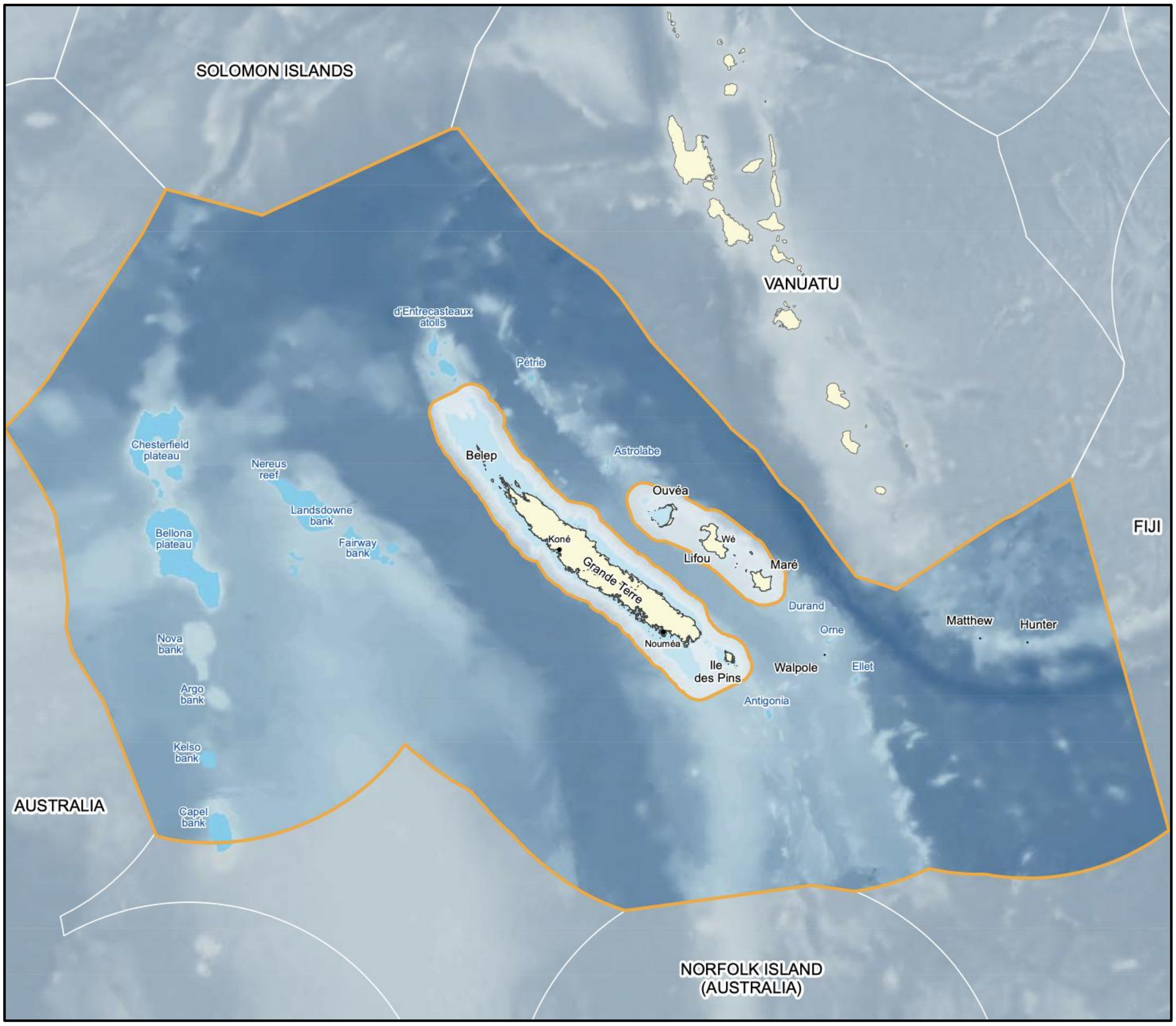


# Informing Marine Spatial Planning for the Coral Sea Natural Park of New Caledonia

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# Chapter 1: Recommendations and conceptual model of an MSP process for the CSNP

MSP is defined as a comprehensive and strategic public process to analyse and allocate the use of the sea areas to minimise conflicts between human activities and maximise benefits, while ensuring the resilience of marine ecosystems (IOC-UNESCO 2009, UNESCO-IOC 2021, Frazão Santos et al. 2020). Effective MSP should be (1) ecosystem-based, (2) participatory and integrative, (3) place-based, (4) adaptive, and (5) strategic and anticipatory (IOC-UNESCO 2009). MSP is a practical tool implemented worldwide for managing ocean space, promoting a balanced approach that integrates development needs, environmental protection, and social and economic benefits (UNESCO-IOC 2021). By the end of 2023, UNESCO-IOC had identified 126 countries and territories engaged in MSP initiatives (MSPGlobal2030).

MSP is about marine spatial management and goes beyond the initial development of a spatial plan. MSP typically encompasses three main phases of management that results in changes and adaptation of the plan over time (Frazão Santos et al. 2020, IOC-UNESCO 2009, Ehler 2012) (**Figure 1**):

1. Planning and analysis to support the development of a marine spatial plan;
2. Implementation of the management measures listed in the plan; and
3. Monitoring and evaluation of the marine spatial plan effectiveness.

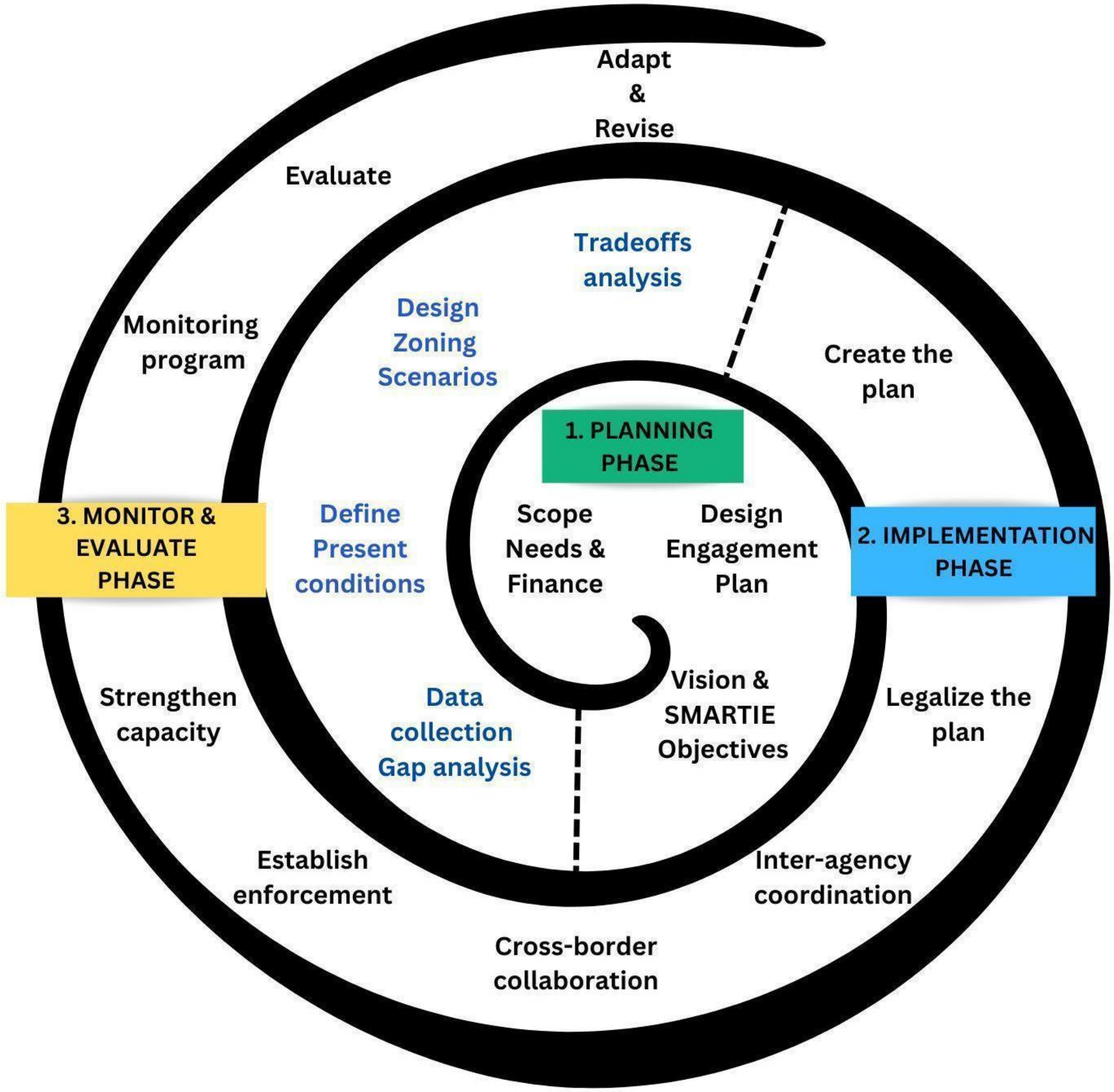


*Figure 1. Conceptual model for an MSP process. The analytical steps in blue are detailed in **Figure 3**.*

MSP emphasizes learning through doing (Frazão Santos et al. 2020), requiring continuous adjustments to address evolving challenges, particularly climate change, biodiversity loss, and competing demands for marine resources (Ehler 2021, Reimer et al. 2023). Social justice concerns such as equity in the distribution of benefits and inclusivity of perspectives are also intrinsic to progressive MSP processes and a sustainable and just blue economy (Bennett 2022). By integrating continuous monitoring, evaluation, and stakeholder engagement, adaptive management enables policymakers to adjust strategies and actions in real-time, ensuring that governance remains effective, resilient, equitable, fair, and responsive to emerging challenges and opportunities (Ehler 2021, van den Burg et al. 2023). This approach not only fosters sustainable use of marine resources but also supports the conservation of ocean ecosystems for future generations. However, implementing adaptive MSP faces challenges, including the need to integrate multiple scales of social and ecological change into governance and jurisdictional frameworks (Frazão Santos et al. 2020, Craig et al. 2017). Countries that lack a legal framework can take years to reach implementation (IOC-UNESCO 2024). Even if a legal framework exists, and an MPA or other setting reaches the point of implementation, the legal mechanism to adapt and change the construct of the MSP in a timely manner rarely exists.

Adaptive MSP must be climate-ready with built-in mechanisms to support both mitigation and adaptation that are effective at enhancing resilience in ecosystems, communities, and blue economies (IOC-UNESCO 2024). In summary, adaptive and climate-ready MSP offers a robust evidence-based framework for balancing development, conservation, and equity. Recognizing the complexities and uncertainties inherent to managing marine spaces (Frazão Santos et al. 2020), MSP provides a structured framework and flexible learning process for decision-making that evolves in response to new insights, political shifts, emerging issues, environmental changes, resource constraints, and stakeholder needs, and social preferences (Zuercher et al. 2022, Ceccarelli et al. 2018, Giacometti et al. 2020). By leveraging innovative approaches and addressing uncertainties, MSP can play a critical role in building resilient marine systems. The sources of uncertainties in MSP arise from various factors, including environmental aspects (climate change, ecosystem dynamics, natural disasters, global crises such as COVID-19), socio-economic aspects (changes in human activities, economic trends), governance (jurisdictional conflicts, political and legal changes), and data-related issues (gaps, temporality of changes, and limitations of predictive models) (Frazão Santos et al. 2024).

MSP, along with its tools, ocean zoning, is widely adopted to engage multiple sectors and increasingly linked to the development of sustainable blue economy and climate adaptation (IOC-UNESCO 2024, Ocean Panel 2023). The MSP approach has potential for helping to address the Kunming-Montreal Global BD Framework conservation goals, including Target 1 (participatory, integrated and biodiversity inclusive spatial planning) and Target 3 (at least 30% of coastal and marine areas effectively conserved by 2030). More recently, MSP is expected to respond to increasing calls for social inclusion and social justice, in particular for greater inclusion of Indigenous People and Local Communities (IPLCs), and addressing gender and poverty issues (IOC-UNESCO 2024, MSP global 2030, Turpie et al. 2022).

MSP has been implemented in various regions globally to manage ocean spaces sustainably, balancing ecological, economic, and cultural needs. MSP is now being adopted in Pacific Island countries, including Vanuatu, Kiribati, Tonga, Samoa and the Cook Islands along with exploration for broader scale multi-national and transboundary

MSP initiatives as part of regional strategic planning (e.g., The Pacific Oceanscape Framework, Micronesia Challenge) (Littaye et al. 2016).

We undertook a literature review to identify international best practices in MSP and protected area networks, with a focus on practices and resources focused on the Pacific region and the specific objectives of the CSNP management plan. We also highlight links to the Goals and Targets of the United Nations Sustainable Development Goals (UN SDGs), the Paris Agreement of the UN Framework Convention on Climate Change (UNFCCC), and the Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework (KMGBF). Since effective MSP has the potential to serve as a spatial nexus to address multiple interlinked SDGs and several of the Targets of the KMGBF it is insightful to crosswalk to these high level critical global policies.

Below are best practices that provide a roadmap for effective MSP implementation, blending global experience with regional needs in the Pacific.

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Equity and justice are integral to the success of MSP, ensuring that the processes and outcomes are inclusive, fair, and reflective of diverse perspectives and knowledge systems. By addressing equity in MSP, planners can balance the distribution of benefits and burdens, recognize the rights and values of marginalized groups, and create decision-making frameworks that are inclusive and transparent. Equity in MSP is multidimensional, encompassing procedural, distributional, and recognitional aspects that are well-known determinants of people's behaviour (Arkema et al. 2024, McDermott et al. 2013, Loos et al. 2023). Each dimension of ocean equity will differ across social, cultural, economic, historical and political contexts.

1. **Procedural Equity** ensures inclusive, accessible, and authentic engagement of all stakeholders in decision-making processes (McDermott et al. 2013). It emphasizes giving marginalized groups, such as women, small-scale fishers, and Indigenous communities, a meaningful voice (Lubchenco & Haugan, 2023). Achieving procedural equity requires iterative engagement, investments in long-term relationships, and compensating stakeholders for their participation. Challenges include ensuring capacity for small communities and marginalized groups to fully engage (Arkema et al. 2024). Best practices involve fostering transdisciplinary and community-based participatory approaches that co-produce knowledge and align decisions with the needs of disadvantaged groups (Arkema et al. 2024).
2. **Distributional Equity** focuses on the fair allocation of benefits and burdens across all community segments, focusing on those in greatest need (McDermott et al. 2013). However, equitable access to natural resources remains uncommon. Analyses are required to understand who benefits from marine resources, how, and where, using metrics such as biophysical, economic, cultural, and health indicators (Arkema et al. 2024). Addressing inequities in resource access is

critical to ensuring that the benefits of MSP extend to historically disadvantaged groups.

3. **Recognitional Equity** acknowledges and incorporates the values, knowledge, and rights of diverse groups, including Indigenous communities, into governance and policy (McDermott et al. 2013, Loos et al. 2023). It challenges dominant worldviews and assumptions, ensuring that alternative perspectives, including ecocentric and cultural worldviews, are respected and integrated (Arkema et al. 2024). Frameworks like the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) highlight the importance of considering both the benefits and disservices of natural systems from different cultural perspectives (Díaz et al. 2018).

Achieving equity in MSP is not straightforward. Small and marginalized communities often face capacity barriers to effective participation, while power asymmetries can skew decision-making processes (Arkema et al. 2024, Zuercher et al. 2022). By prioritizing equity and justice, MSP can foster sustainable and socially just marine governance, benefiting both ecosystems and the communities that depend on them.

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# *1. Phase 1: Planning and analysis to support the development of a management plan*

## *1.1. Establish the institutional and legal basis for marine spatial planning*

The regulation governing MSP serves as the basis for executing the marine spatial plan, and is rooted in relevant legal frameworks. It generally establishes the necessity of MSP implementation, designates the key entities responsible for its execution, details the implementation processes, and clarifies the connection between MSP, approvals for marine activities, and the allocation of rights for sea area usage (UNESCO-IOC European Commission 2021). Effective MSP requires integration across agencies and coordination between jurisdictions to address land-sea interactions, ensure policy coherence, and promote cross-border collaboration.

### 1.1.1. Review the legislation, policies, strategies, and plans relating to MSP and identify who has the authority for implementation

Ensuring that MSP is legally enforceable is crucial. Engaging an independent and experienced external expert, in collaboration with a local legal professional, can provide valuable insights when reviewing the legal framework. An effective MSP process requires authorities for the planning phase and institutions or regulatory bodies for implementation. MSP establishes a framework to align and guide sectoral decision-making toward integrated, ecosystem-based marine management. Identifying the most suitable institutional and decision-making structure to implement MSP is a key step to effective management. Ideally, the responsible government agency should be empowered with a legal mandate to act and considered as neutral to avoid any conflicts of interest or bias toward particular user groups (Albotoush & Tan Shau-Hwai 2023).

In New Caledonia, the MSP process will be implemented within the framework of managing the CSNP. The legal authority responsible for enforcing the park's regulations is the Service du Parc Naturel de la Mer de Corail et de la Pêche (SPMCP). This process will necessarily involve the Management Committee, which brings together representatives of all stakeholder groups. The Management Committee will rely on the support of the Scientific Council of the CSNP, whose role is to provide scientific insights to inform the decisions of the committee members and the SPMCP.

The workshops to be conducted with the various sub-committees of the Management Committee will allow different stakeholders to express their vision for the future of the CSNP. Indeed, there are currently differing priorities among the various stakeholder groups. While all agree that the exceptional ecosystems and biodiversity of this area must be preserved, there is not yet a consensus on the methods to achieve this goal. The recent expansion of highly protected zones has brought underlying tensions between certain groups to the forefront, and some stakeholders now wish to see a slowdown in this expansion process.

The MSP process may therefore be seen as a critical tool that will bring together the newly renewed representatives of the various sub-committees, enabling them to discuss their vision for the use of the CSNP’s space. It is also worth noting that the recent work carried out by customary authorities regarding the Kanak vision of the Ocean will contribute valuable insights to this process.

The SPMCP will have the significant task of facilitating this process and reporting the results of these workshops to the members of the Government, which remains the final decision-making authority.

### 1.1.2. Inter-Agency Coordination and Legislation to support MSP

Most MSP legislation relies on zoning as a key mechanism to implement the plan, with each zone designed to prioritize specific ocean uses or compatible activities. Such legislation often provides initial definitions for key components, including the planning authority, the geographic scope, and guiding principles. The legislation in New Caledonia designating the creation of the CSNP (decree n° 2014-1063/GNC) should be reviewed to see if it supports designation of a multi-use zoning plan, such as would be recommended by the MSP.

MSP must be integrated and aligned with other national and local spatial planning processes, such as coastal zone management, land-use planning, economic development, MPA management, and private sector business planning, to minimize conflicts. Clear connections between MSP and these policies are essential to ensure horizontal integration across sectors and vertical integration across administrative levels, from national to local planning and management, using approaches like nested planning systems (UNESCO-IOC 2021, Ehler 2021).

Coordination among different levels of government and agencies is critical to resolving conflicting priorities, unclear jurisdictions, and incompatible policies (Zuercher et al. 2022). Iterative collaboration through joint planning committees or advisory groups can foster integrated management. Key approaches include:

- **Land-Sea Integration**: MSP must consider land-sea interactions and promote coherence between MSP processes and coastal zone management practices, such as Integrated Coastal Management (ICM) (van den Burg et al 2023). ICM, which emerged from the 1992 Rio Earth Summit, focuses on the management of coastal areas using an integrated approach to achieve sustainability (Frazão Santos et al. 2020).
- **Alignment Across Scales**: Marine spatial plans should align national, regional, and local planning efforts to ensure consistency and avoid fragmentation of management strategies (Ehler 2021).

### 1.1.3. Cross-Border Collaborations

As marine ecosystems and human activities transcend national boundaries, cross-border cooperation is essential for addressing transboundary issues. MSP plans must acknowledge these challenges and foster collaboration across socio-cultural lines, ecosystems, and administrative boundaries (Zuercher et al. 2022).

Key considerations include:

- **Transboundary Coordination**: Directive 2014/89/EU mandates Member States to ensure transboundary cooperation and promote collaboration with third countries (van den Burg et al. 2023). Frameworks like the United Nations Convention on the Law of the Sea (UNCLOS) and the Convention on Biological Diversity can facilitate regional cooperation and support ecosystem-based approaches to marine management. Engage in multilateral agreements and frameworks to harmonize MSP efforts across jurisdictions.
- **Areas Beyond National Jurisdiction (ABNJ)**: While most MSP efforts focus on Exclusive Economic Zones (EEZs), 60% of the world's ocean exists in the ABNJ ("High Seas"). Developing MSP frameworks for ABNJ is essential to addressing global governance gaps and ensuring sustainable management of these areas. The development of MSP for these areas will be crucial for protecting biodiversity and managing human activities like shipping and fishing on a global scale (Ehler 2021, IOC-UNESCO 2024).
- **Transnational Collaboration**: Cross-border cooperation in MSP enhances transnational marine management by ensuring ecosystem-based approaches and balancing conservation with human activities. Such initiatives can help foster

transparent and inclusive stakeholder participation across borders, including governments, industries, and local communities.

Integration across agencies and cross-border collaboration are indispensable for the success of MSP. By aligning policies, incorporating land-sea interactions, and fostering transboundary cooperation, MSP can address the complexities of whole-system marine management and contribute to sustainable and equitable ocean governance at multiple scales.

Transnational collaboration among New Caledonia, Australia, and the Cook Islands has advanced ocean management by fostering the exchange of scientific knowledge, aligning conservation policies, and addressing shared challenges such as marine biodiversity loss and climate change impacts. These efforts include initiatives like the development of Marine Protected Areas (MPAs) and collaborative research on sustainable fisheries. The Cook Islands, for instance, have engaged with New Caledonia and Australia in efforts to align their ocean governance frameworks with international conservation standards, particularly through large-scale MPA cooperation (Friedlander et al. 2016). The establishment of shared agreements and the integration of traditional ecological knowledge have further strengthened regional partnerships, ensuring that ocean management strategies are inclusive and culturally informed (Jupiter & Mangubhai 2014).

