biodiversity, habitat quality, community engagement, and governance challenges. See the Annex II of this document.
- Portals like Web of Science, Scopus and Google Scholar.
- Management plan of the Sites of Community Importance (SIC) of the NATURA 2000 NETWORK of the Province of Lecce.
- Official Bulletin of the Puglia Region - n. 143 of 07-09-2010.
- Pinna, M., Zangaro, F., & Specchia, V. (2024). Assessing benthic macroinvertebrate communities' spatial heterogeneity in Mediterranean transitional waters through eDNA metabarcoding. *Scientific Reports*, 14(1), 17890.
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Main Drivers:

1. Environmental Drivers:

- Plastics: Marine litter, particularly represented by plastics carried by currents from the Adriatic and the Ionian Sea, accumulate on the beach as macro-, micro- and nano-plastics.
- Lagoon Litter: Plastics can accumulate within the lagoon where pollutants can persist longer, potentially interfering with the delicate balance of this NATURA 2000 priority habitat.
- Climate Change and Coastal Erosion: Rising sea levels and the increase in extreme weather events due to climate change accelerate coastal erosion, impairing the beach and dune systems that naturally protect the coastal lagoon ecosystem.
- Non-Indigenous Species: NIS, such as the blue crab (*Callinectes sapidus*) compete with native species potentially compromising the food web.
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2. Socio-Economic Drivers:

- High Tourist Influx: Seasonal tourism can represent pressure on coastal ecosystems.
- Agriculture: Irrigation and land use changes can potentially increase the nutrient concentration, affecting habitat conditions.
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3. Governance Drivers:

- Limited Stakeholder Coordination: Stakeholder networks are limited. There is a need for better stakeholder coordination through the strengthening of a Joint Task Force of Stakeholders for Aquatina di Frigole.

3.2.3 Diagnosis of Knowledge Gaps and Challenges

Ecological Knowledge Gaps:

- Previous and ongoing experimental field activities have laid a solid foundation for knowledge of the biodiversity of the case study. The implementation of these activities requires a routine survey of species diversity in the Aquatina di Frigole Coastal Lagoon to ascertain shifts and alterations in the composition of the communities over time and for early identification of non-indigenous species.

- A routine monitoring of the primary abiotic characteristics of the Aquatina di Frigole Coastal Lagoon is required to compare and analyze the interrelationship between biotic and abiotic factors over time within the coastal lagoon.

- Monitoring of NIS with traditional and innovative tools.

Social Knowledge Gaps:

- It is fundamental to engage younger generations in environmental education initiatives and cleanup programs to disseminate knowledge about the significance and necessity of preserving the beach and the coastal lagoon ecosystems.
- It is essential to involve local stakeholders in an exploratory manner to disseminate knowledge regarding biodiversity monitoring strategies, ecosystem monitoring strategies, and biodiversity conservation strategies through the valorization of local ecological knowledge and the application of citizen science approaches.
- It is necessary to integrate ecological data, such as routine surveys utilizing eDNA metabarcoding, with local ecological knowledge and the support of citizen science.

Economic Knowledge Gaps:

- It is necessary to implement low-cost initiatives aimed at engaging local citizens and stakeholders in the collection of local ecological knowledge, participation in citizen science activities, and the undertaking of efforts to clean up and conserve the beach and coastal lagoon.

Governance Knowledge Gaps:

- Enhanced coordination among the stakeholder network is necessary. The establishment of a fortified Joint Task Force is essential for the conservation endeavors of Aquatina di Frigole.

Challenges:

Based on the socio-ecological drivers and knowledge gaps for Aquatina di Frigole, the main challenges are the following:

- Reduction of marine litter impact in the lagoon, dunes and beach: The marine litter impact can affect both biodiversity and social-economic activities linked to tourism as well as human health. The reduction of marine litter impact will be realised in cooperation with stakeholders' initiatives, including education trainings focused on the use of alternative "plastic free" materials.
- Reduction of environmental degradation of dunes: The collaboration with stakeholders will be focused on education trainings and cooperation with local administration for implementing restoration actions.
- Improving the knowledge of biodiversity to support its conservation: Research activities will be improved by the application of innovative tools in the lagoon and environments around. In parallel, trainings, workshops, study visits and the realisation of a naturalist path will be realised for improving the sensitivity of stakeholders about the relevance of biodiversity conservation and ecosystem services.
- Monitoring of NIS and reduction of impact: NIS are a threat for biodiversity and social-economic activities. A plan for monitoring and reduction of NIS impact will be implemented and applied.

3.2.4 Proposed Engagement Methodologies

Stakeholder Mapping:

A key element of the Case Study initiatives is its emphasis on stakeholder engagement following the quadruple helix model, which brings together:

- Academia, like primary and secondary schools, universities, and research entities.
- Local communities and stakeholders, like local citizens (sole or represented by civil society organisations), fishermen, farmers, and tourism operators.
- Policy makers at regional, national, and international levels.
- Private sector partners, including small and medium-sized enterprises, environmental management enterprises, travel enterprises and sports entities.

This approach fosters collaborative decision-making and allows stakeholders to co-develop sustainable management strategies.

A well-rounded engagement methodology must involve a wide range of stakeholders from different sectors, ensuring that both local and external voices are represented in policy and action. Stakeholder mapping helps identify and define roles for the following key groups:

- Local Government: Municipality of Lecce, Apulia Region (overseeing local land-use regulations and tourism management).
- NGOs: Legambiente, WWF Italy (focused on biodiversity conservation and public engagement).
- Academia: University of Salento and other local research institutions (providing research support and biodiversity monitoring).
- Private Sector: Local fishers, agricultural businesses, and eco-tourism operators (impacting local economies and land-use practices).
- Tourists and Visitors: Seasonal tourists and eco-tourism participants (creating demand for environmental education and sustainable tourism).Local social media platforms, community-level groups, and local newspapers.

Engagement Approaches:

To foster sustainable conservation and ensure community participation, a combination of inclusive, participatory approaches and targeted actions will be applied. These include citizen science initiatives, workshops, participatory mapping, and educational campaigns aimed at tourists.

- Questionnaires and face-to-face interviews will allow to understand the main feelings and needs of the members of the local community.

- Round tables with the stakeholders will allow brainstorming and opinion exchanges.

- Workshops and visits to the Case Study Area will allow to share knowledge about the necessities for behavioural changes and best practices implementations to foster the conservation of Aquatina di Frigole coastal and marine ecosystems.

- The expressions of interest for the integration of the Stakeholders Joint Task Force for Aquatina di Frigole will allow the strengthening of the Joint Task Force towards the common implementation of best practices to improve the Aquatina di Frigole environmental protection. The Joint Task Force will be always consulted to discuss the main topics proposed in PRO-COSAT, to catch needs, to collect new proposals for sustainable management and to share the results of biodiversity studies.

- Environmental educational plans on early biodiversity monitoring, study visits and active actions to reduce anthropogenic impacts and assess Ecosystem Services will allow the knowledge transfer

among academic entities and other stakeholders about the main topics concerning biodiversity conservation and ecosystem preservation.

Adaptive Strategies:

- To develop a PRO-COAST transversal Citizen Science network for the collection of environmental matrices destinated to the application of eDNA metabarcoding for biodiversity assessment in the Case Studies Areas.
- To carry on new environmental education plans for scholars, citizens and visitors by exploiting traditional and modern tools (e.g., podcasts).
- Biodiversity monitoring through Molecular tools such as DNA barcoding, metabarcoding, and environmental DNA (eDNA) will be applied to track species diversity, identify non-indigenous species early, and assess ecosystem health.
- Marine and lagoon litter research will focus on Studying the composition, movement, and ecological impact of marine and lagoon litter, allowing to development of strategies for reducing its presence and mitigating its effects on biodiversity.
- Fish stocks will be monitored thanks to the collaboration with small-scale fisheries.
- Ecosystem service assessments in collaboration with the stakeholders will bring to the evaluation of the economic and ecological benefits provided by the coastal and marine habitats.

3.2.5 Fixing the Focal Action

The most critical focal actions for Aquatina di Frigole are centred around mitigating the pressures identified at the local level, at the macro-regional level, and at the global level. These issues directly contribute to the unbalance of the delicate equilibrium of delicate habitats like the coastal lagoon.

Focal Issues

- At the local level, this case study focuses on mitigating pressures caused by high tourist influx, dune degradation, and pollution through careful planning and stakeholder engagement. Continuous biodiversity monitoring is crucial to assess ecosystem health. This includes citizen science initiatives to involve local stakeholders in early monitoring and the use of DNA-based tools (e.g., eDNA metabarcoding) to monitor species composition, detect non-indigenous species, and assess communities structure in relation to environmental factors. Local-scale efforts also include educational programs for schools, universities, and the general public to raise awareness about the importance of preserving unique habitats and mitigating human impacts on the local environment.
- At the macro-regional scale, the case study addresses broader environmental issues like plastic and other pollutants driven by currents in the Adriatic and Ionian Seas. Marine litter and lagoon litter research is crucial for understanding how marine litter moves through these regions and developing effective mitigation strategies. A particular focus is on identifying microplastics and their potential effects on marine and lagoon biodiversity, especially given the lagoon's proximity to socioeconomic activities and its natural water exchange with the Adriatic Sea. To mitigate regional pressures from marine and lagoon litter, remediation strategies are being explored, including beach clean-up campaigns and coastal dune preservation. These efforts aim to remove plastic from coastal and lagoon areas while restoring natural defenses like dune systems that act as natural barriers. Addressing macro-regional pressures requires collaboration between different regions and nations bordering the Adriatic and Ionian Seas. The PRO-COAST framework promotes the creation of regional partnerships involving local authorities, NGOs, and research institutions to develop coordinated actions for managing and reducing plastic pollution. Additionally, cross-regional educational and awareness campaigns are part of the strategy to tackle the issue at a broader scale, emphasizing the shared responsibility of neighboring coastal communities in reducing pollution.

- At the global scale, the case study incorporates strategies to manage climate change impacts and non-indigenous species, two major global threats influencing local ecosystems. Environmental DNA (eDNA) metabarcoding and other innovative molecular tools are used in the case study to monitor biodiversity and detect non-indigenous species early, tracking their distribution over time. This aids in managing the spread of non-indigenous invasive species and mitigating their effects on the ecosystem. Ongoing research is investigating how climate change is altering the coastal lagoon and dune habitats, including studies on how rising temperatures and changing salinity levels can affect local species and habitats.

Proposed Actions

- School visits and training programs for students from various educational levels, ranging from primary and secondary schools to universities. These activities help foster a connection between younger generations and the natural environment.
- Citizen science networks and Local Ecological Knowledge: Residents will be involved in sharing their local ecological knowledge to collect information about biodiversity and ecosystems. Also, residents will be involved in the collection of environmental data, such as sampling for DNA-based biodiversity assessments, participating in beach clean-ups to tackle marine and lagoon litter, and participating in bird-watching and photographic initiatives.
- Awareness campaigns: The case study aims to increase awareness about biodiversity conservation by developing naturalistic pathways in the case study area and using modern tools (e.g., podcasts) to reach a broader audience.
- Enhancing the biodiversity baseline through more comprehensive monitoring using DNA-based tools to improve understanding of species distributions, particularly in the lagoon and adjacent habitats, and involving residents in sharing their knowledge.
- Establishing an early warning system for the arrival of new non-indigenous species, leveraging molecular technologies for rapid detection.
- Expanding stakeholder collaboration by reinforcing the Joint Task Force of stakeholders, including local authorities, scientific experts, and community representatives, to continuously improve sustainable management practices.
- Implementing further environmental education plans and expanding citizen engagement, both locally, macro-regionally and globally, to strengthen the role of Citizen Science in monitoring and conservation. Realisation of a naturalistic path.

Monitoring and Adaptation

- The initiatives (e.g., Adopt a Beach, Discover a Lagoon, and Aquatina Together) will be realised in collaboration with teachers from schools, students, stakeholders and citizens who will be involved in trainings and workshops for the sharing of knowledge about citizen science simplified monitoring actions that will be put in place with the aim to take care of the selected coastal area, increase the awareness towards coastal environments, e.g., through cleanup actions from plastics and monitoring the effects on the lagoon biodiversity, enhancing sociality and cooperation, including socio-cultural events (e.g., world biodiversity day, Ramsar sites day, etc.).
- Monitoring of beach and lagoon litter removal will allow understanding the amount of plastic litter periodically brought by the Adriatic and Ionian Sea currents.
- Periodic meetings with the stakeholders' Joint Task Force, local community, local managers and decision-makers will help to monitor the on-going of the initiatives.
- Improving press media interactions will help to share the initiatives and results from the case study to a broader audience.
- Monitoring of the effect of change on biodiversity by innovative monitoring tools (e.g., DNA barcoding, DNA metabarcoding, environmental DNA applications).

3.3 Case Study: Area of Strunjan, Slovenia

3.3.1 CS Situation and Baseline

Strunjan Landscape Park, located along the Slovenian coastline, is an ecologically rich area renowned for its salt pans, coastal cliffs, and Mediterranean ecosystems. As part of the NATURA 2000 network, Strunjan park is home to diverse species, including endangered birds and marine life. The reserve faces multiple environmental pressures, primarily from coastal development, increased tourism and habitat degradation, and climate change impacts, which threaten its delicate ecosystems.

The settlement of Strunjan has around 650 inhabitants, though most of them do not live within the actual park area. The Municipality of Piran, which governs the area, has approximately 18,500 inhabitants, with most residing in the towns of Piran and Lucija. The larger Coastal-Karst region (NUTS 3 level) has around 115,000 inhabitants. As for tourists, the Municipality of Piran recorded 1.83 million tourists in 2022, with high seasonality impacting the region.

At the baseline, the ecological condition of the reserve includes habitat degradation, declining biodiversity due to anthropogenic pressure and invasive species, and threats to the salt pans, a key feature of Strunjan's cultural and ecological heritage. Socially, the local community and various NGOs are actively involved in conservation efforts in the Nature reserve area. The area surrounding of the park is primarily agricultural with low population density, but there is an increase in human-wildlife conflicts due to the growing populations of European roe deer and wild boar. Hunters and farmers/landowners are actively involved in management efforts, addressing not only game species but also invasive species such as the coypu (Myocastor coypus). Governance structures involve local, national, and EU-level coordination, with challenges in enforcement and collaboration across different sectors.

n this case study, local stakeholders (park practitioners, hunters, and landowners), as well as national management (Slovenian Forest Services), will be included in workshops and data collection using the SRNA app. These stakeholders play a key role in promoting awareness about the conservation and management of key species. The Hunting Association of Slovenia (HAS), another key stakeholder, is heavily involved in managing wildlife conflicts, helping set camera traps, and using the SRNA app for wildlife monitoring to reduce conflicts with farmers and improve wildlife management plans.

Ecological Baseline:

Strunjan park is home to diverse ecosystems, including salt pans, seagrass meadows, and coastal wetlands, all critical for biodiversity and carbon sequestration. Key species include *Posidonia oceanica* (seagrass), Kentish plover (*Charadrius alexandrinus*), and *Pinna nobilis* (fan mussel). These habitats face threats from invasive species, pollution from agricultural runoff, and tourism pressures, leading to biodiversity loss. Unregulated tourism is one of the highest-rated threats to the Strunjan Landscape Park, leading to habitat degradation and pollution. The POSEIDONE project (2023–2026), a cross-border initiative under Interreg Italia-Slovenia, is currently monitoring the impact of anchored boats on the seabed and tracking coastal visitation through visitor counters. These efforts aim to support future tourism planning by informing sustainable tourism strategies and reducing human pressure on sensitive habitats like salt pans and seagrass meadows. Invasive species such as *Ailanthus altissima* are also displacing native vegetation.

The Strunjan Landscape Park regulation sets the objectives to conserve natural values, to maintain high biodiversity, to conserve populations of endangered and internationally protected wild flora and fauna species, the conservation of at least the existing range of habitat types, which shall preferably be maintained in a favourable condition, the conservation of the landscape with a mosaic distribution of landscape structures, the conservation of the ecological characteristics of the salt marshes, the lagoon and the seashore, and the natural processes and connections between the intertidal zone and the infralittoral. In the park, the growing population of coypu is causing damage by feeding on plants and by burrowing, which undermines saline banks and embankments. On the other hand, agricultural land is

heavily impacted by the increasing population of ungulates, which reduces local production and affects the food chain from local to global, especially in this touristic area

Social Baseline:

The local community consists of farmers, hunters, landowners, park practicioners, and tourism operators. According to the questionnaire, game management, agriculture and tourism are critical but often conflict over land and resource use. Community engagement is moderate, with limited involvement in conservation efforts beyond existing partnerships with NGOs and educational institutions.

The local community plays a key role in agriculture, particularly small-scale farming of vineyards and olive groves. Despite some community engagement in conservation, there are opportunities to strengthen involvement, especially in restoration activities and biodiversity monitoring.

Economic Baseline:

Tourism (ranked 5) and agriculture (ranked 3) are the main economic activities. The tourism industry is growing, contributing to both the local economy and environmental degradation, particularly through unregulated infrastructure developments. Tourism is the dominant economic activity, but it is largely unregulated, increasing environmental risks. Sustainable tourism practices are not widely implemented, despite their potential to balance economic growth with biodiversity protection.

Agriculture, particularly vineyards and olive groves, remains vital with sustainable practice of eco-farming. The conflict which is increasing due to game species management has to be solve to ensure stable local production.Sustainable tourism development is essential to balance economic interests with ecological requirements, reducing the damage from economic activities.

Governance Baseline:

Governance is fragmented across several institutions, including the Landscape Park Strunjan authority, the Municipality of Piran, the Slovenian Environment Agency (ARSO), Slovenian Forest service, and Nature Conservation Act and national ministries. Slovenia has transitioned from a sectoral approach to a more integrated approach in managing coastal areas. This shift aligns with EU requirements and involves decentralization and the subsidiarity principle.

However, enforcement of environmental regulations remains limited, affecting the park's ability to mitigate pressures from tourism and agriculture. Management is hampered by insufficient coordination and a lack of enforcement of sustainable tourism and agricultural practices.

3.3.2 Initial Indicators, Data Sources, and Drivers

Initial Indicators:

Ecological:

- Species Diversity: Presence of species like the Black-winged stilt and *Posidonia oceanica* is crucial for ecological balance (ranked 5 in the questionnaire). This population is notable for its high associated biodiversity, suggesting the need for conservation management plans to protect this ecological asset.
- Wildlife abundance: increasing population of wildbor and roe deer in agricultural field
- Invasive species: Increasing population of coypu
- Habitat Quality: Salt pans and seagrass meadows are degrading due to antropogenic impact and invasive species presence

Social:

- Limited engagement in biodiversity monitoring. Citizen science efforts could enhance participation (ranked 3 in the questionnaire).Local agricultural communities experience negative impacts from tourism and wildlife conflicts.
- Community engagement is currently limited, particularly among farmers, land owners and local residents. Efforts to engage these stakeholders in conservation and biodiversity monitoring are needed, with the SRNA app being a key tool to facilitate local participation in wildlife monitoring and conflict mitigation. Workshops and participatory initiatives are planned to encourage broader involvement from the community.

Economic:

- Economic resilience in tourism and agriculture, both reliant on natural resources.
- Tourism Dependency: Tourism is crucial but largely unregulated, leading to potential ecological risks (ranked 4 in the questionnaire)
- Agricultural Contribution: Small-scale agriculture (vineyards, olive groves) plays a key role in the local economy, though runoff impacts habitats. This is a significant factor in balancing economic and environmental goals.
- Employment Dependence: The tourism and agriculture sectors provide most of the employment in Strunjan, particularly seasonal jobs in tourism.
- Tourism Revenue: Unregulated tourism is a major income source, but its sustainability is questionable without eco-friendly practices (ranked 4 in the questionnaire)

Governance:

- Policy coherence and multi-stakeholder collaboration are key governance indicators.

Data Sources:

- National Legislation: Nature Conservation Act, Regulation on Strunjan Landscape Park, Game and Hunting Act.
- Environmental Reports: Strunjan Park biodiversity surveys, water quality monitoring, and habitat assessments. Biodiversity monitoring and tourism impact studies by ARSO and local environmental agencies.
- Scientific Literature: Sustainable tourism studies and biodiversity impact reports. Studies on coastal habitat degradation and tourism pressures. Found in Web of Knowledge and SCOPUS. Literature Review provides valuable insights into CS. Literature Review provides valuable insights into CS.
- The POSEIDONE Project collects various types of data, including: Physicochemical Parameters: Impact of anchoring on the seabed; Biological Parameters: Status of several seabird species; Species/Habitats Variables: Conservation status of habitats and species in the project area; Pressures: Visitor impact on natural coastlines; Pollution levels and its impact on the marine environment. These data types are collected to support sustainable tourism planning, biodiversity conservation, and environmental monitoring strategies.
- NGO Reports: Contributions from local NGOs like BirdLife Slovenia on habitat conservation or the Hunting Association of Slovenia on wildlife conflicts. Also, Hunters' Association for hunting bag data, which contributes to understanding wildlife dynamics and reducing conflicts with the local farming community.

- Questionnaire Responses: Direct feedback on biodiversity, habitat quality, community engagement, and governance challenges.

Main Drivers:

- Environmental Drivers: Habitat degradation due to anthropogenic impacts and invasive species, increase of game species.
- Socio-Economic Drivers: Growing tourism and its unsustainable practices, leading to habitat destruction and conflicts with agriculture and biodiversity conservation.
- Governance Drivers: Fragmented governance and weak enforcement of environmental regulations.

3.3.3 Diagnosis of Knowledge Gaps and Challenges

Knowledge Gaps:

- Biodiversity: Insufficient long-term data on the ecological impacts of tourism, game management and agriculture, especially on critical ecosystems. A significant knowledge gap exists regarding the density of ungulates (e.g., wild boar, roe deer) and illegal waste sites in the area. This gap can be addressed through wildlife monitoring efforts using the SRNA app and camera traps. The project aims to collect data on species abundance and distribution, which is currently lacking in the park's monitoring efforts.
- Social: Limited community involvement in decision-making processes and conservation initiatives. Data on community engagement in conservation is fragmented.
- Economic: Incomplete assessments of tourism's economic contribution and its sustainability over the long term.
- Governance: A lack of coordination among governance bodies and insufficient policy implementation regarding sustainable tourism.

Challenges:

- Biodiversity loss due anthropogenic impacts and invasive species.
- Habitat degradation.
- Lack of effective control measures for invasive species in key habitats.
- Conflicts between agriculture and tourism, exacerbated by weak governance structures.
- Human wildlife conflicts

- Limited financial and institutional resources for conservation.

3.3.4 Proposed Engagement Methodologies

Stakeholder Mapping:

- Public Institutions: Ministry of the Environment, and the Municipality of Piran. Other key stakeholders include Landscape Park Strunjan Authority (ranked 5 in the questionnaire), engaged in biodiversity monitoring and conservation; Local Farmers (ranked 3 in the questionnaire), essential for managing agricultural impacts on biodiversity; and the Hunting Association of Slovenia, plays a key role in managing wildlife conflicts. Also NGOs like BirdLife Slovenia, local conservation groups. And private Sector: Tourism operators.

Engagement Approaches:

- Increase awareness and outreach to influence the local decision-making process, with the greatest potential impact on the Landscape Park Strunjan and its operations. This includes efforts to better inform visitors and raise awareness about sensitive areas, or to restrict access to parts of the park under threat from excessive human pressure.

- Additionally, estimation of game species abundance and presence will reduce conflicts between wildlife and farmers by influencing sustainable management of conflict species, especially in collaboration with hunters and farmers, providing benefits for both local agriculture and biodiversity conservation. To do so, it can be used on social media platforms such as Instagram, Facebook, Twitter/X, and LinkedIn through the channels of the Molecular Ecology UP group, University of Primorska, and the Faculty of Mathematics, Natural Sciences and Information Technologies. Additionally, engage the University of Primorska website and the faculty's official site, email communications, and face-to-face meetings to ensure effective outreach and collaboration with stakeholders.

- Workshops: Engage landowners, farmers and park practicioners on sustainable practices through educational workshops on sustainable agricultural practices and tourism impacts.
- Participatory Mapping: Involve local communities (hunters and landowners) in biodiversity monitoring via citizen science platforms like the SRNA app. Expand the use of the SRNA App to engage communities in biodiversity monitoring. SRNA should be upgraded to include more species and topics relevant for nature conservation such as information on waste. With the app we aim to collect data about wildlife and potential illegal waste sites in the area. For example, by providing this information to the locals we can improve the waste management by organising cleaning activities. Alternatively, browse other existing citizen science apps to be adopted and adapted.
- It is also pertinent to monitor wildlife species that frequently come into conflict with locals, particularly farmers and landowners. By studying game animals and other selected wildlife in the area, we aim to mitigate human-wildlife conflicts and gain a better understanding of the risks associated with certain species that might carry disease pathogens, thus promoting both public health and wildlife conservation efforts.
- Community Consultations: Hold public consultations to address wildlife and tourism conflicts.
- Tourism Education: Develop programs that promote eco-friendly tourism and raise awareness about Strunjan's ecological value.

Adaptive Strategies:

- Collaborative Platforms: Create online notification in SRNA app for continuous stakeholder engagement, allowing for real-time feedback and adjustment of management plans.
- Seasonal Tourism Caps: Recommend caps on visitor numbers during peak tourism seasons to reduce ecological strain.
- Educational Campaigns: Promote responsible tourism through visitor education on the environmental importance of Strunjan's habitats. To address the growing threat of unregulated tourism, the POSEIDONE project is implementing eco-friendly tourism infrastructure, including visitor counters to track coastal visitation and assess its impact on the seabed. This data will inform future conservation strategies and visitor management policies to protect the sensitive habitats of Strunjan, such as salt pans, seagrass meadows, and marine reefs. Educational campaigns will also be developed to promote responsible tourism and raise awareness about the park's ecological importance.
- Citizen Science Initiatives: Strengthen community involvement in conservation efforts through biodiversity monitoring and restoration projects.

3.3.5 Fixing the Focal Action

The sustainability plan for the coastal areas of Slovenia should focus on integrated coastal area management, addressing climate change impacts on tourism, and enhancing urban forests and green spaces. These strategies will help balance economic development with ecological preservation, ensuring long-term sustainability for the region. The primary socio-ecological challenges in Strunjan are habitat degradation from unsustainable tourism and the spread of invasive species. Immediate actions should focus on:

- Human wildlife conflicts: This can be supported through local community involvement and national policy makers (Slovenian forest service)
- Sustainable Tourism Management: Implement eco-friendly tourism infrastructure and implement visitor education programs.
- Governance Improvement: Enhance the coordination between local and national authorities to strengthen policy implementation regarding sustainable tourism and conservation.

Monitoring efforts will focus on biodiversity indicators and adaptive strategies to ensure the long-term sustainability of both tourism and conservation efforts in Strunjan.

Wildlife management in Strunjan is a top priority. The SRNA app, in collaboration with the Hunting Association of Slovenia, will be used to monitor wildlife species, particularly those that come into conflict with farmers (e.g., wild boar, roe deer). This monitoring aims to mitigate human-wildlife conflicts and reduce crop damage by improving management plans. The app will also track disease-carrying species to assess potential risks to both wildlife and humans.

Monitoring and Adaptation

- Continuous Monitoring: Monitoring programs should track biodiversity, habitat quality, and the effectiveness of sustainable tourism strategies, adjusting as needed based on stakeholder input and scientific assessments
- Adaptive Management: Regularly review and adjust management plans based on monitoring results and community feedback, ensuring that strategies remain relevant and effective.

3.4 Case Study: Boka Kotorska Bay, Montenegro

3.4.1 CS Situation and Baseline

The Bay of Boka Kotorska is a semi-enclosed bay that forms a distinct system from the Adriatic coast and has unique orographical, climatic, hydrogeological, and environmental characteristics. The Bay is 28 km long and 7 km wide in the largest point, with a coastline of 107 km and a total water area of 87 km². The total population of the Boka Bay Area (including Tivat, Kotor, and Herceg Novi municipalities) is over 70.000 inhabitants.In Montenegro, in 2023, tourists realised 2 613 306 arrivals and 16 389 279 overnights. It is divided into three subsystems: the bay of Herceg-Novi, the Bay of Tivat and the bay of Kotor and Risan. Due to its peculiar shape and origin, it is sometimes defined as the southernmost fjord of Europe. The origin of the bay is related to intensive tectonics and karstification processes. The karstic geomorphological structure of the bay with high flow of underground freshwater into the basin created typical conditions that determine distinctive biotic and abiotic factors of the bay.

Boka Kotorska Bay is listed in a UNESCO World Heritage site in Montenegro, known for its stunning landscapes and unique biodiversity. Its marine ecosystems include seagrass meadows, coral reefs, and important fish species like European bass and gilthead sea bream. However, the area faces pressures from tourism, overfishing, and pollution, which threaten its ecological integrity. Montenegro, as a candidate country for EU accession, is actively working towards the establishment of the NATURA 2000 network. According to the Statistical Office in Montenegro, In Montenegro, in 2023, tourists realised 364 049 arrivals and 1 354 781 overnights in municipality in Bka Bokotorska bay area.