## *1.2. Identify need, political will, and financial support*

### 1.2.1. Identify need and establish authority

Whether MSP is necessary can be gauged by examining the importance of a country's marine resources and evaluating how effectively current management preserves them. Based on these findings, government leaders can decide whether to initiate MSP. Clearly defining the problems or conflicts to address through MSP helps maintain focus throughout the process. Without this clarity, there is a risk of losing sight of the original purpose of the effort. Identifying these issues is also a crucial first step in setting goals and objectives for MSP (IOC-UNESCO 2009).

In New Caledonia, the management of maritime space, particularly in the lagoon surrounding Grande-Terre and the Loyalty Islands, dates back to the first human settlements. Coastal Melanesian communities (marine clans) have long practiced customary management of their marine spaces. This traditional management is rooted both in the necessity to preserve seafood resources—essential sources of protein—and in the spiritual value attributed to certain areas (taboo zones) or marine species (totems). The open ocean, beyond the barrier reef, has also been subject to customary management, though this remains poorly documented. Over the past two years, efforts led by the Customary Senate have been underway to document and transcribe this knowledge in writing, as oral transmission has traditionally been the primary means of preserving Melanesian cultural practices. Starting in the 1970s, this customary management began to overlap with a more "Western" approach, marked by the establishment of the first marine protected areas (MPAs). The Yves Merlet Strict Nature Reserve (IUCN Category Ia) was created in 1970 within the Grand-Sud lagoon, followed by the designation of several other MPAs (IUCN & IUEWCMC 2017).

In New Caledonia, the importance of marine environmental protection became more widely recognized in 2008 when the lagoons and their surrounding ecosystems were designated as a UNESCO World Heritage Site (Government of New Caledonia 2018). This designation was accompanied by the strengthening of various local regulatory texts regarding environmental protection and the development of human activities (Environmental Codes of the Southern and Northern Provinces, and the Mining Code of New Caledonia). Beyond its lagoon, New Caledonia possesses one of the largest oceanic Exclusive Economic Zones in the world (1,740,000 km²) relative to its land mass. These marine waters are home to several reefs that can be considered “pristine” and uninhabited islands (Walpole, Matthew, and Hunter).

After several subsequent steps, in April 2014, the Government of New Caledonia established the Coral Sea Natural Park (CSP), a vast MPA covering 1.3 million square kilometers (Government of New Caledonia 2018). Following the establishment of the park and to ensure its effective protection, the government of New Caledonia, in collaboration with various stakeholders, worked on the development of the first management plan for this area. The plan was approved in 2018. One of the key management objectives of the CSNP is to safeguard the most fragile ecosystems, habitats, and species, along with cultural heritage (Government of New Caledonia 2018). This includes the creation of a network of MPAs within the park (Government of New Caledonia 2018).

One of the greatest challenges facing the Coral Sea Natural Park is achieving its management objectives while addressing the diverse interests of a wide range of stakeholders. This highlights the core difficulty of managing a multi-use marine park: striking a balance between environmental preservation and economic priorities. This complexity makes the CSNP an ideal candidate for a comprehensive marine spatial planning process, encompassing the entire exclusive economic zone (EEZ) of New Caledonia except for the provincial (nearshore) waters.

The government of New Caledonia has sought to establish a shared governance system to effectively manage the CSNP. Among the various options for sharing power and responsibilities between the authority managing the area and the different stakeholders, New Caledonia opted for a shared governance approach that allows consultation with stakeholders while retaining decision-making power within the rights-holding authority, namely the collegial government of New Caledonia. The consultation of stakeholders and the search for consensus among them are conducted through the management committee, which was established when this MPA was created. The Department for Maritime Affairs (DMA), through its Fisheries and Marine Environment

Service, acts as the secretariat, coordinating efforts, monitoring progress, and ensuring that the development of the management plan remains on schedule

Consultation with stakeholders and the pursuit of consensus is conducted through the advisory committee (known as *Pucoo a péi*, which means "collectives that study and analyze"), established in 2015 and revised in 2024 (see **section 1.2.2**). This committee serves as an advisory body that contributes to government decision-making by providing opinions on the management of the CSNP.

Today, this committee can be considered the working group responsible for MSP in this area. It is indeed a tool for participatory governance, which enables the reconciliation of divergent interests among stakeholders while fostering the emergence of shared responsibility for the outcomes of the MSP (Ceccarelli et al. 2018).

### 1.2.2. Develop a sustainable financing plan

Ensuring adequate funding is essential for the successful implementation and long-term management of MPAs and areas covered by MSP. Although financing is generally the responsibility of the rights-holding governments, it is often insufficient to meet MSP ambitions, leading to gaps in implementation, particularly for impact assessment and monitoring (Ehler 2021, MSPGlobal).

A robust financial plan must consider the reliability of public funding while integrating alternative sources of financing, such as contributions from the private sector, NGOs, and bilateral or multilateral donors (Ceccarelli et al. 2018). Innovative mechanisms, such as blue carbon or ecological compensation, offer opportunities to mobilize private sector investments for biodiversity conservation (Claes et al. 2022).

In parallel, the use of economic analyses (e.g., cost-benefit analyses, ecosystem services valuation) can strengthen decision-makers' support and attract new funding sources (World Bank 2022). This approach provides a comprehensive understanding of the financial and ecological benefits of marine environments while maximizing advantages for local communities (GOAP 2022)

TEXT BOX

Other alternative financing mechanisms that can be considered for MSP (MSP Global 2030):

- **Grants and Donations**: Funds from international organizations, foundations, and NGOs.
- **Private Partnerships**: Joint investments for shared benefits.
- **User or Access Fees**: Fees related to marine activities (e.g., tourism, diving in Fiji, OECD 2017).
- **Mining Revenues**: Royalties and taxes from mining operations.

- **Renewable Energy**: Revenues from offshore infrastructure (e.g., wind farms, wave energy).
- **Maritime Transport**: Taxes on commercial vessels (transit and anchoring).
- **Fisheries**: Tradable quotas, catch levies, and recreational licenses.
- **Telecommunications**: Right-of-way fees for submarine cables.
- **Trust Funds:** A long-term financial mechanism established to sustainably finance the implementation of MSP, such as MPA management, stakeholder engagement, enforcement, and monitoring.
- **Concessions:** A formal agreement granting rights to a private or community entity to use or manage marine or coastal resources—such as tourism, aquaculture, or renewable energy—in specific zones defined through MSP.

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These approaches collectively highlight the potential of combining economic tools with MSP to balance development, conservation, and equitable resource use. By diversifying funding sources and carefully assessing their feasibility and duration, governments can ensure the successful implementation and longevity of MSP efforts (Bohorquez et al. 2022). Sustainable funding mechanisms are essential to support both marine environmental management and to deliver tangible benefits to local stakeholders engaged in stewardship that may restrict their access to marine resources. One widely used approach is the implementation of user fees, which support both marine management and community-led projects, often selected through a collaborative process. By channeling financial returns to local initiatives, these mechanisms foster a stronger sense of ownership and stewardship, enhancing community compliance with spatial and regulatory measures (Thiele and Gerber 2017). Importantly, the design of such funding and benefit-sharing arrangements should be an integral part of early MSP dialogue and planning to ensure equity and transparency in outcomes.

In New Caledonia, the Pew Charitable Trusts, through the Pew Bertarelli Ocean Legacy Project (PBOL), has played a vital role in the development and management of the Coral Sea Natural Park (CSNP). Pew has contributed as a member of the park's management committee, advocating for large, highly protected marine reserves to conserve biodiversity and migratory species like humpback whales and sea turtles. The organization supported New Caledonia's commitment to protect 200,000 to 400,000 square kilometers within the CSNP and collaborated with local stakeholders to ensure conservation measures align with cultural and ecological needs. By providing scientific expertise and fostering inclusive planning, Pew has been instrumental in shaping effective marine conservation strategies for the park. Now PBOL is supporting marine spatial planning for the CSNP by commissioning a pilot project to develop a draft marine spatial plan for the park that builds on the existing design (10% under high-level protection) initiated in October of 2023.

### 1.2.3. Build a workplan with a timeline

Developing a realistic work plan with an associated timeline is a critical step in creating a MSP. The work plan should clearly outline how the different components of the process are interconnected. It is important for one individual to oversee and maintain a comprehensive view of the work plan throughout its duration. Key elements of the work plan include:

- Identifying the main activities required for MSP development,
- Selecting appropriate timeframes to schedule these activities (e.g., by week, month, quarter, or year), and estimating the start time and duration of each task, often represented visually as a line or bar on a chart.

Additionally, the plan should identify key milestones to monitor progress, typically marked by target completion dates, and assign specific responsibilities to members of the MSP team for each task (Ceccarelli et al. 2018).

An effective work plan will align closely with the goals and objectives of the MSP process and specifically address the following key elements (UNESCO-IOC 2021):

1. Generating the necessary information and tools for planning;
2. Ensuring stakeholder engagement and effective communication;
3. Creating the spatial plan;
4. Implementing the spatial plan; and
5. Monitoring and evaluating the planning process to assess whether the plan is achieving the desired outcomes.

## *1.3. Prepare and implement a stakeholder engagement plan*

Developing a comprehensive stakeholder engagement plan is essential to ensure inclusivity, legitimacy, and alignment between management goals and community needs. Effective engagement addresses key questions (Ceccarelli et al. 2018):

- Who to involve,
- Why engagement is necessary,
- When to engage, and
- How to incorporate diverse perspectives effectively.

Stakeholder involvement should be ongoing throughout the MSP process rather than a single step, integrating insights from consultations to optimize the plan's relevance and increase compliance (Gopnik et al. 2012, Ceccarelli et al. 2018, van den Burg et al. 2023). This approach fosters community participation and stewardship, strengthening the plan's long-term success and ensuring sustainable, equitable marine governance. Develop consistent, trust-based relationships with stakeholders by addressing their concerns and ensuring meaningful participation. Transparency in roles, timelines, and decision-making processes builds credibility and manages expectations (Giacometti et al. 2020). Engaging stakeholders in MSP serves three primary purposes:

1. Stakeholder involvement helps fulfill legal requirements, draw on diverse knowledge systems, promote cross-sectoral learning, and legitimize MSP plans. Stakeholders contribute by identifying problems, offering solutions for the use or protection of marine areas, and providing feedback on the planning process itself (Morf et al. 2019, Giacometti et al. 2020).
2. Engagement aligns with democratic principles, ensuring marginalized groups, such as local fishers and Indigenous communities, have a voice in decision-making. This promotes empowerment, equity, and transparency, key pillars of sustainable MSP processes (Giacometti et al. 2020).
3. Honoring and making use of local (indigenous) knowledge and applying it to the MSP process, while at the same time incorporating the Kanak vision for the MSP/CSNP.

### 1.3.1. Define key phases of consultation plan

Consultation with stakeholders should be iterative and occur throughout the MSP process, especially: 1) during the development of a draft MSP; 2) once the draft MSP has been prepared; and 3) after the new MSP becomes law (Ceccarelli et al. 2018).

As zoning for the CSNP is an iterative process, there have already been several consultations conducted. First in 2016 to conduct stakeholder mapping and identify attitudes about the park, then public hearings for the 10% expansion of protected areas in the park in 2023, and finally, key stakeholder interviews commissioned by PBOL following the implementation of 10% protection. These can be considered the first round of consultation for the MSP process.

An initial zoning of the CSNP was established in 2017 following these consultations, with 47,000 km² designated as highly protected areas. In terms of zoning, a second key step took place in 2023 when the government aimed to extend highly protected areas to 10% of the park's surface. On this occasion, extensive stakeholder consultations were conducted, including an online survey open to the entire Caledonian public, as well as to the metropolitan French public. A parallel round of consultation with key stakeholders was subsequently initiated by PBOL to assess the willingness of these actors to go beyond the 10% target for strong protection.

It is also worth mentioning the ongoing consultation work within the Customary Senate to characterize the *Kanak* vision of the ocean. This work will help integrate the cultural perspective of local communities into the spatial planning of this area. These initial consultation steps can be considered the first phase of the consultation process anticipated as part of the MSP process.

The second round of consultation should occur once the draft MSP has been prepared.

By employing tailored strategies, fostering inclusivity, and maintaining transparency and effective communications, planners can align conservation goals with community needs while managing marine resources sustainably. Through proactive and thoughtful engagement, MSP processes can address diverse stakeholder aspirations and navigate the complexities of marine spatial use. By fostering a participatory culture, MSP can continue to evolve as a model for sustainable marine governance in the face of emerging challenges and opportunities.

### 1.3.2. Determine who should be involved and level of input

MSP often seeks to balance social, economic, and ecological objectives, requiring communication that addresses all affected groups within the MSP area. Communities and stakeholders must be informed about the MSP process, with careful consideration given to involving the right people at the right stages to avoid inefficiencies (Giacometti et al. 2020). Stakeholder mapping can help identify relevant organizations, groups, and individuals with interests in marine space (using these questions can help guide the scoping: Why, Who, When, and How to involve specific stakeholders?) (Giacometti et al. 2020). This creates a “living list” that evolves over time to reflect new priorities, stakeholders, and knowledge to ensure the process remains relevant and inclusive over time (Giacometti et al. 2020). Then, analyze stakeholder needs, expectations, and levels of influence to design tailored engagement strategies. Revisit stakeholder lists and engagement plans regularly.

Stakeholder involvement should take place at appropriate phases of the MSP process, from consultation to full co-decision-making, depending on resources and legal mandates. A detailed work plan should outline when and to what extent stakeholders should participate. Creating a database of individuals and groups interested in being informed or involved is essential. Early engagement fosters trust and builds a shared understanding of objectives, while continuous involvement ensures feedback loops throughout (Giacometti et al. 2020).

Stakeholder engagement and inclusivity are critical for equitable MSP processes, requiring transparent selection and active involvement of stakeholders throughout all phases to ensure balanced representation (van den Burg et al. 2023). Empowering marginalized groups by providing resources, capacity-building opportunities, and decision-making power is essential to amplify their voices and ensure they are heard and respected (Zuercher et al. 2022). Addressing barriers to participation through targeted outreach and capacity-building initiatives is key to ensuring that all voices, including those of underrepresented groups, are effectively incorporated into the MSP process. Examples of such stakeholder groups include the following (Ceccarelli et al. 2018):

- **Resource-Dependent Groups**: Communities and groups directly reliant on local resources (e.g., community groups, women’s groups,  recreational users).

- **Decision-Makers**: Individuals responsible for resource decisions (e.g., Indigenous groups, village chiefs, elders, lawyers). Engaging Indigenous and local communities in the planning process ensures that their knowledge and practices are incorporated into management strategies.
- **Legal Authorities**: Entities with legal claims or obligations over the area (e.g., local and national governments).
- **Industries**: Organizations conducting activities that impact the management area (e.g., fisheries, tourism providers).
- **Seasonal/Geographic Stakeholders**: Groups with specific seasonal or geographic interests (e.g., research teams).
- **Technical Experts**: Individuals with technical knowledge about the area (e.g., scientists).
- **Special Interest Organizations**: Groups with management or advocacy interests (e.g., environmental NGOs, cultural advocacy groups).

These groups must be taken into account at various stages of the MSP process to ensure comprehensive, balanced, and sustainable management of marine spaces.

Today, the PNMC Advisory Committee represents a key governance body for working collaboratively as part of the future MSP process. This advisory committee brings together representatives from various key sectors, including economic stakeholders, civil society representatives, NGOs, and institutional actors (the government, the State, the Customary Senate, and the Economic, Social, and Environmental Council - CESE) (**Figure 2**). This composition ensures the inclusion of all stakeholders to participate in the various stages of PNMC management, particularly regarding the implementation of the MSP process. The amended decree regarding the composition of this committee (modified decree n. 2024-2175/GNC) also provides for the inclusion of five qualified individuals who can contribute expertise to the committee's work. The committee also benefits from the support of the PNMC Scientific Council, which can be consulted to inform the committee members ahead of their decision-making. It is worth noting that Indigenous local communities are currently represented through the Customary Senate and the Customary College, which is composed of representatives from the country's eight customary areas. Over the past two years, the Senate has received support from an NGO, which has helped it organize and develop its vision for the CSNP, enabling it to advocate this perspective effectively during committee sessions. Each sector works to propose a shared vision in response to the ongoing committee discussions. The committee's recommendations are ideally developed through consensus among all sectors; however, if consensus cannot be reached, decisions are made by a simple majority of those present or represented.

The Natural Park of the Coral Sea and Fisheries Service (SPNMCP), a department of the Government of New Caledonia, acts as the committee's secretariat. This service coordinates and leads the management of the CSNP, ensuring the effective implementation of the management plan (Gouvernement de la Nouvelle-Calédonie 2018). It will also be responsible for leading the MSP process. The MSP resulting from the committee's work will be submitted to the Government of New Caledonia, which will decide whether to adopt it as is. The establishment of this advisory committee facilitates the creation of a shared vision for the MSP. During its development, any debates or conflicts arising from divergent interests can be addressed, with shared solutions proposed. This consensus-based advice will significantly guide government decisions.

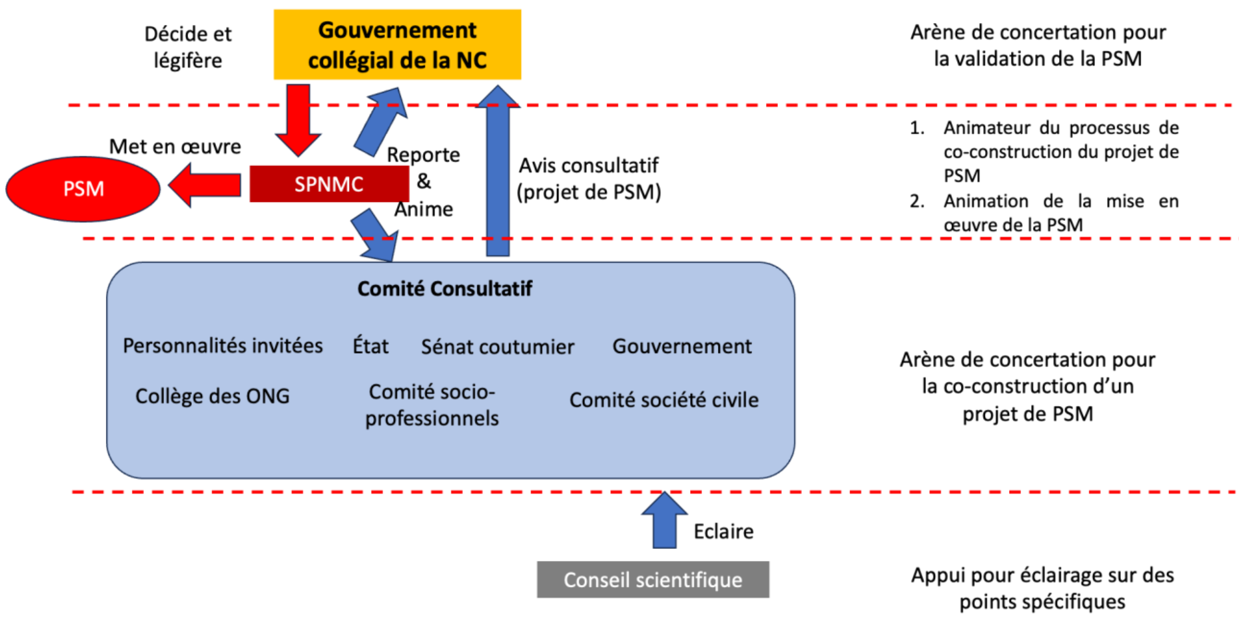


*Figure 2. An organizational diagram for possible governance of the MSP process.*

A recent study performed a detailed inventory of stakeholders for MSP in the CSNP. It characterized key stakeholders and their relationship to the park, their projected attitudes about expansion of protection, and how to move forward in communication with each of them. This level of detail is beyond the scope of this report, however, it is a critical component of developing a stakeholder engagement plan and of the MSP process as a whole.

### 1.3.3. Identify objectives and communication approaches

Stakeholder involvement can take various forms, ranging from simple 'communication,' where participation is minimal, to more collaborative approaches like 'negotiation,' where decision-making power is shared among stakeholders (Giacometti et al. 2020). Make stakeholder strategies and adaptive roadmaps publicly accessible, clarifying the roles and stages of involvement. Transparency helps manage expectations and fosters accountability (Giacometti et al. 2020). It is important for stakeholders to understand how they can contribute and how the information they provide is integrated into the plan.

For each consultation round, it is essential to determine the key messages and the specific information sought from each engaged group. The communication and consultation objectives should align with the government processes and organizational culture in which the MSP is being developed to ensure effectiveness and acceptance.

The consultation plan should also specify effective communication tools for each stage of the process. Tailor communication methods to specific stakeholder groups. For example:

- **Formalized stakeholders:** Groups or individuals with an established relationship with the authorities may prefer structured small committee meetings, detailed reports, or written consultations where discussions are more technical and formalized.
- **Informal or marginalized groups:** Local communities, Indigenous groups, or other less formal stakeholders may respond better to community events, open group meetings, or visual materials such as posters, explanatory videos, or infographics that simplify information and make it more accessible (Wedding et al. 2024, Giacometti et al. 2020). Using innovative communication approaches (web tools, influencers, slogans, etc.) is essential to improve the popularization and dissemination of messages to various stakeholders (Giacometti et al. 2020).

## *1.4. Define vision and objectives*

### 1.4.1. Define clear vision for country MSP

MSP should be guided by a short vision statement about the desired future state of the marine environment, aligning ecological, economic, and social priorities (Ehler 2021, Zuercher et al. 2022). A strong vision serves as a unifying framework to keep planning efforts focused, coherent, and forward-looking, helping managers address present challenges while seizing future opportunities (Lukic et al. 2018). The vision should be positive and broadly outline what MSP aims to achieve, such as the Solomon Islands' vision: *"A healthy, resilient, secure, and productive ocean that supports sustainable use and development for the benefit of the people of Solomon Islands now and into the future" (*MFAET Press 2023). Whether pre-existing or emerging after the development of specific MSP objectives, a well-defined vision provides essential guidance throughout the planning process.

The CSNP management committee has defined the four overarching objectives for the park (Government of New Caledonia 2018):

1. Protection of natural and cultural heritage;
2. Sustainable and responsible use;
3. Functional good governance; and
4. A locally, regionally and internationally integrated park.

These concepts could be combined into a single vision statement such as: *The vision for the Coral Sea Nature Park is to safeguard its natural and cultural heritage through* *sustainable and responsible use, supported by effective governance, while fostering integration and collaboration at local, regional, and international levels.*

### 1.4.2. Define broad objectives for MSP

Within the MSP vision, it is essential to establish broad objectives as statements of desired outcomes such as protecting marine resources, improving food security, or enhancing climate resilience. These overarching goals should emerge from identifying existing problems, conflicts, and threats, as well as analyzing government priorities outlined in current plans, policies, and legislation.

In 2016, the work of the management committee led to the emergence of a series of 4 management objectives (listed above). These objectives align with the eight guidelines (listed below) established by the decree creating the CSNP (Decree 2014-1063/GNC). These guidelines are regulatory and cannot be challenged by the management plan. They are:

- **O1**: "Establish the principles of good governance to support the integrated management of New Caledonia's maritime space."
- **O2**: "Protect the most vulnerable ecosystems, habitats, and species, as well as cultural heritage, while seeking the best balance between conservation and the development of human activities, particularly by establishing a network of protected areas within the CSNP."
- **O3**: "Strengthen the CSNP's surveillance strategy and develop a monitoring network to assess the state of the marine environment, exploited resources, and human uses."
- **O4**: "Improve understanding of management challenges by acquiring new information and by consolidating and enhancing data."
- **O5**: "Raise awareness among Caledonians about the challenges of managing maritime space and promote its richness."
- **O6**: "Contribute to the implementation of sustainable management of the Coral Sea and encourage its responsible exploitation in coordination with the four neighboring countries."
- **O7**: "Contribute to the influence and regional integration of New Caledonia, as well as to the realization of New Caledonia's multilateral commitments in the field of marine environment management."
- **O8**: "Leverage the international visibility of the marine park and its ambitious management framework to develop resources allocated to its management."

Following the definition of these objectives, working groups were established. There were six groups (sub-committees), and they met several times between 2015 and 2016. These groups included members of the management committee and invited participants (scientists) to define specific objectives that aligned with the four selected goals. The management objectives and their goals, as formulated by the management committee, are presented below (Government of New Caledonia 2018):

**Protecting natural and cultural heritage**
- Protect ecosystems and their connections
- Protect heritage, rare and migratory species
- Define and recognize tangible and intangible cultural heritage
- Preserving and optimise tangible and intangible cultural heritage

**Sustainable and responsible use**
- Guarantee and support the development of responsible tourism
- Guarantee and support local fisheries while respecting the resources and habitats
- Reduce pressure from maritime transport to limit its impact
- Prepare for future uses

**Good governance**
- Ensure proper functioning of park authorities
- Involve the public
- Assess and report the effects of management plan implementation
- Strengthen, optimize and pool resources

**A locally, regionally and internationally integrated park**
- Work in harmony with local managers
- Develop regional cooperation for the benefit of the Coral Sea region
- Play a full part in international relations

Each of these objectives was further broken down into sub-objectives (a total of 40). For each sub-objective, potential actions and indicators were also identified during this work.

An evaluation of this first plan took place in 2021, and a series of recommendations were made to improve the definition of these objectives and sub-objectives as part of the plan's revision, scheduled to occur by the end of 2025. These recommendations are not public at this stage.

### 1.4.3 Define specific objectives for MSP

Once the broad objectives are defined, they can be further refined into Specific, Measurable, Achievable, Relevant, Time-bound, Inclusive, and Equitable (SMARTIE) objectives early in the planning process (UNESCO-IOC 2021). By embedding the vision and SMARTIE objectives in MSP, planners can create a structured, results-oriented approach that adapts to emerging challenges and opportunities while ensuring meaningful progress (Ehler 2014). For example, setting minimum size limits for fisheries catch is a targeted step that helps translate broader aims into tangible results.

📌 ***The 15 broad objectives of the CSNP are divided into 40 sub-objectives. Currently, these objectives read more like goals in that the language is very***

***broad-based and generalized. These objectives should be reviewed and revised where appropriate to adhere to the SMARTIE framework. Restructuring the objectives in this way will create a clearer connection to the management activities needed to achieve the desired outcomes. Nevertheless, the management plan does include draft indicators and targets for each objective which will be helpful in guiding management actions when they are finalized and approved.***

## *1.5. Balancing multiple uses through zoning*

MSP is a critical tool for balancing the diverse and often competing demands on marine ecosystems, while ensuring their long-term sustainability. By integrating ecological, social, and economic factors, MSP employs zoning to allocate space for different purposes, such as conservation, tourism, and resource extraction, or combinations of compatible uses. Zoning is a cornerstone of MSP, functioning as a regulatory framework that delineates specific areas for particular activities or protections (Frazão Santos et al. 2020). MSP uses zoning as an effective spatially explicit tool to integrate ecological, cultural, and economic objectives and to minimize conflicts and foster synergies (Frazão Santos et al. 2020, Wedding et al. 2024).

To address socio-cultural connections, MSP must move beyond perceiving ocean systems as spaces and instead recognize them as places tied to community values, local knowledge, and ecological relationships (Wedding et al. 2024). Data and tools play a central role in ocean zoning, providing the foundation for evidence-based decision-making, conflict resolution, and the integration of ecological, social, and economic priorities. The plan should appropriately address interests and concerns across ocean use sectors (Zuercher et al. 2022, Ceccarelli et al. 2018) while safeguarding the biodiversity that underpins a sustainable blue economy (Lubchenco et al. 2020, Benzaken et al. 2022).

This chapter explores the three key analytical steps to inform spatial zoning: 1) Data collection and gap analysis, 2) Define and analyze present conditions, 3) Define and analyze future conditions (**Figure 3**). We also briefly describe data compilation and mapping, scenario and trade-offs analyses and data-sharing practices that support the MSP design phase.

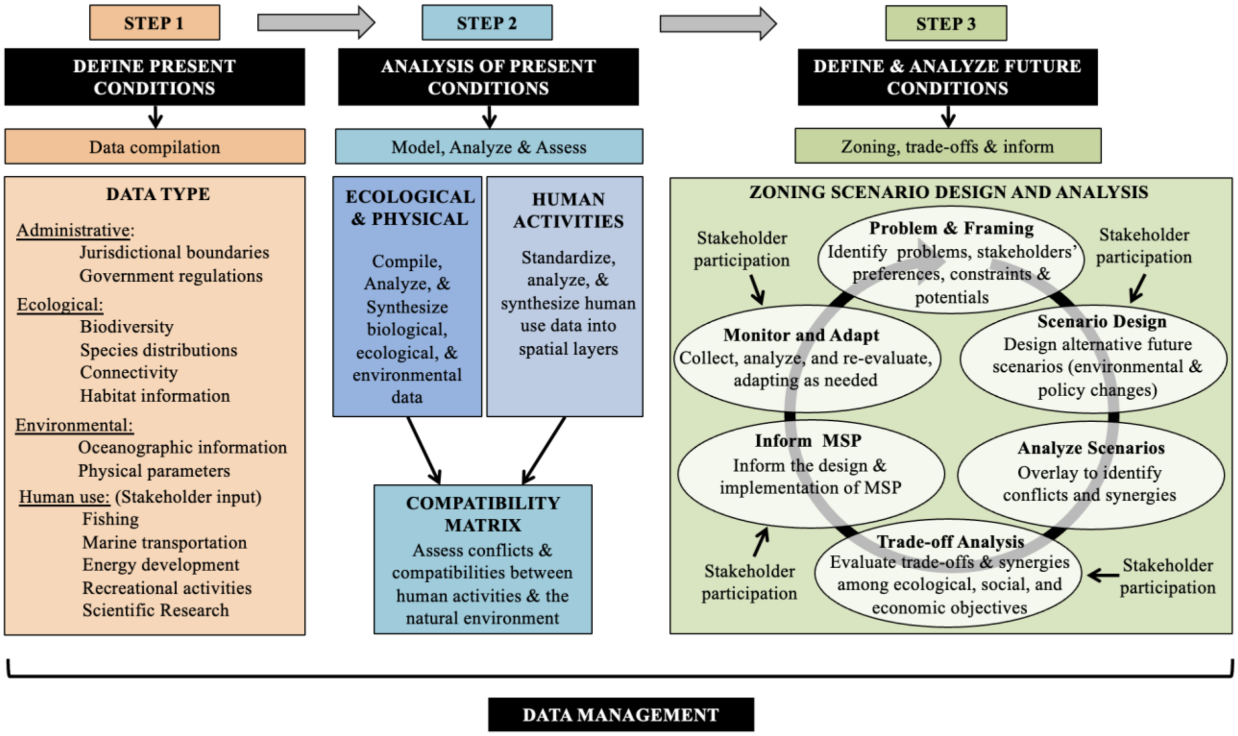


*Figure 3. Key steps for MSP analyses (adapted from Stamoulis and Delevaux 2015).*

## 1.5.1. Data collection, organization, and gap analysis

To achieve sustainable and equitable marine governance, MSP must be informed by Indigenous knowledge and the best available data, including scientific, economic, social, and cultural information (van den Burg et al. 2023, Zuercher et al. 2022). Collecting and conveying information about the marine environment - its condition, uses, and distinctive areas - is a crucial aspect of the planning process. The marine environment is both dynamic and complex, with patterns and trends occurring across varying timeframes and spatial scales.

Maps are the most effective tool for visualizing this information and support all elements of spatial planning. Given that data collection can be both time-intensive and costly, it is essential to prioritize data that directly addresses the identified MSP issues. This approach is particularly advantageous when MSP is being implemented for the first time. Ensuring data harmonization makes it compatible, accessible, usable, and transparent. When reviewing available data, emphasis should be placed on spatial and temporal information that encompasses the majority of the planning area (UNESCO-IOC 2021).

The social and cultural dimensions of the marine environment are complex and deeply connected to people's sense of place, identity, and opportunities for leisure, work, and recreation, drawing on religious, aesthetic, and economic values (McKinley et al. 2019).

Integrating Indigenous and local knowledge (ILK) into MSP is essential for equity and place-based planning, requiring ethical data acquisition, free, prior, and informed consent, and respect for intellectual property rights (Ceccarelli et al. 2018, UNESCO-IOC and UNESCO-LINKS 2024). The CARE Principles (Collective benefit, Authority to control, Responsibility, and Ethics) complement FAIR (Findable, accessible, interoperable, reusable) principles to ensure Indigenous data sovereignty (Global Indigenous Data Alliance 2023). Tools like participatory mapping and oral history collection help foster trust and capture cultural connections to marine spaces (Wedding et al. 2024).

MSP relies on diverse categories of (spatial) data to assess existing conditions and support planning processes, with different levels of accuracy, geographic scale, thematic detail, temporal aspects, which all define the relevance of the data to plan development (Zuercher et al. 2022). Several categories of spatial data are relevant for MSP (Ceccarelli et al. 2018, Stamoulis & Delevaux 2015, UNESCO-IOC and UNESCO-LINKS 2024):

1. **Ecological Data**:
   - Habitat distribution and characteristics (e.g., coral reefs, seagrass beds, mangroves).
   - Species distributions, migration routes, and connectivity pathways.
   - Biodiversity hotspots and areas of ecological significance.
   - Bird migration routes, breeding grounds, and feeding areas.
   - Nursery grounds for key species and high-productivity zones.
2. **Physical Data**:
   - Bathymetry and seafloor topography.
   - Oceanographic processes (e.g., currents, circulation patterns, and upwelling zones).
   - Sediment dynamics and coastal erosion patterns.
   - Mean sea level and sea temperature
   - Ocean winds, wave patterns, and tidal cycles
   - Water chemistry (e.g., salinity, pH, nutrient levels, and dissolved oxygen).
3. **Human Activities**: Spatial and temporal information on fishing, shipping, tourism, and infrastructure.
   - **Fisheries**: Fishery zones (e.g., commercial and traditional), spawning and nursery areas, fish migration routes, fisheries restrictions, aquaculture, and port infrastructure.
   - **Tourism and Recreation**: Routes, recreational zones, and anchoring areas.
   - **Maritime Transport**: Port infrastructure, dredging and dumping zones, shipping routes, anchoring areas, and traffic density (e.g., AIS data), restricted areas reserved for shipping.

    - **Energy and Raw Materials**: Areas for oil, gas, $CO_2$ storage, mineral extraction, and infrastructure (e.g., pipelines and telecommunication cables).
    - **Cultural Heritage** : Traditional and local knowledge, marine archaeological sites and zones of restricted use.
    - **Installations and infrastructures:** Exploration and exploitation areas, installed infrastructure (e.g. platforms, farms, bridges, buoys), safety zones and construction fields.
    - **Defence:** Military exercise areas, radar areas/military observation areas, restricted areas
    - **Scientific research:** Research areas, measuring stations and networks
4. **Managed Areas:** Coastal and MPAs, biosphere reserves, other protection measures.
5. **Indigenous knowledge**: Traditional knowledge, culturally important zones, tabu areas, or other restricted use.

Along with other Pacific nations, New Caledonia is a signatory to the Convention on Biological Diversity, which stipulates that at least 30% of marine environments must be safeguarded within ecologically representative marine protected areas. However, limited and imperfect marine environmental data make it challenging to determine what truly constitutes “ecologically representative.” Relying solely on data from known sites risks protecting only those familiar areas. To address this, a set of draft marine bioregions for the southwestern Pacific has been developed at a scale suitable for national planning (Beger et al. 2020). Data characterizing bioregions can help inform the design of MPA networks with representative areas of each marine bioregion and safeguard areas with high levels of biodiversity (Ceccarelli et al. 2018).

Prior to the establishment of the CSNP, the Agency for Marine Protected Areas facilitated the development of a Regional Strategic Analysis (RSA), which provided an assessment of the environmental and socio-economic issues within the CSNP (Gardes et al. 2014). Based on this knowledge assessment, the management plan was developed, considering both current and future human activities within the park. These activities include tourism and recreational boating, commercial and recreational fishing, maritime transport, and the exploration of living resources.

In terms of social-cultural value, the CSNP management plan refers to ‘tangible cultural heritage’ which includes historical and archaeological sites and remains and ‘intangible cultural heritage’ which includes places and sites important to the indigenous Kanak culture of New Caledonia. These include seamounts and whale resting and migration areas. The collective work carried out as part of the RSA, and subsequently during the implementation of the first management plan, provides a strong knowledge base for developing zoning scenarios within the MSP process for the CSNP (Gardes et al. 2014).

*Data sharing*

Effective MSP requires transparent and collaborative data-sharing frameworks to ensure inclusivity and trust among stakeholders (MACBIO 2018).

- **Centralized Platforms**: Centralized data platforms facilitate data sharing, visualization, and integration across agencies and regions (Giacometti et al. 2020).
- **Ethical Data Use**: When engaging Indigenous and local communities, data-sharing practices must respect Indigenous data sovereignty, balancing openness with ethical considerations (UNESCO-IOC and UNESCO-LINKS 2024).
- **Digital Innovations**: Technologies like AI and real-time satellite monitoring provide up-to-date information for enforcement, compliance, and ecosystem management (MACBIO 2018).

Data and tools are fundamental to informing MSP, offering critical insights into ecological, social, and economic conditions. By leveraging advanced mapping technologies, integrating Indigenous knowledge, and conducting forward-looking scenario analyses, planners can develop adaptive, inclusive, and evidence-based marine spatial plans. Ensuring data transparency and ethical data-sharing practices further supports equitable decision-making and trust-building among stakeholders.

The Government of New Caledonia hosts a data sharing portal (www.georep.nc) where a number of spatial datasets related to the CSNP are available to the public. This centralized data platform advances data access for the region and could be expanded to include new and updated datasets acquired or developed as part of the MSP process.

*Data quality and gap analysis*

Data quality and gap analysis are critical components of effective MSP, ensuring that decisions are informed by accurate, comprehensive, and up-to-date information. High-quality spatial data provide the foundation for identifying marine resource distributions, ecological functions, and human activities, which are essential for balancing conservation and development objectives (IOC-UNESCO 2009). Gap analysis evaluates existing datasets to identify deficiencies, such as incomplete geographic coverage or outdated information, and prioritizes areas for data collection (Foley et al. 2010). This process not only highlights gaps in baseline ecological data but also uncovers the absence of socio-economic data essential for stakeholder engagement and conflict resolution. Integrating robust data quality assessments and addressing gaps ensures that MSP frameworks remain adaptive, inclusive, and aligned with sustainable development goals (Agardy 2010).

### 1.5.2. Define and analyze present conditions

To minimize adverse environmental impacts and biodiversity loss, spatial planning should consider undertaking a vulnerability assessment associated with current uses and their level of impact relative to the sensitivity of the ecological system. This will help define risk and design mitigative actions, while accounting for regional and local contexts (UNESCO-IOC 2021). Advanced mapping and modeling tools allow planners to analyze existing conditions, identify spatial conflicts, and establish baselines for decision-making.

- **Climate-smart MSP**: Spatial assessments of risk, vulnerability, and exposure are vital for climate smart MSP, identifying areas most at risk from hazards like sea-level rise and extreme weather (Frazão Santos et al. 2020).
- **Cognitive Mapping and Stakeholder Tools**: Techniques like cognitive mapping, oral history collection, and stakeholder engagement workshops are valuable for integrating social-ecological perspectives (Wedding et al. 2024).
- **Risk and Vulnerability Mapping**: Mapping tools can highlight where social-ecological systems are most exposed to change, guiding targeted adaptation actions (Frazão Santos et al. 2020)
- **Matrices of interests** are simple yet effective tools for systematically mapping and analyzing relationships between different interests to identify and address conflicts or synergies (Giacometti et al. 2020).

*Identify any special or unique area*

For effective MSP, it is necessary to identify and map special, unique marine areas, most important and representative areas for conservation, and which places are compatible with human use (Ceccarelli et al. 2018, IOC-UNESCO 2009). Some areas and habitats are more important than others for particular species, ecosystems, or processes. Likewise, certain regions carry greater economic value—such as those with sand and gravel deposits, oil and gas reserves, consistent high winds, productive fishing grounds, or heavily used transport routes.

Based on globally accepted criteria, many special and unique areas have been mapped in New Caledonia, including Ecologically or Biologically Significant marine Areas (EBSAs), Important Bird and Biodiversity Areas (IBAs), Important Marine Mammal Areas (IMMAs) and Key Biodiversity Areas (KBAs). In New Caledonia, a portion of these areas recognized as globally important for biodiversity conservation (i.e., IBAs, IMMAs, EBSAs) have been designated as strict reserves under the proposed decree (**Figure 4**) (Gouvernement de Nouvelle-Calédonie 2023).

In 2023, the government of New Caledonia designated at least 10% of the park as “highly protected zones” (**Figure 4**). These new fully protected reserves target critical areas for the preservation of iconic species such as whales, dolphins, sharks, turtles, and seabirds, while also including reefs and seamounts—ecosystems that are as vulnerable as they are remarkable.


*Figure 4. Existing Reserves in the Coral Sea Natural Park in 2023*

Improved spatial ecological modeling capabilities can also support identification of sensitive or ecologically valuable areas (Stamoulis & Delevaux 2015). Sometimes, data gaps and smaller spatial scales will hinder the identification of special or unique areas, such as biodiverse deep seabed areas with high diversity and regionally unique or rare ecological communities (Ceccarelli et al. 2018).

*Identify areas of conflict or compatibility*

Overlaying biophysical and human use maps can help identify potential conflict areas resulting from competition for space, whether between different uses or between human activities and the natural environment. A matrix listing biophysical characteristics and human uses can be used to indicate conflict or compatibility between specific features/activities (Ceccarelli et al. 2018). However, it's important to note that if current conditions are not fully mapped and multiple criteria - such as ecological, economic, and socio-cultural factors - are not thoroughly considered, some conflict zones may remain undetected. In this case, spatial conflicts can be identified through stakeholder feedback and participatory mapping (UNESCO-IOC 2021). In New Caledonia, as elsewhere, conservation is incompatible with many extractive human activities such as industrial fishing and deep-sea mining.

### 1.5.3. Define future scenarios and analyze trade-offs

Once existing conditions have been defined, it may be possible to anticipate a variety of future scenarios. Scenario analysis is a critical tool for MSP adaptation to evolving conditions (Frazão Santos et al. 2020), enabling planners to explore multiple future visions and trade-offs. Future visions explore how marine areas might evolve over 10–20 years under different socio-political priorities, such as conservation or blue growth (Frazão Santos et al. 2020, Lukic et al. 2018). Scenarios, built using qualitative and quantitative methods, present alternative storylines and can be exploratory (what can be done?), normative (what must be done?), or predictive (what is most likely?).

*Design alternate future zoning scenarios*

Within any marine management area, multiple future scenarios are always possible. Depending on the emphasis placed on certain goals and objectives, these scenarios will allocate human activities differently in both space and time. Developing alternative spatial scenarios is a critical step in the MSP process, as it establishes the foundation for determining the direction in which the maritime area will evolve over the chosen timeframe. This can include forecasting trends in the spatial and temporal needs of current human activities, as well as allocating zones to balance future demands for ocean space and climate change adaptation (Calado et al. 2025, Frazão Santos et al. 2020). This is an important consideration in the planning phase of MSP. To support "adaptive" MSP after implementation, it is critical to include zoning considerations anticipating potential future uses.

Ocean zones can take many forms, including MPAs and areas designated for different types of fishing (from subsistence to industrial), mining, shipping, or tourism. Through the MSP process, these zones become legally enforceable. To be effective at the national level, there should be a limited set of standardized zones within the country.

📌 ***Each zone must have clearly defined objectives, as well as rules that determine which human activities are permitted and which are not. Ideally, each zone should also align with and support the overarching vision and objectives of the MSP.***

By standardizing the types of ocean zones, the resulting MSP or zoning plan becomes easier to understand, follow, and implement to achieve the desired outcomes (Day et al. 2019). Incorporating 3D multisectoral planning to include depth in MSP is also important, particularly in deep-sea areas, yet remains to be widely implemented (UNESCO-IOC 2021). Future iterations of MSP are expected to integrate 3D analyses to better address spatial uses, conflicts, and zoning schemes as new knowledge becomes available (UNESCO-IOC 2021). MSP can also address tourism-related challenges by ensuring healthy environmental conditions, regulating tourism facilities, and allocating space to avoid conflicts with other sectors (Papageorgiou 2016).