The Draft Spatial Plan of Montenegro until 2040 highlights the development and improvement of the Port of Kotor, with a specific focus on relocating cruise ship traffic to other areas within the Bay of Kotor. The goal is to limit the Port of Kotor to smaller luxury vessels, as the port's location suffers from poor water circulation and increasing pollution from municipal wastewater and cruise ships. The plan proposes strict environmental regulations, including defining the bay's capacity for marine traffic, restricting activities that harm the marine environment (e.g., shipbuilding, oil extraction, large cruise ships), and banning waste disposal into the sea. It emphasises the need for careful management of the bay's ecological resources, including freshwater inflows, to mitigate the negative impact of increased nautical tourism and waste production. The plan also stresses collaboration with marine biologists to minimise impacts on marine biodiversity, especially in areas affected by tourism and fisheries from Kotor to Ulcinj.

Ecological Baseline

Seagrass meadows and marine habitats are essential for biodiversity but are degrading due to anchor damage, pollution, and coastal development. Key marine species are impacted by overfishing, including commercial species such as bass and sea bream. Other threats include invasive species and untreated wastewater, leading to declining water quality.

The establishment of Marine Protected Areas (MPAs) in Boka Kotorska Bay, guided by the Law on the Protection of the Marine Environment (rated 5 in importance), is vital for biodiversity protection. Areas such as Dražin Vrt and Sopot are under preventive protection as nature reserves, supporting conservation efforts for critical species and habitats.

Social Baseline

Tourism is a key economic driver in the region, with local communities relying heavily on seasonal tourism activities. However, the unregulated growth of tourism, particularly cruise tourism, places significant strain on natural resources and infrastructure.

The local community's engagement in conservation is limited but growing, with opportunities to involve stakeholders in sustainable management initiatives.

Economic Baseline

The local economy depends heavily on tourism and fishery, with fishing providing livelihood opportunities for many. Overfishing, illegal fishing, and pollution threaten long-term sustainability.

Tourism growth, particularly during peak seasons, exacerbates environmental degradation and increases the demand for resources.

Governance Baseline

Local self-government bodies are obliged to provide citizens with the necessary data, explanations and notifications in order to exercise their rights and interests. Notification is also provided through technical means, brochures and public information means. Forms of direct participation of citizens in declaration and decision-making are: initiative, citizens' initiative, assembly of citizens, referendum (local and municipal) and other forms of declaration and decision-making established by statute. The statute, in accordance with the law, regulates in more detail the way and procedure of participation of the local population in declaring and deciding on matters of common interest.

The bay falls under several governance frameworks, including national environmental policies and UNESCO World Heritage protection. Key governance stakeholders on national level include the Ministry of Tourism, Ministry of Ecology, Sustainable Development and Northern Region Development, responsible for overseeing sustainable tourism and ecological management, and the Environmental Protection Agency, which monitors marine ecosystems and enforces pollution controls.

The Port Authority of Kotor manages maritime traffic and pollution prevention from ships, and the Institute of Marine Biology conducts essential research on marine biodiversity and fisheries sustainability. The National Strategy for Integrated Coastal Zone Management also sets the strategic goal of strengthening cooperation and coordination between social actors, effectively involving the public in decision-making processes, and utilizing available knowledge, thereby contributing to the sustainability of societal development. As a specific measure, it emphasizes raising awareness about the need to preserve and enhance coastal area resources.

However, governance gaps, particularly around enforcement of marine protection and pollution controls, are a significant issue. Coordination between stakeholders, including local authorities, tourism operators, and conservation NGOs, is crucial to improving management.

3.4.2 Initial Indicators, Data Sources, and Drivers

Ecological Indicators

- Biodiversity: National Biodiversity Strategy with Action plan 2016-2020 (NBSAP) is defined as a key document for nature conservation, reduction of identified direct pressures. Aligned with this, the Local Biodiversity Action Plan of the Municipality of Kotor, which is a legal obligation and aligned with the National Biodiversity Strategy, focuses on establishing more efficient control over maritime traffic and fisheries, raising public awareness about marine and terrestrial ecology, promoting socio-economic development that respects environmental values, developing guidelines to mitigate the impact of human activities on ecosystems, and conducting educational campaigns on biodiversity protection, particularly targeting youth.

- Species Diversity: The bay is home to important species such as the European sea bass (*Dicentrarchus labrax*), gilthead sea bream (*Sparus aurata*), and *Posidonia oceanica* (seagrass), which are key indicators of marine health. However, overfishing, ghost fishing, and pollution from tourist activities have led to a decline in fish populations and the degradation of seagrass meadows, vital for carbon sequestration. The Boka Kotorska Bay is home to important commercial fish species, including sardines and anchovies, which have significant spawning and nursery grounds

in the bay. The seabed is predominantly covered by coastal terrigenous muds (87%), with smaller portions of Muddy Detritic bottoms and coralligenous habitats (2%), hosting high biodiversity. The bay is also home to notable species like the *Savalia savaglia* and *Posidonia oceanica*, both of which play critical ecological roles. Despite the rich biodiversity, there are concerns about habitat loss and the disappearance of certain algae due to human activities. For instance: the distribution of the endemic alga *Fucus virsoides* has declined in the Boka Kotorska Bay, with four growing sites disappearing due to anthropogenic factors, while the invasive red alga *Womersleyella setacea* has been recorded since 2003. The presence of photophilous algae is limited to shallow waters, whereas sciaphilous algae dominate the inner bay, thriving on complex seabed substrates at depths of 8-10 metres.

- Fauna: Montenegro has recorded 351 bird species, representing 66% of Europe's bird fauna. Of these, 213 species are confirmed breeders, while 106 species are resident, and 107 species are breeding migratory birds. Montenegro is a key location on the Adriatic Flyway, one of Europe's most important bird migration corridors. Significant bird species in the Boka Kotorska area include rare gulls, cormorants, and kingfishers, with migratory birds and species such as warblers, tits, and birds of prey like the Levant sparrowhawk passing through the Grbalj region. This region is also home to important breeding and wintering grounds for many of these species.

- Water Quality: High nutrient runoff and untreated wastewater contribute to eutrophication and harmful algal blooms. Water quality is deteriorating due to nutrient runoff from agricultural activities and untreated wastewater, contributing to eutrophication and harmful algal blooms. Industrial pollutants, including heavy metals like cadmium and lead from nearby shipping and urban areas, are also present in sediment. Elevated levels of oil pollution and plastics further threaten marine biodiversity.

- Pollution, especially from cruise ships and untreated wastewater, is identified as a critical threat (rated 5 in the questionnaire). The Environmental Protection Agency monitors pollutants like heavy metals and microplastics, while additional monitoring programs need to address the impact of ship traffic on water quality and fish stocks.

- Climate indicators include greenhouse gas emissions from cruise ships, which contribute significantly to local air pollution, as well as energy consumption from tourism infrastructure and the overall carbon footprint of the region, driven by both tourism-related activities and local energy use patterns.

Social Indicators

- Community Engagement: Local community involvement in environmental protection is limited, but citizen science initiatives are emerging (ranked 3 in the questionnaire). While local engagement in conservation is still low, initiatives like citizen science projects (e.g., monitoring pollution and biodiversity) have started to gain momentum. The local fishing communities, historically dependent on marine resources, are increasingly aware of the need for sustainable practices but lack formal involvement in decision-making processes. These initiatives are expanding through partnerships with local environmental groups.

- Cultural Heritage: The region is rich in cultural and historical assets, including the Kotor Old Town, which is listed as a UNESCO World Heritage site. Submerged cultural heritage, such as ancient shipwrecks and artifacts, is threatened by pollution and illegal activities. Conservation efforts are in place but remain limited. Preserving these cultural elements is vital for maintaining the region's UNESCO status and fostering a distinctive local identity.

Economic Indicators

- Tourism Dependency: Tourism is the main economic driver, but unsustainable practices are leading to environmental degradation (ranked 4 in the questionnaire). Tourism is a major economic

driver, especially during the summer months when cruise tourism significantly increases the pressure on local ecosystems. Unregulated growth in the tourism sector, including the construction of marinas and hotels, has led to habitat loss, especially in sensitive coastal zones

- Fishing Practices: Overfishing and unregulated fishing practices are threatening marine biodiversity and local livelihoods. The economy is also heavily reliant on fisheries, but overfishing and illegal fishing practices are common, leading to a depletion of local fish stocks. This has significant socio-economic impacts on local communities dependent on marine resources for livelihoods. Sustainable fishing practices are lacking, and enforcement of fishing regulations is weak.

- Maritime Traffic and Fisheries Control: Data from maritime authorities, such as monitoring the number of vessels entering the bay and fishing activities in regulated zones, are essential to enforce stricter controls on maritime traffic and fisheries and their alignment with the National Biodiversity Strategy.

- Smart Specialisation Strategy in Montenegro mapped the economic, innovative and scientific potential of Montenegro. The results have confirmed several of the government's priority sectors: agriculture, energy, ICT, manufacturing, medicine and health, and tourism. The results also identified construction as a possible new priority sector, which was later confirmed in the qualitative analysis.

Governance Indicators

- Policy Coherence: While several governance frameworks are in place, including national and international regulations (e.g., Montenegrin Law on Environment and UNESCO protection guidelines), there is a lack of coherent enforcement of environmental protection laws, particularly around marine pollution and sustainable fishing.

- Stakeholder Collaboration: Collaboration between governmental bodies (e.g., the Ministry of Sustainable Development and Tourism) and local stakeholders is fragmented. NGOs like Green Home Montenegro have been advocating for stronger enforcement, but coordination between different actors remains weak.

Data Sources

- National and International Legislation: Montenegrin environmental policies and UNESCO World Heritage regulations. The Integrated Coastal Zone Management (ICZM) Strategy (2020–2030) outlines key environmental and cultural heritage protection measures, focusing on sustainable tourism, coastal erosion control, and biodiversity conservation.

- Environmental Reports: Studies by the Institute of Marine Biology Kotor on water quality, pollution, and marine biodiversity. The Boka Kotorska Bay Environment Book (2017) provides baseline data on marine biodiversity, pollution levels, and the socio-economic impacts of tourism

- The Environmental State Monitoring Program of Montenegro has been in place since 2008, coordinated by the Environmental Protection Agency (EPA), which prepares an annual monitoring program for submission to the Ministry of Tourism, Ecology, and Sustainable Development. The Water Quality Monitoring Program is overseen by the Ministry of Agriculture, Forestry, and Water Management, and is implemented by the Hydro-Meteorological and Seismological Institute of Montenegro, while the Institute of Public Health monitors drinking water quality. Air quality monitoring is conducted by the Centre for Ecotoxicological Studies (CETI). The data collected forms the basis of an annual Environmental State Report prepared by the EPA, which is approved by the Ministry and adopted by the Government, providing an overall assessment of the state of the environment.

- Scientific Literature: Research on marine biodiversity and tourism impacts from local universities and the Institute of Marine Biology Kotor on water quality, marine biodiversity, and the impacts of human activities offers vital insights into the region's ecological health

- NGO Reports: Contributions from local environmental groups, including Green Home Montenegro, focusing on pollution and overfishing. Green Home Montenegro and other NGOs provide reports on community engagement, sustainable tourism, and pollution control efforts.

Main Drivers

- Environmental Drivers:
    - Pollution from untreated wastewater, overfishing, and habitat loss due to tourism development.
    - Coastal erosion, habitat loss, untreated wastewater, and agricultural runoff.
    - Integrated Coastal Zone Management (ICZM) and Marine Spatial Planning (MSP): ICZM and MSP are essential for the sustainable management of Boka Kotorska Bay. These approaches involve vulnerability assessments for optimal land use and ecosystem-based marine spatial planning to maintain good environmental status.
- Socio-Economic Drivers: The region's dependency on tourism and fishing for economic growth. This places additional stress on natural resources, as both sectors remain largely unregulated.
- Governance Drivers: Weak enforcement of policies and fragmented stakeholder engagement. The enforcement of existing environmental regulations and the lack of collaboration among stakeholders are major governance challenges that hinder effective management of natural resources and conservation efforts

3.4.3 Diagnosis of Knowledge Gaps and Challenges

Knowledge Gaps

- Biodiversity Monitoring: There is limited long-term data on the health of key marine ecosystems, particularly *Posidonia oceanica* meadows and fish populations. The absence of regular monitoring makes it challenging to assess the full impact of overfishing and habitat destruction e.g overfishing on key species, such as sardines and anchovies, which use the bay as spawning and nursery grounds (rated 4 in importance). Further research is required to monitor the health of these stocks and understand their role in the local ecosystem.

- Limited geographic scope in environmental monitoring can result in inadequate data, particularly from remote or hard-to-reach areas, leading to an incomplete picture of environmental conditions. Uneven distribution of monitoring points can create data gaps, making analysis difficult and potentially leading to biased conclusions. Expanding spatial coverage requires substantial financial, equipment, and human resources, posing challenges for organizations with limited budgets.

- Tourism Impact Data: Although tourism is a key economic driver, there is insufficient data on its long-term ecological impacts. Specific gaps include the cumulative effect of cruise ships on marine ecosystems and the carrying capacity of the bay. Detailed data on visitor patterns and waste disposal is missing, which hinders sustainable tourism planning (ranked 4). It could enhance existing knowledge and raise awareness about the negative impact of cruise tourism and contribute valuable insights to inform decision-making and management strategies aimed at preserving and

protecting coastal and marine ecosystems, helping to fill gaps in policy analysis and implementation.

- Marine Pollution Tracking: While pollution, especially from untreated wastewater, is a significant concern, more detailed data is required to understand the exact sources and levels of contaminants like heavy metals and microplastics. Monitoring systems for pollutants from tourist activities and shipping need to be improved. According to the questionnaire, pollution was ranked as a critical challenge (ranked 5).

- Fisheries Sustainability: There is a notable gap in the data regarding the socio-economic impact of overfishing on local communities. Although overfishing is recognized as a problem, the extent of illegal fishing and its socio-economic consequences are poorly documented (ranked 4).

- Governance and Enforcement: Promoting stakeholders and local communities engagement and support through building partnerships to work towards common goals related to coastal management and tourism sustainability; Establishing trust is essential for effective collaboration, engagement and commitment to project goals, as well communicating the value of project data ensures that stakeholders recognize the value of their involvement and contributions to the project.

- The questionnaire identified weak enforcement as a barrier to effective coastal management, with local communities and authorities expressing frustration over insufficient coordination between stakeholders. The results of a previously conducted carrying capacity study remain unpublished (rated 5 in relevance), creating a critical gap in understanding the sustainable number of visitors the island can accommodate. Additionally, there is a lack of data on rat populations, waste generation, and vehicle traffic, all of which impact the island's ecosystem health.

Challenges

1. Marine Pollution: Untreated wastewater and nutrient runoff are leading to eutrophication and degraded water quality. Heavy metals and plastic waste from tourism exacerbate this issue, impacting both biodiversity and public health.

2. Overfishing: Overfishing threatens fish stocks, particularly commercial species like European bass and gilthead sea bream, reducing biodiversity and affecting local livelihoods. Illegal fishing practices and ghost fishing are common and need stronger regulation.

3. Tourism Pressure: The bay experiences significant pressure from unregulated tourism, especially cruise tourism, leading to habitat degradation and pollution. The lack of sustainable tourism practices worsens this issue, making it a high-priority challenge.

4. Weak Governance: There is inadequate enforcement of environmental laws and a lack of collaboration among local authorities, NGOs, and businesses, leading to fragmented efforts in addressing environmental challenges.

5. Invasive Species: Non-native species are displacing local flora and fauna, altering the ecosystem's natural balance. These species are proliferating due to climate change and increased maritime traffic, which goes largely unchecked.

3.4.4 Proposed Engagement Methodologies

Stakeholder Mapping

Key stakeholders identified in the questionnaire include:

- Local Communities and Fishermen: Local fishing communities are directly affected by overfishing and pollution and are crucial for implementing sustainable fishing practices (ranked 4).

- Tourism Operators: Hotels, marinas, and cruise operators must be engaged in sustainable tourism practices, including waste management and responsible anchoring. They play a pivotal role in balancing economic growth with environmental conservation (ranked 3).

- Environmental NGOs: Green Home Montenegro and similar groups are essential in advocating for sustainable practices and raising awareness among both locals and tourists. These groups also monitor environmental impacts and push for stronger enforcement of regulations.

- Local and National Authorities: The Ministry of Sustainable Development and Tourism, along with municipal governments, are responsible for policy implementation and enforcement. However, weak coordination between these actors needs to be addressed through collaborative platforms.

- International Organisations: UNESCO and the European Environment Agency are involved in monitoring and supporting the conservation of Boka Kotorska as a World Heritage site.

- Local social media platforms, community-level groups, and local newspapers.

Engagement Approaches

- Workshops and Capacity Building: Organize capacity-building workshops aimed at local stakeholders, including farmers, fishers, tourism operators, and NGOs. These workshops would focus on sustainable tourism practices, pollution reduction, and responsible fishing techniques. They will raise awareness and provide education on sustainable practices, focusing on the local biodiversity action plan. The questionnaire suggested that there is a strong interest in these kinds of educational initiatives (ranked 3).

- Participatory Mapping: Engage communities in participatory mapping exercises to identify sensitive marine habitats and areas at risk from pollution and overfishing. These exercises can provide valuable data for marine spatial planning and conservation efforts.

- Citizen Science Initiatives: Expand local involvement through citizen science projects that track pollution levels, monitor biodiversity, and report invasive species. Initiatives like ADRINET could serve as a model for engaging local fishers and residents in the monitoring of pollution (ranked 4). Recommended collaboration with NGOs like Friends of the Earth or local community organisations.

- Sustainable Tourism Programs: Develop programs aimed at educating tourists about the ecological sensitivity of Boka Kotorska Bay. These could include eco-certification schemes for local businesses, waste reduction campaigns, and informational workshops on responsible tourism (ranked 4).

- Education and Awareness for Ferry and Cruise Passengers: Create onboard educational programs for ferries and cruise ships that operate in the bay. These programs would include short video documentaries about the bay's unique biodiversity, the importance of protecting marine habitats, and guidance on reducing pollution (e.g., waste management and responsible anchoring). Information flyers and onboard presentations from local environmental groups can complement these efforts. Utilize platforms such as Facebook, Instagram, and Twitter to promote biodiversity education and involve citizens in participatory conservation efforts.

- Educational Workshops for Tourists: Host workshops at key tourist hubs like marinas and hotels, educating visitors on the region's environmental fragility. Topics could include responsible wildlife watching, waste disposal protocols, and guidance on how tourists can support local conservation efforts. Interactive displays, guided eco-tours, and talks by marine biologists can enhance tourist engagement and awareness of sustainable tourism practices.

- Online Engagement Platforms: Launch digital platforms that allow residents and tourists to report pollution, invasive species sightings, and environmental changes in real-time. These platforms would foster a sense of shared responsibility and could be linked to local government databases for policy enforcement and planning.

- Policy discussions: Even if policies cannot be changed or influenced directly, further actions can still have several benefits and outcomes for future strategies by raising awareness, empowering communities, stimulating policy discussions, promoting alternative tourism models, facilitating research and monitoring, and encouraging corporate responsibility. Policymakers may be prompted to consider alternative approaches, such as implementing stricter regulations, imposing environmental taxes, limit the number of cruise ships that can dock during the week or promoting destination diversification to reduce dependency on cruise tourism and CS can highlight the need for further research and monitoring of the impacts of cruise tourism on coastal communities, natural environments, and cultural heritage and by identifying knowledge gaps and research priorities facilitate evidence-based decision-making in the tourism sector.

Adaptive Strategies

- Collaborative Platforms: Establish a multi-stakeholder platform that facilitates communication and joint decision-making between local authorities, NGOs, businesses, and community members. The questionnaire highlighted that stronger collaboration is needed to address governance gaps (ranked 4).

- Sustainable Fisheries Management: Introduce flexible fishing quotas based on seasonal stock assessments and encourage alternative livelihoods, such as eco-tourism, to reduce pressure on fish populations.

- The Tourism Development Strategy of Montenegro 2022-2025 recognizes the natural, cultural, and historical importance of the Kotor-Risan Bay area and stresses that protection of cultural heritage is paramount in all future tourism development. The strategy highlights the need for targeted, controlled development, with careful planning of tourism accommodations, as the carrying capacity of Kotor is almost exhausted. Furthermore, the strategy aligns with international conventions and agreements, mandating sustainable use of natural and cultural resources. Further studies within PRO-COAST can inform policy refinements, such as establishing sustainable tourism guidelines, limits on cruise ships, and conservation measures for vulnerable areas within the bay.

- Tourism Capacity Control: Limit the number of cruise ships and tourists allowed in sensitive areas during peak seasons. Implementing eco-certifications for businesses and enforcing waste management practices would help mitigate the environmental impacts of tourism.

3.4.5 Fixing the Focal Action

Focal Issues

1. Over-Tourism: High visitor numbers during peak seasons lead to habitat degradation and increased waste production. Unregulated tourism practices further strain local ecosystems. Tourism, particularly cruise tourism, is a major economic driver but poses significant risks to marine habitats (rated 5 in importance). Stricter regulations on cruise ship traffic are required, including limiting the number of ships allowed during peak seasons and establishing carrying capacity limits for key ecosystems in Boka Kotorska Bay.

   Given the high dependency on tourism, especially cruise tourism, sustainable practices must be adopted to preserve the ecological integrity of the bay. We propose introducing a tourism capacity control system, which would limit the number of cruise ships and visitors during peak seasons to reduce environmental strain. Additionally, eco-certifications for local tourism businesses could

promote green practices, such as reducing plastic waste and responsible waste disposal. Promoting eco-friendly activities, like guided eco-tours and wildlife watching, would not only educate visitors but also generate sustainable revenue streams.

2. Marine Pollution Control: Untreated wastewater and nutrient runoff are critical threats to Boka Kotorska Bay's marine ecosystems. Establishing stricter wastewater treatment standards is essential to reduce eutrophication and prevent the degradation of water quality. We suggest launching a comprehensive pollution control initiative, focusing on improving sewage infrastructure and enforcing stricter regulations on maritime and tourism-related waste disposal. Engaging local businesses, such as hotels and marinas, in waste management campaigns will be vital.

3. Sustainable Fisheries Management: Overfishing is reducing biodiversity and negatively impacting local fish stocks. Implementing seasonal fishing quotas and no-take zones in sensitive marine areas would allow fish populations to recover. This action should be supported by local communities through training programs on sustainable fishing techniques. We also recommend providing alternative livelihood opportunities, such as involving local fishermen in eco-tourism activities, which can reduce dependency on overexploited marine resources while still providing economic benefits.

4. Habitat Restoration Initiatives: Seagrass meadows, crucial for biodiversity and carbon sequestration, are severely damaged by anchoring and pollution. Launching a seagrass restoration initiative focused on replanting and protecting these habitats is vital for the ecosystem's recovery. Creating no-anchoring zones in sensitive areas would help reduce further damage. This initiative could be paired with public awareness campaigns to educate tourists and local boat operators on the importance of protecting these critical habitats.

5. Tourism and Environmental Governance for influencing local policy developments, particularly concerning the environmental impacts of cruise tourism. By contributing data and insights on the ecosystem's carrying capacity, this case study can help shape guidelines for sustainable tourism practices, such as limiting the number of cruise ships allowed in the bay and implementing conservation measures. These policies will align with both the Tourism Development Strategy 2022-2025 and the Draft Spatial Plan, ensuring a balanced approach to economic growth and environmental protection.

6. Vernacular architecture and ecology. Sustainable development in the Boka Kotorska region of Montenegro can be achieved through vernacular architecture and ecology, but uncontrolled urban expansion threatens environmentally sensitive planning policies.

Strategies

To achieve a sustainable future for Boka Kotorska Bay, it is imperative to implement Integrated Coastal Zone Management and Marine Spatial Planning, address the impacts of tourism and urban development, preserve the unique cultural landscape, and incorporate vernacular architecture and ecological principles into planning. These strategies collectively support the environmental, economic, and cultural sustainability of the region.

- Sustainable Tourism Management: Develop and implement sustainable tourism guidelines. Align the strategies with national environmental policies and UNESCO World Heritage guidelines to protect the bay's ecological and cultural vaue. Collaborate with local municipalities, tourism operators, and NGOs to explore alternative action plans e.g. to certificate good practices or to regulate access to sensitive areas and promote eco-friendly practices among tourism operators. Outcome: Controlled visitor flows, reduced environmental impact, and enhanced protection of marine ecosystems.

- Marine Health Monitoring: Create localized data collection frameworks for monitoring marine health. Develop a digital library to promote biodiversity awareness and advocate for the adjusting

of local policies to ensure conservation and sustainable use of biodiversity.
Engage local communities in citizen science initiatives to collect data on marine biodiversity and pollution levels. Launch a pollution control initiative to address untreated wastewater and marine litter. Complete the first phase of the initiative (co-designing improvements and awareness campaigns) within 18 months. Outcome: Improved understanding of marine health and better-informed management decisions.

- Promoting Sustainable Practices: Implement guidelines for sustainable practices among local businesses and tourism operators. Work with stakeholders to promote waste reduction, responsible visitor management, and conservation efforts. Reduce nutrient runoff and plastic waste by 25% over the next two years through improved infrastructure and stricter waste management enforcement. Outcome: Enhanced sustainability of tourism activities and reduced ecological footprints.

Monitoring and Adaptation

- Monitoring Water Quality: Regular water quality assessments will track improvements in nutrient levels and pollutants. This will provide ongoing data for refining wastewater treatment and pollution control efforts.
- Tourism Impact Monitoring: Implement monitoring protocols to track the environmental footprint of tourism, such as the amount of waste generated, visitor numbers, and their impact on sensitive areas.
- Fisheries Monitoring: Establish a program to track fish stocks, adjusting seasonal quotas based on stock recovery and implementing adaptive management strategies to ensure the long-term sustainability of fisheries.
- Stakeholder Feedback: Regular stakeholder meetings will gather feedback from local communities, NGOs, and government agencies to ensure that these focal actions are effectively addressing the identified challenges. Adaptation will involve fine-tuning the initiatives based on environmental data and stakeholder input.

- Continuous Monitoring: Implement a structured monitoring program to evaluate the effectiveness of tourism management strategies and marine health initiatives.

- Adaptive Management: Use monitoring data to adjust tourism practices, regulations, and stakeholder engagement efforts as needed.

3.5 Case Study: Streedagh beach, Sligo, Ireland

3.5.1 CS Situation and Baseline

Streedagh beach, located in Sligo, the northwest coast of Ireland, features a rich variety of ecosystems, including coastal dunes, and grasslands, which are critical for biodiversity coastal resilience. The region is home to several protected species and ecosystems under the EU NATURA 2000 network, including Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). The Special Areas of Conservation (SAC) in Sligo include important habitats that are part of the EU Natura 2000 network. However, Sligo faces growing pressures from tourism, agriculture, and climate change, leading to habitat degradation and biodiversity loss. The local population near Streedagh Beach is concentrated in the nearby Grange community township, with approximately 569 residents. The area attracts significant tourist numbers, with around 186,000 international and 263,000 domestic visitors annually, further stressing the region's fragile ecosystems, particularly during the peak summer season.

At Streedagh Beach, various stakeholders have different interests. Clean Coasts and the National Parks and Wildlife Services focus on environmental and biodiversity conservation, while Sligo City Council and the National Tourism Development Authority are invested in enhancing tourism and beach services for economic benefits. Councillors represent community and political interests, and business owners are concerned with sustainable local businesses. Landowners worry about access to their lands, and farmers and the Irish Cattle and Sheep Farmers Association prioritise the preservation of grazing areas. Researchers are interested in the area's scientific value for biodiversity studies.

Ecological Baseline

Human activities, particularly habitat conversion and degradation, are causing significant declines in local biodiversity. These pressures have reduced species richness, total abundance, and rarefaction-based richness globally, with marked spatial variation[7]. In Streedagh, key habitats such as coastal dunes, salt marshes are threatened by coastal erosion, overgrazing, and invasive species. The area's biodiversity is under pressure, with species like the curlew (*Numenius Arquata)* and common seal (***Phoca vitulina*** being affected by habitat loss. The sand dunes along Streedagh Beach are eroding due to the effects of tourism and climate change.

Social Baseline

The local community in Sligo depends on tourism, agriculture, and fishing for their livelihoods. **Tourism** is an important economic driver, but unregulated visitor activity is causing significant environmental degradation. There are ongoing community efforts to promote sustainable tourism and habitat restoration, but engagement is still limited, especially among tourists and seasonal visitors. **Rural depopulation** remains a key challenge, with young people migrating to urban areas due to the lack of economic opportunities.