In the CSNP, there currently exist conservation zones with high protection (IUCN categories I and II). These zones cover 10% of the park area and there is intention to expand protection towards 30% of the park area as required by Target 3 of the latest Global Biodiversity Framework. In addition to these conservation zones, several other zones may be relevant and feasible for the CSNP:

- **Zones for the protection of culturally significant sites** (to be managed by Kanak co-managers): These zones will most likely overlap with some of the biodiversity protection sites.
- **Sustainable blue economy development zones:** These zones are intended to encourage maritime economic activities while respecting the principles of environmental sustainability.
- **Specified vessel traffic lanes, or conversely, 'blue corridors'** that are strictly enforced and correspond to known (and likely seasonal) migration corridors; and areas of sensitive habitat (e.g., coral reef systems).
- **Tourism zones** (with land connection and BMPs that set standards for the conduct of tourism activities, including carrying capacity): These zones are defined to organize and regulate tourism in order to avoid negative impacts on the environment.
- **Open access zones**: Whatever is not a specified zone becomes a default "open access zone", allows for fishing and any other activity that is not in violation of the park-wide regulations.

Developing these zoning scenarios can be guided by specific guidelines and will make different tradeoffs in terms of balancing conservation and human activities. Maps of these alternate future zoning scenarios will be key components of the draft marine spatial plan and form the basis for the second round of stakeholder consultations (Section 1.2).

A number of new MPAs were proposed for the CSNP during the consultation for the 10% target in 2023 and there is intention to expand protection towards 30% of the park area as required by Target 3 of the latest Global Biodiversity Framework (**Figure 5**). These proposed protection areas will be evaluated along with other information and integrated into future zoning scenarios to be considered during the MSP process.

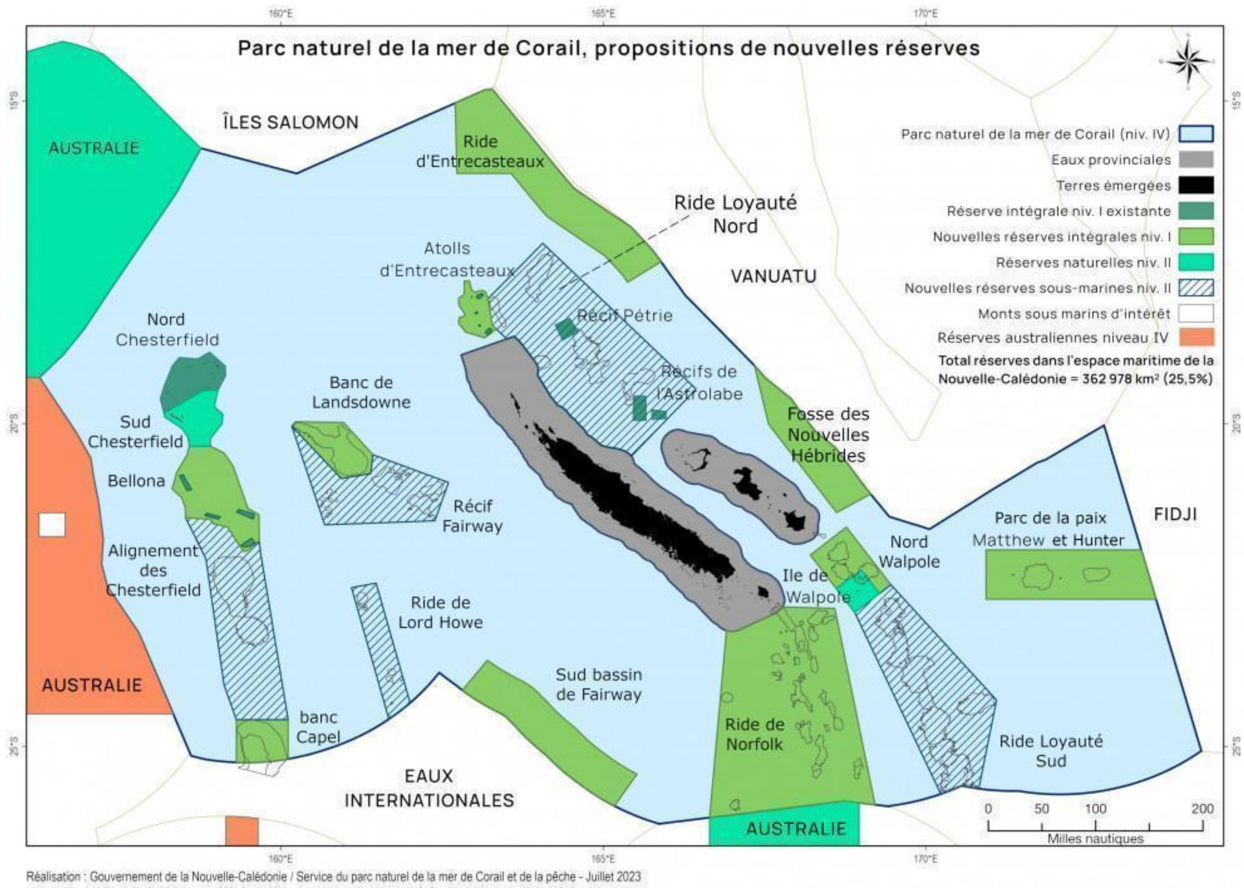


*Figure 5: Proposed new reserves in the Coral Sea Natural Park*

*Design zoning principles and guidelines*

Placement guidelines for ocean zoning provide a framework for determining the most suitable locations for different types of ocean zones. Establishing the placement of these zones is a crucial step in the planning process. Well-designed and strategically placed zones help reduce user conflicts, safeguard ecologically significant areas, and enable commercial activities to proceed with confidence. These placement guidelines are composed of two categories of design principles. Zoning marine spaces should consider socio-economic, cultural, and management feasibility principles and operational goals, while a set of biophysical principles can help guide the design of MPA networks.

Socio-economic, cultural, and management feasibility considerations for zoning can be summarized into four main principles (Ceccarelli et al. 2018):

1. Optimize the alignment of ocean zones with existing human values, activities, and opportunities.
2. Ensure that the final selection of ocean zone locations acknowledges the associated social, cultural, and economic costs and benefits.

3. Prioritize placing ocean zones in areas that complement current and anticipated management and tenure arrangements.
4. Enhance public and community understanding and acceptance of new ocean zones, supporting better compliance and cooperation.

**MPAs** are key zoning tools within the MSP toolbox, offering spatial solutions for balancing biodiversity conservation and human activity. MPAs are defined as designated regions, established through legal or other measures, to safeguard all or part of the marine environment within their boundaries (IUCN 2017). They help maintain or restore native species diversity and abundance, ensuring habitat variety, supporting keystone species, and preserving biological connectivity (Ceccarelli et al. 2018, Frazão Santos et al. 2020). Ceccarelli et al. (2021) outline key design principles for offshore MPA networks summarized here:

1. **Ecological Connectivity and Representation**: MPAs should represent all bioregions, habitats, and ecological features like high-productivity zones, with 20–30% of marine bioregions designated as no-take zones to ensure ecosystem sustainability. Protect areas with unique geomorphology, aggregation zones, nursery grounds, spawning sites, or high biodiversity. Empowers local communities to manage their fishing grounds sustainably. For example, customary marine tenures, such as Locally Managed Marine Areas, integrate traditional governance systems in marine resource management.
2. **Size and Shape**: Offshore MPAs should be 50–200 km in diameter to protect wide-ranging species and critical ecological features. MPAs must be coupled with blue corridors to ensure the protection of migratory spaces (Balbar & Metaxas 2019, Pendoley et al. 2014). Simple shapes such as rectangles are often favored because they maximize operational efficiency.
3. **Network Design**: MPAs should include multiple types, combining core no-take zones with areas permitting sustainable use to enhance resilience and ecological function.

**Blue corridors** are also essential components of MSP, designed to connect critical habitats and support the migration and movement of marine species. These pathways enhance biodiversity conservation, bolster ecosystem health, and ensure the sustainability of fisheries. For example, the blue corridors of the Eastern Pacific Ocean link migratory pathways for migratory whales (Palacios et al. 2023) and the MigraMar swimway initiative for sharks, rays and turtles (https://www.migramar.org/en/index). Designing effective blue corridors requires:

1. **Mapping Critical Habitats**: Identify and map migratory routes, spawning areas, nursery grounds, and feeding habitats for key species, including whales, sharks, and turtles. Consider habitat connectivity and how currents facilitate larval dispersal and species migration.
2. **Incorporating Flexibility**: Design corridors to accommodate shifts in species ranges caused by climate change, such as longer and wider corridors to

encapsulate a range of potential future geographical shifts and ensuring their long-term efficacy (Frazão Santos et al. 2020). Balance conservation goals with industry needs like shipping and fisheries.

3. **Ecological and Socio-Cultural Integration**: Link coastal ecosystems like mangroves and seagrass beds to offshore areas to maintain inshore-offshore ecological flows. Align corridor designs with traditional knowledge and customary marine tenure systems to enhance local acceptance and governance.
4. **Regional and International Collaboration**: Work with neighboring countries to establish corridors spanning multiple EEZs, ensuring connectivity across political and ecological boundaries.

By integrating zoning tools, MPAs and blue corridors, MSP offers a comprehensive strategy to address the complexities of human activities and environmental protection. Effective zoning ensures that ecological integrity is maintained while supporting sustainable economic development and local community needs.

*Scenario analysis and Trade-offs assessments*

By analyzing trade-offs, MSP processes can quantify the costs and benefits of spatial decisions, particularly for marginalized communities (Giacometti et al. 2020, Zuercher et al 2022)**.** Tools like *InVEST* (integrated valuation of ecosystem services and trade-offs tool) and *Marxan* (systematic conservation planning tool) model trade-offs, helping planners assess future ecological and socioeconomic impacts of management decisions (Frazão Santos et al. 2020, Stamoulis & Delevaux 2015, Delevaux et al. 2024). Scenario modeling, using Bayesian Belief Network-GIS, can help decision makers explore potential consequences and risks associated with different zoning and management decisions (Pinarbaşı et al. 2019).

Predictive species distribution models and global climate projections (e.g., IPCC RCPs) provide insights into changes to suitable habitat under future climate projections, coral reef distribution, and fisheries productivity in surveyed and unsurveyed locations (Stamoulis & Delevaux 2015), however, they are insufficient to fully capture the complexity of local climate impacts and other human impacts in MSP (Frazão Santos et al. 2020). Incorporating localized predictions of shifting human activities is essential for climate-smart MSP (Frazão Santos et al. 2016).

Although modeling tools can inform future scenario analyses, a more straightforward approach, such as systematic brainstorming and drawing on in-country expertise, can also be effective. For example, all current uses could be listed and mapped where possible, and then predictions made on where those uses are most likely to occur in the future (Ceccarelli et al. 2018).

Engaging stakeholders in discussions around options and trade-offs is a foundational component of MSP. These deliberations must extend beyond zoning and management choices to encompass economic and social dynamics, including mechanisms to compensate stakeholders who may face reduced access to marine resources. Integrating sustainable financing instruments and incentive-based approaches can enhance stakeholder buy-in and long-term plan viability. Ensuring meaningful participation, especially in contexts where livelihoods are at stake, contributes to fairer and more effective marine governance (Lombard et al. 2019).

## *1.6. Prepare and approve the spatial management plan*

The marine spatial plan is a policy tool that identifies key areas for conservation while also outlining agreed-upon objectives and scenarios for future sectoral developments within the planning region.

### 1.6.1. Prepare a draft marine spatial plan for consultation

A preliminary version of the MSP is formulated based on gathered information and feedback from the initial consultation phase (Ceccarelli et al. 2018). This draft includes maps and supporting materials that outline zoning proposals and other management recommendations. The draft MSP generally comprises several key elements (IOC-UNESCO 2009):

- the overarching vision and objectives;
- a description of the MSP area and its boundaries;
- details of the proposed ocean zones, including a map showing their locations;
- the intended governance arrangements;
- management measures needed to achieve the vision and objectives;
- arrangements for monitoring and evaluation;
- and a timetable specifying the formal actions required to implement the plan, including responsibilities and timelines.

These components provide a comprehensive foundation for the consultation and refinement phases of the MSP process.

The Government of New Caledonia designated 10% of the CSNP as high level protection (IUCN categories I and II) in September of 2023. The draft MSP plan for the CSNP will include an analysis of potential user conflicts, as illustrated by the map presented by the Government of New Caledonia during the 2023 process to expand the fully and highly protected areas of the CSNP, and the feedback provided by members of the CSNP management committee during the public consultation conducted for this expansion.

### 1.6.2. Finalise the marine spatial plan after considering all submissions received during the consultation

Feedback from interested parties, including communities, government agencies, non-governmental organizations, users, and the private sector, will be considered and potentially incorporated to finalize the MSP. The finalized plan must then be approved by the New Caledonian government, which will decide whether to include a consultation phase prior implementation. The responsible management authority or authorities should be clearly identified along with their respective responsibilities (Ceccarelli et al. 2018).

## *2. Phase 2: Implementation of the management measures of the plan*

The most extended phase within the planning cycle is the implementation stage of the marine spatial plan (**Figure 1**). A recent analysis of 11 MSP cases revealed that the review intervals for finalized plans generally vary between 5 and 12 years, depending on the country (Stelzenmüller et al. 2021). Nevertheless, fast-paced changes can undermine certain assumptions of an established marine spatial plan and question the relevance of certain management activities (UNESCO-IOC European Commission 2021). Examples could include shifts in tuna stock distribution in New Caledonia waters due to climate change, as warming ocean temperatures alter migratory patterns, and exploitation of deep-sea mining resources, which could impact previously designated conservation or fishing zones.This highlights the importance of investing in future condition analyses and conducting scenario planning, as outlined in **Section 1.4.3**. Anticipating plausible future developments can help mitigate unexpected challenges or enable timely adaptations.

### *2.1. Guide the MSP through the necessary government processes to enter it into formal law*

To formalize the MSP in New Caledonia, it must navigate the appropriate government processes to ensure it is legally recognized and enforceable. This involves aligning the MSP with existing legislative frameworks or, if necessary, drafting new legislation or amendments to accommodate its objectives and provisions. The process typically begins with submission to relevant governmental bodies, such as the provincial and territorial administrations, for review and endorsement. Public consultations and stakeholder engagements are essential to gather support and address potential conflicts. Once endorsed by the appropriate authorities, the MSP can be presented to the Congress of New Caledonia for approval. Upon legislative adoption, the plan becomes part of the formal legal framework, enabling its implementation and ensuring compliance through regulatory mechanisms and enforcement measures.

## 2.2. Determine and establish surveillance and enforcement strategies

Effective compliance and enforcement are critical to ensuring that MSP achieves its intended objectives, such as sustainable resource management, ecosystem protection, and equitable use of ocean space. Enforcement can demand immediate action. These components uphold legal standards, provide accountability, and help enforce zoning regulations and other MSP policies.

A robust legal framework is essential to define the rules, responsibilities, appointed authority, and enforcement protocols within MSP (IOC-UNESCO 2024, Zuercher et al. 2022). Such frameworks should include:

- **Legal Authority**: Establishes the legal authority for enforcing MSP and MPA rules and policies and clear mandates and methods for enforcement agencies and penalties for violations (Ceccarelli et al. 2018, Zuercher et al 2022). Create accountability mechanisms for stakeholders and set penalties for violations to deter non-compliance (Zuercher et al 2022). Regularly updating legislation to reflect new scientific insights and emerging challenges is important to ensure adaptive management.
- **Integration**: Aligns enforcement with national development priorities while safeguarding marine ecosystems (South Africa's MSP Act 2019).

Where the plan is legally binding, sectoral authorities and approving bodies are required to adhere to its stipulations. A critical aspect of enforcement is ensuring that rules are clearly communicated to stakeholders and applied consistently and transparently. Additionally, stakeholders such as NGOs and market institutions can play a supporting role by detecting and reporting non-compliance. NGOs may initiate legal actions against companies or governments for non-compliance or inadequate enforcement, while banks and insurance companies may condition loans or coverage for offshore developments on compliance with the marine spatial plan (IOC-UNESCO 2009).

To implement MSP effectively, diverse enforcement methods and tools must be employed, including:

**Technological Tools**: Geographic Information Systems (GIS), remote sensing, and automated reporting enhance the ability to monitor compliance and enforce zoning regulations more efficiently. These technologies enable:

- Detection of illegal activities (e.g., unauthorized fishing, habitat destruction).
- Mapping of restricted areas to guide enforcement actions.
- Automated alerts for violations.
- Combine technological tools with field-based patrols to ensure comprehensive coverage.

**Partnerships**: Collaborations with international organizations or regional agencies capable of conducting enforcement, such as coast guards or environmental protection units, can strengthen capacity. Encourage cross-sectoral collaboration to address overlapping jurisdictional issues.

**Capacity building:** Long-term capacity-building initiatives are essential to train personnel in MSP rules, monitoring protocols, and enforcement technologies and ensure sustained enforcement capabilities. Awareness campaigns and participatory approaches can encourage voluntary compliance and reduce enforcement burdens.

**Regular Evaluation**: Enforcement actions should be evaluated periodically to assess their effectiveness and identify gaps or inefficiencies. This feedback loop allows for adjustments to enforcement strategies and integration with broader monitoring and evaluation frameworks (Zuercher et al. 2022, Ceccarelli et al. 2018).

**Resource Constraints:** Enforcement requires adequate funding for equipment, personnel, and training. Budget allocations should be prioritized, with a focus on high-risk or high-value areas.

In the CSNP, the New Caledonia surveillance center monitors the existing protected areas. In addition, the national navy is charged with surveillance of the EEZ for illegal activity and has recently begun to play a larger role in natural resource enforcement. They are well equipped for enforcement of the marine park and would be the ideal organization to carry out this activity.

Monitoring and surveillance in New Caledonia, particularly within the framework of the CSNP, are carried out through collaboration between the State and local authorities. Since 2017, the park's surveillance has been primarily funded through the State-New Caledonia development agreement, with the State contributing 70% (equivalent to 240 million CFP). A modernization of surveillance systems has been implemented, notably through the transformation of the Maritime Rescue Coordination Centre (MRCC) into the Operational Surveillance and Rescue Center (COSS). The COSS ensures continuous monitoring of maritime activities and pollution. Tools such as the Maritime Information Fusion Center (CFIM) allow for the centralization and analysis of data to better coordinate surveillance interventions. Finally, partnerships with the military and recent legislative advancements have strengthened the capacity to effectively protect the CSNP and ensure the sustainable management of its resources.

By integrating robust legal frameworks, leveraging advanced technologies, and fostering partnerships, MSP can achieve its ecological, economic, and social objectives. Continuous monitoring and evaluation further strengthen enforcement by identifying gaps, improving strategies, and ensuring adaptive, equitable governance

## *2.3. Strengthen capacity*

Capacity building is a cornerstone of effective MSP, ensuring that stakeholders across various scales—from local communities to national governments—have the knowledge, skills, and resources necessary to implement, monitor, and adapt MSP effectively. Strengthening capacity not only enhances shared governance but also fosters collaboration across sectors and borders, supporting long-term sustainability. Regular transparent reporting on the beneficial outcomes of increased capacity will help to build support for future investments in capacity building.

### 2.3.1. Building Institutional and Technical Capacity

Developing the capacity of institutions responsible for MSP is essential for its success. This includes training stakeholders to manage and monitor marine spaces, ensuring they have the skills and tools needed for planning and enforcement. Key considerations include:

- **Institutional Capacity**: Entities responsible for developing MSP must have the technical expertise and experience to engage with plan recipients and implementers (Zuercher et al. 2022). This includes the ability to conduct ongoing monitoring, enforcement, evaluation, and adaptation. Strengthening local government capacity is particularly important to implement MSP policies, enforce regulations, and adapt to changing conditions.
- **Training Programs**: Capacity-building efforts should target local authorities, NGOs, and community representatives to empower them with skills in marine resource management and participatory governance. Tailored training initiatives should address specific needs, from GIS and remote sensing to stakeholder engagement and conflict resolution.
- **Knowledge Transfer**: Sharing best practices and lessons learned among institutions can strengthen overall capacity for effective MSP implementation. Encourage knowledge exchange among sectors such as fisheries, tourism, and conservation to ensure an integrated approach.

### 2.3.2. Regional Collaboration for Capacity Building

Regional cooperation is critical for addressing transboundary issues and fostering collective capacity. This is also important so that human uses are not displaced outside of the MSP boundaries and into a neighboring country’s EEZ. Mechanisms such as legal agreements, conventions, and regional fisheries management organizations support shared governance frameworks:

- **Legal Cooperation**: Neighboring nations can collaborate on formal agreements to align MSP efforts, ensuring consistency across shared ecosystems.

- **Sectoral Cooperation**: Regional fisheries management organizations can play a key role in harmonizing conservation and resource use practices. For example, New Caledonia participates in the Western and Central Pacific Fisheries Commission (WCPFC) as a member of the French delegation, contributing to the management and conservation of highly migratory fish stocks, such as tuna, within the Western and Central Pacific Ocean.
- **Policy Frameworks**: Regional conventions and agreements facilitate collective capacity building by pooling resources and expertise to address shared challenges.

Strengthening capacity at all levels is vital for the success of MSP. By investing in institutional capacity, fostering community involvement, and promoting regional collaboration, MSP can achieve its goals of sustainable resource management and equitable governance. Capacity-building initiatives not only empower stakeholders but also ensure the resilience and adaptability of marine planning in the face of evolving challenges.

## *3. Phase 3: Monitoring and evaluation of the marine spatial plan performance*

Monitoring and Evaluation (M&E) are critical components of MSP providing a systematic framework to assess progress, effectiveness, and equity while fostering adaptive management (**Figure 1**) (Ehler 2021). In the context of dynamic marine environments and competing human uses, M&E is not just a mechanism for accountability but a tool for adaptive learning and governance. It ensures that MSP can effectively track and balance ecological preservation, economic development, and social equity (van den Burg et al. 2023). M&E ensures that MSP processes remain dynamic, evidence-based, and responsive to changing environmental, social, and economic conditions. Evaluation complements monitoring by systematically examining the relevance, efficiency, effectiveness, and impact of these activities in light of the set SMARTIE objectives (UNESCO-IOC European Commission 2021). Together, M&E serves two core purposes:

1. **Accountability**: Track and demonstrate policies achieve stated goals and objectives (van den Burg et al. 2023).
2. **Learning and Adaptation**: Stimulates social learning and empowers stakeholders (e.g., effects on the roles and interactions amongst stakeholders in the MSP process) contributing to improved decision-making and adaptive management. M&E enhances MSP quality by fostering participatory processes that promote cross-sectoral and cross-border learning (van den Burg et al. 2023). By continuously monitoring progress, decision makers can adjust strategies to align with new challenges, opportunities, and timing considerations (Giacometti et al. 2020). Involving stakeholders in designing and conducting M&E to enhance cross-sectoral and cross-border learning (van den Burg et al. 2023).