[7] Newbold, T., Hudson, L., Hill, S., Contu, S., Lysenko, I., Senior, R., Börger, L., Bennett, D., Choimes, A., Collen, B., Day, J., Palma, A., Díaz, S., Echeverría-Londoño, S., Edgar, M., Feldman, A., Garon, M., Harrison, M., Alhusseini, T., Ingram, D., Itescu, Y., Kattge, J., Kemp, V., Kirkpatrick, L., Kleyer, M., Correia, D., Martin, C., Meiri, S., Novosolov, M., Pan, Y., Phillips, H., Purves, D., Robinson, A., Simpson, J., Tuck, S., Weiher, E., White, H., Ewers, R., Mace, G., Scharlemann, J., & Purvis, A. (2015). Global effects of land use on local terrestrial biodiversity. Nature, 520, 45-50. https://doi.org/10.1038/nature14324.

Economic Baseline

Tourism, particularly around **Streedagh Beach**, provides substantial economic benefits, but it is also a major contributor to environmental degradation. Agriculture, particularly **sheep grazing**, plays an important role in the local economy but contributes to **habitat fragmentation** and nutrient runoff. The challenge is finding a balance between economic activities and conservation.

Governance Baseline

Several governance frameworks influence the management of Sligo's coastal ecosystems, including the **Sligo County Council**, the **National Parks and Wildlife Service (NPWS)**, and the **Environmental Protection Agency (EPA)**. However, there are gaps in enforcement and coordination between different authorities, leading to inconsistent implementation of environmental regulations.

3.5.2 Initial Indicators, Data Sources, and Drivers

Ecological Indicators

- **Species Diversity**: Streedagh is home to a range of protected species under the EU Natura 2000 network, including the curlew (*Numenius arquata*), corncrake (*Crex crex*), and common seal (*Phoca vitulina*). These species are indicators of habitat health, with declines in populations due to habitat degradation from agriculture and tourism pressures. Biodiversity loss is highlighted as a critical issue. Tourists injuring, killing, or taking wildlife pose a significant threat to local biodiversity. This includes disturbances to nesting birds and illegal collection of plants and animals. Strengthening enforcement of wildlife protection laws and increasing on-site monitoring are necessary to mitigate these impacts.
- **Water Quality**: Coastal waters around Streedagh suffer from nutrient pollution, primarily from agricultural runoff (nitrates and phosphates). The degradation of Streedagh Beach and the surrounding coastal ecosystems due to eutrophication is a pressing concern.

- **Habitat Degradation**: Tourists parking in undesignated areas have led to significant loss of Marram grass (*Ammophila arenaria*), which plays a critical role in stabilizing dunes. Additionally, driving on and destroying salt marshes further exacerbates coastal habitat degradation (rated 5 in importance). To mitigate these issues, designated parking areas and physical barriers must be implemented to protect these sensitive habitats. Also, tourists camping on the dunes and lighting fires have further accelerated the degradation of these already eroding habitats. The dunes are a critical natural barrier against storms and flooding, but human activities are undermining their stability (rated 5 in importance). Introducing designated camping areas, away from sensitive zones, and restricting fires are urgent measures needed to protect these dunes.

- **Waste Management**: Pollution and littering by visitors, particularly on **Streedagh Beach**, continue to degrade the coastal environment (rated 5 in importance). Establishing proper waste management infrastructure, such as **bins**, **recycling stations**, and **regular clean-up campaigns**, alongside public awareness campaigns, is essential to tackle this persistent issue.

- **Infrastructure Gaps**: The **lack of restraining fencing** around sensitive habitats, such as dunes and salt marshes, allows tourists to park in undesignated areas, causing further habitat destruction (rated 5). Installing **fencing** to restrict vehicle access and guide visitors to designated parking areas

is critical to preventing further damage. Moreover, the **lack of accessible routes** to **Streedagh Beach** for parents with children, the elderly, and disabled persons presents a significant gap in infrastructure (rated 5 in importance). Improving accessibility through the installation of **wheelchair-accessible paths** and **family-friendly routes** would ensure the site is inclusive for all visitors.

Social Indicators

- **Community Engagement**: There is moderate community engagement in conservation efforts, but local participation could be increased, especially in areas such as **coastal conservation**. The questionnaire indicates that more awareness programs could foster stronger involvement from farmers and tourism operators (ranked 4).
- **Tourism Impacts**: Tourism, especially during the summer, is both an economic driver and a significant environmental stressor. High visitor numbers are linked to coastal erosion, littering, and wildlife disturbances. Initiatives to promote sustainable tourism are emerging but are not yet widespread.

Economic Indicators

- **Agricultural Pressure**: Intensive sheep grazing on the coastal dunes contributes to habitat loss and nutrient runoff. Farming is crucial to the local economy but poses a significant risk to biodiversity if not managed sustainably. Agricultural runoff, highlighted as a major concern, was ranked 4 in the questionnaire.
- **Tourism Growth**: Sligo's tourism sector, focused around **Wild Atlantic Way** destinations such as **Streedagh Beach**, contributes to local economies but also stresses coastal and rural ecosystems. Sustainable tourism practices, such as eco-certifications and limiting visitor numbers, are needed to mitigate these impacts (ranked 3).

Governance Indicators

- **Multiple key stakeholders.** Sligo County Council (SCC) plays a leading role in local land-use planning and environmental management (rated 5 in importance). Elected officials and the National Parks & Wildlife Service (NPWS) provide crucial oversight of protected areas, while the Environmental Protection Agency (EPA) enforces environmental regulations. Additionally, local farmers and landowners, who directly impact peatlands and dunes through grazing and land-use practices, are critical to achieving sustainable outcomes (rated 4).

- **Weak Enforcement**: The enforcement of environmental regulations, particularly regarding tourism and land use, is inconsistent. Local stakeholders expressed concerns about weak governance, especially around habitat protection and waste management from tourism (ranked 4).
- **Collaborative Governance**: The lack of coordinated action between local councils, national authorities, and NGOs has been identified as a challenge. There is room for better collaboration and stakeholder engagement, as mentioned in the questionnaire.

Data Sources

- **National Legislation**: The Sligo County Council Climate Adaptation Strategy and the National Biodiversity Action Plan 2022-2027 provide a legal framework for habitat protection and species conservation in the region.

- **Environmental Reports**: Regular reports from the Environmental Protection Agency (EPA) and the National Parks and Wildlife Service (NPWS) monitor biodiversity, water quality, and peatland health.
- **Scientific Literature**: Studies on coastal erosion, peatland conservation, and biodiversity loss from University College Dublin and local research institutions provide critical ecological data. These can be found in portals such as the Web Of Science and Scopus.
- Citizen Science Apps: SCORE Project - Co-Creation Toolkit: A toolkit designed to involve communities in co-creating sustainable urban and environmental solutions, including monitoring and reporting environmental changes. SCORE Community Geosurveys[8]: A platform for community-driven geospatial surveys that enable citizens to contribute to environmental monitoring efforts through georeferenced data.
- **NGO Reports**: Organizations like CleanCoast and the Irish Wildlife Trust offer valuable data on community engagement, habitat restoration, and pollution monitoring.

- **Questionnaire Responses:** Direct feedback on biodiversity, habitat quality, community engagement, and governance challenges.

Main Drivers

- **Environmental Drivers**: Extreme weather, coastal erosion and overgrazing, are driving habitat degradation in Sligo, particularly in Streedagh Beach and peatland areas.
- **Socio-Economic Drivers**: Tourism and agriculture are essential for the local economy but are contributing to ecosystem decline through unsustainable practices. Tourism is also a driver of environmental degradation, particularly around Streedagh Beach. The high influx of visitors during peak seasons causes dune erosion, littering, and wildlife disturbances. Implementing measures like timed access, zoning for access, or promoting eco-certification for tourism operators are recommended to mitigate these impacts while sustaining local economies. In general across Ireland, farming is important and presents a relatively positive picture in terms of landscape heterogeneity, with semi-natural habitats accounting for an average of 13% of farm area[9]. Almost 10% of intensively managed farms in Ireland comprised habitats beneficial for wildlife, with linear features like hedgerows, buffer strips, and drainage ditches accounting for 43% of the total area of wildlife habitat surveyed in the study.
- **Governance Drivers**: Weak enforcement of environmental policies and limited stakeholder collaboration are hindering progress in sustainable conservation.

3.5.3 Diagnosis of Knowledge Gaps and Challenges

Knowledge Gaps

- **Biodiversity Monitoring**: There is limited long-term data on the populations of key species such as the **curlew** and **corncrake**. The lack of comprehensive species monitoring makes it difficult to track the impacts of habitat degradation, particularly in coastal dunes and peatlands (ranked 5 in the questionnaire). A critical gap exists in the lack of a comprehensive biodiversity baseline, particularly for protected species under the EU Natura 2000 network (rated 5 in importance). Data

[8] https://geosurveys.score-eu-project.eu/

[9] Sheridan, H., Keogh, B., Anderson, A., Carnus, T., McMahon, B., Green, S., & Purvis, G. (2017). Farmland habitat diversity in Ireland. Land Use Policy, 63, 206-213. https://doi.org/10.1016/J.LANDUSEPOL.2017.01.031.

on species such as the curlew and common seal is sparse, and monitoring efforts need to be expanded to assess the impacts of habitat degradation and climate change on biodiversity.

- **Tourism Impact on Ecosystems**: Streedagh received 186,000 international tourists and 263,000 domestic tourists according to latest available information (2015). However, there is insufficient data linking the economic benefits of tourism to the environmental costs. More detailed studies are needed to assess the long-term impacts of visitor activities on biodiversity, water quality, and coastal erosion. The **lack of waste management infrastructure** to handle the waste generated by tourists, particularly around camping and recreational areas, is a critical challenge. Without proper waste disposal systems, litter and pollution degrade the coastal ecosystem, harming both terrestrial and marine habitats. Developing a coordinated waste collection strategy and installing dedicated facilities is essential.

Challenges

1. **Coastal Erosion**: Erosion of **Streedagh Beach** and surrounding coastal areas, driven by rising sea levels and unregulated tourism, threatens both biodiversity and local infrastructure.
2. **Tourism Pressure**: High visitor numbers, especially during peak seasons and considering the available infrastructure, are causing significant environmental stress. Strategies are needed to promote sustainable tourism and reduce habitat degradation.
3. **Weak Governance**: Insufficient enforcement of environmental regulations is undermining conservation efforts, especially around coastal and agricultural land use.

3.5.4 Proposed Engagement Methodologies

Stakeholder Mapping

- **Local Farmers and Landowners**: Their land-use practices, particularly grazing and land management, directly impact both the peatlands and coastal ecosystems. They are critical to any conservation and sustainable farming initiatives (ranked 4 in the questionnaire).
- **Tourism Operators**: Businesses focused on tourism, particularly those around Streedagh Beach, need to adopt sustainable tourism practices to reduce their environmental footprint.
- **Environmental NGOs**: Groups like CleanCoast and Wild Atlantic Nature Project are involved in citizen science initiatives, restoration efforts, and public awareness campaigns.
- **Local and National Authorities**: Sligo County Council, NPWS, and EPA play key roles in policy implementation and environmental regulation enforcement. Enforcement of environmental regulations could be improved, particularly regarding land use and tourism management . The fragmentation of responsibilities between local and national authorities, such as Sligo County Council, NPWS, and EPA, leads to gaps in policy implementation. Stronger coordination and clearer roles are needed to improve regulatory outcomes.

Environmental Monitoring and Policy Support

- Local debates at the Municipal Council highlight the need for a comprehensive environmental survey to assess the extent of dune damage over the past 20 years. This survey is crucial for informing restoration plans and guiding future management strategies.

- There is an ongoing debate at the **Municipal Council** regarding the provision of **accessible routes** to **Streedagh Beach** for the elderly and disabled (rated 5 in importance). Addressing these infrastructure gaps is key to ensuring inclusivity while protecting the integrity of the site.

Engagement Approaches

1. **Collaborative Clean-Up Initiatives:** Partner with local groups like Tidy Towns and Clean Coasts to organise regular beach clean-ups at Streedagh Beach, involving local residents, schools, and businesses. These events will not only improve the beach's environment but also foster community engagement in conservation efforts.

2. **Marine Habitat Awareness Campaign:** Develop and distribute educational materials to raise awareness about the importance of marine biodiversity and the impact of waste, especially microplastics, on the ecosystem. This can be done through social media campaigns, school workshops, and informational sessions in collaboration with the National Parks and Wildlife Services and local NGOs.

3. **Workshops on Marine Conservation:** Hold regular workshops for local stakeholders, including farmers, businesses, and tourists, to highlight the biodiversity of Streedagh Beach and the surrounding SACs. These workshops would cover topics such as the negative effects of pollution on marine life and actionable steps to protect the habitats.

4. **Workshops and Training for Farmers**: Engage local farmers in workshops focusing on sustainable farming techniques, including controlled grazing, reducing runoff, and restoring peatlands. Emphasise the economic benefits of sustainable practices through agri-environmental schemes like GLAS (Green Low-Carbon Agri-Environment Scheme).
5. **Tourism Education and Awareness Campaigns**: Launch public awareness campaigns targeting tourists visiting Streedagh Beach and other popular sites. These campaigns can educate visitors on the ecological sensitivity of the area, the importance of protecting coastal dunes, and how they can minimise their environmental footprint. Local businesses can offer eco-friendly services, with tourists receiving information about sustainable tourism upon arrival (ranked 3 in the questionnaire).
6. **Citizen Science Initiatives**: Engage the local community in citizen science programs, allowing them to participate in biodiversity monitoring efforts by reporting sightings of wildlife or issues such as pollution through mobile apps or online platforms. Expand local and visitor participation in monitoring biodiversity and pollution through devices like the **Smart Pebble**[10]. These low-cost sensors allow participants to collect and share data on beach erosion. By incorporating technologies like the Smart Pebble, tourists and residents can actively contribute to ongoing environmental monitoring efforts.

Adaptive Strategies

- **Eco-Certifications for Businesses**: Introduce eco-certification schemes for local businesses, especially tourism operators, to incentivize sustainable practices such as reducing plastic waste, using renewable energy, and promoting eco-friendly tourism activities.

[10] https://sensors.score-eu-project.eu/sensor/smart-pebbles/

- **Collaborative Platforms and Awareness Campaigns**: Establish a platform for continuous stakeholder dialogue between local authorities, landowners, and NGOs to ensure coordinated action in habitat restoration and sustainable tourism management. Create a social media campaign and distribute educational materials in schools, community centres, and businesses, raising awareness about aquatic biodiversity and the negative impacts of waste. This campaign should be supported by regular community talks and workshops facilitated by experts from the National Parks and Wildlife Services.

- **Community Coastal Clean-Up and Education Hub**: Establish regular clean-up events at Streedagh Beach in partnership with local groups like Tidy Towns and Clean Coasts. These events will double as educational sessions where participants learn about the importance of marine habitats, the effects of microplastics, and biodiversity conservation. Each clean-up event will include short workshops or info sessions on marine protection.

3.5.5. Fixing the focal action

The focal actions for Sligo focus on strengthening coastal erosion management, promoting sustainable tourism practices, and enhancing community engagement in monitoring efforts. These actions are vital for addressing the pressures of climate change and tourism on coastal ecosystems.

Focal Issues

- **Coastal Erosion**: Increased coastal erosion due to human activities and climate change poses significant risks to local habitats.

- **Tourism Pressures**: Unsustainable tourism practices lead to habitat degradation and increased waste, threatening sensitive ecosystems.
- **Limited Community Engagement**: A lack of community involvement in monitoring and decision-making reduces the effectiveness of management strategies.

Proposed Actions

- **Coastal Erosion Management**
  - **Action**: Implement a comprehensive coastal erosion management plan that prioritizes the restoration of vulnerable areas while designating specific zones for preservation and intervention
  - **Strategy**: Identify critical areas for restoration, such as eroding dunes and wetlands, and establish protective measures, including the planting of native vegetation and the installation of erosion barriers.
  - **Outcome**: Designate "no-go" zones where human activity is limited to allow ecosystems to recover naturally, while implementing active restoration strategies in areas that have already been degraded.
- **Awareness and Engagement**
  - **Action**: Develop targeted awareness campaigns aimed at both local residents and visitors, especially those from Tallinn, to foster a sense of stewardship and responsibility for coastal ecosystems.
  - **Strategy**: A) **Visitor Education**: Create informative signage and brochures in multiple languages, highlighting the ecological significance of Kloogaranna-Laulasmaa and the

importance of protecting sensitive areas. Organize guided tours that educate visitors about local biodiversity and conservation efforts, encouraging responsible behaviour while enjoying the coastal environment. B) **Local Engagement**: Host community workshops and events that bring together residents to discuss coastal management issues, share local knowledge, and participate in restoration projects. Involve schools and local organizations in citizen science initiatives, such as beach clean-ups and biodiversity monitoring, to foster community pride and engagement.

- **Outcomes**: A volunteer programme that allows local residents and visitors to participate in restoration activities, such as planting native species or conducting erosion assessments. Collaborate with local businesses to implement eco-friendly practices and promote sustainable tourism options, creating incentives for tourists to engage in conservation efforts.

Monitoring and Adaptation

- **Continuous Monitoring**: Develop a structured monitoring program to assess the effectiveness of coastal erosion management strategies, visitor impacts, and community engagement outcomes. Regular data collection will provide essential information for adaptive management.
- **Adaptive Management**: Conduct annual reviews of management strategies based on monitoring results and community feedback. This process will allow for necessary adjustments to ensure that actions remain relevant and effective in addressing on-going challenges related to coastal erosion and tourism pressures.

3.6 Case Study: Arne Parish, UK

3.6.1 CS Situation and Baseline

The **Arne Parish case study** in the UK is located in Dorset, forming part of the Purbeck Heaths National Nature Reserve (NNR). This area is ecologically significant, encompassing heathlands, wetlands, salt marshes, and woodlands, which support endangered species such as the red squirrel and bird species like the nightjar (*Caprimulgus europaeus)* and Dartford warbler (*Sylvia undata)*. However, the region faces challenges from habitat degradation, invasive species such as grey squirrels (*Sciurus carolinensis)* and rhododendrons (*Rhododendron ponticum*), eutrophication of Poole Harbour and tourism pressure. The local population is small, with around 1,370 residents, while the area receives over 150,000 visitors annually, particularly to its nature reserves, with another 250,000 passing through on their way to nearby Swanage. Tourism, alongside farming and conservation efforts, is one of the main economic activities in the area as are industries such as clay mining, farming, and conservation work, but these activities also contribute to environmental pressures. Key stakeholders involved in managing and preserving the area's biodiversity include Natural England, the National Trust, the RSPB, and the Dorset Wildlife Trust.

In the Arne Parish case study, high engagement with the local public is essential, particularly due to the ecological sensitivity of the area and the presence of diverse stakeholders, including residents, farmers, conservationists, and tourists. The strategy should focus on direct community interaction to foster collaboration and support for conservation and sustainable practices.

Ecological Baseline

The main ecological challenge is the habitat degradation caused by increasing visitor numbers and the spread of invasive species such as grey squirrels and rhododendron. The grey squirrel, in particular, has been linked to the decline of the native Eurasian red squirrel (*Sciurus vulgaris*) and has caused extensive damage to forestry. Understanding the dynamics of these invasions and the effectiveness of control measures is crucial for conservation efforts. These invasions impact native flora and fauna, with grey squirrels displacing red squirrels and damaging young trees through bark stripping.

Social Baseline

One of the central social challenges in the case study area is the imposition of conservation policies without adequate consultation with local communities. These top-down approaches often neglect the traditional knowledge, values, and needs of the people who live in and interact with the environment daily. Many residents, including farmers, landowners, and local business owners, feel excluded from the decision-making processes that directly affect their livelihoods. The lack of community involvement can foster distrust toward conservation authorities and result in reduced compliance with environmental regulations. This disconnect highlights the urgent need for inclusive decision-making frameworks where local voices are incorporated into the creation and implementation of conservation strategies, ensuring that the community becomes a collaborative partner in long-term environmental management.

Another key social issue is the lack of awareness about the detrimental effects of introduced alien species on ecosystems, especially in relation to climate change mitigation strategies such as carbon sequestration. While some species, like invasive trees or plants, may be seen as beneficial for capturing carbon and reducing the effects of climate change, their introduction can lead to significant ecological damage by outcompeting native species, disrupting ecosystems, and reducing biodiversity. In many communities,

there is a limited understanding of how these species can degrade habitats and undermine long-term conservation goals. Raising public awareness and providing education campaigns focused on the unintended consequences of invasive species is crucial for ensuring that local climate mitigation efforts do not come at the expense of ecological integrity. Engaging the community in ecosystem-based solutions and promoting the benefits of native species restoration will be essential for aligning social attitudes with conservation priorities.

The area is popular with tourists, attracting over 150,000 annual visitors, with many passing through to nearby Swanage. While tourism supports the local economy, it places stress on habitats. The local population is small, with just over 1,370 inhabitants, mostly engaged in service industries, tourism, conservation, and farming. Due to recent shifts in population cycles, long-time residents of Arne Parish are being forced to leave the area as they struggle to find affordable housing.

Economic Baseline

Tourism is a key economic driver, along with conservation work and clay mining. However, nutrient runoff from agriculture poses risks to biodiversity and water quality in Poole Harbour. Sources of nitrogen are primarily upstream of Arne Parish, so this project will not address them.

Governance Baseline

Natural England, the National Trust, the RSPB, and the Dorset Wildlife Trust oversee conservation and habitat restoration efforts from local administrative offices. Local governance is coordinated by the Arne Parish Council, but enforcement of conservation measures remains a challenge. Additional stakeholders such as the British Association for Shooting and Conservation and the Game and Wildlife Conservation Trust also influence policy from more remote offices, with potential rated highly for conservation efforts in this project (4-5 importance). The organisations with local offices may inform the local Arne Parish Council of their activities but tend to hold consultations independent of this most local government level.

3.6.2 Initial Indicators, Data Sources, and Drivers

Ecological Indicators

- **Species Diversity**: Grey squirrel population range has expanded significantly in Britain, causing significant damage to trees, with thin-barked tree species being most at risk. Red squirrels, nightjars, and Dartford warblers are key species. However, invasive grey squirrels are a significant threat to red squirrels. Grey squirrels have led to the wide-scale extinction of native red squirrels in areas they colonise due to competition for resources and disease transmission[11]. The presence of the pine marten (*Martes martes)* reverses red squirrel replacement by grey squirrels in Britain and Ireland, but grey squirrels are likely to persist in urban areas[12].
- **Habitat Quality**: Heathlands, wetlands, and woodlands are threatened by habitat fragmentation, invasive species, and visitor pressure. Habitat restoration efforts have focused on these areas.

[11] Wauters, L., Lurz, P., Santicchia, F., Romeo, C., Ferrari, N., Martinoli, A., & Gurnell, J. (2023). Interactions between native and invasive species: A systematic review of the red squirrel-gray squirrel paradigm. , 11. https://doi.org/10.3389/fevo.2023.1083008.

[12] Bamber, J., Shuttleworth, C., Hayward, M., & Everest, D. (2020). Reinstating trophic cascades as an applied conservation tool to protect forest ecosystems from invasive grey squirrels (Sciurus carolinensis). Food Webs, 25. https://doi.org/10.1016/j.fooweb.2020.e00164.

- **Tools** such as RANGES[13] are utilised for analysing animal location data, specifically to estimate the home range and habitat use of species through GPS and telemetry tracking. Additionally, REDS[14] will be applied for modelling species distributions and environmental dynamics, helping to predict habitat changes. Survey packages, including tools such as Distance, are employed for population density estimates during wildlife surveys[15], while statistical packages (e.g. R) are helpful for performing detailed analyses.

Social Indicators

- **Awareness:** The public has little knowledge of grey squirrel's negative impacts and considers control methods recommended by wildlife professionals as least acceptable[16]. Local communities in red squirrel areas are more knowledgeable about squirrels and their management, value red squirrels more, and consider grey squirrel controls more acceptable than the wider population[17].

- **Community Engagement**: Local residents and organisations are engaged in conservation efforts, though public perception of invasive species management, particularly regarding grey squirrels, remains a challenge (ranked 4 in the questionnaire). The Red Squirrels United project empowered volunteers to detect and remove grey squirrels, aiding red squirrel conservation in the UK[18].

- Over the past 50 years, the influx of new settlers has transformed the area, leaving long-standing **rural families** with traditional countryside occupations as a **resentful minority**. This group includes not only **older generations** but also their children, who face being **priced out of local homes** due to rising property values driven by new residents and **holiday-home ownership**.
- **Tourism Pressure**: High visitor numbers during peak seasons lead to habitat degradation and increased stress on local wildlife.

Economic Indicators

- **Tourism Impact**: Tourism is vital for the local economy, but sustainable tourism strategies are required to minimise environmental degradation. The local clay mining industry also affects land use and water quality.

Governance Indicators

- **Policy Enforcement**: There is limited enforcement of conservation policies, especially regarding invasive species control and land-use management (ranked 5).

Data Sources

[13] https://www.anatrack.com/ranges_home
[14] https://sycl.net/file_link/00064/Reciprocal_Environmental_Decision_Support_(REDS)_638628676574933256.pdf
[15] Kenward, R.E., Walls, S.S., Hodder, K.H., Pahkala, M., Freeman, S.N. & Simpson, V. R. 2000. The prevalence of non-breeders in raptor populations: evidence from rings, radio-tags and transect surveys. Oikos 91:271-279.
[16] Dunn, M., Marzano, M., Forster, J., & Gill, R. (2018). Public attitudes towards “pest” management: Perceptions on squirrel management strategies in the UK. Biological Conservation, 222, 52-63. https://doi.org/10.1016/J.BIOCON.2018.03.020.
[17] Dunn, M., Marzano, M., & Forster, J. (2021). The red zone: Attitudes towards squirrels and their management where it matters most. Biological Conservation, 253, 108869. https://doi.org/10.1016/j.biocon.2020.108869.
[18] Shuttleworth, C. (2020). Evolving grey squirrel management techniques in Europe. Management of Biological Invasions, 11, 747-761. https://doi.org/10.3391/mbi.2020.11.4.09.

- Local: Dorset Wildlife Trust, RSPB Arne, Dorset Area of Outstanding Natural Beauty (AONB) partnership.
- National: Natural England, Environment Agency.
- EU: Natura 2000 Network, European Environment Agency.

- Portals like Web Of Science and Scopus. Literature Review provides valuable insights into CS.

- Questionnaire Responses: Direct feedback on biodiversity, habitat quality, community engagement, and governance challenges.

Main Drivers

- **Invasive Species**: The spread of grey squirrels and rhododendrons is significantly impacting native biodiversity.
- **Tourism Pressure**: Unregulated visitor activity is leading to habitat degradation.
- **Climate Change**: Warming temperatures are expanding the habitat for invasive species like grey squirrels, further displacing red squirrels.

- **Public attitudes** towards grey squirrel management are crucial for the success of control programs. A national survey in the UK found that the public often lacks knowledge about the negative impacts of grey squirrels and views them as desirable. Wildlife professionals need to raise awareness about the damage caused by grey squirrels and the importance of control methods to foster more effective collaboration with local communities[19].

- Community Involvement and Outreach. Local communities play a vital role in the survival of red squirrels. Targeted outreach efforts have increased awareness and involvement in squirrel management in red squirrel areas. Despite high interest, barriers such as time constraints and lack of skills prevent broader participation. Outreach programs should address these barriers by promoting volunteer roles and providing suitable training[20].

3.6.3 Diagnosis of Knowledge Gaps and Challenges

Knowledge Gaps

- **Impact of Invasive Species**: While the negative effects of grey squirrels on red squirrels are well-documented, there is a lack of long-term data on how other invasive species, such as rhododendron, impact the local ecosystem. Mathematical models are essential tools for developing and optimising strategies to manage invasive species. As an example, this study[21] on Anglesey, UK, used a stochastic, spatial model to represent habitat structure and population dynamics, including the trapping and removal of grey squirrels. This model assessed different management procedures to protect red squirrels from re-invasion by grey squirrels, highlighting the importance

[19] Dunn, M., Marzano, M., Forster, J., & Gill, R. (2018). Public attitudes towards “pest” management: Perceptions on squirrel management strategies in the UK. Biological Conservation, 222, 52-63. https://doi.org/10.1016/J.BIOCON.2018.03.020.
[20] Dunn, M., Marzano, M., & Forster, J. (2021). The red zone: Attitudes towards squirrels and their management where it matters most. Biological Conservation, 253, 108869. https://doi.org/10.1016/j.biocon.2020.108869.
[21] Jones, H., White, A., Lurz, P., & Shuttleworth, C. (2017). Mathematical models for invasive species management: Grey squirrel control on Anglesey. Ecological Modelling, 359, 276-284. https://doi.org/10.1016/J.ECOLMODEL.2017.05.020.

of continuous intervention to prevent the spread of Squirrelpox virus (SQPV) from mainland populations. Also, Long-term trapping campaigns are necessary to limit the spread of grey squirrels, but these efforts are often constrained by budgets. Effective management requires standardised data collection to quantify population abundance and inform resource planning. A case study on grey squirrel management in the UK[22] emphasised the importance of human and operational aspects in implementation and suggested ways to prioritise analytical requirements for better conservation outcomes. A systematic review of the interactions between red and grey squirrels highlighted the complex mechanisms underlying their competition[23]. Factors such as habitat type, multi-species interactions, and landscape-level processes influence the outcome of this competition. Understanding these dynamics is crucial for developing effective grey squirrel control efforts.

- **Tourism's Impact on Habitat**: A gap exists in understanding the specific impact of tourism on sensitive habitats, such as heathlands and wetlands, particularly during peak visitor seasons. This gap limits the ability to develop targeted sustainable tourism strategies.
- **Climate Change**: More data is needed on how climate change will affect the local ecosystems, particularly the heathlands, wetlands, and red squirrel habitats.
- **Policy Enforcement:** There is insufficient enforcement of policies, particularly concerning invasive species control and land-use regulations, which impacts the efficacy of conservation efforts.

- **Fine-grain granularity:** Currently, certain species and habitats in Arne Parish may be under-mapped or lack detailed data. Through active citizen involvement and GIS technologies, gaps in species monitoring—particularly in hard-to-reach areas—can be filled, ensuring a more comprehensive and detailed biodiversity inventory. This is particularly valuable for real-time monitoring of backyards as well as seasonal changes, species migrations, and climate-related shifts in habitats.

Challenges

1. **Invasive Species Management**: Grey squirrels and rhododendron are disrupting the local ecosystem, competing with native species for resources.
2. **Tourism Pressure**: Unregulated tourism is causing significant habitat disturbance, particularly in sensitive heathland and wetland areas.
3. **Habitat Fragmentation**: Urban development and land-use change are contributing to the fragmentation of essential habitats.
4. **Climate Change**: Warming temperatures are allowing invasive species to thrive while increasing the vulnerability of native species like red squirrels.

3.6.4 Proposed Engagement Methodologies

Stakeholder Mapping

[22] Waal, Z., & Mill, A. (2023). Evidencing success: Data requirements to model the impacts of long-term management of invasive squirrels. , 11. https://doi.org/10.3389/fevo.2023.1105091.
[23] Wauters, L., Lurz, P., Santicchia, F., Romeo, C., Ferrari, N., Martinoli, A., & Gurnell, J. (2023). Interactions between native and invasive species: A systematic review of the red squirrel-gray squirrel paradigm. , 11. https://doi.org/10.3389/fevo.2023.1083008.

Key stakeholders include:

- **Local Farmers and Landowners**: Their land-use decisions directly impact habitat conservation (ranked 4 in the questionnaire).
- **Conservation NGOs**: **RSPB**, **Dorset Wildlife Trust**, and the **National Trust** are vital for conservation efforts.
- **Tourism Operators**: Local businesses involved in tourism need to adopt sustainable practices to mitigate environmental impacts.
- **Public Institutions**: **Natural England** and the **Environment Agency** provide governance and policy enforcement.
- **Media**: Local and national papers, TV & radio
- **The Poole Harbour Advisory Group on Squirrels** will play a critical role in managing the red squirrel population in the Arne area, focusing on mitigating the threats posed by the invasive grey squirrel. Their involvement is essential in maintaining the ecological balance and protecting the region's biodiversity, particularly within the Purbeck Heaths National Nature Reserve.

Engagement Approaches

1. **Use online community platforms** to underpin the project's engagement and coordination efforts, ensuring stakeholders remain informed and involved in real-time discussions and activities. The System for Community Liaison (SYCL)[24] may serve as a central hub for discussions, updates, repository for resources, and collaboration related to the project.

2. **Door-to-Door Engagement:** Personalised outreach by local volunteers or conservation staff will involve visiting residents directly to raise awareness about conservation efforts, invasive species management (e.g., grey squirrel control), and habitat protection initiatives. This approach can be highly effective in engaging older or less tech-savvy community members and ensuring broad involvement.

3. **Community Encounters and Events:** Organise community meetings and workshops at local halls or outdoor spaces, focusing on key topics such as biodiversity conservation, the importance of Purbeck Heaths NNR, and managing the impacts of tourism. Encourage discussions around local concerns and suggestions, offering residents a platform to voice their views on environmental challenges and solutions.

4. **Community-Led Initiatives**: Encourage local residents to participate in citizen science projects. Programs such as the on-going **National Squirrel Monitoring Program** provide opportunities for locals to help monitor the populations of red and grey squirrels. Engaging volunteers in habitat restoration, such as removing invasive rhododendrons, will also foster local stewardship.

5. **Visitor Education Programs**: Implement educational signage and interactive workshops to educate tourists about the importance of conserving local habitats. Information on the role of red squirrels and the damage caused by grey squirrels can be part of these campaigns.

[24] https://sycl-uk.sycl.net/1/getting-started-with-sycl

6. **Partnership with Local Businesses and Tourism Providers:** Work closely with tourism operators and local businesses to integrate sustainability into their operations. This includes educating visitors on respecting wildlife and local habitats, promoting eco-friendly tourism, and providing information on how they can contribute to conservation efforts during their stay. For instance, introduce eco-certifications for local businesses that adopt sustainable tourism practices. Developing low-impact boardwalks and visitor quotas during peak seasons can help protect sensitive habitats.

Adaptive Strategies

- **Squirrel Management Programs**: Immediate focus is required on invasive species management, with grey squirrels and rhododendrons having the most significant impact on native biodiversity. Control measures such as habitat restoration, grey squirrel trapping, and community-led rhododendron removal should be prioritised. Implement grey squirrel control and reintroduction of red squirrels. Strategies include trapping and habitat restoration. Public campaigns can educate residents on the importance of restoring red squirrels. Restoring native predators, such as the pine marten, can also help control grey squirrel populations[25]. Research has shown that increased pine marten presence correlates with higher red squirrel occupancy and lower grey squirrel occupancy. This approach offers a sustainable method for grey squirrel control by reinstating a missing trophic component and reducing red squirrel exposure to SQPV.

- To mitigate the impact of tourism, **eco-certifications** for businesses and low-impact infrastructure such as boardwalks and visitor quotas during peak seasons could be implemented to protect sensitive habitats.

- **Invasive Plant Management**: Focus on the removal of invasive rhododendrons through community-led programs. A community-led program for rhododendron removal can be structured with training, volunteer engagement using GIS tools or apps to map, Sustainable Disposal, and Restoration using native species, among other things.

- **Climate Change Adaptation**: Ensure that restoration efforts incorporate climate resilience by enhancing habitat connectivity to support species migration. Utilise GIS mapping to identify areas most vulnerable to climate change impacts, such as rising temperatures, changing rainfall patterns, or sea level rise. This will help prioritise the restoration of critical habitats, especially those supporting endangered or climate-sensitive species. Mapping should also focus on identifying potential corridors that will enable species to migrate as their current habitats become unsuitable. Long-term monitoring allows conservationists to assess whether species are successfully migrating and whether additional interventions are needed.

- **Flexible Engagement Models**: Based on feedback from community members, adapt the frequency and format of outreach methods. For example, during peak tourist seasons, focus more on educating visitors, while off-season efforts might prioritise residents and local farmers. Identify and empower more **community leaders** or "champions" or “change agents” who can advocate for

[25] Bamber, J., Shuttleworth, C., Hayward, M., & Everest, D. (2020). Reinstating trophic cascades as an applied conservation tool to protect forest ecosystems from invasive grey squirrels (*Sciurus carolinensis*). Food Webs, 25. https://doi.org/10.1016/j.fooweb.2020.e00164.

environmental stewardship within Arne Parish. These individuals can drive engagement forward and act as a bridge between conservation organisations and the local public.

- **Seasonal and Thematic Events**: Organise engagement efforts around specific times of the year, such as squirrel breeding seasons or heathland restoration activities. Tailor these initiatives to the community's evolving concerns and conservation priorities, ensuring that the engagement remains relevant and impactful.

- **Feedback Loops**: Regularly gather feedback through door-to-door surveys or at community events to adjust approaches based on community needs. If certain engagement efforts, like door-to-door visits, prove particularly effective, increase their frequency and involve more local volunteers.

- **GIS-based decision support software:** By providing real-time data on local ecosystems, species populations, and conservation efforts, the software tool will enable citizens, conservationists, and local authorities to make more informed decisions about managing natural resources and protecting biodiversity. In this case study, the tool could enhance community engagement by allowing locals to track wildlife sightings, monitor invasive species, and evaluate environmental impacts of human activities. Furthermore, if implemented across other case studies, this software could standardise conservation efforts, making it easier to compare ecological data across regions and develop tailored conservation strategies. Its adaptability and scalability make it a critical tool for citizen-driven conservation, empowering communities to take an active role in preserving their local environment while contributing to larger, regional conservation objectives.

3.6.5. Fixing the focal action

The focal actions for Arne Parish concentrate on strengthening invasive species management, enhancing habitat restoration initiatives, and expanding community engagement in monitoring efforts. These actions are essential for addressing the dual challenges of biodiversity loss and habitat degradation in this ecologically significant area.

Focal Issues

- **Invasive Species**: The introduction and spread of invasive species, such as grey squirrels and rhododendrons, threaten native biodiversity and disrupt local ecosystems. These species outcompete native flora and fauna, leading to a decline in ecosystem health.
- **Habitat Degradation**: Habitat degradation caused by human activities, including unsustainable land use and recreational pressures, has led to a loss of crucial habitats for various species, affecting overall biodiversity.
- **Limited Community Engagement**: Although there is strong community interest in conservation efforts, limited structured involvement in monitoring and decision-making reduces the effectiveness of management strategies and local stewardship.

Proposed Actions

Invasive Species Management

- **Action**: Implement a comprehensive invasive species management plan aimed at monitoring and controlling non-native species.
- **Strategy**: Develop a targeted eradication programme for invasive species, focusing on high-impact species such as grey squirrels and rhododendrons. This includes mapping their distribution and implementing removal strategies. Create a community monitoring network to involve local residents in identifying and reporting invasive species. This participatory approach enhances data collection and increases community ownership of conservation efforts.

Habitat Restoration Initiatives

- **Action**: Enhance habitat restoration efforts to improve the health of native ecosystems and support biodiversity.
- Strategy:
    - **Reintroduction of Native Flora**: Reintroduce once-common-now-rare plants that provide essential food sources for birds and butterflies, thus promoting cultural ecosystem services and enhancing biodiversity.
    - **Creation of New Ponds**: Develop new ponds to support invertebrates and amphibians, which serve as food sources for birds. This will contribute to regulatory ecosystem services by supporting food webs and enhancing habitat diversity.
    - **Restoration of Red Squirrel Populations**: Implement a plan to restore populations of red squirrels from adjacent offshore islands. This not only aids in biodiversity but also contributes to carbon sequestration efforts through the restoration of forest habitats.

Awareness and Engagement

- **Action**: Develop educational programmes and outreach initiatives to raise awareness about the importance of native biodiversity and the threats posed by invasive species.
- Strategy:

    - Host workshops and seminars for local residents and schools focused on the identification and impact of invasive species, as well as the importance of habitat preservation.
    - Create informative materials, such as brochures and online resources, that provide practical advice on how residents can contribute to invasive species management and habitat restoration efforts.

Monitoring and Adaptation

- **Continuous Monitoring**: Establish a robust monitoring programme to assess the effectiveness of invasive species management and habitat restoration initiatives. This will include regular surveys and data collection to track progress and inform adaptive management.
- **Adaptive Management**: Conduct annual evaluations of management strategies based on monitoring results and community feedback. This adaptive approach will allow for adjustments to

be made as new challenges arise or existing ones evolve, ensuring that efforts remain effective and relevant.

3.7 Case Study: Bergen, Norway

Bergen, located on Norway's western coast, is renowned for its rich marine biodiversity, vibrant fishing industry, and important natural habitats such as kelp forests and coral reefs. The area faces serious challenges from ghost fishing—lost or abandoned fishing gear that continues to trap marine life—affecting fish stocks and overall marine ecosystem health. Ghost fishing is particularly prevalent in the Vestland region, where strong currents and busy fishing routes increase gear loss.

With a population of approximately 650,000, Bergen and the wider area of the west-coast Norway is a key area for assessing the impacts of ghost fishing, marine biodiversity loss, and environmental pressures from both the local population and tourists who engage in leisure-fishing activities leisure. Bergen, as the urban center of Norway's West Coast, serves as a key access point to the fjords and coastal areas, widely used by fisher but also NGOs working on ghost fishing and marine litter issues. As Norway's second-largest city, Bergen hosts representatives from a wide range of relevant stakeholders, making it an ideal location for building strong collaborative networks to combat ghost fishing gear. Issues such as overfishing, marine pollution, and the lack of comprehensive biodiversity monitoring, all pose significant threats to the long-term health and sustainability of the region's rich marine habitats.

3.7.1 CS Situation and Baseline

Ecological Baseline

The coastal waters around Bergen are home to important species, including **basking sharks** (*Cetorhinus maximus)*, **Atlantic cod** (*Gadus morhua)*, and **humpback whales** (*Megaptera novaeangliae***)**. However, marine biodiversity is under threat due to ghost fishing, overfishing, and pollution from urban runoff. Coastal habitats, especially **kelp forests** and **seagrass meadows**, are particularly vulnerable to marine debris and ghost gear. Ghost fishing, caused by abandoned, lost, and discarded fishing gear (ALDFG), poses significant ecological and socioeconomic challenges.

Social Baseline

Bergen's fishing community, both commercial and recreational, relies heavily on marine resources. Ghost fishing not only harms biodiversity but also affects local livelihoods by reducing fish stocks. Awareness about the impacts of ghost fishing remains limited, despite efforts by responsible authorities like the Norwegian Directorate for Fisheries and local organizations -such as the Green Warriors of Norway and Skjærgårdsservice- to raise awareness and recover lost fishing gear.

In Norway, everyone has the right to engage in recreational saltwater fishing without a license. This, combined with the country's vast coastline and fjords, along with its deep-rooted history as a fishing nation, has led to an extensive recreational fishing culture, with every third Norwegian engaging at least yearly in salt-water leisure fishing (Kleiven, 2023). Recreational fishing is not only widely practiced by the local population, it also attracts a thriving tourism industry, drawing recreational fishers from across Europe.

However, this wide practice also leads to a large span of experiences and skills among recreational fishers regarding their fishing practices and gear management.[26]

Economic Baseline

The economy of Bergen is closely tied to fishing, with commercial and recreational fishing contributing significantly to local employment. However, ghost fishing, pollution, and gear loss lead to financial losses for fishers, with the economic impact extending to the tourism and seafood sectors.

Governance Baseline

Governance is shared between local and national bodies, including the Norwegian Directorate of Fisheries and the Coast Guard, which oversee fishing regulations and gear management. Lost gear by commercial fishing activities is removed to large parts by these bodies. However, enforcement of policies aimed at reducing ghost fishing has been limited particularly within recreational fishing activities due to underreporting and a lack of efficient tracking and retrieval mechanisms. Additional key stakeholders include Skjærgårdsservice, which plays a significant role in ghost gear retrieval operations, using advanced diving equipment and ROVs. Recreational diving clubs also engage in local gear-remval activities. Private enterprises, including fishing gear vendors, also contribute to the local economy and are involved in supporting sustainability practices (rated 5 in relevance).

3.7.2 Initial Indicators, Data Sources, and Drivers

Ecological Indicators

- **Ghost Fishing**: High levels of lost and abandoned fishing gear have been reported, particularly affecting species such as **crabs**, **cod**, and **sharks**. In some areas, up to 29% of lost traps were still actively catching marine life.The Norwegian Directorate of Fisheries conducts an annual ghost gear survey, but the spatial coverage is limited to highly fished areas, with much of Vestland's coast, including Bergen, remaining unsurveyed. This gap in coverage presents challenges in understanding the full extent of ghost fishing and its impact on marine biodiversity.
- **Marine Biodiversity**: Key species like **Atlantic cod** and **haddock** (*Melanogrammus aeglefinus*) are experiencing population declines due to overfishing and ghost fishing.
- **Pollution Levels**: Pollution from lost gear, plastic waste, and urban runoff is affecting coastal water quality and damaging habitats such as coral reefs and kelp forests.

Social Indicators

- **Community Engagement**: Limited community involvement in ghost gear recovery efforts has been identified. Parts of the recreational fisher community, divers and local NGOs like Green Warriors of Norway are actively involved but broader public engagement is lacking.
- **Fisher Awareness:** A portion of the recreational fishing community has limited awareness and engages in poor fishing practices, leading to lost gear. Additionally, a lack of knowledge on how to report lost gear, along with concerns about penalties and shame, contributes to underreporting.

[26] Kleiven, Alf Ring: fritidsfiske i Store norske leksikon på snl.no. Retrieved October 16, 2024, from https://snl.no/fritidsfiske

Economic Indicators

- **Economic Losses**: Ghost fishing gear results in significant economic losses for local fisheries, reducing fish stocks and increasing the costs of gear recovery.
- **Tourism Impact**: The degradation of marine environments negatively affects Bergen's eco-tourism industry, especially in popular fishing and diving areas.

Governance Indicators

- **Policy Enforcement**: Weak enforcement of regulations related to gear loss and marine debris has contributed to the growing problem of ghost fishing. The **Norwegian Directorate of Fisheries** conducts limited patrols and clean-ups, which cover only parts of the Vestland coast each year primarily focusing on recovering heavy, large-scale lost commercial fishing gear. Moreover, several global and regional organisations are mandated to monitor and control ALDFG and ghost fishing, but there is a need to harmonise data collection protocols and fill existing gaps to improve regional monitoring. Binding measures to prevent and remediate ALDFG are in place, but only a limited subset of available tools is utilised. Expanding the use of complementary management methods could enhance effectiveness[27]. The Norwegian Marine Resources Act (2009)[28] marked a paradigm shift by integrating conservation and sustainable use principles, requiring regular evaluation to ensure sustainability of fishing activities.

Data Sources

- **Global Ghost Gear Initiative (GGGI)[29]** Tracker for ghost fishing gear reporting and retrieval.
- **Norwegian Directorate of Fisheries**. It provides national data on fishing gear loss and retrieval efforts. It focuses on heavily fished areas, covering only a limited area annually. Self-reporting of lost and found fishing gear is available nationwide, particularly for leisure fishers, through an online platform[30].
- Norway developed two key tools — the Stock Table and Fisheries Table — to track the status of fish stocks and prioritise management actions. These tables help balance conservation with industry needs by identifying critical issues (e.g., bycatch, habitat impact) and facilitating stakeholder discussions. These pages provide an overview of how the Directorate manages fish stocks, including regulatory frameworks and tools used and include stock assessments and the management measures..
- **Norwegian Marine Data Centre** for marine habitat mapping and biodiversity data.

- **Questionnaire Responses**: Direct feedback on biodiversity, habitat quality, community engagement, and governance challenges.

- Portals like Web Of Science and Scopus.

- **Ghost Fishing Survey** and surveys from the Coast Guard patrols. Provides comprehensive data on lost and discarded fishing gear, including nets, pots, metal lines, fishing lines, ropes, trawling

[27] Gilman, E. (2015). Status of international monitoring and management of abandoned, lost and discarded fishing gear and ghost fishing. Marine Policy, 60, 225-239. https://doi.org/10.1016/J.MARPOL.2015.06.016.
[28] https://www.fiskeridir.no/English/Fisheries/Regulations/The-marine-resources-act
[29] https://www.ghostgear.org/
[30] https://www.fiskeridir.no/English

nets, anchors, and buoys. This survey has been critical in identifying the types of gear contributing to ghost fishing and its impacts on marine ecosystems.

Main Drivers

- **Fishing Gear Loss**: Operational challenges and gear conflicts are the primary causes of gear loss in Bergen's coastal waters. Ghost fishing is the most critical issue affecting marine ecosystems. The Norwegian Directorate of Fisheries leads annual surveys but lacks sufficient spatial and temporal coverage. Fishermen's reluctance to report lost gear is a major barrier to addressing ghost fishing. Awareness campaigns and policy incentives are needed to increase reporting.
- **Pollution from Urban Runoff**: Urban waste and litter contribute to marine pollution, exacerbating the problem of ghost fishing.
- **Lack of Protection Status**: The ecosystem in the area lacks any formal protection status, leaving it vulnerable to unchecked activities that threaten its sustainability. This absence of legal or environmental protections allows for continued exploitation without safeguards.
- **Lack of Stakeholder Advocacy**: Stakeholders, including local communities and environmental groups, are currently not lobbying the government for stronger protections or policy changes. This lack of advocacy results in minimal pressure on the government to address the issues, perpetuating the unsustainable fishing practices that continue to harm the ecosystem.
- **Public Engagement and Awareness:** While local NGOs like Green Warriors of Norway are active, broader community engagement is lacking. Public education and citizen science initiatives should be expanded.

3.7.3 Diagnosis of Knowledge Gaps and Challenges

Knowledge Gaps

- **Underreporting of Lost Gear**: A major knowledge gap exists due to underreporting of lost fishing gear, driven by fishers' fear of penalties. This cultural barrier reduces the effectiveness of reporting systems, and current estimates suggest that only 10% of ghost gear is reported. Fishermen are often hesitant to report lost gear due to fear of penalties or stigma, leading to insufficient data on the true scale of ghost fishing (ranked 5 in the questionnaire).
- **Impact of Ghost Fishing on Marine Biodiversity**: There is limited data on the long-term ecological effects of ghost fishing on non-target species like **humpback whales** and **sharks**.This gap limits understanding of the long-term ecological effects of ghost gear on marine ecosystems.
- **Socio-Economic Impacts**: Data on the financial losses caused by ghost fishing for small-scale and commercial fishers is incomplete.
- **Biodiversity monitoring in the Bergen** area is currently insufficient, particularly in relation to the impacts of ghost fishing and other marine activities on local ecosystems. While some data is collected through public reporting tools, there is a lack of comprehensive, continuous monitoring of key species and habitats, especially regarding long-term impacts on species such as basking sharks, Atlantic cod, and humpback whales. The limited spatial and temporal coverage of current monitoring efforts creates significant gaps in understanding how biodiversity is being affected, leaving critical marine ecosystems vulnerable to unobserved degradation.

- There is currently no explicit mention of ghost fishing in policy documents outside of National Parks, and the area of this case study h is not located within a national park. This creates a significant gap in policy coverage, as ghost fishing remains a critical issue affecting marine biodiversity and fisheries in other areas, such as the Bergen region. While practices to address ghost fishing do exist—such as annual surveys by the Directorate of Fisheries and Coast Guard patrols—they are limited in scope and fail to effectively promote reporting of lost fishing gear. Even in national parks, where monitoring is more intensive, the rate of retrieval does not keep pace with the rate of lost equipment.

Challenges

1. **Ghost Fishing**: Lost and abandoned fishing gear continues to harm marine species and reduce fish stocks.
2. **Inadequate Reporting and Retrieval**: Lack of efficient reporting systems and limited government-led clean-up operations exacerbate the issue.
3. **Limited funding sources** for cost-intensive removal operations conducted by NGO's.
4. **Marine Pollution**: Urban runoff and discarded plastic waste further degrade marine habitats and contribute to the accumulation of ghost gear.
5. **Lack of Public Engagement**: Community involvement in marine conservation efforts remains limited, reducing the effectiveness of existing policies.

6. **Governance Challenges:** There is currently no national policy specifically targeting ghost fishing outside of national parks, limiting the effectiveness of ghost gear recovery efforts. Although reporting tools exist for both commercial and recreational fishers, these are underutilised due to fear of penalties, further contributing to the issue. Additionally, climate-induced shifts in spatial distribution of fish stocks in the Northeast Atlantic require a multi-disciplinary approach for effective management[31].

7. **Cost-Effectiveness of Management Measures**: Gear retrieval programs, while beneficial, may not be the most cost-effective management response. Other measures might provide better value for money in mitigating ghost fishing impacts[32].

3.7.4 Proposed Engagement Methodologies

Stakeholder Mapping

- **Governmental Agencies and Local Authorities:** Norwegian Directorate of Fisheries, Ministry of Climate and Environment, Bergen Municipality, and the Coast Guard oversee fishing regulations and environmental protection.

- **Research Institutions:** University of Bergen (UiB), Institute of Marine Research (IMR), Nansen Environmental and Remote Sensing Center (NERSC)

[31] Gullestad, P., Sundby, S., & Kjesbu, O. (2020). Management of transboundary and straddling fish stocks in the Northeast Atlantic in view of climate-induced shifts in spatial distribution. Fish and Fisheries. https://doi.org/10.1111/faf.12485.
[32] Brown, J., & Macfadyen, G. (2007). Ghost fishing in European waters: Impacts and management responses. Marine Policy, 31, 488-504. https://doi.org/10.1016/J.MARPOL.2006.10.007.

- **Industry Stakeholders:** Fishing Industry (local fishermen associations), aquaculture Companies, Tourism Operators
- **Environmental NGOs:** Green Warriors of Norway (NMF), WWF Norway, Local Environmental Activists and Citizen Science Groups
- **International and Regional Bodies:** Nordic Council of Ministers, ICES (International Council for the Exploration of the Sea)
- **Fishing Communities**: Both commercial and recreational fishers play a crucial role in gear reporting and retrieval efforts.

Engagement Approaches

1. **Stakeholder Integration at Every Stage:** Engaging fishers, regulators, industry stakeholders and environmental NGO's as well as divers and ROV operators from the outset in the design, use, and disposal of fishing gear ensures that all parties are aligned. This builds a cooperative framework to prevent gear loss and manage gear lifecycle.
2. **Community Workshops and Public Education:** Organise workshops for fishers on sustainable fishing practices and responsible gear management. Public education campaigns can be launched to raise awareness about the impact of ghost fishing on marine biodiversity and the local economy. Promoting the Directorate of Fisheries reporting app for lost gear can help increase reporting rates .
3. **Joint NGO and Government Initiatives:** Collaborate with NGOs like Green Warriors of Norway to organise ghost gear clean-up campaigns and raise public awareness. These efforts can be funded through local environmental grants and support from the Handelens miljøfond (Environmental Fund of Commerce).
4. **Public Awareness Campaigns on Marine Conservation:** Leverage social media platforms, local events, and partnerships with tourism operators to educate the public about marine conservation and the dangers of ghost fishing. Promote citizen science initiatives, such as the use of ghost gear tracking apps, to involve the local community in identifying and retrieving lost fishing gear.
5. **Encouraging App Adoption for Recreational Fishers**: A key part of the engagement strategy will involve increasing awareness and usage of the **Directorate of Fisheries' app** for **recreational fishers**. By promoting the app through local fishing clubs, community events, and social media, the goal is to increase the reporting of lost gear. Providing simple, step-by-step guides on how to download and use the app will be central to this effort, encouraging widespread adoption.

Adaptive Strategies

- **Ghost Gear Recovery Programs**: Implement large-scale gear recovery programs, leveraging local divers and fishing communities to retrieve lost gear from known hotspots.

- **Lifecycle Management of Fishing Gear:** Using the SPADE method[33], the entire lifecycle of fishing gear is analysed, from design and use to end-of-life management. This approach ensures that gear is designed to minimize the risk of loss, is traceable during use, and has a clear end-of-life pathway (recycling or safe disposal).
- **Policy Incentives for Reporting Gear Loss**: Introduce policy incentives to encourage fishers to report lost gear without fear of penalties, potentially through gear buy-back schemes.

3.7.5 Fixing the Focal Action

The focal actions for Bergen are addressing ghost fishing, enhancing marine biodiversity conservation, and improving waste management practices. These actions are crucial for maintaining the ecological integrity of the marine environment while engaging local communities and stakeholders in sustainable practices.

Focal Issues

- **Ghost Fishing**: The presence of abandoned, lost, or discarded fishing gear poses a significant threat to marine life, leading to the unintentional capture of fish, marine mammals, and other wildlife. This issue not only impacts biodiversity but also undermines the health of the marine ecosystem.
- **Marine Pollution**: Pollution from coastal activities, including plastic waste and runoff, further degrades marine habitats and contributes to the decline of local species.
- **Limited Stakeholder Engagement**: Although there is a commitment to marine conservation, engaging local fishers, communities, and stakeholders in monitoring and management efforts has been inconsistent, which reduces the overall effectiveness of conservation strategies.

Proposed Actions

Ghost Fishing Management

- **Action**: Implement a comprehensive ghost fishing management plan that includes regular monitoring and removal of abandoned fishing gear.
- Strategy:
    - **Regular Monitoring**: Establish a schedule for the systematic monitoring of fishing areas to identify and retrieve abandoned gear.
    - **Community Engagement**: Engage local fishermen and communities in reporting and retrieval efforts through incentive programs that recognize their contributions to reducing ghost fishing impacts. This could include training sessions on identifying ghost gear and organizing retrieval events.

[33] Deshpande, P., & Haskins, C. (2021). Application of Systems Engineering and Sustainable Development Goals towards Sustainable Management of Fishing Gear Resources in Norway. Sustainability, 13, 4914. https://doi.org/10.3390/SU13094914.