## 3.1. Monitor and evaluate marine spatial planning

Adaptive management mainly relies on two key steps: (1) monitoring and evaluation and (2) revision (IOC-UNESCO 2009). Incorporating robust M&E frameworks into MSP ensures that plans remain relevant, adaptable, and equitable. Effective M&E is vital for ensuring that MSP achieves its intended environmental, social, and economic objectives. The dynamic, iterative process should be periodically reviewed and adjusted to address any constraints (Frazão Santos et al. 2020).

**Process Evaluation**: Starts early and continues throughout the MSP cycle to assess procedural effectiveness and stakeholder participation (Giacometti et al. 2020). Monitor and evaluate representation, recognition, and equitable distribution of benefits and burdens among stakeholders. Assess whether stakeholder engagement was balanced, inclusive, and transparent across all phases of planning (van den Burg et al. 2023). Certain groups may receive greater advantages, or be seen as receiving more benefits, in terms of ongoing or new access to information and data, participation in decision-making, as well as the allocation of space and resources (van den Burg et al. 2023). Ensure that the values, knowledge, and needs of underrepresented groups are reflected in planning outputs and governance processes (Arkema et al. 2024). It is also important to ensure a transparent selection of stakeholder representatives to build trust and track their participation throughout the MSP process.

**Performance and Outcome Monitoring** tracks the achievement of goals and objectives, measuring success or identifying the need for adjustments (Zuercher et al. 2022). This type of monitoring can include indicators like habitat health, fish stock levels, and compliance with zoning regulations (Ehler 2021). Outcome Evaluation is conducted after plans have been in place for a while to measure long-term impacts on environmental, socio-economic, and cultural systems (Frazão Santos et al. 2020, Stelzenmuller et al. 2021). Evaluate whether economic and social benefits and harms resulting from MSP are equitably distributed (Zuercher et al. 2022).

### 3.1.1. Develop the monitoring and evaluation program

A robust monitoring framework helps countries embed the precautionary principles into their plans and track their effectiveness, feasibility and relevance, in order to adapt to changing conditions (Reimer et al. 2023, Kusters et al. 2024). Adapt methods to the specific objectives and context of each MSP initiative, such as addressing ocean-use conflicts or tracking economic benefits (van den Burg et al. 2023). Adaptive MSP processes require customised and concurrent M&E strategies and procedures (Stelzenmuller et al 2021)

An effective M&E plan involves several key actions:

1. Develop the M&E to align with goals and objectives (Zuercher et al. 2022). Objectives must be re-confirmed with stakeholders and decision-makers, as they

may have evolved during the planning process. These objectives form the foundation for the monitoring system. Anticipated outcomes - positive results from the implementation of MSP measures - must be agreed upon. This focus on outcomes helps reframe problems, enhance transparency, and build a knowledge base on what measures work. Advanced tools and data platforms can help support the M&E process, such as :

- Centralize data sharing and visualization to support decision-making (Giacometti et al. 2020).
- Satellite data and targeted patrols can help enforce zoning regulations and prevent illegal activities (Zuercher et al. 2022).
- Advancements in machine learning or artificial intelligence could enhance real-time monitoring and predictive analysis.

2. M&E requires defining clear Key Performance Indicators (KPIs) grounded in scientific approaches and allocating resources for implementation (Ehler 2021, Zuercher et al. 2022). For instance, track the movement of target species and the health of habitats within blue corridors or fish stocks enhancement from protecting spawning and feeding grounds. However, caution is needed to avoid overloading the system with too many indicators, and their selection may require refinement over time.
3. Baseline data must be established to measure current conditions, providing a reference point for assessing future performance. Finally, outcome targets are set, offering measurable interim steps toward achieving longer-term goals. These targets, developed through participatory processes, are informed by outcomes, indicators, and baseline data. Together, these steps create a structured framework to monitor and enhance the success of MSP initiatives (Stelzenmuller et al 2021).

### 3.1.2. Report results of evaluation

KPIs should be analyzed and reported in comparison to baseline conditions and earlier measurements, as this allows for a clearer understanding of trends, directions, and outcomes. The more robust and frequent the data collection, the greater the confidence in identifying meaningful patterns and results. To ensure the findings are effectively communicated, a strong communication strategy is vital for sharing information with stakeholders. Transparent and accessible dissemination of performance data fosters stakeholder trust, encourages their involvement in the governance process, and strengthens the legitimacy of MSP efforts. Open and inclusive evaluations not only build trust but also promote accountability, enabling all stakeholders to engage meaningfully with the results and contribute to adaptive management processes (UNESCO-IOC 2021).

## *3.2. Adapt and revise the marine spatial plan*

Monitoring and evaluation results should inform adjustments to marine spatial planning and management to ensure actions achieve their intended outcomes. Management plans must be periodically reviewed and updated to remain effective. An adaptive approach involves exploring alternative strategies to meet MSP objectives, predicting their potential outcomes based on current knowledge, implementing one or more options, and monitoring their effects. The insights gained are then used to refine and improve management actions. Adaptive management emphasizes continuous learning and is essential for fostering sustainable development in marine management areas (Beaty et al. 2024).

Adjustments may include revising MSP goals and objectives of monitoring and evaluation that reveal their costs outweigh the benefits to society or the environment, modifying desired outcomes if initial objectives are not being met, or altering management measures to explore alternative strategies that are more effective, cost-efficient, or equitable. These modifications should be made as part of the next planning cycle within a continuous process. The initial management measures of any MSP program should be seen as a starting point, designed to influence human activities toward a desired future. While some actions may yield immediate results, others will require longer timeframes to demonstrate their effectiveness (IOC-UNESCO 2009).

## *3.3. Adapting to climate change using MSP*

Consideration for people's capacity to cope and adapt to climate change is crucial for developing and achieving an equitable, inclusive climate-smart MSP (Frazão Santos et al. 2024, Cinner et al. 2018, Bennett 2018). To support climate mitigation, MSP can help offset greenhouse gas emissions associated with shipping, fisheries, and tourism by prioritizing space allocation and adoption of eco-efficient technologies and low-emission energy sources (Frazão Santos et al. 2020).

To support climate adaptation, strategic tools to adjust zoning, protect less vulnerable habitats (deeper coral reefs or upwelling zones), and policies based on new data and climate change impacts are needed. While integrating climate change into MSP remains limited, ***promising approaches*** include (Frazão Santos et al. 2020):

- **Dynamic ocean management** is a flexible planning approach designed to minimize conflicts between shifting ocean resources and mobile human activities. By using near real-time data, such as remote sensing, it enables the adaptive designation of management areas with boundaries that change over time and space (Dunn et al. 2016, Hazen et al. 2018). This approach has significant potential for MSP because it enhances efficiency and adequacy in ocean use by directing activities to more suitable locations, reducing their spatial and temporal footprint (Maxwell et al. 2015). However, its current applications are often limited to specific sectors, such as fisheries and conservation.

- **Anticipatory zoning** is a precautionary approach that involves proactively designating areas for future ocean uses or conservation in response to anticipated climate change impacts (Craig 2012, Hazen et al. 2013, Coleman et al. 2017). This flexible approach minimizes political and legal challenges by protecting sensitive ecosystems, avoiding potential conflicts, and prioritizing ocean uses before significant investments in infrastructure are made (Craig 2012).
- **Just-in-time planning** is a flexible approach that relies on planning laws and rules to address qualitative relationships between activities and system factors, rather than creating rigid, long-term statutory plans. Unlike traditional methods, it avoids attempting to anticipate all possible scenarios or achieving a fixed future vision (Alfasi & Portugali 2004).
- **Anticipatory bidding for use rights** is a proactive approach that combines elements of anticipatory zoning and dynamic ocean management (Craig 2012). It allocates future rights to use specific ocean areas through a competitive bidding process, based on anticipated climate change impacts and evolving resource needs (Craig 2012).

## *4. Conclusion*

In conclusion, the recommendations and conceptual model presented here for the MSP process in the CNSP provide a comprehensive framework for achieving sustainable and equitable marine management in New Caledonia. By integrating ecological preservation, socio-economic development, and cultural heritage, the proposed approach emphasizes inclusivity, adaptability, equity, and evidence-based decision-making. The recommendations underscore the importance of stakeholder engagement, robust governance, and alignment with national and regional policies to ensure the MSP process reflects local realities while addressing global challenges. Through careful planning, continuous monitoring, and adaptive management, this framework seeks to balance the diverse interests of stakeholders, safeguard marine ecosystems, and foster long-term resilience for the Coral Sea Nature Park and the communities of New Caledonia.

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## Chapter 2: Data gathering and gap analysis to implement MSP for the CSNP

Marine Spatial Planning (MSP) is a critical tool for balancing the diverse and often competing demands on marine ecosystems, while ensuring their long-term sustainability. By integrating ecological, social, and economic factors, MSP employs zoning to allocate space for different uses, such as conservation, tourism, and resource extraction. Zoning is a key part of MSP, functioning as a regulatory framework that delineates specific areas for particular activities or protections (Frazão Santos et al. 2020). “Ocean zoning is a set of regulations and maps that specify prohibitions on, or permission for, ocean uses in a given management area” (Frazão Santos et al. 2020). While zoning is not synonymous with planning (Frazão Santos et al. 2020), it is a critical tool to integrate ecological, cultural, and economic objectives to minimize conflicts and foster synergies (Ceccarelli et al. 2018). To address sociocultural connections, MSP must move beyond perceiving ocean systems as spaces and instead recognize them as places tied to community values, local knowledge, and ecological relationships (Wedding et al. 2024).

Data and tools play a central role in ocean zoning, providing the foundation for evidence-based decision-making, conflict resolution, and the integration of ecological, social, and economic priorities into zoning (Stamoulis & Delevaux 2015) (**Figure 1**). To support the MSP process in New Caledonia, we addressed the following questions:

- What data is necessary to implement MSP?
- What knowledge is available?
- What are the gaps for the development and implementation of this model in the Coral Sea Natural Park?
- What knowledge would be necessary to close these gaps?

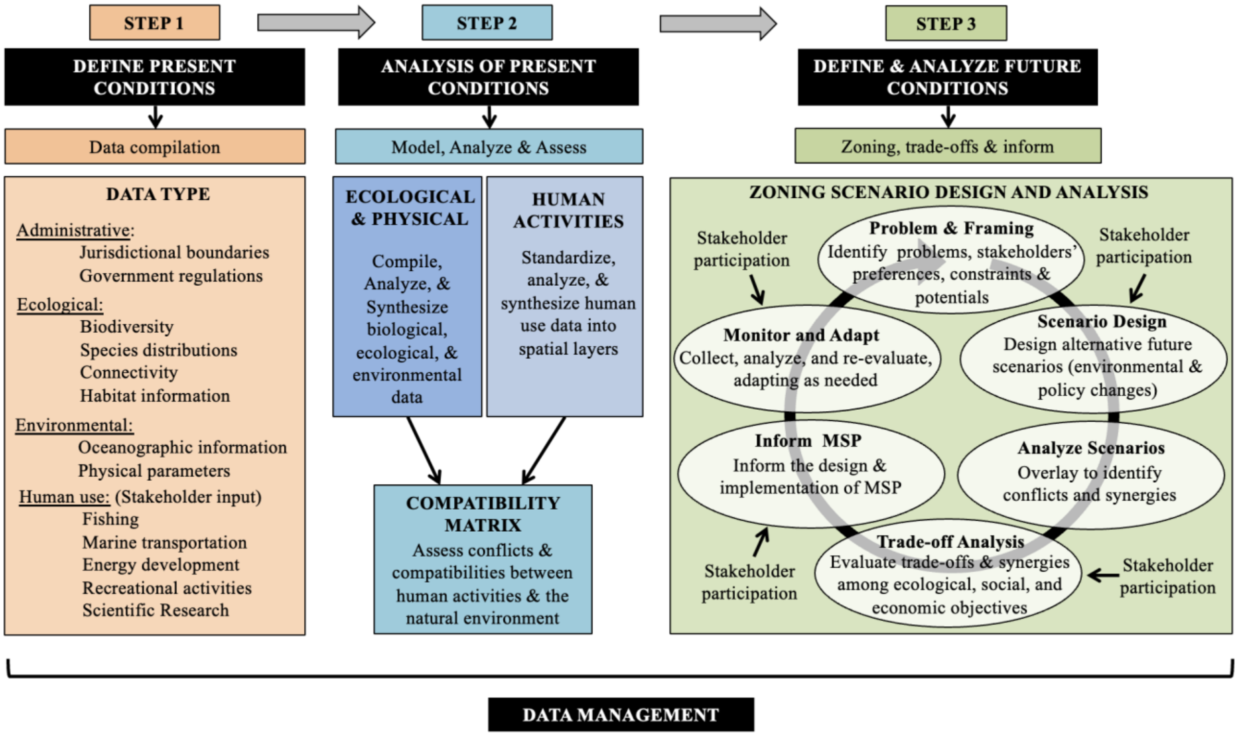


*Figure 1. Key analytical steps, data types and tools for MSP scenario design and analyses (adapted from Stamoulis and Delevaux 2015).*

**Figure 1** outlines the set of key socio-economic and ecological factors that must be taken into account within New Caledonia's maritime space, focusing on ecosystem management and the sustainable development of current or potential maritime activities. These factors then inform discussions aimed at determining the most appropriate management actions for the CSNP's social-ecological contexts.

This chapter will set the foundation for Chapter 3 which aims to develop a conceptual approach to design MPA networks and socio-economic zones to support the local economy and secure the natural capital of the CSP now and into the future for many generations to come.

# 1. Data collection process and necessary to inform MSP

## 1.1. Data necessary for MSP in the CSNP

Implementing MSP in the CSNP relies on diverse categories of (spatial) data to assess existing conditions and support planning processes.

Several categories of spatial data are relevant for MSP (Ceccarelli et al. 2018, Stamoulis & Delevaux 2015, UNESCO-IOC and UNESCO-LINKS 2024, UNESCO-IOC 2021). Below we list the data types necessary to inform the MSP of the CNSP:

1. **Physical Data**:
    - Bathymetry and seafloor topography.
    - Oceanographic processes (e.g., currents, circulation patterns, and upwelling zones).
    - Mean sea level and sea temperature.
    - Ocean winds, wave patterns, and tidal cycles.
    - Water chemistry (e.g., salinity, pH, nutrient levels, and dissolved oxygen).
2. **Ecological Data**:
    - Habitat distribution and characteristics (e.g., coral reefs, seamounts).
    - Species distributions, migration routes, and connectivity pathways.
    - Biodiversity hotspots and areas of ecological significance.
    - Bird migration routes, breeding grounds, and feeding areas.
    - Nursery grounds for key species and high-productivity zones.
3. **Human Activities**: Spatial and temporal information on fishing, shipping, tourism, and infrastructure.
    - **Fisheries**: Fishery zones (e.g., commercial and traditional), fish migration routes, spawning and nursery areas, fisheries restrictions, aquaculture, and port infrastructure.
    - **Tourism and Recreation**: Routes, recreational zones, and anchoring areas.
    - **Maritime Transport**: Shipping routes, port infrastructure, dredging and dumping zones, anchoring areas, vessel traffic density (i.e., AIS data), restricted areas reserved for shipping.
    - **Energy and Raw Materials**: Areas for oil, gas, $CO_2$ storage, mineral extraction, and infrastructure (e.g., pipelines and telecommunication cables).
    - **Cultural Heritage and Indigenous knowledge**: Marine archaeological sites and zones of restricted use.
    - **Installations and infrastructures:** Installed infrastructure (e.g. platforms, farms, bridges, buoys), safety zones and construction fields, exploration and exploitation areas.
    - **Defence:** Radar areas/military observation areas, military exercise areas, restricted areas.
    - **Scientific research:** Measuring stations and networks, research sites.

Cross-cutting themes will also be addressed: global threats (climate change, macro-waste) and human activities not specific to a particular ecosystem (pollution, transport, etc.).

4. **Managed Areas:** MPAs, biosphere reserves, other effective area-based conservation measures (OECMs).
5. Other non-area-based protective measures (laws and regulations), proposed measures by stakeholders.

Together these data will be used to inform the MSP process with particular emphasis on harmonizing two objectives:

1. Conservation of natural resources that require targeted conservation actions.
2. Socio-economic needs relating to human activities to achieve sustainable development.

These objectives are identified through a cross-analysis of conservation priorities and the socio-economic needs relevant to New Caledonia. Balancing and integrating these two categories enables the optimization of economic benefits from various activities while safeguarding biodiversity, ecological processes, and natural resources.

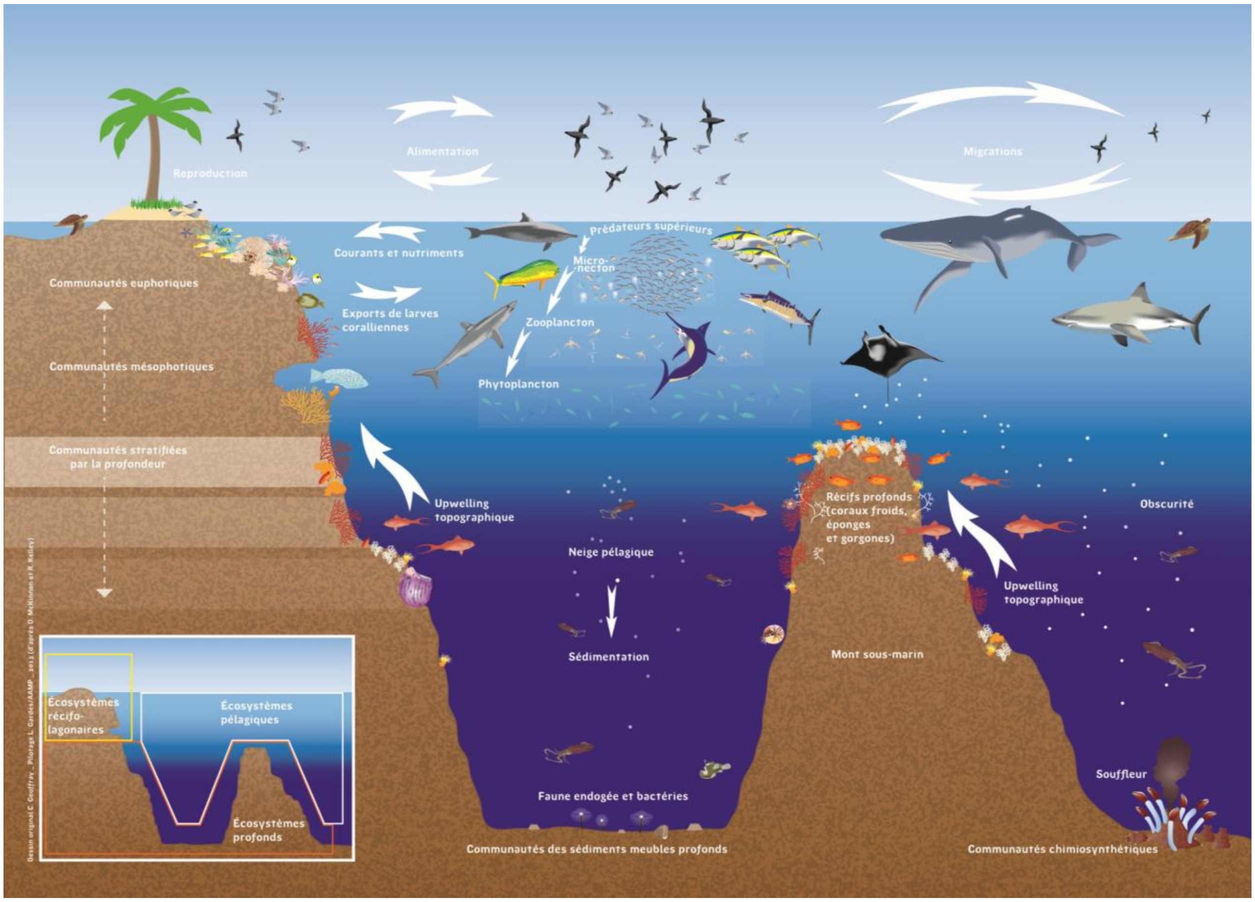

*Figure 2. Conceptual figure of major habitats and key species groups of the CSNP ([Gardes et al. 2014](#)).*

## 1.2. Development process

The data collection and gap analysis were developed based on both technical work and local engagement following the steps described below:

***Step 1: Assess current knowledge of the extent and functions of the ecosystems, biodiversity, and human uses and values, including socio-economic and cultural importance, and archeological value:***

The first phase of analytics identified the main elements of ecosystems, human uses (current and future where they can be anticipated) and global threats to consider for the planning area and zones.

The technical work reviewed existing grey and peer-reviewed literature to identify datasets relevant to the MSP of the CSP. As part of this process we identified individuals that collect and/or manage data in the CSNP whom we contacted to request data (**Table 1**).

*Table 1: List of individuals contacted to request data for the CSNP*

| Name | Position | Descriptifs/Expertise or data |
|---|---|---|
| Auger, Thomas | CI et ancien Observateur des Pêches pour le gouvernement de la Nouvelle-Calédonie | Fishing |
| Cabanes, Sophie | Commandant de la Zone Maritime (CZM) et de l'Action de l'État en Mer (AEM) | Military zones and activities |
| Carlier, Agnès | Directrice, OFB Noumea | Multiple |
| Champilou, Nadège | Direction de l'Industrie, des Mines et de l'Energie (DIMENC), Service Géologie | Deep sea mining |
| Chateau, Olivier | Directeur de l'aquarium | Sea turtles |
| Derville, Solène | Spécialiste des mammifères marins, en poste à l'IRD | Marine mammals |
| Ducrocq, Manuel | Chef adjoint des Pêches et de l'Environnement Marin, Chef du service du parc naturel de la mer de corail et de la pêche | Ecosystems, fishing, proposed MPAs |
| Garrigue, Claire | Opération Cétacés | Marine mammals |
| Jaunay, Elodie | Kenua Agency Directrice | Cruise ship tourism |
| Lagarde, Sébastien | Prestataire en charge de notre étude sur les routes maritimes for PBOL NC | Shipping routes, fishing, recreational boating |

| Name | Position | Descriptifs/Expertise or data |
|---|---|---|
| Laronde, Julie | Directrice de Nouvelle-Calédonie Tourisme (NCT) | Tourism |
| Oremus, Marc | Directeur de l'antenne WWF NC | Sea turtles |
| Tiavouane, Josine | Coordinator at CI et pour la Blue Nature Alliance, du groupe de travail sur la vision Kanak de l’océan | Cultural sites/ zones |
| Vidal, Eric | Spécialiste des oiseaux marins, en poste à l'IRD | Birds migratory routes |
| Vigliola, Laurent | Spécialiste des requins et poissons en poste à l'IRD | Fish and sharks |

***Step 2a: Define the current conditions based on the best available and accessible data:***

Prioritize and integrate the social, ecological and economic values depicted by data to define data gaps, research and monitoring needs and management priorities integrating both conservation and socio-economic dimensions.