- **Awareness Campaigns**: Launch awareness initiatives to educate the community and visitors about the impacts of ghost fishing on marine ecosystems, emphasizing the role of responsible fishing practices.
- **Fishing Gear Buyback Programs**: Encourage fishers to return old or damaged gear through incentivized buyback schemes. This would reduce the amount of gear lost at sea and support the transition to more sustainable gear types

Regulatory Collaboration

- **Action**: Collaborate with government bodies, industry stakeholders, and environmental NGOs to develop and enforce regulations on fishing gear management.
- Strategy:

    - **Regulatory Development**: Work with local and national authorities to establish clear regulations regarding the disposal and management of fishing gear. Promote the use of biodegradable fishing gear to minimise environmental impact. PBEAS fishing nets show an 82% mineralization rate in composting conditions, making them eco-friendly and sustainable alternatives to non-degradable nylon fibres[34].
    - **Waste Management Improvement**: Enhance waste management practices in coastal areas by setting up collection points for discarded gear and promoting recycling initiatives. Raise awareness among local fishers about the economic and environmental impacts of lost gear, providing training on how to minimize gear loss and encouraging sustainable practices.

Monitoring and Adaptation

- **Continuous Monitoring**: Establish a robust monitoring program to evaluate the effectiveness of ghost fishing management strategies, marine conservation efforts, and waste management practices. Regular assessments will provide essential data for adaptive management. Stricter controls on gear usage, alongside regular inspections and enforcement of gear handling protocols, could significantly reduce the incidence of ghost fishing.
- **Adaptive Management**: Conduct annual reviews of management strategies based on monitoring results and stakeholder feedback. This iterative process will enable adjustments to be made in response to changing conditions and emerging challenges, ensuring that management efforts remain effective and relevant.

[34] Kim, J., Park, S., Bang, J., Jin, H., & Kwak, H. (2023). Biodegradation in Composting Conditions of PBEAS Monofilaments for the Sustainable End-Use of Fishing Nets. Global Challenges, 7. https://doi.org/10.1002/gch2.202300020.

3.8 Case Study: Kloogaranna-Laulasmaa, Estonia

3.8.1 CS Situation and Baseline

Kloogaranna-Laulasmaa is a coastal area in northern Estonia, known for its **sandy beaches**, **dunes**, and **afforested coastal habitats**. The region, part of the **Meremõisa National Landscape Protected Area**, hosts key coastal ecosystems that are important for biodiversity, including species such as the **Narrow-mouthed Whorl Snail** (*Vertigo angustior*). Coastal erosion, **tourism pressure**, and residential expansion are the main threats to this sensitive environment.

The local population is relatively small, around **1,500 inhabitants**, with many commuting to nearby cities like **Tallinn or Keila** for employment. The area experiences heavy tourism, particularly during the summer months, although exact numbers have not been closely monitored. The region sees a high influx of visitors from **Tallinn**, leading to increased strain on natural resources and infrastructure. The primary employment in the area is outside the region, with the local economy reliant on some **public sector jobs** (schools) and **private sectors** such as hospitality and tourism. In terms of engagement, the beach and surrounding areas are also known for their **cultural history**, with remnants of historical estates and Soviet-era holiday facilities adding to the appeal for both locals and tourists. Given the **proximity to Tallinn**, this makes it a prime location for short vacations and day trips

Ecological Baseline

Key habitats in the area include **permanent vegetated sand dunes** and **afforested dunes**, which are under threat from both natural processes like erosion and human activities such as **unregulated tourism**. Climate change is exacerbating these pressures, leading to further degradation of these habitats.

Social Baseline

The local population is small, but the area is heavily visited by tourists, particularly during the summer. **Hundreds of summerhouses** are owned by seasonal residents, and the area sees a significant influx of visitors from **Tallinn**, Estonia's capital, which is just a short drive away. Local communities have limited involvement in conservation, and there is a need for increased public awareness regarding the impacts of tourism. The most preferred shore type in Estonia is sandy, with a willingness-to-pay of 42 million euros annually for natural shores[35].

Economic Baseline

Tourism and seasonal residential development are the main economic drivers in the region. However, the expansion of tourism infrastructure, including resorts like **LaSpa**, has placed significant stress on the coastal environment. Sustainable tourism practices are needed to balance economic development with habitat conservation.

[35] Reimann, M., Ehrlich, Ü., & Tõnisson, H. (2018). Recreational Preferences of Estonian Coastal Landscapes and Willingness-to-Pay in Comparison – A Good Tool for Creating National Beach Management Strategy. , 895-912. https://doi.org/10.1007/978-3-319-58304-4_46.

Governance Baseline

The **Lääne-Harju Municipality**, in collaboration with the **Estonian Environmental Board (EEB)**, oversees land use and conservation efforts in the area. The **Municipal Comprehensive Plan**, currently being updated for the newly merged **Lääne-Harju Municipality**, plays a key role in defining the framework for spatial planning and sustainable development (relevance 5). This plan will integrate both development and conservation goals, helping to protect sensitive coastal habitats from further degradation. This municipality collaborates with other key stakeholders including the **State Forest Management Centre** (relevance 3) that plays a role in managing state-owned forests and creating recreational facilities, which are expected to expand within the case study area. Additionally, private enterprises, such as **LaSpa resort**, also have a significant impact on the local economy and the environment (relevance 3-4). However, enforcement of environmental regulations is weak, and there is a need for improved collaboration between local authorities, businesses, and conservation groups.

3.8.2 Initial Indicators, Data Sources, and Drivers

Ecological Indicators

- **Species Diversity**: The area is home to protected species like the **Narrow-mouthed Whorl Snail** and several types of coastal flora. However, the biodiversity of these species is under threat due to habitat degradation (ranked 5 in the questionnaire).
- **Coastal Habitat Integrity**: Erosion, tourism, and climate change are degrading key habitats such as **sandy dunes** and afforested coastal areas, leading to habitat fragmentation. The **expansion of residential areas** is a significant contributor to habitat degradation in the Kloogaranna-Laulasmaa region (rated 4). Development in sensitive coastal areas, such as **vegetated dunes**, is leading to habitat loss and fragmentation. Strengthening land-use planning to protect these habitats is critical to conservation efforts. Climate change impacts Saaremaa Island's coastal environment, causing erosion and sediment deficits, and highlighting the need for integrated coastal zone management.

Social Indicators

- **Tourism Pressure**: The coastal area is heavily visited by tourists, particularly from **Tallinn**, which puts strain on infrastructure and natural resources (ranked 4 in the questionnaire), particularly during summer. Tourism from Tallinn places a significant strain on local infrastructure. The absence of adequate facilities, such as parking and waste management systems, exacerbates the environmental degradation caused by large numbers of visitors. Sustainable tourism infrastructure is urgently needed to manage this influx and protect sensitive coastal habitats.
- **Community Engagement**: Local communities are only moderately involved in conservation efforts. Increasing awareness and engagement through local NGO partnerships and educational initiatives could improve conservation outcomes.

- **Historical and Economic Context:** The historical context of Estonia's coastal management includes the transition from Soviet-era collective fisheries to a free-market coastal economy. This shift involves reducing fishing efforts, managing coastal fishery stocks, and promoting smaller production units and diverse economic activities

Economic Indicators

- **Tourism Dependency**: Seasonal tourism, including visitors from Tallinn and other parts of Estonia, is a key economic activity but is contributing to habitat degradation. Local businesses, including resorts and guesthouses, need to adopt eco-friendly practices to minimise their impact.

Governance Indicators

- **Policy Enforcement**: Environmental regulations are insufficiently enforced, particularly around the expansion of tourism infrastructure and land use changes. The weak enforcement of environmental regulations is exacerbated by poor coordination between local authorities, such as the Lääne-Harju Municipality, and the Estonian Environmental Board (relevance 4). Improved communication and collaboration between these bodies are necessary to ensure the effective management of protected areas and adherence to conservation regulations.

- **Planning Consistency**: Consistent planning and a supportive policy environment are crucial components of successful ICM. The alignment of national and EU legislations, such as the Maritime Spatial Planning (MSP) Directive and the EU Strategy on the Blue Economy, plays a significant role in this process

Data Sources

- **Local**: Reports from the **Lääne-Harju Municipality** and **Estonian Environmental Board**.
- **National**: **Estonian Nature Conservation Agency**.
- **EU**: **Natura 2000 Database** for protected areas.

- **Questionnaire Responses**: Direct feedback on biodiversity, habitat quality, community engagement, and governance challenges.

- Portals like Web Of Science, Scopus and Google Scholar.

Main Drivers

- **Tourism Pressure**: The growing number of tourists, particularly during summer months, is putting strain on the region's coastal habitats.
- **Climate Change**: Rising sea levels and coastal erosion are further degrading key habitats like the sand dunes and afforested areas.

3.8.3 Diagnosis of Knowledge Gaps and Challenges

Knowledge Gaps

- **Visitor Impact Data**: There is insufficient data on the number of visitors and the long-term environmental impacts of tourism activities on the region's sensitive coastal ecosystems (ranked 4 in the questionnaire). The lack of accurate data regarding the number of visitors and the evolution of tourism over time makes it difficult to assess the full impact of tourism on the local environment

and infrastructure, hindering the ability to plan sustainable tourism strategies or manage environmental pressures effectively.

- **Environmental data**: Quantitative data to assess the status of protected habitats and species to justify the strict regulations for recreational activities are missing. A gap also exists in the **lack of long-term data** on the environmental impacts of visitor activities. Without comprehensive monitoring of tourist impacts on key habitats, such as vegetated dunes and forests, it is difficult to assess the scale of habitat degradation and implement effective management strategies.

- **Impact of Climate Change**: Data on the effects of climate change, particularly on coastal erosion and habitat loss, is limited.

Challenges

1. **Tourism Pressure**: Unregulated tourism is leading to habitat degradation, particularly along the sandy beaches and dunes.
2. **Coastal Erosion**: Rising sea levels and erosion are threatening the integrity of coastal habitats.
3. **Weak Enforcement**: Environmental regulations are not effectively enforced, leading to unchecked tourism development and residential expansion.
4. **Community Involvement**: Moderate engagement from the local population and businesses limits the effectiveness of conservation efforts. Stakeholder involvement, research base, planning consistency, policy environment, and plan development are crucial for successful integrated coastal management in Estonia[36].

3.8.4 Proposed Engagement Methodologies

Stakeholder Mapping

Key stakeholders include:

- **Lääne-Harju Municipality**: Local governance responsible for land use and development (ranked 5 in the questionnaire).
- **Tourism Operators**: Local businesses such as LaSpa Resort and smaller guesthouses play a role in adopting sustainable practices.
- **Environmental NGOs**: Local NGOs are critical for organising conservation efforts and citizen science projects.
- **Local Communities**: Both permanent and seasonal residents need to be involved in conservation and sustainability initiatives.

- **Local social media** platforms, **community-level groups**, and **local newspapers**

Engagement Approaches

1. **Sustainable Tourism Guidelines:** Collaborate with tourism operators and local businesses to develop sustainable tourism guidelines. These guidelines should focus on reducing the

[36] Baltranaitė, E., Povilanskas, R., Dučinskas, K., Ernsteins, R., & Tõnisson, H. (2020). Systems Approach to Eastern Baltic Coastal Zone Management. Water. https://doi.org/10.3390/w12113102.

environmental footprint of tourists, limiting visitor numbers, and promoting eco-friendly infrastructure.

2. **Public Education Campaigns:** Launch education campaigns to raise awareness about the importance of coastal conservation among both tourists and local communities. Workshops could focus on climate change, habitat protection, and sustainable tourism practices.
3. **Citizen Science Initiatives:** Engage local residents in biodiversity monitoring programs through initiatives like eBiodiversity[37] and PlutoF[38], which use citizen science to track changes in habitat health and species populations. This will help bridge the data gaps identified and foster a sense of shared responsibility. Implement participatory GIS tools to involve local communities, businesses, and government agencies in decision-making, ensuring broad consensus on land-sea interactions and coastal planning.

4. **Promote Community-Based Entrepreneurship**: Encourage local businesses, especially in coastal areas, to engage in sustainable development projects, enhancing both environmental and socio-economic resilience

5. **Local Social Media and Facebook Community Groups**: There are local Facebook groups where residents discuss community events, environmental concerns, and local governance issues. It is recommended to share regular updates on conservation efforts, tourism impact studies, and community-led clean-up initiatives in these groups. Use polls and surveys to gather feedback from residents on environmental issues, and encourage active participation by showcasing local success stories or volunteers. Local newspapers also provide an ideal platform for reaching both local residents and policymakers. Actions may include: submitting articles or press releases regarding the findings of the case study, focusing on how tourism impacts the local environment; highlighting biodiversity protection efforts and citizen engagement activities, and offering experts for interviews on issues like ghost fishing and coastal conservation. Partner with local bloggers or influencers in the city to create a series of educational posts or interviews with stakeholders involved in conservation. Interactive Campaigns, Collaborative Content Creation and Call to action series are encouraged.

Adaptive Strategies

- **Coastal Erosion Management**: Implement natural and engineered solutions such as dune restoration and coastal barriers to protect vulnerable areas from erosion.
- **Increased Stakeholder Collaboration**: Improve coordination between local government, businesses, and NGOs to enforce environmental regulations and ensure long-term sustainability.

3.8.5 Fixing the Focal Action

The focal actions for Kloogaranna-Laulasmaa will concentrate on enhancing coastal management through effective stakeholder engagement, promoting sustainable tourism practices, and developing high-quality public spaces. These actions are essential for addressing the pressures of coastal erosion and ensuring the ecological integrity of this important coastal area.

[37] https://elurikkus.ee/en
[38] https://plutof.ut.ee/

Focal Issues

- **Coastal Erosion**: Increased erosion due to human activities and climate change threatens the stability of coastal habitats and reduces their ecological function.
- **Tourism Pressures**: Unsustainable tourism practices lead to habitat degradation, waste generation, and increased human activity in sensitive coastal areas.
- **Limited Stakeholder Engagement**: There is a need to integrate the interests and positions of local and central governmental authorities, as well as various stakeholder groups, to ensure cohesive coastal management and conservation efforts.

Proposed Actions

Integrated Stakeholder Engagement

- Action: Foster effective stakeholder engagement by understanding and leveraging the interests of different groups.
- Strategy:

- **Stakeholder Mapping**: Conduct a deep stakeholder analysis to identify key groups, their interests, and how they can contribute to coastal management and conservation. This includes local communities, government agencies, businesses, and NGOs.
- **Public Engagement Tactics**: Implement multiple public engagement strategies, such as community forums, workshops, and online platforms, to raise awareness and gather input on coastal management strategies.
- **Quality Public Spaces**: Invest in creating high-quality public spaces that enhance accessibility and promote recreational ecosystem services. This could involve developing parks, trails, and viewpoints that encourage responsible enjoyment of the coastal environment.

Evidence-Based Governance

- **Action**: Support evidence-based governance to enhance decision-making processes.
- Strategy:

- **Data Collection and Analysis**: Establish a robust data collection framework to monitor coastal health and track tourism impacts. Engage local universities and research institutions to provide scientific backing for management decisions.
- **Integration of Authorities**: Facilitate regular meetings between local and central authorities to align their positions and interests regarding coastal management. This will help streamline efforts and ensure that policies are cohesive and effective.

Sustainable Tourism Practices

- Action: Develop sustainable tourism practices that minimise environmental impacts while promoting local economic benefits.
- Strategy:

- **Guidelines for Sustainable Tourism**: Create guidelines for tourism operators that emphasise responsible practices, such as waste reduction, habitat protection, and community engagement.
- **Promote Eco-Tourism**: Encourage ecotourism initiatives that showcase the natural beauty of Kloogaranna-Laulasmaa while educating visitors about conservation efforts.

Monitoring and Adaptation

- Continuous Monitoring: Establish a structured monitoring program to assess the effectiveness of stakeholder engagement, tourism practices, and habitat conditions. Regular assessments will provide essential feedback for adaptive management.
- Adaptive Management: Conduct annual reviews of strategies based on monitoring results and stakeholder feedback. This adaptive approach will ensure that management efforts remain responsive to changing conditions and emerging challenges in coastal systems.

By implementing these targeted strategies, Estonian conservationists can effectively address the pressing issues of coastal erosion and unsustainable tourism while fostering strong stakeholder engagement and promoting sustainable practices. This comprehensive approach will enhance the resilience of coastal ecosystems and ensure the long-term health and sustainability of Kloogaranna-Laulasmaa.

3.9. CS9: Corbu, Romania

3.9.1 CS Situation and Baseline (Corbu, Romania)

Corbu, located on the Romanian Black Sea coast and adjacent to the Danube Delta Biosphere Reserve[39], is a region of ecological and cultural significance. It features sandy beaches, coastal dunes, and wetlands, making it a critical habitat for both marine and terrestrial species. However, the area faces significant environmental pressures, including coastal erosion, pollution, and unregulated tourism and real estate development, which threaten its ecological integrity and socio-economic stability.

Ecological Baseline

The ecological value of Corbu is reflected in its inclusion within the NATURA 2000 network, and it benefits from the protection of the Danube Delta Biosphere Reserve. The coastal dunes are home to rare plant species, and the wetlands support diverse bird populations, including migratory species that depend on these habitats. However, biodiversity is under threat from human activities, including unregulated construction and agricultural runoff, which contribute to habitat degradation.

The EU Marine Strategy Framework Directive (MSFD)[40] and the Water Framework Directive (WFD) are essential for addressing these environmental challenges. The MSFD supports efforts to achieve Good Environmental Status (GES) of marine waters, focusing on mitigating pollution and overfishing. The WFD addresses agricultural runoff affecting water quality and ecosystems, relevant to Corbu where agriculture contributes to coastal eutrophication. These directives provide the regulatory framework for the focal action related to pollution control and sustainable agricultural practices.

Coastal erosion in Romania's Black Sea region is accelerated by climate change[41], port construction, and the alteration of natural sediment transport by hydraulic works along the Danube. A major project co-financed by the European Investment Bank (EIB) and the European Union is providing €97 million to restore Romanian beaches, protect 17,000 hectares of wetlands, and rehabilitate coastal structures. This project aligns with EU directives such as the Marine Strategy Directive and the Water Framework Directive, which emphasize coastal resilience and environmental protection.

Urban and rural planning in Corbu Beach is shaped by the Local Development Strategy for Corbu (2023–2030) (rated 5) and the Management Plan of the Danube Delta Biosphere Reserve (rated 5), both of which aim to balance ecological preservation with controlled development. These strategies influence land use, tourism, and conservation efforts, ensuring that sensitive coastal ecosystems are protected from unregulated development. The 2021–2027 Regional Development Plan for Southeast Romania (rated 3) and the Strategy for Intelligent Specialization of Southeast Romania (rated 2) provide additional frameworks for managing infrastructure and economic growth in the region, though their direct influence on the local environment is more limited.

[39] https://danubeparks.org/members/danube-delta-biosphere-reserve/returning-to-the-last-danube-trail
[40] https://danube-region.eu/about/targets/
[41] https://www.eib.org/en/stories/coastal-erosion-romania

Climate change is expected to exacerbate coastal erosion and increase the frequency of severe storms, further threatening Corbu Beach's fragile ecosystem (rated 3 for relevance). Sea-level rise and increased storm surges will require the implementation of adaptive infrastructure and nature-based solutions, such as dune restoration and coastal defences, to protect both human infrastructure and biodiversity.

Social Baseline

The local community in Corbu relies heavily on natural resources, particularly for tourism and fisheries. While there is increasing awareness of the potential for ecotourism, which could align economic growth with conservation goals, tourism development remains largely unregulated, leading to environmental strain. Community engagement is mixed, with limited but growing participation in conservation efforts, often supported by NGOs like Mare Nostrum.

The Integrated Coastal Zone Management (ICZM) Protocol and Barcelona Convention offer a guiding framework for managing coastal development in a sustainable way. These frameworks encourage integrated coastal zone management, promoting the sustainable development of coastal areas while protecting ecosystems from urbanisation and tourism-related pressures. The goal is to balance land-use planning and conservation, ensuring that real estate development is compatible with environmental protection.

Stakeholders' perceptions of tourism's environmental impact in the Romanian Black Sea coastal area suggest it should benefit from management and planning efforts[42].

Economic Baseline

Tourism is the primary economic driver in Corbu, with a growing reliance on this sector for local income (rated 5 in importance). However, tourism must be managed sustainably to prevent overdevelopment and habitat destruction. Private tourism enterprises have a significant influence on the sector's growth and its alignment with local development strategies. The Romanian National Strategy for Ecotourism supports efforts to integrate ecotourism into local plans, ensuring that development benefits both the environment and the economy.

Corbu's economy is heavily reliant on natural resources, particularly tourism and fisheries. The increasing popularity of Corbu as a tourist destination has led to economic benefits but also poses risks due to unregulated tourism development. The tourism sector, if properly managed, presents an opportunity for sustainable ecotourism initiatives that protect local biodiversity while providing economic growth.

The Romanian National Strategy for Ecotourism promotes low-impact tourism in natural areas, aligning with the focal action on developing ecotourism in Corbu. This strategy encourages the creation of eco-friendly tourism infrastructure, which can help mitigate the negative effects of mass tourism and unregulated development. Additionally, the EU Strategy on Green Infrastructure (GI) promotes nature-based solutions that can integrate green infrastructure into tourism developments, such as eco-friendly accommodations and coastal protection measures.

[42] Stan, M., Aivaz, K., Vintila, D., & Lonițiu, L. (2021). Assessing the perception of stakeholders regarding the impact of coastal tourism on the environment in the Romanian Black Sea coastal area. Journal of Eastern European and Central Asian Research (JEECAR). https://doi.org/10.15549/jeecar.v8i4.695.

The Romanian National Fisheries Strategy[43] also plays a crucial role in ensuring the sustainability of local fisheries, addressing issues of overfishing and declining fish stocks. Sustainable fishing practices must be implemented as part of the focal action to protect marine biodiversity and support local livelihoods.

Governance Baseline

Governance structures in Corbu are shaped by both local authorities and national and EU-level frameworks, such as the Danube Delta Biosphere Reserve Management Plan and the Romanian Spatial Planning and Urban Development Law. However, there are gaps in enforcement, particularly regarding illegal construction and pollution control, which hinder effective environmental management.

Key stakeholders in Corbu Beach governance include the Corbu Municipality, which manages local land-use planning and environmental initiatives, and the Constanța County Council, responsible for regional development and coastal management (rated 5 in relevance). At the national level, the National Agency for Environmental Protection (ANPM) oversees compliance with environmental regulations, while the Danube Delta Biosphere Reserve Authority (ARBDD) ensures the protection of sensitive habitats near the Danube Delta (both rated 5). Local NGOs, such as the Romanian Ornithological Society/BirdLife Romania and NGO Mare Nostrum (both rated 4), play critical roles in promoting biodiversity conservation and raising awareness about sustainable practices. Additionally, private enterprises contribute significantly to local development (both rated 5).

The Sustainable Development Strategy of Romania (2018-2030)[44] sets out clear guidelines for balancing economic growth with environmental sustainability, particularly in coastal and ecologically sensitive areas like Corbu. This strategy supports the focal actions on sustainable development by promoting green infrastructure, responsible land use, and integrated coastal zone management.

The Romanian Spatial Planning and Urban Development Law (Law no. 350/2001) provides a legal framework for regulating urban and real estate development in sensitive regions, helping to prevent unregulated building in coastal areas like Corbu[45]. This law ensures that development aligns with environmental protections and that sustainable urban planning practices are enforced.

3.9.2 Initial Indicators, Data Sources, and Drivers

In the case of Corbu, Romania, the identification of **initial socio-ecological indicators** and the use of **available data sources** allow us to highlight the critical factors affecting the region's sustainability. Given the limitations on accessing new data, this section relies on existing literature, reports, and local assessments to understand the drivers of change in the area.

- **Initial Indicators**

[43] https://daciat.ro/multiannual-national-strategic-plan-for-aquaculture-2021-2030-romania/
[44] https://dezvoltaredurabila.gov.ro/files/public/10000001/Romania-Sustainable-Development-Strategy-2030-en.pdf
[45] https://www.rhn.ro/en/real-estate-projects-developed-on-corbu-beach-are-blocked/

The initial indicators used for assessing the socio-ecological conditions in Corbu focus on four key dimensions: ecological, social, economic, and governance.

Ecological Indicators:

- **Species Diversity**: The presence of rare and endemic plant species in coastal dunes and migratory bird species in wetlands, such as the red-backed shrike (*Lanius collurio)*, are critical for maintaining ecological balance[46]. This information was provided by the questionnaire, which highlighted biodiversity as a top concern (ranked 5) due to pressures from habitat degradation. Additional literature supports the biodiversity value of coastal dunes in the Black Sea region .
- **Habitat Quality**: The degradation of coastal dunes, wetlands, and marine ecosystems due to **coastal erosion**, **pollution**, and **urban development**. The quality of these habitats is declining due to a lack of enforcement of environmental protections. This was indicated in the **questionnaire**, with pollution and habitat loss ranked as high concerns (ranked 4 and 5). Coastal erosion, pollution, and biodiversity loss are critical issues (coastal erosion and biodiversity both rated 5). The Danube Delta Biosphere Reserve Authority works to mitigate the impacts of coastal erosion, while the ANPM addresses pollution control, particularly from agricultural runoff and unregulated construction. Additionally, biodiversity, especially within the NATURA 2000 network, is under threat from habitat loss and invasive species. Coastal dunes and wetlands provide key ecosystem services, but their degradation risks long-term ecological sustainability.
- **Ecosystem Services under threat from unregulated tourism and pollution.**: Coastal protection (e.g., storm buffering from dunes), water filtration (wetlands), and biodiversity conservation are key services under threat due to habitat degradation.

Social Indicators:

- **Community Engagement**: Engagement in conservation efforts is low but growing. Local NGOs, such as Mare Nostrum, Black Sea NGO Network or Romanian Ornithological Society (SOR), and initiatives supported by the Romanian Ministry of Foreign Affairs and the European Commission such as **Black Sea Synergy** and the **Black Sea NGO Forum** play a critical role in increasing community awareness and participation in biodiversity conservation and sustainable tourism. The questionnaire indicates a low level of initial community engagement (ranked 3), with room for improvement. Studies on local community participation in conservation across the Black Sea coast suggest similar patterns of limited involvement.
- **Cultural Heritage**: Traditional fishing practices are a significant part of the local culture but are under threat due to overfishing and environmental degradation. Efforts to promote **ecotourism** are helping preserve cultural heritage. Efforts to protect cultural heritage need to be strengthened
- **Social Equity**: There are disparities between the tourism sector, which benefits economically, and traditional fisheries, which are struggling due to declining fish stocks. The questionnaire highlights concerns about the distribution of benefits from tourism (ranked 3), with locals seeing fewer benefits than external investors.

Economic Indicators:

- **Economic Resilience**: The local economy is dependent on **tourism** and **fisheries**, both of which are facing sustainability challenges: the tourism sector is growing rapidly, but the lack of sustainable practices is a risk to both the economy and the environment (ranked 5). Tourism, if not managed

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https://www.researchgate.net/publication/285586831_BIODIVERSITY_POTENTIAL_IN_CAMPING_DESTINATIONS_CORBU_AND_VADU_FROM_DANUBE_DELTA_BIOSPHERE_RERSERVE

sustainably, could lead to overdevelopment, while fisheries are under pressure from declining stocks.

- **Tourism Dependency**: Unregulated tourism development is putting significant pressure on natural resources. The questionnaire emphasises the growing reliance on tourism as the primary economic driver in Corbu (ranked 4). Existing studies confirm that tourism growth, if unchecked, leads to environmental degradation. The Romanian Black Sea Coast's tourism development faces limits, constraints, and bottlenecks, requiring sustainable management decisions based on tourism carrying capacity[47].

Governance Indicators:

- **Policy Coherence: T**here are gaps in the enforcement of national and EU-level policies in Corbu. The questionnaire highlights difficulties in implementing policies related to pollution control and habitat protection (ranked 4). Literature further supports the challenges of policy enforcement in the Romanian coastal region.
- **Stakeholder Collaboration:** Collaboration between local government, NGOs, and private stakeholders remains limited, as indicated in the questionnaire (ranked 3). Existing studies suggest that stronger multi-stakeholder engagement is crucial for effective coastal management.

Data Sources

The assessment of Corbu's socio-ecological conditions draws from a variety of **existing data sources**:

- **National Legislation**: The Romanian National Strategy for Ecotourism, National Fisheries Strategy, and Sustainable Development Strategy are key documents for understanding the legal and policy context of sustainable tourism and fisheries management.
- **Questionnaire Responses:** Direct feedback on biodiversity, habitat quality, community engagement, and governance challenges.
- **Environmental Reports**: These include biodiversity assessments, coastal erosion studies, and water quality monitoring reports from national and local environmental agencies.
- **Scientific Literature**: Studies on coastal erosion, biodiversity loss, and socio-economic impacts of tourism in Romania. For instance, studies on the Romanian Black Sea coastal ecosystems highlight the critical role of dunes and wetlands for biodiversity. Portals like **Web Of Science** and **Scopus** can provide further information**.** Studies[48] suggest that tourism on Comino Island (Malta) negatively impacts biodiversity by reducing species richness, abundance, and habitat availability, and by promoting the spread of non-native invasive species. The suggestion is that Corbu biodiversity will be similarly affected.
- **NGO Reports**: Reports from local NGOs such as **Mare Nostrum** offer insights into community engagement, pollution issues, and local conservation efforts.

Main Drivers

Based on the indicators and data sources, the following are the main **socio-ecological drivers** impacting Corbu:

Environmental Drivers:

[47] Stanciu, A., Dinu, R., & Popovici, N. (2016). Tourism-Environment Impact Relationship on the Romanian Black Sea Coast. Ovidius University Annals: Economic Sciences Series, 143-147.

[48]

- **Coastal Erosion**: The rapid erosion of Corbu's beaches and dunes is exacerbated by climate change and human activities. The loss of coastal habitat poses a significant risk to biodiversity and ecosystem services, such as storm protection. The questionnaire ranked this issue as critical, supported by literature on the impacts of erosion along the Black Sea.
- **Pollution**: Agricultural runoff and untreated waste from urban and tourism developments are contributing to water pollution and eutrophication in the coastal and marine ecosystems. This threatens both biodiversity and the local fisheries. The questionnaire highlights pollution as a high-priority issue (ranked 4).
- **Biodiversity Loss**: Habitat destruction from real estate development, overfishing, and pollution is reducing the biodiversity of coastal and marine ecosystems, threatening species that are protected under **NATURA 2000** and other conservation frameworks. The questionnaire ranks this as a top concern (ranked 5).

Socio-Economic Drivers:

- **Unregulated Tourism Growth**: While tourism brings economic benefits, the lack of regulation and sustainable practices is leading to habitat destruction, increased waste, and pressure on local infrastructure (ranked 4). The dependence on tourism is growing, making the local economy vulnerable to environmental degradation.
- **Overfishing**: Unsustainable fishing practices are depleting fish stocks in the Black Sea, affecting both biodiversity and the livelihoods of local fishing communities. This highlights the need for improved fisheries management as part of the **focal action**.

Governance Drivers:

- **Weak Enforcement of Environmental Laws**: Despite national and EU-level regulations, local authorities struggle to enforce laws related to construction, pollution control, and habitat protection. This governance gap undermines the effectiveness of conservation efforts. The questionnaire identifies enforcement gaps as a major challenge (ranked 4). Literature supports the need for stronger enforcement mechanisms in Romania's coastal regions.
- **Lack of Stakeholder Collaboration**: The absence of coordinated efforts between local communities, government, NGOs, and private developers weakens the capacity to implement sustainable development practices. Better collaboration is needed to address the challenges of real estate expansion and tourism development in Corbu. The questionnaire indicates that stakeholder collaboration is insufficient (ranked 3). Studies on coastal management highlight the importance of coordinated efforts across sectors .

3.9.3 Diagnosis of Knowledge Gaps and Challenges

The analysis of **Corbu's socio-ecological drivers** has revealed several significant **knowledge gaps** that hinder effective management and sustainability efforts. These gaps, combined with the complex challenges faced by the region, make it difficult to implement the necessary strategies for biodiversity conservation, sustainable tourism, and fisheries management.

One significant knowledge gap is the **lack of enforcement** of environmental regulations, despite the existence of robust national policies (ranked 4). This includes the weak implementation of pollution controls and construction limits, as noted by local stakeholders. Additionally, **community engagement** in

conservation efforts, while growing, remains insufficient (rated 3), with limited involvement from local citizens in decision-making processes. To address these gaps, more targeted studies on enforcement mechanisms and public participation are required to ensure that governance structures can support sustainable development.

Knowledge Gaps

Biodiversity Data Gaps:

- The lack of comprehensive, long-term biodiversity monitoring is a critical issue in Corbu. While some data exists on specific species, such as the MidWinter Count for bird populations, overall biodiversity assessments are incomplete, particularly for plant and marine species. The questionnaire indicated the need for broader ecological monitoring, as current efforts are insufficient to capture changes in species diversity and habitat quality (ranked 4). Literature also highlights the regional issue of biodiversity data gaps in Black Sea coastal ecosystems .
- A major knowledge gap exists in monitoring the health of marine ecosystems, particularly in relation to the impacts of pollution and overfishing (both rated 4). While some data on biodiversity is available, there is insufficient long-term monitoring of marine species and habitat quality in the Black Sea. This limits the ability to design effective conservation interventions or track the recovery of threatened species.
    - **Marine Ecosystem Health**: There is limited information on the health of marine ecosystems, particularly related to the impacts of pollution and overfishing on marine biodiversity. Studies on marine biodiversity in the Black Sea indicate the need for more comprehensive assessments of fish populations and marine habitat degradation, which are currently lacking in Corbu .

Socio-Economic Projections:

- There is a lack of reliable **economic projections** regarding the long-term impacts of tourism and fisheries on the local economy. While tourism is growing rapidly, there is little data on its sustainability or the economic effects of potential environmental degradation. The **questionnaire** noted that the economic benefits of tourism are poorly distributed and that there is uncertainty about the future economic resilience of the region (ranked 3). Literature supports the need for better socio-economic projections in regions heavily reliant on tourism and natural resources .
- **Fisheries Management**: Data on the socio-economic impacts of overfishing on local fishing communities is incomplete. Although overfishing is recognised as a major issue, the extent to which it affects community livelihoods and local economies is unclear. The questionnaire ranked this as a significant knowledge gap.

Governance Weaknesses:

- Weak governance, particularly in the enforcement of environmental regulations, is a well-documented challenge in Corbu. However, there is a lack of understanding of the underlying causes of these governance failures, including the capacity and resource constraints faced by local authorities. The **questionnaire** highlighted enforcement as a key issue, but there is insufficient data on how governance structures could be strengthened (ranked 4). Literature also points to the need for more detailed analysis of governance mechanisms in coastal regions .
- **Stakeholder Collaboration**: The absence of data on effective stakeholder collaboration mechanisms is another gap that hampers progress. While the **questionnaire** indicated low levels of collaboration between local communities, government bodies, and the private sector (ranked 3),

the reasons for this fragmentation, and how to overcome it, remain unclear.
Literature on coastal management highlights similar gaps in stakeholder engagement in Romania's coastal zones .

Challenges

- **Resource Management Issues**: **Coastal Erosion and Habitat Degradation**: One of the most significant challenges is the ongoing **coastal erosion** and the resulting degradation of critical habitats, including dunes and wetlands. The **questionnaire** ranked this as a high-priority issue (ranked 5), and existing literature emphasises the difficulty of implementing long-term erosion control measures in regions like Corbu, where development pressures are high and resources for mitigation are limited.

- **Pollution Control**: Agricultural runoff and unregulated tourism-related pollution are contributing to the degradation of both marine and terrestrial ecosystems. The lack of adequate data on pollution levels and their effects on biodiversity and human health makes it challenging to address these issues effectively. The **questionnaire** emphasised pollution as a critical challenge (ranked 4), but more targeted studies are needed to design effective mitigation strategies .
- **Stakeholder Conflicts**:
    - **Tourism vs. Conservation**: The tension between **economic development through tourism** and **environmental conservation** is a persistent challenge. While tourism provides economic benefits, it also puts pressure on natural resources and leads to habitat destruction. The **questionnaire** highlighted this conflict as a major issue (ranked 4). The challenge lies in reconciling these two goals and promoting **sustainable tourism** practices that align with conservation efforts. Literature further supports the notion that balancing tourism growth with environmental sustainability is a difficult task in coastal regions like Corbu .
    - **Overfishing and Livelihoods**: Overfishing not only threatens marine biodiversity but also undermines the livelihoods of local fishing communities. The questionnaire indicated that conflicts over resource use between different stakeholder groups, particularly between tourism developers and fishing communities, exacerbate the problem. Literature points to the need for better fisheries management that includes the input of local stakeholders to prevent further resource depletion .
- **Governance and Policy Enforcement**: Weak Enforcement of Environmental Laws: Even when environmental policies exist, such as those under the Danube Delta Biosphere Reserve Management Plan and Natura 2000, enforcement is often inconsistent. This is due to limited resources, corruption, or lack of political will, as noted in the **questionnaire** (ranked 4). The challenge lies in building governance capacity and ensuring that local authorities have the tools and support they need to enforce environmental regulations. Literature corroborates these governance issues across Romania's coastal regions, citing similar enforcement challenges in other protected areas .
- **Lack of Long-Term Planning for Sustainable Development**: The absence of long-term, integrated planning for sustainable tourism and fisheries management remains a key challenge. The questionnaire highlighted concerns about the short-term focus of economic development strategies, with little regard for environmental sustainability (ranked 3). Literature supports the argument that many coastal regions in Romania suffer from short-sighted development practices that prioritise immediate economic gains over long-term ecological sustainability.

3.9.4 Proposed Engagement Methodologies

To effectively address the socio-ecological challenges identified in Corbu, Romania, it is essential to engage key stakeholders through participatory and adaptive methodologies. This approach fosters collaboration and ensures that management actions are not only contextually appropriate but also supported by the communities and institutions involved. The methodologies outlined below focus on **stakeholder mapping**, **engagement approaches**, and **adaptive strategies**.

Stakeholder Mapping

The following key stakeholders were identified through the **questionnaire** as critical to the success of the engagement and management actions in Corbu:

- **Local Communities**: Residents of Corbu, particularly those involved in **fishing** and **tourism**, are primary stakeholders. They are directly affected by coastal erosion, biodiversity loss, and the socio-economic shifts caused by tourism. Local communities are also key players in implementing sustainable tourism and conservation practices.
- **Non-Governmental Organisations (NGOs)**: Local NGOs such as **Mare Nostrum** play an essential role in promoting biodiversity conservation and environmental awareness. They are involved in citizen science initiatives, monitoring pollution, and advocating for sustainable tourism practices. These organisations are instrumental in bridging the gap between policymakers and local communities.
- **Government Bodies**: The **Danube Delta Biosphere Reserve Authority** and local municipal authorities are responsible for implementing and enforcing environmental regulations. They play a crucial role in governance, land-use planning, and resource management. However, as identified in the **questionnaire**, governance issues and enforcement challenges require these bodies to be more actively engaged.
- **Private Sector Actors**: Businesses in the tourism sector, real estate developers, and agricultural producers are key economic stakeholders. Their activities have significant environmental impacts, and they must be involved in discussions about sustainable practices. Engaging with the tourism industry is especially important given its rapid growth and its role as the primary economic driver in Corbu.
- **Seasonal Tourists**: Visitors who come during the summer months for recreation and leisure significantly impact Corbu's environment. Their activities, particularly in fragile dune ecosystems, contribute to habitat degradation and pollution.
- **Non-Resident Property Owners**: Individuals who own vacation homes or properties in Corbu but do not reside there year-round. Their investment in real estate often leads to **increased development pressure** on coastal zones, while their limited involvement in local issues makes it challenging to include them in conservation or sustainable tourism efforts.

- Local social media platforms, community-level groups, and local newspapers

Engagement Approaches

To effectively address the socio-ecological challenges in Corbu, a variety of **engagement methodologies** should be employed. These approaches are designed to involve stakeholders in the decision-making process, encourage collaboration, and foster a sense of ownership over the management actions.

- **Workshops**: Participatory workshops will be organised to bring together diverse stakeholders, including local communities, government bodies, and NGOs, to discuss the key issues facing Corbu. These workshops will focus on co-designing solutions to challenges such as **coastal erosion**, **pollution control**, and **sustainable tourism development**. The **questionnaire** suggested that workshops can serve as a platform for **stakeholder education** and to build consensus around sustainable practices.
- **Seasonal Workshops and Events**: Organise workshops and events specifically aimed at seasonal tourists. These can be eco-tourism tours, sustainability talks, or conservation volunteer programs that educate tourists on local biodiversity and involve them in hands-on activities such as planting vegetation in dunes or helping with beach clean-ups.
- **Short-Term Participatory Mapping**: Engaging tourists and non-residents in short-term participatory mapping exercises allows them to contribute to the identification of sensitive areas and the collection of local environmental data during their stay.
- **Tourist Education Campaigns**: Seasonal tourists need to be educated about the **environmental sensitivity** of Corbu's ecosystems. Information can be provided through **educational materials** at tourist hotspots, hotels, and beach areas, as well as through **signage** on protected dunes and wetlands. Social media campaigns targeting tourists before and during their visits can also raise awareness of responsible behaviour, such as proper waste disposal and respecting wildlife habitats.
- **Eco-Friendly Tourist Initiatives**: Introduce **incentive programs** for tourists who participate in eco-friendly activities such as beach clean-ups, responsible wildlife watching, or cycling tours instead of car travel. Partnering with local tourism businesses can help incorporate **sustainable tourism practices**, like offering discounts to tourists who engage in these activities.
- **Participatory Mapping**: Engaging local communities in **participatory mapping** exercises allows stakeholders to identify critical habitats, areas under threat, and key zones for conservation or sustainable development. This method empowers local residents by involving them in land-use planning and conservation efforts. Participatory mapping has been successfully used in other coastal regions to align conservation goals with community needs .
- **Public Consultations**: Regular consultations with local communities, businesses, and NGOs will ensure ongoing dialogue about **land-use decisions**, **real estate development**, and **tourism management**. Public consultations provide a forum for addressing conflicts and gathering input from all stakeholders, making the decision-making process more transparent and inclusive.
- **Citizen Science Initiatives**: Universities and NGOs have experience in running **citizen science programmes** focused on environmental monitoring. Expanding these initiatives to involve local residents in tracking pollution, biodiversity changes, and coastal erosion can help fill the data gaps identified in earlier sections. Such initiatives also foster community engagement and raise environmental awareness.
- **Stakeholder Platforms**: Creating **online platforms** or **forums** for continuous stakeholder dialogue allows for the sharing of knowledge, monitoring progress, and adjusting strategies in real-time. These platforms facilitate regular communication between all involved parties, enabling quick responses to emerging socio-ecological issues.
- **Information and Outreach at Real Estate Offices**: For non-resident property owners, engagement can start at the point of property purchase or during seasonal stays. **Real estate offices** can be partnered with to provide **sustainability guides** to new property owners, informing them about building restrictions, water conservation practices, and how to contribute to local conservation efforts.

- **Seasonal Online Platforms**: Create **seasonal digital engagement platforms** where tourists and non-residents can share their experiences and learn about ongoing conservation efforts in Corbu. These platforms can provide updates on local environmental challenges, engage tourists in virtual discussions, and offer ways for them to support conservation efforts financially or through advocacy even after their stay.

Adaptive Strategies

Given the dynamic and evolving nature of socio-ecological systems in Corbu, the engagement methodologies must be flexible and responsive to changing conditions. The following **adaptive strategies** ensure that stakeholder engagement and management actions remain effective over time:

- **Iterative Engagement**: Stakeholder engagement should not be a one-time event. Regularly scheduled workshops, consultations, and participatory activities must be integrated into the management plan to adapt to new data, evolving environmental conditions, and shifting stakeholder priorities. This approach allows for the incorporation of **ongoing feedback** from stakeholders, ensuring that management actions are continuously refined and improved.
- **Scenario Planning**: By involving stakeholders in **scenario planning** exercises, future socio-ecological changes—such as **climate change impacts**, **tourism growth**, or **economic shifts**—can be anticipated and addressed in advance. Scenario planning ensures that stakeholders understand the potential risks and benefits of various actions, and it prepares the community to adapt to different futures.
- **Flexible Management Plans**: Management plans for Corbu must be **adaptive**, allowing for changes in governance structures, economic development strategies, and conservation efforts. As new information becomes available—whether from **citizen science data**, **environmental reports**, or **local observations**—management actions should be updated to reflect current conditions and stakeholder input.
- **Capacity Building**: Training local stakeholders, including government bodies and community groups, in sustainable management practices is essential for long-term success. This includes building the capacity of local authorities to enforce environmental regulations and equipping community members with the knowledge and tools to participate actively in conservation and sustainable tourism efforts. Capacity-building programmes can be delivered through partnerships with NGOs and academic institutions.
- **Tourism Impact Monitoring**: Seasonal tourism brings fluctuating environmental pressures. Adaptive management strategies must include **real-time monitoring** of tourism's impact on ecosystems (e.g., dune degradation, waste levels) during peak seasons. This can be achieved through **partnerships with NGOs** and **citizen science initiatives** where tourists contribute data on their visits.
- **Flexible Conservation Initiatives**: Implement **seasonal conservation campaigns** that adjust to the influx of tourists. For example, during peak tourist season, local authorities and NGOs can ramp up **public awareness campaigns** and organise **volunteer events** aimed at preserving sensitive areas.
- **Incentives for Sustainable Tourism**: Collaborate with local businesses to offer incentives for tourists who engage in sustainable behaviours (e.g., staying in eco-friendly accommodations, participating in beach clean-ups). This encourages seasonal visitors to become part of the long-term solution for conservation, even if their stay is temporary.

- **Seasonal Collaboration with Real Estate Investors**: For part-time residents and property investors, seasonal meetings can be organised to **align property development** with **local conservation efforts**. These meetings can introduce **sustainable building practices**, such as the use of eco-friendly materials or water-saving systems in new properties.

3.9.5 Fixing the Focal Action

The focal actions for Corbu Bay centre around addressing the pressing issues of coastal erosion and habitat loss, alongside mitigating pollution, overfishing, and unregulated tourism. These actions are crucial for improving the ecological resilience of the region while ensuring the socio-economic stability of local communities that rely on the natural environment.

Focal Issues

- **Coastal Erosion and Habitat Loss**: Coastal erosion, ranked as the most critical concern, threatens local biodiversity and the integrity of ecosystems that provide essential services, such as storm buffering. The degradation of dunes and wetlands compromises the region's natural beauty, which is vital for tourism.
- **Pollution**: Increased pollution from agricultural runoff and urban waste further exacerbates habitat degradation, impacting water quality and marine life.
- **Overfishing**: Unsustainable fishing practices are diminishing fish populations, negatively affecting both biodiversity and the livelihoods of local fishers.
- **Governance Gaps**: Weak governance and regulatory frameworks hinder effective management and conservation efforts, allowing unchecked development and pollution.
- **Unregulated Tourism and Real Estate Pressure**: Rapid tourism growth and real estate development contribute to habitat destruction, increasing pollution and putting additional strain on the environment.

Proposed Actions

Coastal Restoration Project

- Action: Launch a coastal restoration project focusing on the rehabilitation of dunes and wetlands.
- Strategy:
- Implement native vegetation planting to stabilize dunes and enhance habitat quality.
- Create no-development zones in vulnerable areas to prevent further habitat degradation.
- Collaborate with local NGOs and government agencies to facilitate restoration efforts, aiming to commence within the next year.
- Establish a continuous monitoring program to track the recovery of key habitats and species.

- Outcome: Improved coastal resilience, enhanced biodiversity, and better protection against erosion.

Pollution Mitigation

- **Action:** Introduce new waste management systems and buffer zones around agricultural lands to prevent runoff into waterways.
- **Strategy:**

- Engage local farmers and municipal authorities in developing and implementing these systems.
- Promote educational campaigns on best practices for reducing agricultural runoff.
- Regular water quality monitoring will be essential to assess the effectiveness of these interventions and inform necessary adjustments.

- **Outcome**: Reduced pollution levels in water bodies and improved water quality.

Sustainable Fishing Practices

- **Action**: Establish fishing quotas and no-take zones to promote the recovery of fish populations.
- **Strategy:**

- Collaborate with the Romanian National Fisheries Authority and local fishing cooperatives to develop a sustainable fisheries management plan.
- Monitor fish populations to track recovery and ensure local communities benefit from alternative livelihood programs.

- **Outcome**: Enhanced marine biodiversity and sustained economic opportunities for local fishers.

Strengthening Governance

- **Action**: Enhance governance capacity through improved enforcement of environmental regulations.
- **Strategy**:

- Create a multi-stakeholder platform involving government bodies, NGOs, and private sector actors to facilitate collaboration and joint decision-making.
- Implement regular reviews to track the effectiveness of enforcement actions and stakeholder engagement, with the aim of improving governance capacity within the next year.

- **Outcome**: More effective conservation strategies and compliance with environmental regulations.

Sustainable Tourism Strategy

- **Action**: Develop and implement a sustainable tourism strategy to manage visitor numbers and promote eco-friendly practices.
- **Strategy**:

- Engage with the Danube Delta Reserve Administration to promote sustainable development and educate local authorities and developers about true ecotourism practices.
- Enforce stricter building regulations and develop eco-friendly tourism infrastructure.
- Conduct regular assessments to evaluate the impact of tourism on the environment and local communities.

- **Outcome**: Controlled tourism growth that aligns with conservation efforts, preserving Corbu's natural beauty while supporting the local economy.

Community Engagement and Education

- **Action**: Involve and educate local communities through awareness campaigns and training programs.
- **Strategy**:

- Develop a comprehensive ecotourism strategy that leverages funding for conservation projects and raises awareness about biodiversity and conservation efforts.
- Organize workshops and community meetings to engage residents in decision-making processes and foster a sense of ownership over local resources.

- **Outcome**: Enhanced community stewardship, improved understanding of conservation issues, and greater participation in local management efforts.

Monitoring and Adaptation

- **Continuous Monitoring**: Establish a structured monitoring program to evaluate the effectiveness of coastal restoration, pollution mitigation, sustainable fishing practices, and tourism management strategies. Regular assessments will provide essential feedback for adaptive management.
- **Adaptive Management**: Conduct annual reviews of strategies based on monitoring results and stakeholder input, ensuring that management efforts remain flexible and responsive to emerging challenges and changing conditions.

3.10 Case Study: Eidsvika-Kildn, Norway

3.10.1 CS Situation and Baseline

Eidsvika-Kildn, located on the island of Askøy near Bergen, Norway, represents a coastal area currently at the centre of significant socio-ecological and political debates. The site is characterised by its bog landscape interspersed with rocky elements and shrubs, and serves as a vital recreational area for the densely populated southern Askøy region. It includes coastal habitats, rocky formations used by nesting birds, and a small bay with sandy substrate.

Despite its ecological value and current designation as a recreational and agricultural zone (LNF område), there are proposals to develop a cruise ship terminal within this area, posing substantial environmental and socio-political challenges. The land-use plan for Askøy, which is under revision (expected enforcement in spring 2025), will determine whether the site retains its current protection or is reclassified for harbour development.

Ecological Baseline:

The site does not currently hold formal protection status under either EU or Norwegian environmental legislation. However, existing land-use regulations impose constraints on development activities. Key ecological features include bogs, coastal shrublands, and rocky outcrops that serve as nesting grounds for avian species. Biodiversity data remains limited; preliminary investigations indicate the potential presence of red-listed species, although comprehensive ecological assessments are still pending.

Social Baseline:

Askøy is home to approximately 30,300 residents, with demographic growth attributed to its proximity to the urban centre of Bergen. The area in question is extensively utilised for recreational purposes, including hiking, climbing, and swimming, predominantly by the local population. Notably, there is marked opposition to the proposed cruise terminal, particularly from the non-governmental organisation *Eidsvikas Venner*, which comprises over 1,000 members.

Economic Baseline:

Economic activity within Askøy is relatively limited, with the majority of residents commuting to Bergen for employment. Proponents of the cruise terminal project present it as a prospective catalyst for local economic development; however, its economic feasibility and potential environmental repercussions remain subjects of significant debate.

Governance Baseline:

Governance of the site involves a range of institutional actors, including the Askøy Municipality, Vestland County, the Norwegian Coastal Administration (Kystverket), and the Norwegian Environment Agency. The interplay between municipal authorities, private developers (notably Tertnes Holding), and civil society organisations shapes the decision-making landscape. The ongoing land-use planning process will play a pivotal role in determining the future utilisation of the site.

3.10.2 Initial Indicators, Data Sources, and Drivers

Ecological Indicators:

- Presence and health of bog and coastal habitats.
- Occurrence of red-listed species.

Social Indicators:

- Level of recreational use (visitor counts, community surveys).
- Degree of community engagement (participation in hearings, protests).

Economic Indicators:

- Potential economic benefits from cruise tourism.
- Current commuting patterns and local employment statistics.

Governance Indicators:

- Effectiveness of stakeholder engagement in land-use planning.
- Policy alignment with climate and biodiversity targets.

Data Sources:

- Land-use plan hearings and public submissions.
- Environmental consultancy reports (e.g., sediment toxin studies).
- NGO and citizen science data (planned biodiversity monitoring).

Drivers:

- Environmental: Potential habitat destruction and pollution from cruise terminal development.
- Economic: Promises of local economic benefits from tourism.
- Social: Recreational use and community opposition to development.
- Governance: Policy decisions within the land-use planning process.

3.10.3 Diagnosis of Knowledge Gaps and Challenges

Knowledge Gaps:

- Insufficient ecological data on biodiversity, especially regarding red-listed species.
- Limited monitoring of recreational use patterns.
- Potential biases in existing environmental assessments funded by developers.

Challenges:

- Balancing economic interests with ecological and social concerns.
- Ensuring transparency and inclusivity in governance processes.
- Mitigating potential environmental impacts if development proceeds.

3.10.4 Proposed Engagement Methodologies

Stakeholder Mapping:

- Public institutions (Askøy Municipality, Vestland County, Kystverket).
- Private enterprises (Tertnes Holding).
- NGOs (Eidsvikas Venner, Naturvernforbundet Askøy).
- Local citizens and landowners (Follese Felleskap).

Engagement Approaches:

- Workshops and consultations involving all stakeholder groups.

- Citizen science initiatives for biodiversity monitoring and recreational use assessments.

- Use of social media (e.g., Facebook group managed by Eidsvikas Venner) and local newspapers for outreach.

- Development of creative storytelling initiatives (e.g., Instorier) in collaboration with local communities.

3.10.5 Fixing the Focal Action

Focal Issues:

- Threat of habitat degradation and pollution from proposed cruise terminal.

- Governance gaps in stakeholder engagement and decision-making processes.

Action Plan:

- Implement a citizen-led biodiversity monitoring programme to document species presence and habitat conditions.

- Develop a visitor monitoring system to quantify recreational use.

- Facilitate multi-stakeholder workshops to enhance dialogue between developers, government, and citizen groups.

- Advocate for the inclusion of ecological and social data in the land-use planning process to ensure informed decision-making.

4. COMPARING CASE STUDIES

The ten case studies in the PRO-COAST project represent diverse socio-ecological systems (SES) along European coastlines, each with unique challenges and opportunities. The objective of benchmarking these case studies is to compare their socio-ecological profiles to identify commonalities, differences, and best practices that can be applied across different contexts. This involves assessing key indicators such as biodiversity status, socio-economic dynamics, governance frameworks, and environmental pressures. The comparison aims to inform targeted engagement strategies, enhance management practices, and promote sustainable development and conservation efforts across diverse coastal environments.

In this benchmarking analysis, we follow the structured scheme used in the case study (CS) analyses. This scheme includes five key sections: (1) CS Situation and Baseline, (2) Initial Indicators, Data Sources, and Drivers, (3) Diagnosis of Knowledge Gaps and Challenges, (4) Proposed Engagement Methodologies, and (5) Fixing the Focal Action. Each section provides a comprehensive overview for understanding the socio-ecological context of each case study and identifying effective strategies for management and sustainability.

Table 4: Comparing Case Studies

Case Study	Challenges	Data Sources and Drivers	Knowledge Gaps	Challenges (Detailed)	Engagement Method	Action
Malta (Comino Island)	High influx of tourists leading to habitat degradation, pollution, and the introduction of invasive species.	Limited long-term ecological and socio-economic data. Main drivers include tourism and invasive species.	Insufficient long-term ecological and socio-economic data on tourism impact and invasive species. Limited information on biodiversity and habitat changes due to high tourist activity.	Unregulated tourism, waste management issues, and the introduction of invasive species. Weak local engagement in citizen science limits efforts to mitigate environmental damage.	Citizen science initiatives and visitor education programs aimed at tourists and local residents. Focus on reducing the environmental impact of tourism through waste management campaigns.	Implement stricter tourism regulations, establish waste management systems, and introduce invasive species control programs.

Italy (Acquatina di Frigole)	Reduction of marine litter impact in the lagoon, dunes and beach; Reduction of environmental degradation of dunes; Improving the knowledge of biodiversity to support its conservation. Monitoring and reducing the impact of NIS.	Data for baseline knowledge available in literature. Drivers of change are recognized at different spatial-temporal scales. New surveys will improve biodiversity knowledge and its relationships with pressures.	Quantitative and qualitative assessment of marine litter in the NATURA 2000 habitats. Fragmented data on socio-economic structure around the NATURA 2000 Site. Mapping of stakeholders. Monitoring of NIS,	Reduction of marine litter impact in the lagoon, dunes and beach: The marine litter impact can affect both biodiversity and social-economic activities. The reduction of marine litter impact will be realized in cooperation with stakeholders initiatives. The collaboration with stakeholders will be focused on education, training and cooperation with local administration for implementing restoration actions. Improving the knowledge of biodiversity to support its conservation	Workshops, training, study visits stakeholders. Increased collaboration between local communities and research institutions for monitoring biodiversity and NIS.	Develop the use of eco-friendly materials to reduce the impact of marine litter (e.g., plastics). Develop innovative monitoring tools for biodiversity and NIS. Reduction of the impact of NIS.