***Step 2b: Characterize the quality of the data, identity gaps and prioritize data gathering to consider:***

Establish other proposals for action in terms of acquisition of new knowledge, local, national and regional cooperation, and capacity development to strengthen partnerships across key actors in NC.

Finally, we synthesized the state of the knowledge and information in the CSNP and future actions to fill those gaps and advance the MSP of the CSNP.

## *1.3. Data characterization*

This analysis seeks to identify the most significant knowledge gaps, both qualitatively and quantitatively, and establish a thematic and spatial hierarchy of knowledge needs. The selected data align with relevant criteria and are at an appropriate and consistent spatial scale. For descriptive data on species, resources, and activities, only data acquired in New Caledonia were used. For ecosystem functioning and human activity pressures, examples from the broader literature were included when local information was unavailable. Priority was given to easily accessible data that effectively illustrate distinctive spatial patterns and issues at the scale of New Caledonia’s maritime space.

Accessing data can be challenging due to availability and format issues with both older and recent datasets. Older data are often no longer relevant, inaccessible, proprietary, or unsuitable for conversion to spatially referenced digital data. Recent data often face delays in integration into public use and informing policies and can also have problems of poor accessibility, high cost, or insufficient spatial extent and resolution to inform MSP (Shucksmith et al. 2014).

## *2. Existing data and knowledge gaps for the CNSP*

We gathered available data and those that actors were willing to share and organized them by type, considering spatial scale, resolution, coverage and completeness, and relevance for planning (Zuercher et al. 2022).

Below we describe available and existing data which are summarized in **Appendix**, **Table C2.A1**. We also include a list of existing data from Gardes et al. (2014) in **Appendix**, **Table C2.A2**.

### *2.1. Physical and environmental data*

MSP relies on diverse environmental and oceanographic datasets to ensure informed decision-making and the sustainable management of marine resources. Among these, bathymetry, oceanographic conditions, productivity, temperature, and salinity play crucial roles in defining ecological, economic, and social priorities for marine space allocation (IOC-UNESCO 2009).

#### 2.1.1. Bathymetry

Understanding the seafloor topography can help define (Wanda et al. 2023):

- Marine habitats by influencing species distributions, ecosystem connectivity, and habitat suitability (e.g., deep-sea corals, seagrass meadows). Identifies essential habitats such as seamounts, ridges, and canyons, which are biodiversity hotspots or migratory corridors.
- Supports the designation of navigation routes and fishing zones by indicating areas suitable for specific gear types (e.g., trawling vs. longline fishing).
- Guides infrastructure planning (e.g., offshore energy installations, submarine cables, aquaculture siting).
- Contributes to hydrodynamic modeling, affecting ocean currents, nutrient transport, and sediment deposition.

By combining the 2024 GEBCO bathymetric layers, the 2021 New Caledonia façade MNT, and the 2022 multibeam data (**Figure 3**), an updated “hybrid” bathymetry map was produced for the PNMC (**Figure 4**, Baletaud et al. 2024). Multibeam sounder data now covers 40.5% of the PNMC, representing an increase of about 4% (an additional 51,500 km²) since the previous inventory in 2019 (Baletaud et al. 2024).

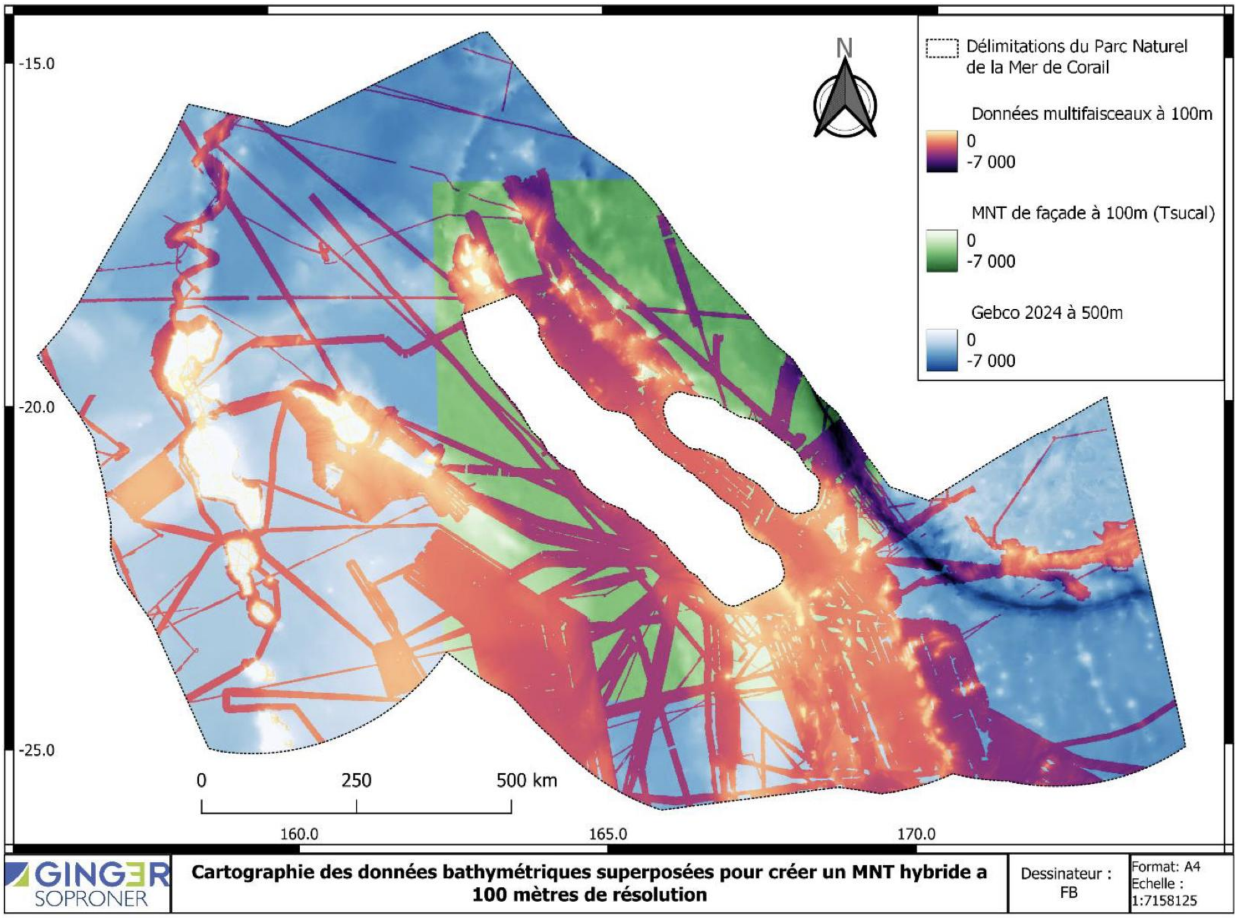


*Figure 3. Illustration of the three bathymetric layers used as data sources to compile the most up-to-date depth values within the Park (Baletaud et al. 2024).*

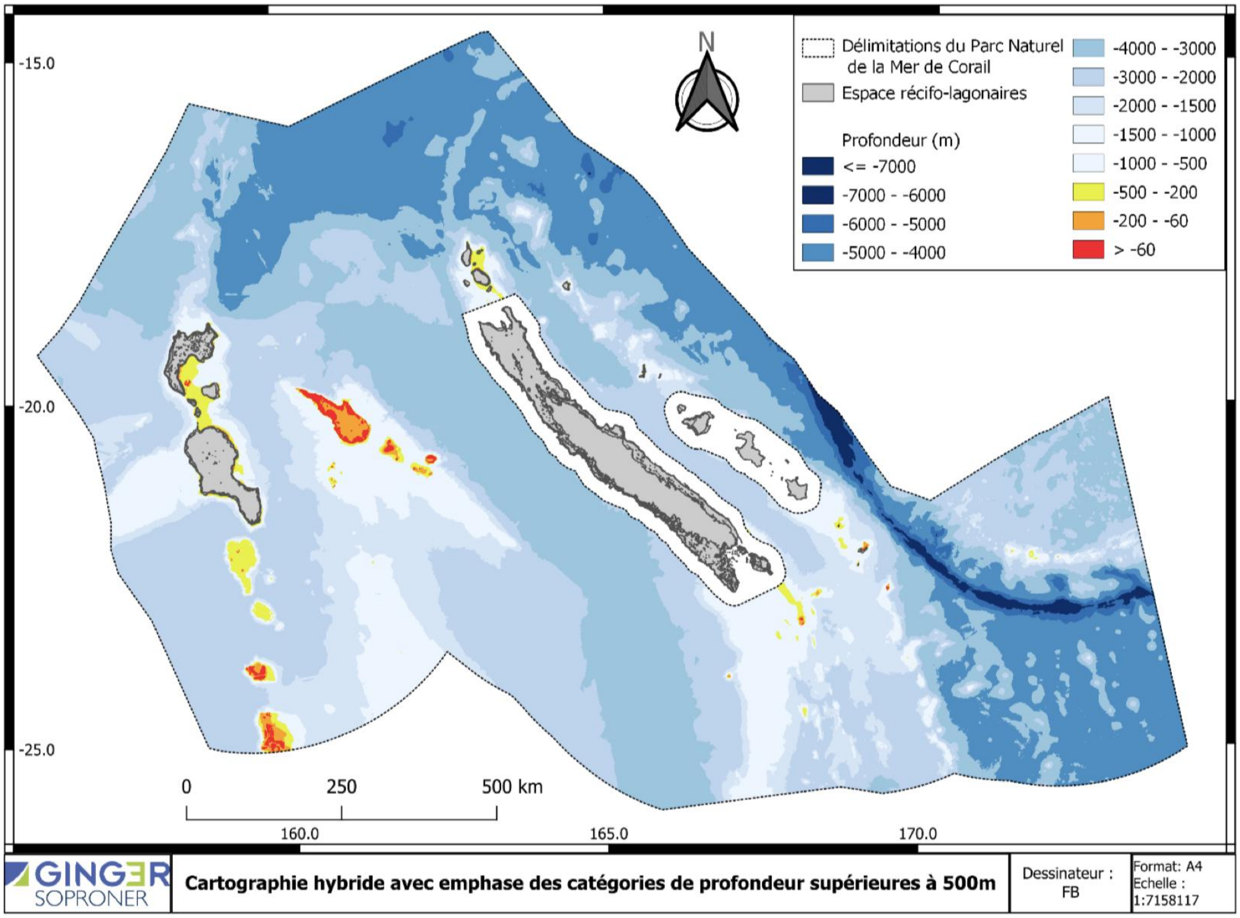


*Figure 4. "Hybrid" DEM of bathymetry in the CSNP with an emphasis on depths less than 500 m illustrating areas of distant reefs and shallower seamounts (Baletaud et al. 2024).*

## 2.1.2. Oceanography

Data on oceanographic conditions, such as currents, circulation, temperature, salinity and productivity, discussed below, are important to MSP because they drive the following processes (UNESCO-IOC 2021):

- Influences connectivity between ecosystems and dispersal patterns for larval transport (e.g., fish, corals).
- Determines nutrient transport and influences ocean stratification affecting productivity and food webs, and fisheries productivity.
- Determines species distributions and ecosystem boundaries, influencing where marine species can thrive (e.g., corals, fisheries stocks, migratory species).
- A determinant in the placement of human use activities, both in terms of potential impacts (e.g., from a vessel spill and what may be impacted downstream); and

for considerations of sea conditions in the case of the placement of vessel traffic lanes or placement of most productive fishing grounds.

The year-round trade wind regime has a major impact on circulation in the maritime space of New Caledonia. During the hot season, winds tend to be more stable and stronger in the southern part of the EEZ, while remaining weaker in the north (Pagli et al. 2024). Both currents and trade winds strongly affect surface oceanographic characteristics, with distinct seasonal variations observed (Pagli et al. 2024).

*Currents / Regional circulation*

The primary currents in the tropical Pacific Ocean arise from easterly winds, creating westward flow known as the South Equatorial Current (SEC). The westward-flowing South Equatorial Current (SEC) does not remain a single continuous current but instead splits into multiple zonal jets upon reaching the islands of Fiji, Vanuatu, and New Caledonia. These include the North and South Fiji Jets, the North Vanuatu Jet (NVJ), and the North Caledonian Jet (Cravatte et al. 2015). The SEC branch that originates north of Fiji is primarily deflected northward upon encountering the Vanuatu Archipelago, supplying the westward-flowing NVJ north of Santo Island. A smaller portion of this branch appears to pass through more permeable sections of the Vanuatu Archipelago, directly feeding the North Caledonian Jet near 17°S or recirculating eastward toward Fiji (Cravatte et al. 2015).

Between 18°S and 22°S, the SEC branch known as the South Fiji Jet is largely diverted southward upon meeting the Vanuatu Archipelago, subsequently feeding the northwestward-flowing East Caledonian Current, which runs east of the Loyalty Islands. The East Caledonian Current continues to supply both the narrow North Caledonian Jet, which flows westward between 17°S and 18°S, and potentially the “Grand Passage,” a 500-meter-deep, 52-kilometer-wide channel located between the main island reef and the d’Entrecasteaux reef (**Figure 5**, Cravatte et al. 2015).

*Figure 5. Modeled currents around New Caledonia. Colors represent the average velocity and direction (red: eastward and blue: westward, in cm/s). Black and gray shading shows depths of 0, 100 and 300 m. Points with no data are white (Cravatte et al. 2015).*

*Waves*

During the austral summer, New Caledonia is influenced by waves from multiple sources, including swells from the Tasman Sea (south to southwest), trade wind waves from the Central South Pacific (southeast), north swells from mid-latitudes in the Northern Hemisphere, and waves driven by the Northern Hemisphere’s northeast trade winds (**Figure 6**). In contrast, the wave climate during the austral winter is primarily dominated by swells from the Tasman Sea. These long-period waves (~15 seconds) result from strong winds blowing over extensive fetches, such as those in Regime 4 (**Figure 6a**). In comparison, waves generated by southeast trade winds (Regime 2, **Figure 6a**) have shorter periods, as they originate locally under weaker winds and are therefore younger (Pagli et al. 2024).

*Figure 6. (a) Average of significant wave height, direction and wave period (bottom row) for the four wave regimes. (b) Average Seasonal occurrence over 1990–2017 fore each of the four wave regimes (Pagli et al. 2024)*

These four primary wave regimes are influenced by the El Niño–Southern Oscillation (ENSO) and the Southern Annular Mode (SAM). During El Niño, Tasman Sea swells and trade-wind waves are more common, while La Niña increases swells from the northern hemisphere westerlies above 30°N and waves are driven by northeast trade winds. SAM also influences the variability of wind and waves in the Southern Hemisphere mid-latitudes. During summer, the negative phase of SAM increases the frequency of high energy Tasman Sea swells (Regime 4, **Figure 6b**, Pagli et al. 2024).

*Water temperature and salinity*

Mean surface temperature shows a strong north-south gradient (**Figure 7**) and also differs notably between the east and west coasts. Seasonal variation is most pronounced in the southeastern region of the EEZ, with temperatures differing by as much as 5 °C between the hot and cool seasons, whereas temperature fluctuations are smaller in the northern area (Vega et al. 2006). Upwelling to the southwest of Grande Terre brings colder waters to the surface, occasionally below 23 °C even during the hot season. Additionally, New Caledonia serves as a barrier to the circulation of water masses, resulting in a north-south contrast in average temperatures between the east and west coasts. Generally, waters on the east coast are warmer than those on the west coast.

Surface salinity exhibits patterns similar to temperature, featuring a dominant north-south gradient and a distinct east-west gradient, with higher salinities found in western New Caledonia. Salinity levels can reach 35.6 ‰ in the south but drop below 35.1 ‰ in the north. During the warm season, the east-west contrast in salinity intensifies compared to the cool season. The greatest seasonal variability occurs west of the EEZ, around the Chesterfield Islands, while the lowest fluctuations are observed in the northern and southern regions of the EEZ (Vega et al. 2006).

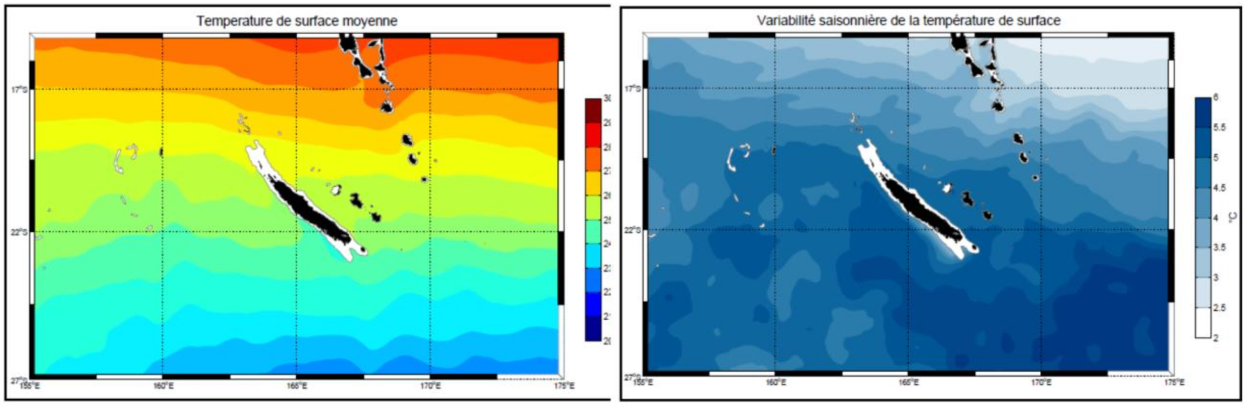


*Figure 7. Annual mean surface temperatures (left) and annual surface temperature variability (right) (from Vega et al. 2006).*

*The upwelling to the southwest of Grande-Terre*

Upwelling occurs along the west coast of New Caledonia from November to April, driven by trade winds during the warmer months (**Figure 8**, Vega et al. 2006). This process cools surface waters and introduces a significant influx of nutrients. Water sampling has revealed that New Caledonia is part of a globally significant nitrogen fixation hotspot in the Western Tropical South Pacific linked to surface iron concentrations that fuel plankton blooms (Bonnet et al. 2017). During upwelling, chlorophyll *a* concentrations (primary productivity) increase and consequently provide abundant food for secondary productivity such as zooplankton, pelagic fish and diverse marine megafauna (Smeti et al. 2015). Identifying areas of upwelling are important to the MSP process because nutrient rich waters are an important part of the food chain attracting seabirds, marine mammals, fisheries resources, and an indication that may be afforded high levels of protection in an MSP plan.

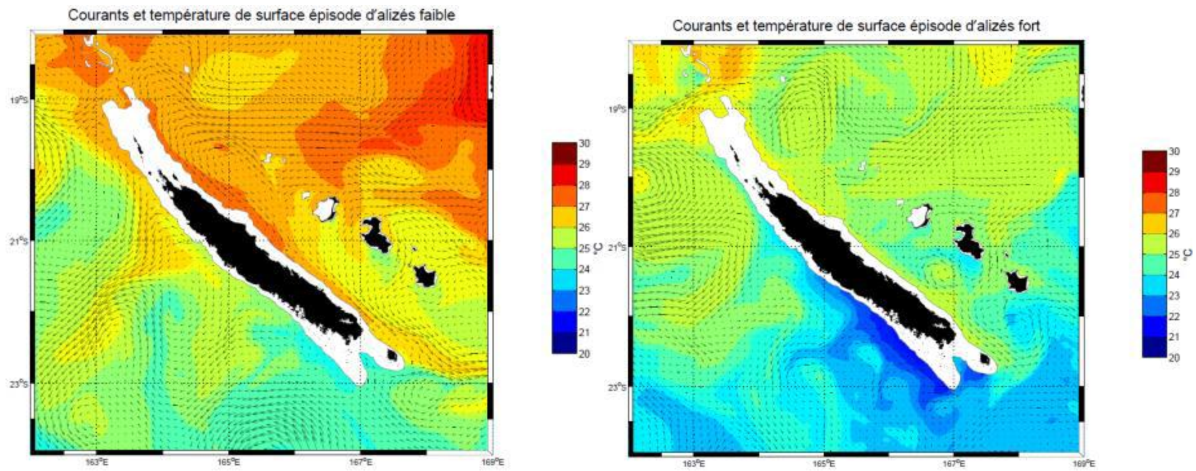


*Figure 8: Circulation patterns during the absence and presence of an upwelling event in the hot season. On the left, the situation of weak trade wind, on the right the situation of strong and sustained trade wind. (Vega et al. 2006).*

### 2.1.3 Deep sea resources and vulnerable ecosystems

Due to its distinctive geological history, the seabed of New Caledonia's maritime area contains potential mineral and hydrocarbon resources, as well as a variety of marine habitats that have fostered diverse fauna. Scientific campaigns since the mid-1980s have underscored the remarkable nature of New Caledonia's deep sea ecosystems, while research under the ZoNéCo program confirmed the presence of hydrocarbon potential (Gardes et al. 2014). In 2009, the Government of New Caledonia announced plans to revive deep-sea exploration and scientific work to promote its EEZ to industry (Gardes et al. 2014). Following these efforts, industry requests led the government to undertake a review of its regulatory framework for hydrocarbons in the EEZ in 2012 (Gardes et al. 2014).

In June 2023, the New Caledonian government drafted a law imposing a ten-year moratorium on deep-sea mineral resource exploration and exploitation within its EEZ (Boltz 2023). Additionally, New Caledonia, as a member of the Pacific Islands Forum (PIF), is among the ten members opposing the imminent commencement of deep-sea mining activities (Fepulea'i-Tapua'i 2025). This collective stance reflects a precautionary approach, emphasizing the need for comprehensive scientific research to understand the potential environmental impacts before proceeding with deep-sea mining. However, New Caledonia has not yet enacted the proposed ten-year moratorium on deep-sea mining within its EEZ. While the government has expressed strong support for this moratorium, the legislative process is still underway, and the ban has not been officially implemented. Consequently, deep-sea mining activities remain under consideration, pending the formal adoption of the moratorium.

*Benthic habitat diversity*

The diversity of potential benthic habitats was assessed through a synthesis of available physical data, including substrate types, seabed morphology, and the characteristics of water masses near the seabed. The analysis highlighted the most diverse areas, including the Guyot Chain of Lord Howe's Ridge, the northern and southern regions of the Norfolk Ridge, the Landsdowne Bench and Fairway Ridges, the Loyalty Ridge from north to south, and the margins of the New Hebrides Trench, particularly around the Matthew and Hunter zone (Gardes et al. 2014). By integrating these datasets, distinct physical habitat types were identified. This information was grouped into 0.25° polygons, where the number of distinct habitat types (**Figure 9**) was calculated to represent physical habitat diversity. In contrast, less diverse areas included the Entrecasteaux Basin, the southern Lord Howe Ridge and Basin, the Fairway Basin, and the New Caledonian, Loyalty, and North Fiji Basin, as well as parts of the South Fiji Basin (Gardes et al. 2014). However, limited data availability in basin areas may obscure their true diversity. Additionally, these basins likely harbor a variety of habitats and associated communities that remain undescribed and understudied. Further deep sea exploration will help address spatial data gaps and provide data to build better predictive models (e.g., Costa et al. 2015) when combined with environmental data to identify and rank seafloor biodiversity including mesophotic reefs.

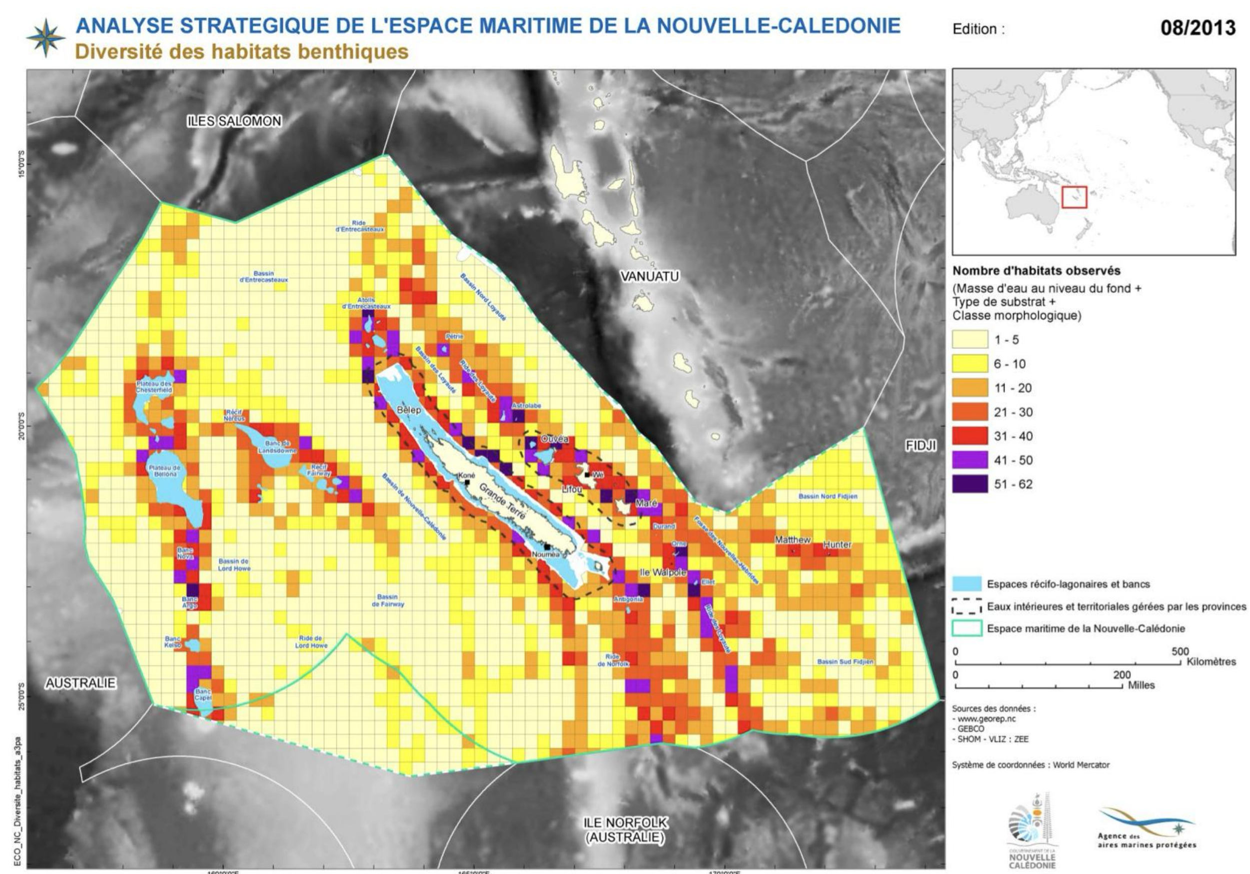

*Figure 9. Synthesis of benthic habitat diversity within the maritime space of New Caledonia. Diversity was assessed based on the morphology, nature and type of the seabed, as well as the nature of the water masses present (Gardes et al. 2014).*

### *Hydrocarbon and mineral resources*

The entire continental region within the EEZ exhibits significant oil potential, including areas such as the Fairway Basin, New Caledonia Basin, Norfolk Ridge, Lord Howe Ridge, and Loyalty Basin. This region is part of the submerged continent known as "Zealandia," which encompasses New Caledonia and New Zealand (Gardes et al. 2014). Deep sea mineral resources including polymetallic nodules, ferromagnesian crusts, and sulphide deposits all have potential for exploitation within New Caledonia's EEZ (Maurizot et al. 2009, Gardes et al. 2014). Gardes et al. (2014) mapped potential areas for deep sea mining based on available information (**Figure 10**).

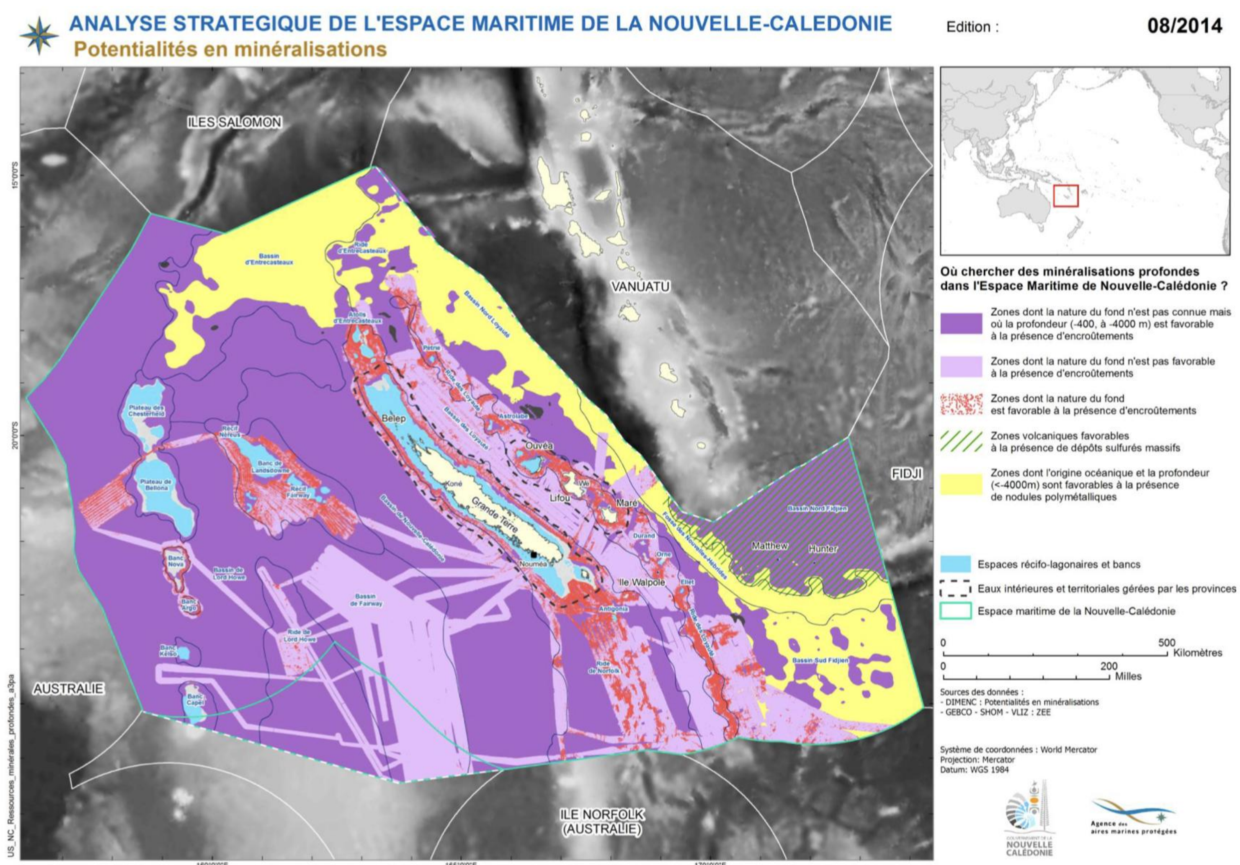

*Figure 10. Map of potential areas for deep sea minerals in the maritime space of New Caledonia (Gardes et al. 2014).*

### 2.1.4. Climate

New Caledonia, located just north of the Tropic of Capricorn, experiences a mix of tropical and temperate climates that vary throughout the year. However, the surrounding ocean and steady trade winds help to regulate these influences. The hot season, which occurs during the first few months of the year, is shaped by tropical weather patterns and the South Pacific Convergence Zone (SPCZ). This season is characterized by heavy rainfall and high temperatures, though extreme heat is softened by ocean breezes. It is also the time when tropical storms and cyclones are most likely to occur, sometimes causing significant damage. In contrast, the cool season lasts from June to September and brings a shift in weather patterns as the SPCZ moves northeast. During this time, temperate weather systems from the Tasman Sea push northward, bringing cold fronts, rain, and occasional westerly winds. These disturbances interrupt the usual dry and mild weather, sometimes leading to lower temperatures, especially in certain areas. (Maitrepierre and Caudmont 2007).

The shift between seasons in New Caledonia happens gradually, making it hard to pinpoint exactly when one ends and the next begins. The dry season, which runs from August to November, falls between the cool and hot seasons. During this time, rainfall is minimal, with cool nights and increasingly warm days as the sun's intensity peaks in December. The lack of rain, combined with high evaporation rates, dries out vegetation, making the landscape more prone to bushfires—especially when strong trade winds and thermal breezes are present. The return of much-needed rain is eagerly awaited, but El Niño events can delay it significantly, leading to even drier and harsher conditions. (Maitrepierre and Caudmont 2007).

*Cyclones*

Cyclones are among the most intense weather events on Earth, capable of significantly impacting coral ecosystems and islands. Their effects, sometimes dating back centuries, are often evident on reefs exposed to the open ocean. In this sense, cyclones play a natural role in shaping the evolution of reefs and the communities they support. **Figure 11** highlights the relatively high cyclone risk in the northern part of the maritime area, suggesting greater vulnerability of the reef-lagoon ecosystems in Chesterfield, Bellona, and Entrecasteaux to these powerful and destructive events.

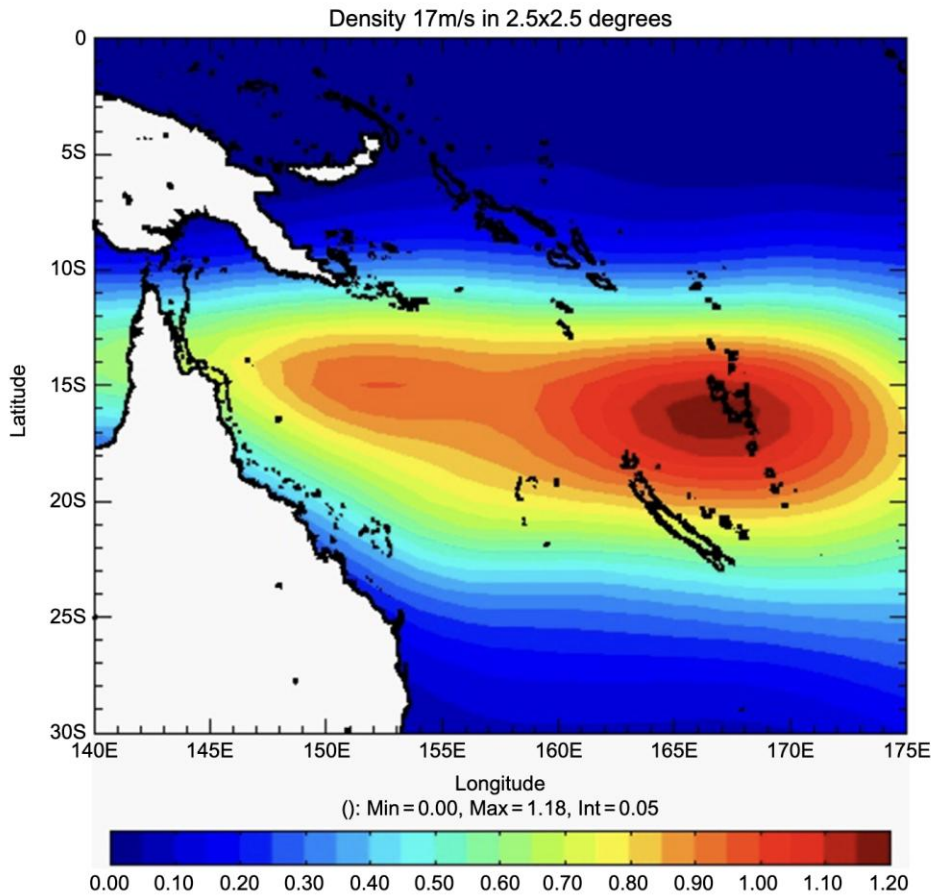


*Figure 11. Yearly cyclone density for the 1970–2007 period calculated from the IBTraCS cyclone database (Knapp et al. 2010, https://www.ncdc.noaa.gov/ibtracs/). Only storms with wind speed above 17 m/s are included (Payri et al. 2019).*

*Climate change*

Over the past four decades, air temperatures in New Caledonia have risen by approximately 1.2°C, while sea surface temperatures have increased more gradually, by about 0.5°C over the past 50 years. However, no significant changes have been detected in available data on precipitation, the El Niño–Southern Oscillation (ENSO), or cyclones (Payri et al. 2019). Since 1993, satellite observations indicate an absolute sea level rise of approximately 3.5 mm/year in New Caledonia, whereas tide gauge data from Nouméa suggest a relative sea level rise of 2.2 mm/year ± 1.7 over the same period (**Figure 12**, Aucan et al. 2017). Long-term records dating back to the late 1950s show a more moderate rate of relative sea level rise at ~0.9 mm/year ± 0.4. These measurements also highlight a distinct annual cycle (~10 cm) and strong interannual variability (~30 cm) (**Figure 12**, Payri et al. 2019).

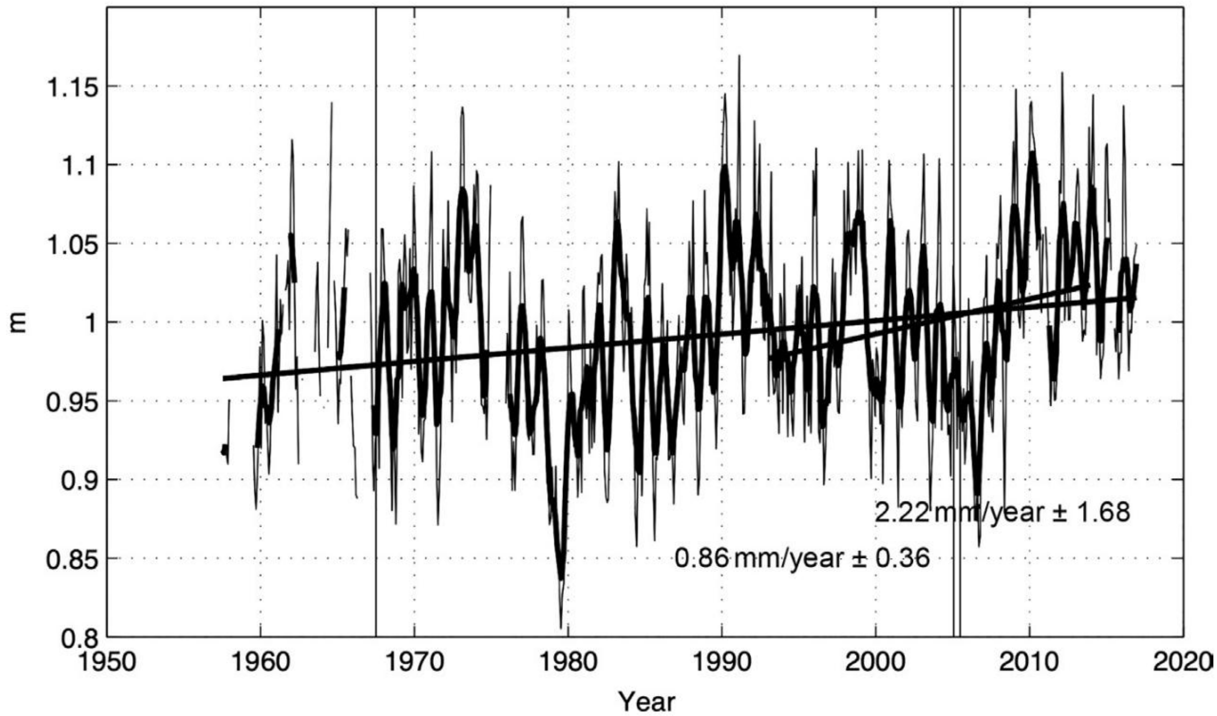


*Figure 12. Observed sea level in Nouméa, from reconstructed tide gauge data, between 1957 and 2017. (Payri et al. 2019, Aucan et al. 2017).*

Future climate conditions will be determined by greenhouse gas emission levels. This analysis focuses on the RCP8.5 scenario, commonly known as the "business as usual" scenario, which reflects current emission trends. Under this projection, sea surface temperatures (SST) in New Caledonia are expected to rise by approximately 2.5°C by 2100 compared to 2009 levels (**Figure 13**, Payri et al. 2019). Changes in precipitation patterns remain uncertain, as climate models struggle to accurately represent the South Pacific Convergence Zone (SPCZ), leading to no clear consensus on future trends. Similarly, studies examining potential shifts in the El Niño–Southern Oscillation (ENSO) have yet to reach an agreement on overall patterns. However, Cai et al. (2012) suggest that under RCP8.5, the frequency of the strongest El Niño events could double by 2100, increasing from approximately one every 15 years to one every seven years. These intensified events could have significant consequences for drought frequency, precipitation distribution, and ocean productivity.

Projections for cyclones in the South Pacific suggest a potential decrease in frequency, estimated between 0% and 70%, though there is no clear agreement on whether their intensity will change (Payri et al. 2019). Regarding sea level rise, climate models provide estimates based on emission scenarios, predicting a relative sea level increase of 40 to 80 cm in New Caledonia and the Southwest Pacific region by the end of the century (IPCC 2021).

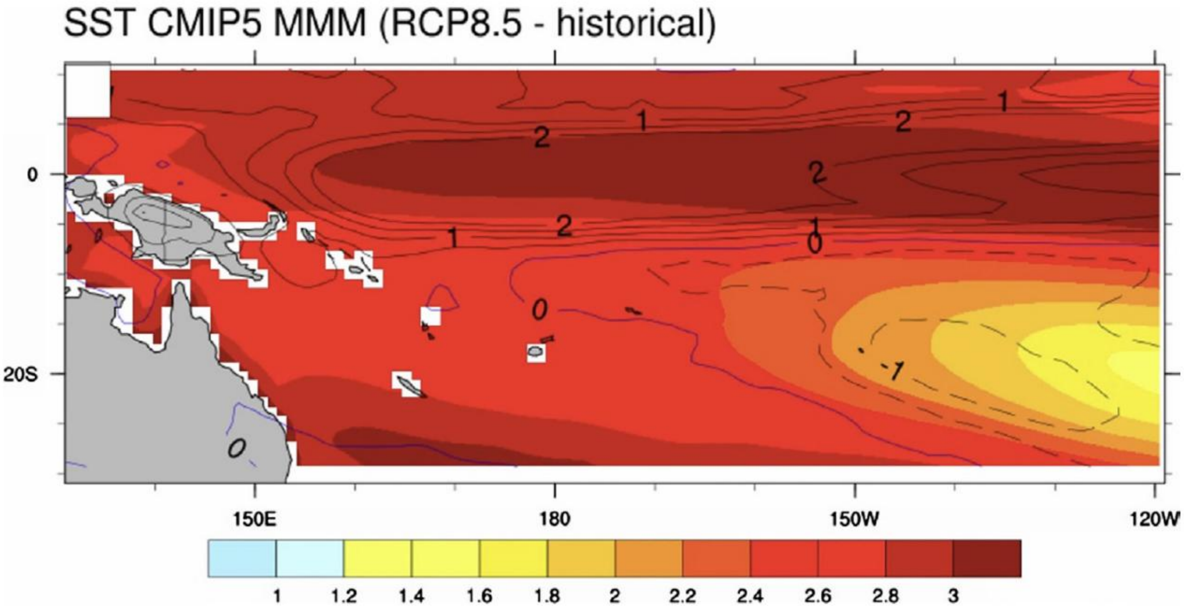


*Figure 13. Sea surface temperature (SST) changes in degrees Celsius are based on the average projections from 35 climate models under the RCP8.5 scenario. The changes are shown as the difference between the 2080–2099 period and the 1989–2009 baseline. Contour lines indicate the predicted precipitation changes over the same period, measured in millimeters per day (Payri et al. 2019).*

### 2.1.5. Data gaps for the physical environment

Bathymetry data for the maritime space remains incomplete, including in areas with particularly high biological potential. Multibeam coverage, which are direct measurements and therefore the most accurate, currently accounts for 40.5% of the CSNP (Baletaud et al. 2024). This data is essential for characterizing deep sea habitats. This is particularly true for all zones whose bathymetry is less than 1000 m. These areas are particularly rich, both in terms of biodiversity and potential resources, and whose bathymetric coverage by multibeam sounder could be completed relatively easily. The northern and southeast parts of the maritime space are also bathymetric data gaps and the great depths in these areas require the mobilization of more efficient sounders.