Slovenia (Strunjan)	Salt pans and seagrass meadows face threats from pollution and tourism. Sustainable agricultural practices help balance conservation efforts.	Good availability of data from EU and national sources, focusing on sustainable agriculture and tourism.	Limited data on biodiversity impacts from tourism and agriculture. Gaps in understanding the long-term resilience of ecosystems such as salt pans and seagrass meadows.	Managing invasive species and balancing agricultural practices with conservation. Governance and policy enforcement need to be more coherent and collaborative.	Educational programs promoting sustainable tourism and habitat restoration. Collaboration with local farmers to reduce agricultural impacts on biodiversity.	Develop invasive species control programs and promote eco-friendly agricultural practices. Establish seasonal caps on tourism to protect habitats.
Montenegro (Boka Kotorska Bay)	Tourism and overfishing are degrading the ecosystem, with marine pollution increasing due to inadequate regulation.	UNESCO data supports understanding of marine pollution, but localized data gaps exist.	Inadequate localized data on marine pollution and the ecological effects of tourism. Limited long-term monitoring of ecosystem health.	Over-tourism, habitat degradation, and insufficient governance frameworks for sustainable tourism and marine conservation.	Public awareness campaigns and stakeholder forums promoting sustainable tourism and marine conservation. Efforts should target both local businesses and tourists.	Improve tourism infrastructure to mitigate environmental damage. Develop localized data collection frameworks for monitoring marine health.
Ireland (Sligo)	Peatland degradation and coastal erosion threaten ecosystems. Agricultural practices contribute to habitat loss.	Data gaps in understanding the impacts of peat extraction and agricultural practices.	Lack of data on the long-term impacts of peat extraction and agricultural runoff on coastal and freshwater ecosystems. Limited	Peatland degradation, coastal erosion, and the effects of unregulated tourism. Weak governance structures slow down effective	Workshops and public consultations with local farmers and tourism operators to raise awareness of sustainable land use and peatland restoration. Community-	Implement peatland restoration projects and enforce regulations to reduce agricultural runoff. Promote eco-friendly tourism practices.

			biodiversity monitoring.	policy enforcement.	led conservation initiatives.	
UK (Arne Parish)	Invasive species like grey squirrels and tourism are pressures, but strong conservation efforts have limited negative impacts of tourism.	Extensive monitoring programs supported by Natural England and local groups. Data focuses habitat restoration with less on invasive species.	Insufficient long-term data on the impact of invasive species such as grey squirrels and some plant species.	Habitat degradation due to invasive species and tourism. Community engagement is strong but could be improved in terms of awareness around invasive species.	Educational outreach and community-led programs, including species monitoring, habitat restoration, and invasive species management. Extensive engagement with local conservation organizations.	Strengthen invasive species management programs and expand community engagement in monitoring efforts. Enhance collaboration with local and national authorities.
Norway (Bergen)	Marine biodiversity is affected by ghost fishing and marine pollution, but strong governance and local efforts reduce the long-term damage.	High-quality data from national research institutions and marine studies, with focus on ghost fishing and marine biodiversity.	Minimal gaps due to robust monitoring systems. Some data gaps remain in terms of underreporting of ghost fishing gear and its long-term impacts on biodiversity.	Ghost fishing, marine pollution from urban runoff, and overfishing. Policy enforcement for ghost fishing needs strengthening.	Strong collaboration between fishing communities, NGOs, and local authorities. Ghost fishing awareness campaigns and community-led marine monitoring initiatives.	Expand ghost fishing gear retrieval programs and introduce stricter enforcement of marine pollution regulations.

Estonia (Kloogaranna-Laulasmaa)	Tourism impacts coastal ecosystems, with some local efforts to mitigate damage. Key habitats are under threat from erosion and climate change.	Adequate data on coastal habitats, though long-term erosion monitoring is needed.	Moderate gaps in understanding the long-term impacts of coastal erosion and tourism on ecosystems. Data on socio-economic impacts, especially regarding sustainable tourism, are limited.	Managing tourism pressure on sensitive coastal habitats, particularly in terms of infrastructure and waste management.	Local workshops and community engagement in coastal monitoring. Focus on sustainable tourism practices and raising awareness about environmental pressures on sensitive habitats.	Strengthen coastal erosion management strategies and introduce sustainable tourism guidelines. Engage local communities in biodiversity monitoring.
Romania (Corbu Bay)	Coastal erosion, unregulated fishing, and pollution from agricultural activities are major challenges.	Sparse data on overfishing and pollution. Coastal erosion is driven by human intervention and climate change.	Sparse data on pollution, habitat degradation, and the socio-economic dynamics of local communities, particularly regarding fisheries and tourism.	Unregulated fishing, habitat destruction due to agriculture, and coastal erosion. Gaps in data hinder efforts to develop comprehensive conservation strategies.	Local NGO-led community workshops that focus on conservation and sustainable fishing practices. Need for stronger community involvement in decision-making processes.	Establish fishing quotas and habitat restoration programs. Strengthen the governance framework to address pollution and erosion.
Norway (Eidsvika-Kildn)	The proposed cruise ship terminal threatens habitats, increases pollution risk, and affects local	Land-use plan hearings, environmental consultancy reports, NGO and citizen science data. Drivers include	Lack of comprehensive biodiversity data (red-listed species), limited recreational use data,	Governance conflicts, habitat degradation, socio-political tensions around land-use decisions.	Citizen science biodiversity monitoring, recreational use assessments, stakeholder dialogues.	Advocate for inclusion of ecological and social data in planning, implement biodiversity monitoring and visitor

	recreational spaces.	tourism development, governance decisions, and community opposition.	biased environmental assessments.			counting systems, foster multi-stakeholder workshops.

The following table provides a comparative overview of the socio-ecological profiles of ten case studies within the PRO-COAST project. Each case study is assessed across four key variables: Impact of Human Activities, Citizen Science Advancement, Quality of Data Sources, and Information Gaps. These indicators help to illustrate the degree of human impact on ecosystems, the role of citizen engagement in environmental monitoring, the availability and quality of relevant data, and any existing gaps in information that may hinder effective management. This comparison highlights the diversity of challenges and opportunities across different European coastal regions, providing a foundation for developing tailored solutions and best practices.

Case Study	Impact of Human Activities	Citizen Science Advancement	Quality of Data Sources	Information Gaps
Malta (Comino Island)	High	Low	Low	High
Italy (Acquatina di Frigole)	Moderate	Moderate	High	Moderate
Romania (Corbu Bay)	High	Low	Low	High
Montenegro (Boka Kotorska Bay)	High	Low	Moderate	Moderate
Estonia (Kloogaranna-Laulasmaa)	Moderate	High	Moderate	Moderate
Norway (Bergen)	Moderate	High	High	Low
UK (Arne Parish)	Low	High	High	Low
Ireland (Sligo)	Low	Moderate	Moderate	Moderate
Slovenia (Strunjan)	Low	Moderate	High	Low
Norway (Eidsvika-Kildn)	Moderate	Moderate	Moderate	High

Table 6: Comparative overview of the socio-ecological profiles

The following table presents an overview of the Proposed Citizen Science Initiatives and Appropriate Technologies for each case study in the PRO-COAST project. These initiatives aim to engage local communities and other stakeholders in environmental monitoring, ranging from biodiversity tracking to pollution and coastal erosion assessments. The recommended technologies, such as mobile apps, sensors, and drones, are tailored to the specific needs of each region, facilitating data collection and empowering citizens to contribute to sustainable environmental management.

Case Study	Proposed Citizen Science Initiatives	Appropriate Technologies
Malta (Comino Island)	Tourist-led biodiversity monitoring and waste management education.	Mobile apps for tracking biodiversity and waste impact.
Italy (Acquatina di Frigole)	Training about biodiversity for stakeholders and use of LEK.	Innovative DNA-based tools for biodiversity monitoring, cameras and UAV.
Romania (Corbu Bay)	Fishing activity monitoring and coastal erosion tracking.	Coastal erosion sensors and fishing activity data collection tools.
Montenegro (Boka Kotorska Bay)	Community-based marine biodiversity and pollution tracking.	Underwater drones and pollution tracking devices.
Estonia (Kloogaranna-Laulasmaa)	Coastal erosion monitoring and tourism impact assessment.	Coastal monitoring tools and citizen science mobile platforms.
Norway (Bergen)	Ghost fishing monitoring and marine biodiversity citizen surveys.	Ghost fishing gear recovery tools and marine species monitoring apps.
UK (Arne Parish)	Invasive species tracking and monitoring restored native species.	Species tracking apps and habitat restoration platforms.
Ireland (Sligo)	Peatland and water quality monitoring by local communities.	Water quality sensors and peatland monitoring devices.
Slovenia (Strunjan)	Agriculture impact assessment and biodiversity tracking programs.	Drones for agricultural monitoring and biodiversity tracking apps.
Norway (Eidsvika-Kildn)	Biodiversity monitoring and recreational use assessments through citizen science.	Mobile apps for biodiversity tracking, visitor counters, and online storytelling platforms (e.g., Instorier).

Table 7: Proposed CS initiatives

The following table provides a summary of key environmental indicators for each case study in the PRO-COAST project. The data includes assessments of Biodiversity Status, Water Quality, and Habitat Health across the different regions. These indicators help to understand the environmental challenges and

conservation priorities for each coastal area, including the impact of human activities, levels of pollution, and the condition of critical habitats. This comparison highlights the varying degrees of environmental stress faced by these ecosystems and provides a foundation for targeted management actions.

Case Study	Biodiversity Status	Water Quality	Habitat Health
Malta (Comino Island)	Endemic species under threat from tourism. Limited monitoring.	Pollution from tourism. Marine habitat degradation.	Degraded by trampling, invasive species, and lack of regulations.
Italy (Acquatina di Frigole)	High values of biodiversity, threats from NIS and marine litter (e.g., species richness, abundance)	High water quality and threats of degradation due to climate change and local impacts (e.g., abiotic parameters)	Good health of habitats. Threats are linked to global (e.g., climate change) and local (e.g., dune degradation) pressures (e.g., beta biodiversity, area).
Romania (Corbu Bay)	Coastal habitats degrading from erosion, pollution affecting biodiversity.	Pollution from agriculture and coastal erosion.	Coastal dunes degrade due to human intervention.
Montenegro (Boka Kotorska Bay)	Marine biodiversity is threatened by overfishing and pollution.	Untreated wastewater leading to eutrophication.	Seagrass meadows and marine habitats under threat from tourism.
Estonia (Kloogaranna -Laulasmaa)	Coastal habitats face erosion, key species monitored.	Tourism pressure affects water quality.	Coastal erosion impacting habitats.
Norway (Bergen)	Strong governance protecting marine biodiversity.	High quality water monitoring systems in place.	Seagrass meadows and marine habitats are well-protected.
UK (Arne Parish)	Robust efforts in habitat and invasive species management.	Some eutrophication despite strong water quality monitoring.	Well-maintained habitats through active monitoring.
Ireland (Sligo)	Peatland habitats threatened by agriculture.	Agricultural runoff degrading water quality.	Peatlands and coastal habitats are degrading.
Slovenia (Strunjan)	Salt pans and seagrass meadows face pollution but are supported by local monitoring.	Good monitoring but pollution from tourism.	Pollution and tourism threaten sensitive habitats.

Norway (Eidsvika-Kildn)	Limited data; potential presence of red-listed species. Coastal bogs and bird nesting sites under threat from development.	Risk of pollution from proposed cruise terminal; sediment toxin concerns.	Coastal bog and rocky habitats under threat; a key recreational area for locals.

Table 8: Summary of key environmental indicators

The following table provides a comparison of how the 5Q Helix Stakeholders—Government, Industry, Academia, Civil Society, and Environment—are already engaged across the ten case studies in the PRO-COAST project. This analysis highlights the role of each stakeholder group in shaping socio-ecological management efforts, from policy enforcement and industry collaboration to community participation and environmental protection. Understanding these dynamics helps identify gaps in stakeholder involvement and opportunities to strengthen partnerships for sustainable coastal management.

Case Study	Government	Industry	Academia	Civil Society	Environment
Malta (Comino Island)	Limited coordination with local authorities.	The tourism industry is minimally engaged in sustainable practices.	Minimal academic involvement in ecological monitoring.	Visitor education programs but limited local community involvement.	Weak engagement with environmental groups for biodiversity protection.
Italy (Acquatina di Frigole)	Strong collaboration with national, regional, and local authorities but moderate local stakeholders engagement.	Stakeholders involved in training and workshops for sustainable practices.	Collaboration with research institutions for biodiversity monitoring and climate change effect monitoring.	Workshops and programs for local and regional stakeholders.	Collaborations with environmental NGOs, citizen science, and stakeholders on sustainable tourism management and to improve the knowledge about biodiversity and ecosystem services.
Romania (Corbu Bay)	Moderate integration of local and national policies.	Limited involvement from industry in conservation efforts.	Limited academic involvement in pollution research and conservation strategies.	NGO-led community workshops for conservation and sustainable fishing.	Moderate involvement of environmental organizations in conservation.

Montenegro (Boka Kotorska Bay)	Collaboration with UNESCO, but weak enforcement by local authorities.	Tourism and fishing industries engaged through public awareness campaigns.	Collaboration with academic institutions for marine health data collection.	Public awareness campaigns targeting local communities and tourists.	Public forums and campaigns with environmental stakeholders.
Estonia (Kloogaranna-Laulasmaa)	Collaborative efforts with local municipalities and national authorities.	The tourism industry is engaged in sustainable coastal management.	Involvement of local universities in coastal monitoring.	Local community engagement in workshops and coastal monitoring.	Involvement of local environmental groups in tourism and coastal management.
Norway (Bergen)	Strong governance with local authorities and national bodies.	The fishing industry is highly involved in marine conservation efforts.	Strong collaboration with research institutions for marine conservation.	High community involvement in ghost fishing awareness programs.	High collaboration with environmental NGOs on marine conservation.
UK (Arne Parish)	Highly effective collaboration with local and national governments.	Low industry impact but strong engagement in tourism management.	Academic involvement in habitat monitoring and invasive species research.	Strong community engagement in conservation efforts and species monitoring.	Strong partnerships with environmental groups for habitat restoration.
Ireland (Sligo)	Moderate engagement with national policies, needs improvement in local governance.	Agricultural industry involved in peatland conservation programs.	Moderate collaboration with universities for environmental monitoring.	Community-led conservation initiatives focused on peatland restoration.	Moderate involvement of environmental organizations in peatland conservation.
Slovenia (Strunjan)	Effective collaboration between local and national authorities.	Agriculture and tourism industries engaged in sustainable practices.	Collaboration with universities on sustainable agriculture and tourism.	Local communities engaged in sustainable agriculture and tourism programs.	Partnerships with environmental groups for habitat and biodiversity protection.

Norway (Eidsvika-Kildn)	Strong involvement of Askøy Municipality and Vestland County in land-use planning; national agencies partially engaged.	Cruise terminal developer (Tertnes Holding) driving development pressure; limited engagement in sustainability debates.	Moderate collaboration with research institutions; pending ecological studies on biodiversity.	Active civil society engagement led by Eidsvikas Venner; strong mobilisation against the cruise terminal.	Environmental groups like Naturvernforbundet involved; lack of comprehensive ecological data remains a challenge.

Table 9: Comparison of the Stakeholder Engagement

The following table presents a comparative analysis of the **Governance**, **Engagement Methodologies**, and **Education & Awareness Programs** proposed across the ten case studies in the PRO-COAST project. This data highlights the approaches taken by each region to foster community involvement, implement sustainable practices, and promote environmental education. The table also identifies areas where governance frameworks are either strong or need improvement, providing insight into how stakeholder collaboration and awareness programs should contribute to the overall socio-ecological management of each case study.

Case Study	Governance	Engagement Methodologies	Education & Awareness Programs
Malta (Comino Island)	Limited policy engagement, needs coordination with local authorities.	Citizen science initiatives and visitor education programs.	Target tourists but limited local outreach.
Italy (Acquatina di Frigole)	Strong collaboration between local, regional, and national authorities, weak local stakeholder integration.	Meetings, workshops and training for stakeholders to promote sustainable practices, and biodiversity monitoring procedures.	Programs for stakeholders focused on environmental education, biodiversity monitoring, and ecosystem services evaluation.
Romania (Corbu Bay)	Moderate collaboration, needs integration of local policies.	NGO-led community workshops focused on sustainable fishing and conservation.	NGO programs focus on environmental protection, and need more school involvement.
Montenegro (Boka	Collaboration between UNESCO and local	Public awareness campaigns and stakeholder forums	Awareness campaigns for sustainable tourism need youth engagement.

Kotorska Bay)	authorities, weak enforcement.	promoting sustainable tourism.	
Estonia (Kloogaranna-Laulasmaa)	Collaborative efforts between local municipalities and national authorities.	Local workshops on coastal monitoring and sustainable tourism.	Successful programs for schools, workshops, and tourists.
Norway (Bergen)	Strong policy frameworks with NGOs and local authorities.	Collaborations with NGOs and fishing communities, marine monitoring initiatives.	Comprehensive educational programs for schools and community.
UK (Arne Parish)	Highly effective collaboration with conservation organizations and authorities.	Educational outreach and community-led programs on species monitoring.	Extensive educational programs, community involvement in conservation.
Ireland (Sligo)	Moderate collaboration with tourism operators, needs better policy integration.	Workshops for farmers and tourism operators, community-led conservation.	Moderately effective, needs to target more diverse community groups.
Slovenia (Strunjan)	Effective collaboration, room for more inclusive stakeholder engagement.	Educational programs promoting sustainable tourism and habitat restoration.	Effective but could benefit from broader community outreach.
Norway (Eidsvika-Kildn)	Strong engagement with local governance, community groups, and environmental authorities; ongoing land-use policy discussions.	Citizen science monitoring, stakeholder workshops, social media, and local newspaper engagement.	Community awareness through storytelling initiatives, participatory biodiversity and recreational monitoring.

Table 10: Comparative analysis of the Governance, Engagement Methodologies, and Education & Awareness Programs

The following table provides a summary of the Main Baseline Aspects and proposed Follow-up Actions for each case study in the PRO-COAST project. The baseline aspects reflect the key environmental, social, and governance challenges identified during the initial assessment, including issues such as pollution, habitat degradation, and human activities. The follow-up actions outline targeted strategies aimed at addressing these challenges, ranging from policy enforcement and habitat restoration to promoting sustainable tourism and agricultural practices. This table serves as a quick reference for understanding both the current state and future management priorities for each region.

Case Study	Main Baseline Aspects	Follow-up Actions
Malta (Comino Island)	High tourist pressure, habitat degradation, pollution, invasive species.	Implement stricter tourism regulations, waste management systems, and invasive species control.
Italy (Acquatina di Frigole)	Biodiversity conservation, marine litter reduction, monitoring of NIS.	Improving coastal monitoring programmes, habitat restoration, environmental education plans, NIS control, marine litter reduction.
Romania (Corbu Bay)	Coastal erosion, unregulated fishing, agricultural pollution.	Establish fishing quotas, implement habitat restoration programs, and strengthen governance.
Montenegro (Boka Kotorska Bay)	Over-tourism, marine habitat degradation, weak local governance.	Improve tourism infrastructure, develop marine health monitoring frameworks.
Estonia (Kloogaranna-Laulasmaa)	Tourism pressures, coastal erosion, some local management efforts.	Strengthen coastal erosion management, introduce sustainable tourism guidelines.
Norway (Bergen)	Ghost fishing, strong marine governance, marine biodiversity protection.	Expand ghost fishing gear retrieval, enforce marine pollution regulations.
UK (Arne Parish)	Invasive species management, low tourism pressure, effective governance.	Enhance invasive species management, expand community engagement.
Ireland (Sligo)	Peatland degradation, agricultural pollution, water quality concerns.	Implement peatland restoration projects, enforce agricultural runoff regulations.
Slovenia (Strunjan)	Salt pans, seagrass meadows, pollution from tourism, sustainable agriculture.	Develop invasive species control, establish seasonal tourism caps, promote eco-friendly agriculture.
Norway (Eidsvika-Kildn)	Development pressures from proposed cruise terminal, habitat degradation risks, limited biodiversity data.	Implement citizen science biodiversity monitoring, recreational use assessments, foster multi-stakeholder workshops, advocate for integration of ecological and social data into land-use planning.

Table 11: Summary of the Follow-Up Actions

The benchmarking of the ten case studies in the PRO-COAST project reveals significant diversity in socio-ecological challenges, stakeholder engagement, and citizen science initiatives across European coastal regions. While some areas, such as Norway and the UK, show strong governance and community involvement, other regions, like Malta and Romania, face greater challenges due to weaker policy enforcement and limited citizen participation.

Common environmental threats, including pollution, habitat degradation, and the impact of tourism, are present in many regions, but the level of response and the tools available vary. Engagement of key stakeholders like governments, industries, and civil society is crucial, and regions with strong partnerships tend to have more effective management strategies. Citizen science initiatives have the potential to fill data gaps and increase local involvement, especially when paired with appropriate technologies such as mobile apps and sensors.

In conclusion, the benchmarking highlights the importance of tailored approaches for each case study, focusing on improving governance, expanding citizen science programs, and adopting relevant technologies to address specific socio-ecological issues. By leveraging best practices from regions with successful engagement and management strategies, other areas can strengthen their efforts to protect and sustainably manage their coastal ecosystems.

5. CONCLUSIONS AND FUTURE STEPS

The benchmarking analysis of the ten case studies in the PRO-COAST project has provided valuable insights into the socio-ecological profiles, stakeholder engagement, and citizen science initiatives across various European coastal regions. Each case study presents unique challenges and opportunities that highlight the importance of context-specific strategies for effective coastal management.

The analysis reveals that while all case studies face significant environmental threats, such as pollution and habitat degradation, the severity and nature of these challenges differ markedly. For instance, Malta (Comino Island) grapples with high tourist pressure leading to habitat degradation and pollution, compounded by a lack of effective policy engagement and local stakeholder involvement. In contrast, Norway (Bergen) showcases a robust governance framework, with strong partnerships between government bodies, NGOs, and local communities actively working on marine biodiversity protection. This disparity underscores the need for tailored governance models that consider local contexts and stakeholder dynamics.

Effective stakeholder engagement is a critical determinant of success in managing coastal ecosystems. The UK (Arne Parish) exemplifies effective collaboration between local authorities and community groups, resulting in successful habitat restoration and invasive species management initiatives. The active involvement of local conservation organizations fosters a sense of ownership and accountability among community members, demonstrating that strong civil society engagement can significantly enhance management outcomes.

In contrast, Italy (Aquatina di Frigole) shows moderate industry involvement in sustainability initiatives, primarily through workshops with local and regional stakeholders. However, the limitation of effective integration of local stakeholder interests into broader governance frameworks hinders the potential for more comprehensive solutions. This highlights the necessity of fostering stronger ties between governmental policies and local practices to create more cohesive management strategies.

The role of citizen science in addressing data gaps and enhancing community involvement has emerged as a key theme throughout the analysis. For instance, Estonia (Kloogaranna-Laulasmaa) proposes local workshops that engage the community in coastal monitoring and sustainable tourism practices. This initiative not only empowers local residents but also helps gather valuable data on coastal erosion and its impacts. Similarly, the proposed initiatives in Romania (Corbu Bay) emphasize fishing activity monitoring and coastal erosion tracking, which could foster a stronger connection between local fishers and conservation efforts.

Malta's proposed citizen science initiative involves tourist-led biodiversity monitoring, aiming to educate visitors about the ecological value of the region while simultaneously gathering data. By utilizing mobile apps for tracking biodiversity and waste management impact, this approach enhances awareness and encourages responsible tourism practices. Such initiatives are crucial in cultivating a culture of stewardship among both residents and visitors, ultimately contributing to the long-term sustainability of coastal ecosystems. The appropriate use of technology can further enhance the effectiveness of these citizen science initiatives. For example, the integration of water quality sensors and drones for monitoring, as proposed in Italy, could provide real-time data that inform management decisions and increase transparency. In Norway and in Slovenia, the emphasis on ghost fishing monitoring using specialized gear

recovery tools illustrates how technology can assist in addressing specific environmental challenges.

In conclusion, this benchmarking analysis emphasizes the necessity of adopting tailored approaches for each case study, focusing on improving governance, expanding citizen science programs, and leveraging relevant technologies. By learning from successful models like those in Norway and the UK, other regions facing greater challenges can develop strategies that enhance stakeholder engagement and foster a more inclusive approach to coastal management. The insights gained from this analysis can serve as a foundation for future initiatives aimed at protecting and sustainably managing Europe's coastal ecosystems, ensuring they remain resilient and vibrant for generations to come.

The findings across the ten case studies highlight the need for continued efforts in data-driven management, stakeholder collaboration, and policy integration to support the resilience and sustainability of coastal socio-ecological systems. Moving forward, fostering cross-case study learning and collaboration will be key to addressing shared challenges and leveraging common opportunities for sustainable coastal management.

6. REFERENCES

General Links for International Data Sources

Organization/Source	Link	Description
Directorate-general ENVIRONMENT	https://commission.europa.eu/about-european-commission/departments-and-executive-agencies/environment_en	Department responsible for EU policy on the environment.
Natura 2000 Network	https://natura2000.eea.europa.eu/ https://environment.ec.europa.eu/topics/nature-and-biodiversity/natura-2000/managing-and-protecting-natura-2000-sites_en	European network of protected areas to protect biodiversity.
EU Habitats Directive (92/43/EEC)	https://ec.europa.eu/environment/nature/legislation/habitatsdirective/	EU legislation protecting habitats and species.
Global Biodiversity Information Facility (GBIF)	https://www.gbif.org/	Platform for accessing biodiversity data globally.
LIFEWatch ERIC	https://www.lifewatch.eu/	European infrastructure supporting biodiversity and ecosystem research.
LIFE Program	https://cinea.ec.europa.eu/programmes/life_en	EU's funding instrument for the environment and climate action.

Darwin Core Standard (DwC)	https://dwc.tdwg.org/	Biodiversity data standard for describing species and observations.
European Citizen Science Platform	https://eu-citizen.science/	Offers tools, literature, and networking for citizen science projects.
Eurostat	https://ec.europa.eu/eurostat	Provides statistical information on economic, environmental, and social conditions across Europe.
Copernicus	https://www.copernicus.eu/en	European Union's Earth observation program, providing satellite data for environmental management.
Agenda 2030 for Sustainable Development	https://sdgs.un.org/goals	UN platform for tracking progress towards the Sustainable Development Goals.
European Environment Agency (EEA)	https://www.eea.europa.eu/	Provides environmental data and analysis across Europe, including coastal and marine ecosystems.

INSPIRE Geoportal	https://inspire-geoportal.ec.europa.eu/	EU's spatial data infrastructure for sharing environmental information across Europe.
NATURA 2000 Network	https://natura2000.eea.europa.eu/	European network for biodiversity protection.
Global Biodiversity Information Facility (GBIF)	https://www.gbif.org/	Platform for biodiversity data, including Apulia region.
LIFEWatch ERIC	https://www.lifewatch.eu/	European infrastructure for biodiversity and ecosystem research.
Esri (GIS Software)	https://www.esri.com/	GIS software for mapping biodiversity and environmental data.
The European Maritime Spatial Planning Platform	https://maritime-spatial-planning.ec.europa.eu/	A service for Member States to share relevant knowledge and experiences on Maritime Spatial Planning (MSP)

Malta - Comino Island Links

Organization/Source	Link	Description
Ambjent Malta (AM)	https://www.ambjentmalta.org.mt/	Maltese agency responsible for environmental protection.
Environment and Resource Authority (ERA)	https://era.org.mt/	Regulatory body for environmental protection in Malta.
Malta Tourism Authority	https://www.mta.com.mt/	Governs tourism activities and promotes sustainable tourism.
Comino Island - N2K Management Plan	https://era.org.mt/wp-content/uploads/2019/05/Kemmuna_ManagementPlan.pdf	Management plan for Comino Island's Natura 2000 site.
Gozo and Comino Local Plan	https://www.pa.org.mt/en/local-plan-details/gozo-comino-local-plan	Land-use and development regulations for the area.
Planning Authority (Malta)	https://www.pa.org.mt/	Oversees development and planning in Malta.
Malta Tourism Strategy	https://www.mtobservatory.org/_files/ugd/9121fd_23901142c3434d72b9cf4748a1cfb328.pdf	Malta's strategy for sustainable tourism development.
National Coastal Protection	https://pa.org.mt/	Strategy for protecting Malta's coastal zones.

Strategy for Malta		
BINCO (Biodiversity Inventory for Conservation).	https://binco.eu/projects/malta/	Monitoring species populations and habitat conditions in various ecosystems across the Maltese islands.
BEE Cause Hub	https://foemalta.org/green-resource-centre/bee-cause-hub/	Bees Diversity and Distribution in the Maltese Islands

Italy - Aquatina di Frigole Links

Organization/Source	Link	Description
University of Salento	https://www.unisalento.it/	Leading research on biodiversity in the Apulia region.
Italian Ministry of Culture	https://cultura.gov.it/evento/acquatina-di-frigole-capitale-naturale-tutela-ambientale-valorizzazione-e-fruizione-sostenibile	Italian Leader Ministry for Culture
Apulia Region (Puglia)	https://www.regione.puglia.it/	Regional authority responsible for environmental policy.
Municipality of Lecce	https://www.comune.lecce.it/	Governs Lecce and its local environmental policies.
Legambiente	https://www.legambiente.it/	Environmental NGO active in biodiversity conservation.
WWF Italy	https://www.wwf.it/	Leading conservation organization in Italy.

Slovenia - Strunjan Beach Links

Organization/Source	Link	Description
Landscape Park Strunjan	https://www.parkstrunjan.si/	Official website of the protected area.
Hunting Association of Slovenia (HAS)	https://www.lovska-zveza.si/	Governs hunting practices, wildlife conservation.
POSEIDONE Project	https://www.ita-slo.eu/en/poseidone	EU-funded project on marine biodiversity.
Ministry of the Environment, Climate, Energy	https://www.gov.si/en/state-authorities/ministries/ministry-of-the-environment-climate-and-energy/	Slovenian government body for environmental policy.
Slovenia Forest Service	https://www.zgs.si/eng/	Manages forest and protected areas in Slovenia.
Nature Conservation Act (ZON)	https://www.uradni-list.si/glasilo-uradni-list-rs/vsebina/2019-01-3421/zakon-o-ohranjanju-narave-zoon-5	Law protecting Slovenia's natural areas.
SRNA Appp	https://srna.lovska-zveza.si/login	App for monitoring wildlife.
ADRINET	https://www.adrinet.me/	Interreg to improve a joint coastal management system and create governance plans

Montenegro - Boka Kotorska Bay Links

Organization/Source	Link	Description
Ministry of Ecology, Sustainable Development	https://www.gov.me/en/mers	Ministry governing Montenegro's environmental protection.
Ministry of Maritime Affairs	https://www.gov.me/en/mpo	Oversees maritime activities and coastal management.
Environmental Protection Agency	https://epa.org.me/	Agency responsible for environmental monitoring in Montenegro.
Institute of Marine Biology, University of Montenegro	https://aquariumboka.ucg.ac.me/en/institute-marine-biology/	Marine biology research institute focusing on biodiversity.
National Strategy for Climate Change 2030	https://www.preventionweb.net/publication/montenegro-national-strategy-field-climate-change-2030	Climate change mitigation strategy.
National Biodiversity Strategy with Action Plan	https://www.cbd.int/doc/world/me/me-nbsap-v2-en.pdf	Biodiversity action plan for Montenegro.
NATURA 2000 Sites in Montenegro	https://www.eea.europa.eu/themes/biodiversity/natura-2000	EU platform for Natura 2000 sites in Montenegro.

Ireland - Sligo Links

Organization/Source	Link	Description
Sligo County Council	https://www.sligococo.ie/	Local government responsible for environmental management.
Sligo County Council Environment Portal	https://www.sligococo.ie/Environment/	Portal for environmental data in Sligo.
National Parks & Wildlife Service	https://www.npws.ie/maps-and-data	Provides data on wildlife and conservation areas in Ireland.
Environmental Protection Agency (EPA)	https://www.epa.ie/	Regulatory body for environmental protection.
CleanCoasts (NGO)	https://cleancoasts.org/	NGO promoting coastal conservation efforts.
Local Biodiversity Action Plan 2022-2027 Grange	https://actionforbiodiversity.ie/app/uploads/2023/10/Grange-Sligo-Local-Biodiversity-Action-Plan-2022-2027.pdf	Action plan for protecting biodiversity in Grange, County Sligo.
National Biodiversity Data Centre	https://biodiversityireland.ie/	Irish data portal for biodiversity.
Central Statistics Office Ireland	https://data.cso.ie/	National statistical office providing socio-economic data.

United Kingdom - Arne Parish Links

Organization/Source	Link	Description
Natural England	https://www.gov.uk/government/organisations/natural-england	UK government body managing protected areas.
British Association for Shooting and Conservation (BASC)	https://basc.org.uk/	Association involved in wildlife management and conservation.
Ramsar Convention on Wetlands	https://www.ramsar.org/	International treaty for the conservation of wetlands.
Red Squirrel National Biodiversity Action Plan	https://squirrelaccord.uk/	Action plan for protecting red squirrels in the UK.
Biological Records Centre	https://www.brc.ac.uk/	UK data centre for biodiversity records.

Norway - Bergen Links

Organization/Source	Link	Description
Norwegian Directorate of Fisheries	https://www.fiskeridir.no/	Governs fisheries and marine resources in Norway.
Ministry of Climate and Environment	https://www.regjeringen.no/en/topics/climate-and-environment/id925/	Responsible for Norway's environmental policies.

Green Warriors of Norway (NMF)	https://www.nmf.no/	NGO focused on environmental protection and activism.
BarentsWatch – Lost Fishing Gear Portal	https://www.barentswatch.no/fiskinfo/lostfishingfacility/	Portal for reporting and retrieving lost fishing gear.
Global Ghost Gear Initiative (GGGI)	https://www.ghostgear.org/	International effort to tackle marine debris and lost fishing gear.
Directorate of Fisheries' app	https://www.fiskeridir.no/Fritidsfiske/Meld-tapt-og-funnen-reiskap	Recreational Fishing Reporting App
Institute for Marine Research	https://www.hi.no/radgivning/bestandsoversikt/en/	Population Table
Barentswatch	https://www.barentswatch.no/	Commercial Reporting Portal

Estonia - Kloogaranna-Laulasmaa Coast Links

Organization/Source	Link	Description
Lääne-Harju Municipality	https://laaneharju.ee/	Local government responsible for environmental management.

Estonian Environmental Board (EEB)	https://www.keskkonnaamet.ee/en	Governs environmental protection in Estonia.
State Forest Management Centre (RMK)	https://www.rmk.ee/	Manages Estonia's forest and conservation areas.
Laulasmaa Landscape Protection Area Management Plan	https://www.keskkonnaamet.ee/en/laulasmaa-management	Management plan for the protected area.
eBiodiversity Portal	https://elurikkus.ee/en	Biodiversity data portal for Estonia.

Romania - Corbu Beach Links

Organization/Source	Link	Description
Corbu Municipality	https://www.primaria-corbu.ro/	Local government responsible for Corbu Beach.
Constanța County Council (CJC)	https://www.cjc.ro/	County-level government for the Corbu Beach area.
National Agency for Environmental Protection (ANPM)	http://www.anpm.ro/	Governs environmental monitoring and protection in Romania.
Danube Delta Biosphere Reserve Authority (ARBDD)	http://www.ddbra.ro/en	Manages the Danube Delta Biosphere Reserve, including Corbu Beach.
Romanian Ornithological Society / BirdLife Romania	https://www.sor.ro/	NGO focused on bird conservation and habitat protection.

NGO Mare Nostrum	https://www.marenostrum.ro/	NGO involved in marine and coastal conservation.
Romanian National Strategy for Ecotourism	https://turism.gov.ro/web/autoritati-de-resort/dezvoltare-turistica/strategie-ecoturism/	National strategy for promoting sustainable tourism.
INSSE	https://insse.ro/cms/en	Romanian National Institute of Statistics
DDNI	https://ddni.ro/wps/	Danube Delta National Institute for Research and Development

Eidsvika-Kildn Links

Organization/Source	Link	Description
Statistics Norway (SSB)	https://www.ssb.no/kommunefakta/askoy	Official demographic and socioeconomic data for Askøy municipality, including population and employment.
Stakeholder Identification (Draft)	Google Spreadsheet	Draft stakeholder mapping for the case study, identifying nature, issues, solutions, and engagement levels.
Rådgivende Biologer AS	https://www.radgivende-biologer.no	Consultancy responsible for environmental assessments, including sediment toxin analysis in Eidsvika-Kildn.

7. ANNEX: QUESTIONNAIRE SENT TO THE CASE STUDY PARTNERS

For this deliverable, we opted not to include the ten completed questionnaires within the main document. Instead, they have been formatted and made publicly available as an annex on the Zenodo platform. This approach ensures transparency and convenient access to supplementary data[49].

[PRO-COAST] Case Study definition _____INCLUDE_CS_NAME_HERE

This questionnaire is to be completed by each PRO-COAST partner hosting a Case Study (expected time required 30-60 minutes). All the inputs are expected in the form of texts in the tables below. This document can be found online in the PRO-COAST shared folder → WP5 → T5.1. Please rename the document including the name of the Case Study. Once completed and renamed, please upload the document to the same folder and/or send it by email to Fermín Serrano fermin@ibercivis.es DEADLINE May 31, 2024

0. About and glossary of terms

The PRO-COAST project was launched to address the issue of biodiversity loss in European coastal ecosystems. Around 40% of Europeans live within 100km of the coast, relying directly on ecosystem services that are threatened by both quantitative and qualitative losses. Groups already facing socioeconomic vulnerabilities are likely to be disproportionately affected. PRO-COAST aims to empower local communities to support the restoration and maintenance of biodiversity and ecosystem services across Europe, integrating local knowledge into practice and policy making. The project is now underway, coordinating the efforts of 20 partners across 14 countries working on 9 unique case studies. These case studies cover multiple conservation approaches across various coastal ecosystems, testing different governance models and social incentives to engage local actors in adopting technologies and actions for biodiversity conservation.

An important element of PRO-COAST is its holistic, interdisciplinary approach, based on a conceptual framework that treats social-ecological systems as interconnected. By mapping relationships between ecosystem components and uncovering feedback dynamics, the project seeks to identify leverage points for transformative change. PRO-COAST promotes integrated bottom-up decision-making, recognizing that environmental issues cannot be separated from social, economic, and political factors. Through extensive citizen engagement guided by state-of-the-art conservation science, the project aims to build community capacity for biodiversity management, providing scalable solutions that balance conservation needs with local socio economic priorities. Now in its early stages, PRO-COAST hopes to inform adaptive, participatory approaches to governance that avoid biodiversity losses and ensure sustainable, equitable access to coastal resources.

Glossary of terms:

Case studies (CS)	The project methods will be tested in ten case studies located on the European continent, both in EU and non-EU areas. The coastal ecosystem is the common thread running through all the case studies, but each one presents specific issues and its own framework for addressing them.

[49] Fundación Ibercivis, Fundación CARTIF, Università del Salento, Universitetet I Bergen, Tallinna Tehnikaülikool, Univerza na Primorskem Universita del Litorale, Total PR Business SRL, Privredna Komora Crne Gore Podgorica, Friends Of The Earth Malta, Atlantic Technological University, European Sustainable Use Group, Anatrack, & Coventry University. (2024). PRO-COAST D5.1 ANNEXES. Zenodo. https://doi.org/10.5281/zenodo.14012469

	There are three Mediterranean cases, three cases in the North-east Atlantic Ocean, one case in the Baltic Sea and one case in the Black Sea. They include island and continental coastal environments.
CS partners	CS1 Comino island | Malta | Partner: Friends of the Earth, Malta CS2 Aquatina di Frigole | Apulia | Italy | Partner: University of Salento CS3 Area of Strunjan | Slovenia | Partner: University of Primorska CS4 Boka Kotorska Bay area | Partner: Montenegro Chamber of Economy CS5 Sligo | Ireland | Partner: Atlantic Technical University CS6 Arne Parish | UK | Partner: Anatrack CS7 Bergen | Norway | Partner: University of Bergen CS8 Kloogaranna-Laulasmaa | Estonia | Partner Tallinn University of Technology CS9 Corbu | Romania | Partner: Total PR
Social-ecological systems framework (SESF)	The social-ecological systems framework (SESF) is a conceptual framework providing a list of variables that may be interacting and affecting outcomes in social-ecological systems (SES). SESF is useful to advance collective action theory and more as a general tool to diagnose the sustainability of social-ecological systems The SESF is structured into tiers of nested and related concepts and variables. The first tiers include the Resource System (RS), Resource Units (RU), Governance System (Gov), Actors (A), Social, Economic and Political Settings (S), Interactions (I), External Ecosystems (Eco), and Outcomes (O). SESF is useful to advance collective action theory and more as a general tool to diagnose the sustainability of social-ecological systems. The SESF is divided into several 1st-tier components representing social and ecological as well as external factors and system interactions and outcomes, each divided into multiple 2nd-tier variables.

1. Mission and vision of this questionnaire

The questionnaire presented in this document is framed within the **baseline for each CS** and comprises the (preliminary) characterization of the CS: geographical locations and boundaries, objectives of the CS, baseline information of the current situation of the CS, as well as drivers, references levels and knowledge gaps.

At this point, the CS partner would be ready to get initial feedback based on their current status and capacities. It should be noted that the CS stages are flexible and iterative, adapting to the specificities of each pilot and revising each stage whenever necessary.

The questionnaire pursues a double objective:

1. **Provide a comprehensive definition of the 9 CS.** The definition of case studies involves the identification, characterization, and contextualization of specific coastal ecosystems facing biodiversity challenges. This will help drawing the social ecological profiles and benchmarks of the 9 case studies (CS) as a general site diagnosis around key aspects: (1) goals and objectives; (2) environmental; (3) political, institutional and power dynamics; (4) technological; (5) public engagement; and (6) sociodemographic dimensions; This

baseline information serves as the diagnosis of the current background situation of each CS before they apply the whole set of actions designed under PRO-COAST.

This questionnaire is intended to be completed by the CS partners participating in the task 5.1 complementing the work performed in other work packages (namely WP2, WP3, WP4 and WP6). The gathering of the data will be undertaken by those partners, enquiring into the current context in the key dimensions that are relevant for setting-up and executing CS. The questions provided are a support tool to promote self-reflection and understanding of each innovation CS current situation. Moreover, it will serve as the focal point for applying the Integrated Assessment Methodology (IAM) developed within WP5.

This questionnaire compliments another questionnaire (in the shape of google sheet) identification of main stakeholders (nature, issues, solution, level of engagement). See this DRAFT document the identification of main stakeholders (nature, issues, solution, level of engagement).

Link to the questionnaire for CS stakeholder identification (DRAFT): https://docs.google.com/spreadsheets/d/1j0MQRyR0Km6QxwTx2nZaumF_OPWEm3UC/edit#gid=1061616313

Perform situational analyses to define a shared strategy for the CS partners to make the necessary adaptations to move forward on their citizen engagement activities guided by state-of-the-art conservation science. The questionnaire will generate important information for the PRO-Coast partners to design appropriate measures in support of the 9 pilots and to ensure that collective learning across the pilots is systematic in the way that it is looking for commonalities and differences across the pilots. For instance, PRO-COAST will develop an Integrated Assessment Methodology (IAM). The mentioned strategy will be co-defined between PRO-COAST partners, including CS partners. The strategy will provide insights addressing all the CS relevant dimensions, and once agreed and implemented, will allow CS partners to move into the situational onboarding of citizens or involvement.

1.1. How to answer this questionnaire?

CS partners are responsible for answering the questions of the mentioned dimensions. Consultation of the different experts and stakeholders within the CSs is encouraged for further clarification and support for the process of answering the questionnaire. Most of the questions follow a qualitative methodology, except for the sociodemographic analysis that is mainly based on quantitative indicators. The pilot owners in charge of answering these questions should be aware of the needs and objectives pursued for their specific CS.

2. Situational screening questionnaire

2.1 Goals and objectives of the CS

CS overarching goals and objectives have been pre-defined by CS partners of PRO-COAST. Having these objectives been defined by following a top-down approach, or hybrid approach, it is important to realise the different stakeholders that will be involved may have divergent interests or values and the objectives of the CS may incline more towards preferences and wishes of some stakeholders than those of others. These interests may also change with time. The same can happen with the benefits these stakeholders can perceive.

The following aspects were considered for the initial selection of case studies: (1) the biodiversity of the area and the challenges that threaten it; (2) the community that inhabits it and the cultural context in which they live; (3) the economic driver and primary production; in addition, (4) governance arrangements.

For those reasons, the following questions are focused on facilitating the self-assessment with regards to the connection of the stakeholders.

To address the mentioned issues, each CS partner should consider the following questions:

1. Which stakeholders have been consulted or are expected to be consulted during the formulation of the CS objectives and goals, and why? Please rate their relevance on a scale of 1 to 5, indicating from least to most relevant. *[Prompt] For each group, list the names of each stakeholder in the following rows (more than one stakeholder per group), providing relevant info about their specific objectives and goals. Include any observation if required.* *[Recommendation] Reflect on the following:* Is the involvement of these stakeholders important in the future?* How does this exclusion affect the PRO-COAST project's goal?* If the stakeholders that were not consulted are important to reach the CS objectives, map them.*
a. Public Institutions (specify if they are local, regional or national)
b. Academia or groups of experts
c. Private enterprises or private initiatives
d. NGOs or other third sector groups
e. Citizens (specify if they are local citizens who live there, foreign citizens, tourists, etc.)

2. Please identify the national, regional, and/or local policies and plans, along with their targets, that could potentially be influenced by the outcomes of the CS. Please rate their relevance on a scale of 1-5 (from least to most relevant). *[Recommendation] Take into account the identified policies for the definition of the CS activities and outputs. How could the CSs foster policies' implementation? Identify the objectives (within the policy) to which the CSs will/could favour.*

2.2 Political, institutional and power dynamics dimension

In the situational analysis of a CS, the political, institutional and power dynamics dimension holds significant importance. It refers to the recognition of and consideration of the political and institutional structures and processes that influence the functioning and impact of the CS.

The **political dimension** encompasses the policies and decision-making frameworks within which the CS operates. It involves understanding the relationships between different stakeholders, such as government bodies, regulatory authorities, and civil society organisations, and how these interactions shape the CS's objectives, goals, and outcomes.

The **institutional dimension** focuses on the formal and informal structures, rules, and norms that guide the functioning of the CS. This includes the governance mechanisms, organisational structures, and accountability frameworks that ensure transparency, participation, and equitable representation of diverse stakeholders.

The **power dynamics** dimension addresses the power balances/imbalances among the different actors of a CS. It maps the internal power dynamics that connect the objectives, the functioning and the results of the initiatives of each innovation pilot. It supports the description of how the current decision-making system works and presents information about the formal and informal rules and regulations related to the central topic of the CO.

By considering the political, institutional and power dynamics dimension, the CS partners can effectively engage with decision-makers, advocate for change, and influence policy processes. It also allows for the creation of robust and inclusive governance mechanisms that promote transparency, accountability, and meaningful participation of citizens in decision-making processes.

3. What are the programs or plans that could potentially impact the operation of the CS? Please identify them and briefly explain how they could interact with the CO. Please rate their relevance on a scale of 1-5 (from least to most relevant). A non-exhaustive list of policy areas is provided for inspiration: *[Recommendation] To take into account the identified policies for the CS activities and outputs. How the CSs could foster policies' implementation? Identify the objectives or indicators (within the policy) to which the CSs will/could favour. Extract any useful guidelines or best practices to perform the CS activities.*
a. Climate change
b. Biodiversity

c. Urban and rural planning
d. Mobility
e. Tourism
f. Participatory research
g. Agriculture
h. Others

4. Identify the governance units/departments within your area that have direct competence within the CS. Please rate their relevance on a scale of 1-5 (from least to most relevant). *[Recommendation] Make sure that the governance units/departments cover all the CS objectives' topics. You can, for example, align the CS objectives with the listed governance units/departments in a matrix to explore if this is done. Include the responsible for legislative creation and decision-making, which could act as participants or receivers of the CS process. A governance structure can be planned.*

5. Which stakeholders, including public institutions, academia, private businesses, NGOs, other third-sector organizations, and citizens, are involved in or influence policy-making regarding the topics

addressed by the CS objectives? Please rate their relevance on a scale of 1-5 (from least to most relevant).

[Recommendation] Contact them to inform them about the project and invite them to join it in any form.

6. Who has decision-making authority at each step in the policy making cycle within your organisation as pilot owner?

[Recommendation] Consider involving them in the governance structure of the CS.

a. Agenda setting

b. Policy formulation

c. Decision making

d. Policy implementation

e. Policy evaluation

7. If policies cannot be changed or influenced, what benefits or outcomes do you believe CS can have in future strategies?

[Recommendation] These benefits could be the basis for involving different types of stakeholders (e.g., as inputs for the engagement strategy).

2.3 Environmental dimension

8. What is the legal protection status of the CS area based on EU, national and international legislation? *[Recommendation] As examples: NATURA 2000 site, Local Protection Status, other international conventions (Ramsar, SPAMI, etc.).*

9. What are the key natural values of the CS area? *[Recommendation] Indicate current status* in terms of natural landscapes, habitats, and biodiversity (flora and fauna species)
a. Natural Landscapes: Most characteristic natural landscapes (e.g. sandy, rocky beaches, gorges, sea caves, rocky outcrops, forests, agricultural land, river deltas, estuaries etc.).
b. Habitats: Key habitats
c. Habitats: Number of Annex I of Directive 92/43/EEC habitats
d. Habitats: Number of priority habitats
e. Fauna: Key fauna species

f. Fauna: Number of species within Annex II of Directive 92/43/EEC
g. Fauna: Number of wild bird species
h. Fauna: Target species of wild birds based on Directive 2009/147/EC

10. Has a Management Plan(s) been elaborated and is it being implemented? Please elaborate.

11. What are the main uses of the CS area? Please list them based on importance/ intensity. 1-5 (from least to most relevant). *[Recommendation] Consider, as examples, the following elements: tourism, grazing, hunting, agriculture, fishing, urban development, others.*

12. What are the primary threats/ pressures impacting the protection status of the coastal area of the CS? Please list them and rate their relevance on a scale of 1-5 (from least to most relevant). *[Recommendation] Consider, as examples, the following elements: uncontrolled visitation, fragmentation of management competencies, types and intensity of economic activities within the area, conflict of uses, lack of financial resources for protection and management, etc.*

13. What are the primary issues or challenges or impacts affecting the protection status of the coastal area of the CS? Please list them based on importance/ intensity. 1-5 (from least to most relevant).

[Recommendation] Consider, as examples, the following elements: Habitat degradation, pollution, climate change impacts, biodiversity loss, soil erosion, invasive species, etc.

14. Are there any existing environmental monitoring programs or initiatives in place in the case study area? If so, please describe it in detail (e.g., scale of the program, active/inactive, degree of public engagement, measured variables, etc).

[Recommendation] Investigate the presence of ongoing environmental monitoring initiatives, including biodiversity monitoring programs, pollution tracking systems, and climate monitoring efforts, within the CS area.

a. Yes, no?

b. Spatial scale of program (national, local, protected area, etc.)

c. Which authority/ies is responsible for the program?

d. How long is it being implemented?

e. What kind of data is being collected (physicochemical parameters, biological parameters, species/ habitats variables, pressures, etc.)?

15. Are there any gaps or limitations in the existing environmental data collection and monitoring efforts? Please rate their relevance on a scale of 1-5 (from least to most relevant).
[Prompt] Please try to describe them in the form of challenges. We provide you the following variables to help.
a. spatial coverage
b. temporal coverage
c. data quality and resolution
d. monitoring frequency
e. stakeholder engagement limitation
f. accessibility and availability of data
g. data integration and interoperability
h. technical expertise of the CS stakeholders
i. funding

j. infrastructure and supporting services
k. other

2. 4 Technological dimension

16. What technologies, from your current technological stack, do you envision to use for the CS? *[Recommendation] Explore the benefits and needs of using tools apart from the ones you already have in place.*
. General technologies for engagement (e.g., existing platforms related with CS)
b. Data gathering technologies (e.g., citizen science apps, public reporting portals, etc)

17. What communication technologies and channels would you use for sharing information about the topics addressed by the CS objectives with stakeholders? *[Prompt] e.g., Face to face, telephone (call or SMS), email, Websites or blogs (e.g. PRO-COAST website), social media (Facebook, X, Instagram, etc.), Smartphone Apps (WhatsApp, Viber, Line, etc.), Mass and print media (radio, TV, etc.).* *[Recommendation]Leverage these communication channels to support the creation/run of the local community.[SEP]Explore if the identified communication channels are suitable for all the stakeholders and explore if these still are the best option to communicate with them.*
a. Public institutions

b. Academia or groups of experts
c. Private enterprises
d. NGOs or other third sector groups
e. Citizens

18. What primary data sources do you already use to monitor the status of the CS (e.g., biodiversity monitoring, transparency portals for public policies, etc) that you want to influence?
[Recommendation] Identify how useful those data sources are for the CS regarding PRO-COAST and CS challenges. Consider the following questions:
a. How transparent are those data sources for analysis purposes? and, for environmental policy making?
b. Are there any potential data gaps where PRO-COAST may be able to complement data/information?

19. What datasets are missing and could be covered by the PRO-COAST CS?
[Prompt] Please bear in mind that even if there are datasets for a specific topic, CSs could complement them with more data density for the pilot area (e.g., currently unreached areas).

[Recommendation] Establish dialogue among the rest of PRO-COAST partners to explore how to access, maintain or even exploit new data sources.

20. How do you analyse the identified datasets (from question 15)? Please specify the software tools utilised.

[Recommendation] Specify the possible thematic exploration per use case, and potential KPIs generated so that decision-makers can leverage from the information distilled. A link with PRO-COAST indicators may be established. Consider geographic information systems (GIS) software for spatial analysis, statistical software for quantitative analysis, and qualitative data analysis software for qualitative data. Also, data visualization tools.

21. In relation to your existing datasets, what data structure and metadata are you using?

[Recommendation] Reflect on data volume, formats and ways of accessing and processing such data so that thematic co-explorations can be assembled. If possible, consider using metadata standards reflect formats like CSV (Comma-Separated Values) or JSON (JavaScript Object Notation) for information about data source, collection methods, temporal and spatial coverage, and quality assurance procedures.

2.4 Public Engagement dimension

To reach many people with a call for participation in the CS we need to align our calls with local debates and issues that matter for already engaged people. That requires a screening of the local media landscape, researching previous participatory initiatives & talking with mediators that know what issues make people become actively engaged in issues of public concern.

22. Do you have any previous experience in organizing community-based research or participatory initiatives? If yes, please provide detailed information about your experience.

[Recommendation] If the initiative is related to any of the topics addressed by the CS, to recover the contact data of the engaged community in order to reach them again.

a. Topic of the initiative

b. Communities of citizens involved (e.g., students, elderly people,...)

c. Communication channels

23. What are the local debates and prominent issues that are connected or could potentially be connected to the aspirations of your CS?

[Recommendation] Aim at conciliating the parties by involving the different actors in the dispute (administrations, private sector, communities).Communication should always be oriented towards mediating between conflicting interests and not aiming to avoid conflicts/tensions.Leverage local debates to create the engagement strategy per stakeholder type.

24. Are you following any specific methodology or toolkit for public engagement purposes).

[Prompt] If yes, please describe how and specify the step of the process (identification, framing, design, testing). If no, please provide the reasons (e.g., lack of awareness, utilization of alternative methods, insufficient capacity, etc.).

[Recommendation] If not, please consider using some existing methodologies e.g. the Bristol Approach or the Extreme Citizen Science. You may find a basic overview of these proposed approaches in this document. This may help engaging participants at all stages of the process, from problem definition to data collection and analysis, focusing on issues of importance to them. Consider free and informed consent from local communities early in the public engagement process, formalizing terms through a community protocol to guide conduct over the lifetime of the CS. Additionally, consider involving artists to facilitate these encounters.

25. In which kinds of media are local debates carried out and hot issues expressed? *[Recommendation] Use/leverage the different media channels identified & tailor call for participation to different audiences' issues.*

26. Who is expressing these and with which interest? *[Recommendation] Involve the different groups in participation and dissemination of the CS. To propose strategies to reconcile and dialogue between different discourses*

27. Who is not speaking in these public debates but is the object of what is spoken about? (e.g. under-represented groups) *[Prompt] To understand better why these groups are excluded & get closer to the forms of dialogue and discourse of these excluded communities.* *[Recommendation] : Consider historically under-represented groups including: Children; People from minority ethnic backgrounds; People with health conditions or impairments; Older people;*

28. Are there any other forms of expression, like public protests that serve as medium to engage in public debates & hot issues? *[Recommendation] If well-established associations are found, invite their participation or avoid conflict with them through dialogue.*

2.5 *Sociodemographic dimension*

The information gathered through answering to the requirements of the current dimension will be processed by the CS partners by using an intersectional analysis, which focuses on different social categories (sectionalities) that are interconnected. These social categories are addressed by the breakdown of the indicators that we ask CS partners to investigate in their related databases (e.g. official statistical offices).

This analysis considers the characteristics of the population living in the study area and linked population as well as the specific social context of each CS. It ensures that the CS partners are suitable and inclusive, promoting participation and effectively carrying out the activities of the innovation pilots. It is important to look at the population from an intersectional perspective and strive for equality in terms of representation among different groups, including minority groups.

Since the information available varies among each CS country, the segregation or breakdown of the different indicators should be provided according to the available data, in each specific CS.

29. Number of inhabitants in the CS? *[Prompt] Make clear the limits of the CS (e.g. coastal region, NUTS region, etc)* *[Recommendation] Ensure that the data covers the entire study area of the case study (CS) and includes information on both permanent residents and seasonal populations, if applicable. Consider disaggregating population data by age groups, gender, ethnicity, and socioeconomic status to gain insights into the demographic composition of the area.*

30. Number of visitors/ tourists in the CS and indication of seasonality.
a. What is the number of tourists that should be ideal for sustainability?

31. Main employment and economic activities of the population of the CS area.