Little in-situ sampling data has been acquired to date on the physical chemistry of seawater, especially in deep areas of New Caledonia. Global models are available to fill these gaps (www.bio-oracle.org, ecological marine units), however, higher resolution regional models more appropriate for local planning and research would benefit from validation through in-situ data collection. It would also be useful to improve the characterization of localized enrichment, particularly around remote islands and the main reliefs of the maritime space.

MSP in the South Pacific is increasingly challenged by climate change, yet significant data gaps remain that hinder effective adaptation and management. One major gap is the lack of fine-scale oceanographic and biophysical models that predict changes in sea surface temperature, ocean acidification, and extreme weather events at regional levels. These oceanographic processes drive patterns in primary productivity and fisheries stocks, among other factors relevant to MSP.

The ambiguity of what climate change impacts in the CSNP MSP process poses a lot of uncertainty. This provides a strong argument for invoking the precautionary principle and conducting a large-scale vulnerability assessment in order to prioritize which ecological resources should be ensured greater protection. Vulnerability Assessments are a useful tool (Zacharias and Gregr 2005) for figuring out where an MPA should concentrate their capital (human, financial, political) in terms of protection of natural resources.

## *2.2. Ecological data*

Three major groups of ecosystems are found within the maritime space of New Caledonia, each with their own species assemblages and habitat types:

- **Coral reef and island ecosystems** form atop significant underwater landforms. Their existence depends on corals and other fixed organisms, most of which thrive in clear, warm waters.
- **Pelagic ecosystems** are linked to oceanic water masses and host numerous organisms that inhabit and interact within the water column. The intricate dynamics of these ecosystems are shaped by the biophysical and chemical properties, as well as the movement of water masses.
- **Deep benthic ecosystems** are associated with the geological complexity of the seabed and are sustained by sedentary organisms such as cold-water corals and sponges. These ecosystems are typically found on the slopes of islands, reefs, and seamounts at depths ranging from 200 to 2,000 meters.

## 2.2.1. Habitats

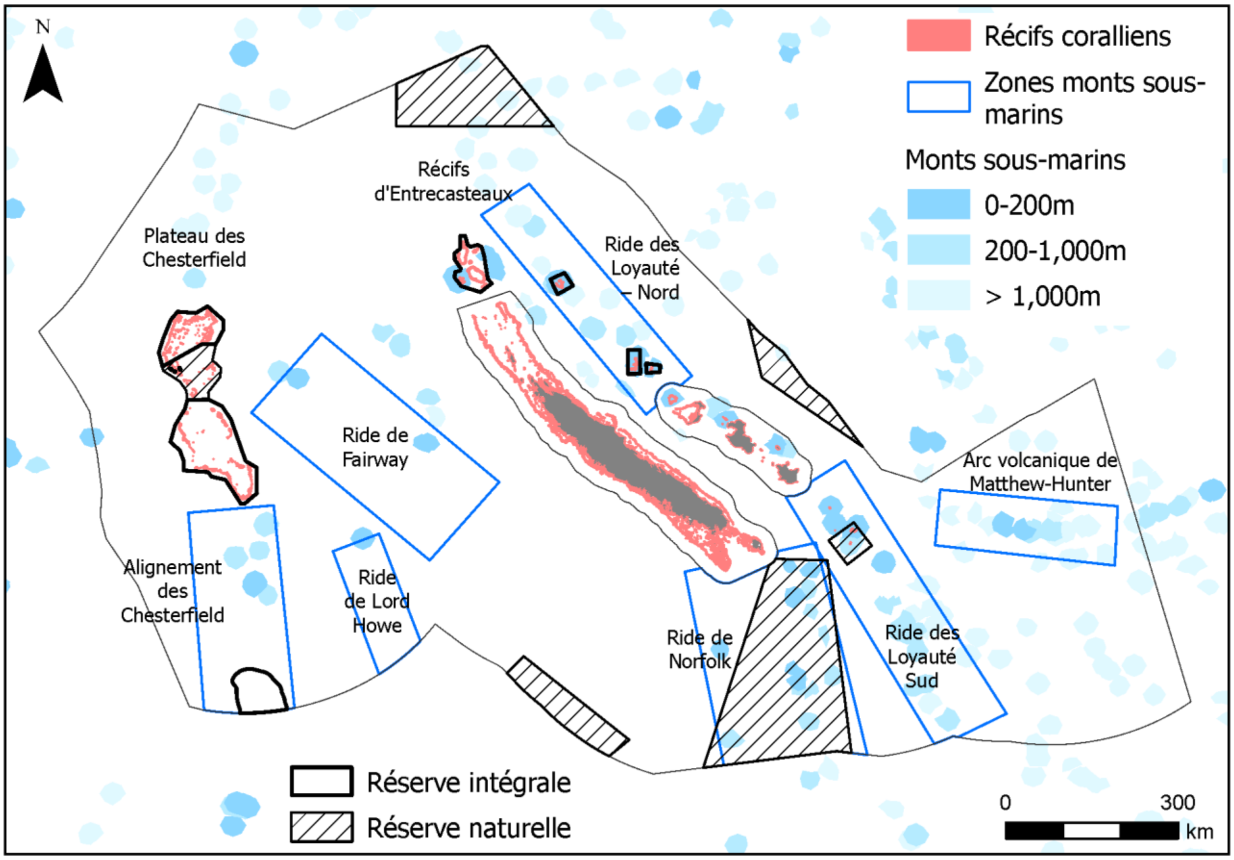


*Figure 14: Coral reefs (Allen Coral Atlas) & seamounts of the CSNP shown with the existing marine reserves: integral reserves (IUCN category I) and natural reserves (IUCN category II). These existing reserves are included for reference in various maps and further described in Section 2.4. Seamount data is from Yesson et al. (2011) and seamount zones delineate areas determined to be important for management.*

*Coral reefs*

The coral reefs of New Caledonia represent a cumulative area of nearly 13,700 km². 44% of New Caledonia's reef-lagoon areas are part of the CSNP under the jurisdiction of the Government of New Caledonia. The remaining 56% are associated with the inhabited islands and fall under the jurisdictions of the three provinces (Gardes et al. 2014). The coral reefs of the CSNP are grouped into four major areas, aligned with the emergence of the Lord Howe, Fairway, Norfolk, and Loyalty ridges, as well as the edge of the subduction trench between the North and South Fiji basins (**Figure 14**).

The Lord Howe Ridge, situated 200 miles west of Grande Terre in the central Coral Sea, is home to the Chesterfield-Bellona reef-lagoon complex. This ecosystem covers more than 13,000 km² of reef-lagoon habitats and forms two plateaux: the Chesterfield and Bellona (**Figure 14**, Gardes et al. 2014). The Fairway Ridge is midway between Grande Terre and the Guyot Chain of the Lord Howe Ridge, supporting two reef-lagoon systems (**Figure 14**). To the north lies the Landsdowne Bank, culminating in the northwest with the Nereus Reef. To the southeast are the Fairway Reef, forming the second significant reef-lagoon assembly. The Norfolk Ridge includes the reefs of Entrecasteaux, Grande Terre and Ile des Pins. The Entrecasteaux Reefs, covering a total area of 951 km², consist of four atolls and two isolated reefs (**Figure 14**). Finally, in addition to the coral reefs of the inhabited Loyalty islands, the Loyalty Ridge hosts several reef complexes within the boundary of the CSNP including (from north to south) Petrie reef, Astrolabe reef, Durand reef, Orne bank, Walpole island, and Ellet bank (**Figure 14**).

*Coral reef bioregions*

A detailed study was carried out to classify reef-associated areas based on both biological and environmental data (Beger et al. 2020). Researchers gathered biodiversity records from multiple sources, including scientific contributors, open-access databases, and existing studies within the region. To ensure accurate predictions, species distribution models were created for species that had been recorded at least 30 times across the Pacific. The key environmental factors used in the analysis included calcite levels, chlorophyll-a concentrations, sea surface temperature, pH, light availability (photosynthetically active radiation), and nitrate levels. These variables were chosen because they align with previous large-scale coral reef studies, making them reliable indicators for modeling reef ecosystems. Reef-associated bioregions were classified based on the modeled probabilities of species occurrence, grouping sites with similar species assemblages into clusters (**Figure 15**, Beger et al. 2020).

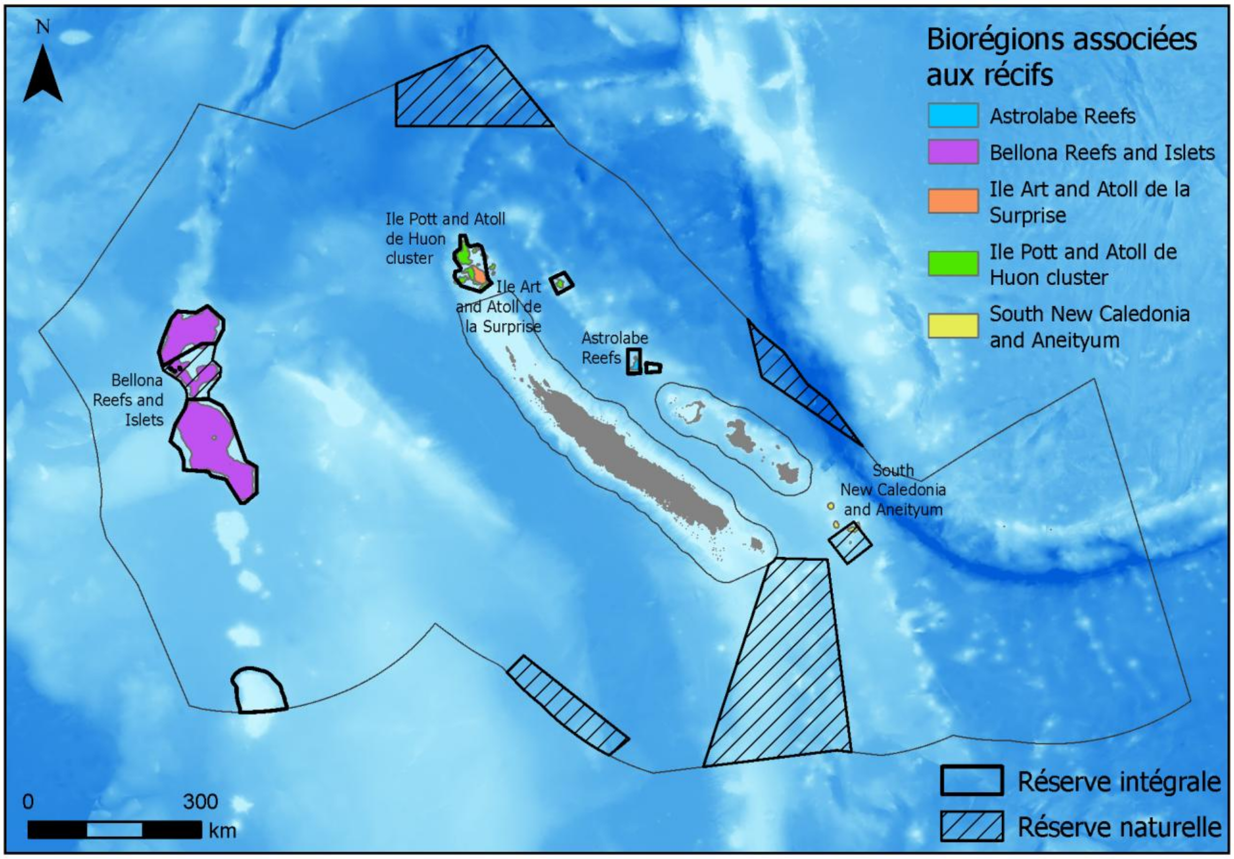


*Figure 15. Map of coral reef bioregions in the CSNP data from Beger et al. 2020).*

*Seamounts and deep sea*

The ecological role of seamounts is largely determined by their physical characteristics, particularly their elevation relative to the ocean floor. Greater elevations often correlate with higher biological diversity, as these features provide habitats for various marine organisms. When the summit of a seamount reaches the shallow zone (<200 m depth), interactions with the photic zone can enhance biological productivity through oceanographic processes like nutrient-rich upwellings and plankton trapping. This increased food availability supports benthic communities and mobile fauna, with some shallow seamounts serving as critical habitats for pelagic species (Genin and Dower 2007). Light penetration, which can extend to depths of around 1000 m, is another key structuring factor; beyond this depth, total darkness prevails.

To account for these features, seamount elevations were categorized based on height (Allain et al. 2008) and summit depth (**Figure 16**, Gardes et al. 2014). Those > 1000 meters in height are seamounts, 500-1000 m are domes, and > 500 m are hills. These are further classified by depth to distinguish those between the surface and -200 m, those between -200 m and -1000 m, and those deeper than -1000 m. Over one-third of seamounts in New Caledonia rise more than 2,000 meters from the ocean floor. Among them, sixteen seamounts are even taller, exceeding 3,000 meters in height. Many of these towering underwater mountains are clustered along the Loyalty Ridge.

*Figure 16. Classification of underwater features by height (seamounts (> 1 km), domes (0.5-1 km) and hills (0-0.5 km)) and distance from their summit to the surface (shallow <-200 m; -200 m < medium depth <-1000 m; deep >-1000 m) (Gardes et al. 2014).*

*Habitat suitability for cnidarians*

Some benthic species, such as sponges and cnidarians, create unique habitats in deep environments by serving as living structures that support numerous other organisms. Cnidarians, particularly colonial "architect" species, are ecologically significant because they modify their physical surroundings, enhancing biodiversity (Freiwald et al. 2004). Among cnidarians, cold-water coral reefs formed by anthozoans (e.g., true corals, soft corals, gorgonians, and black corals) and certain hydrozoans (e.g., lace corals) are particularly noteworthy. However, limited sampling areas make it difficult to determine the distribution of these species across large regions. Niche modeling, which statistically links species distributions to abiotic factors, helps predict areas favorable for these species' presence using environmental data (Davies & Guinotte 2011, Yesson et al. 2012). In New Caledonia, this approach has identified significant potential habitats for species like *Enallopsammia rostrata* and *Solenosmilia variabilis*, with favorable areas estimated at 83,400 km² and 49,000 km², respectively, and 39,500 km² where both species might coexist (Davies & Guinotte 2011).

Globally, only 3% of the seabed is suitable for the simultaneous presence of seven octocoral suborders, yet in New Caledonia, such areas cover 146,000 km², representing 10% of its maritime space—three times the global average (**Figure 17**, Yesson et al. 2012). Favorable habitats for cnidarians are concentrated along ridges at depths of 200–2000 meters, supported by stable temperatures, diverse substrates conducive to larval settlement, accelerated currents around ridges and seamounts that enhance nutrient availability, and a deep aragonite saturation horizon (1000–2000 meters) (Kitahara 2011). These habitats, however, are particularly vulnerable to threats such as climate change, ocean acidification, trawling, and deep-sea mining (Ramirez-Llodra et al. 2011). While some stations have recorded diverse scleractinian communities with up to 40 species, the unavailability of comprehensive data limits their inclusion in this study. The exceptional extent of these habitats highlights the importance of preserving these ecosystems and addressing threats to their survival.

*Figure 17. Modelled map of areas potentially favorable to the presence of the 7 octocoral suborders in the New Caledonia EEZ (Gardes et al. 2014, Yesson et al. 2012).*

*Deep-water bioregions*

The classification of deep-water bioregions was developed using 30 environmental datasets from satellite and ship measurements, incorporating factors like depth, salinity, sea surface temperature, and chlorophyll alpha (CHLa) concentration. Data were limited to depths up to 1000 meters, as deeper data were unavailable. Given the significant impact of bathymetry on deep-water habitats and species, the "depth" parameter was given double weight in the analysis to better reflect its importance (**Figure 18**, Beger et al. 2020).

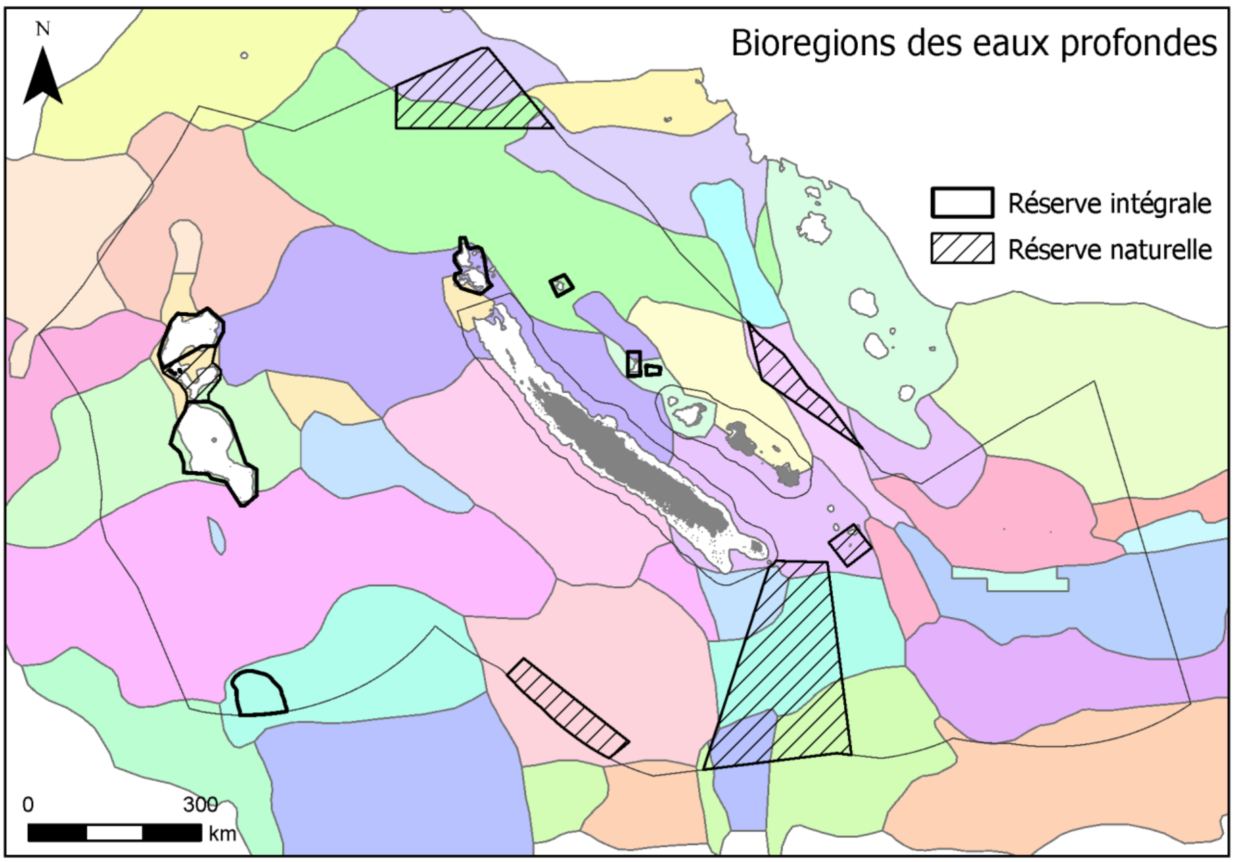


*Figure 18. Map of deepwater bioregions in and around New Caledonia (from Beger et al. 2020) with existing marine reserves (Section 2.4).*

## 2.2.2. Biodiversity and species distributions

Biodiversity plays a central role in MSP by ensuring that ecosystems remain resilient and continue to provide critical services, including fisheries, coastal protection, and carbon sequestration. MSP frameworks rely on biodiversity data to identify priority areas for conservation, and to balance ecological sustainability with economic activities like shipping and aquaculture (Moity et al. 2024). The integration of biodiversity assessments enables planners to account for ecosystem complexity, ensuring that management measures are adaptive and based on scientific evidence (Wang et al. 2025). Furthermore, biodiversity data facilitates stakeholder engagement by providing a clearer understanding of marine ecosystems, fostering collaborative decision-making (Webb et al. 2025).

Various efforts have been made to synthesize biodiversity and species information to identify key areas for biodiversity or particular species groups. These area designations can be particularly useful for MSP as they are based on a synthesis of existing information. Examples relevant for MSP of the CSNP include Ecologically or Biologically Significant Areas (EBSAs), Important Marine Mammal Areas (IMMAs), and Important Bird and Biodiversity Areas (IBA/ZICO) (**Figure 19**).

**EBSAs** are regions of the ocean identified for their critical ecological roles or significant biological diversity. These areas are recognized under the framework of the Convention on Biological Diversity (CBD) as being essential for the functioning of marine ecosystems and for the conservation of marine biodiversity. EBSAs are identified based on criteria such as uniqueness, importance for threatened species, productivity, and biodiversity, serving as a tool for informed MSP and sustainable ocean management (CBD Secretariat 2009).

**IMMAs** are areas of the ocean identified as critical habitats for marine mammals, based on their ecological significance. Established under the auspices of the International Union for Conservation of Nature (IUCN), IMMAs aim to support marine spatial planning by highlighting regions where marine mammals perform essential life functions such as feeding, breeding, and migration. These areas are identified using scientific criteria, including habitat importance, distinctiveness, and vulnerability, contributing to global efforts for marine biodiversity conservation (Tetley et al. 2022).

**IBAs (ZICO)** are sites identified globally as critical habitats for bird conservation, based on rigorous scientific criteria. These areas are essential for maintaining bird populations, particularly for species that are globally threatened, have restricted ranges, or are dependent on specific habitats. IBAs serve as a vital tool for conservation planning and management, often informing the establishment of protected areas and supporting sustainable land and marine use practices. The IBA program is coordinated by BirdLife International, aiming to safeguard avian biodiversity and promote ecosystem health (Donald et al. 2019).

**Key Biodiversity Areas (KBAs)** are sites of global significance for biodiversity conservation, identified using standardized scientific criteria. They encompass terrestrial, freshwater, and marine ecosystems that support species populations, ecological integrity, and essential biological processes. KBAs are designated based on criteria such as the presence of threatened species, restricted-range species, ecological integrity, and biological processes critical for species survival (IUCN 2016). These areas serve as priorities for conservation planning, guiding the establishment of protected areas and informing sustainable land and marine management policies (Eken et al. 2004). In the marine context, KBAs are particularly important for maintaining ecological connectivity and preserving biodiversity hotspots essential for ecosystem resilience (Edgar et al. 2008).

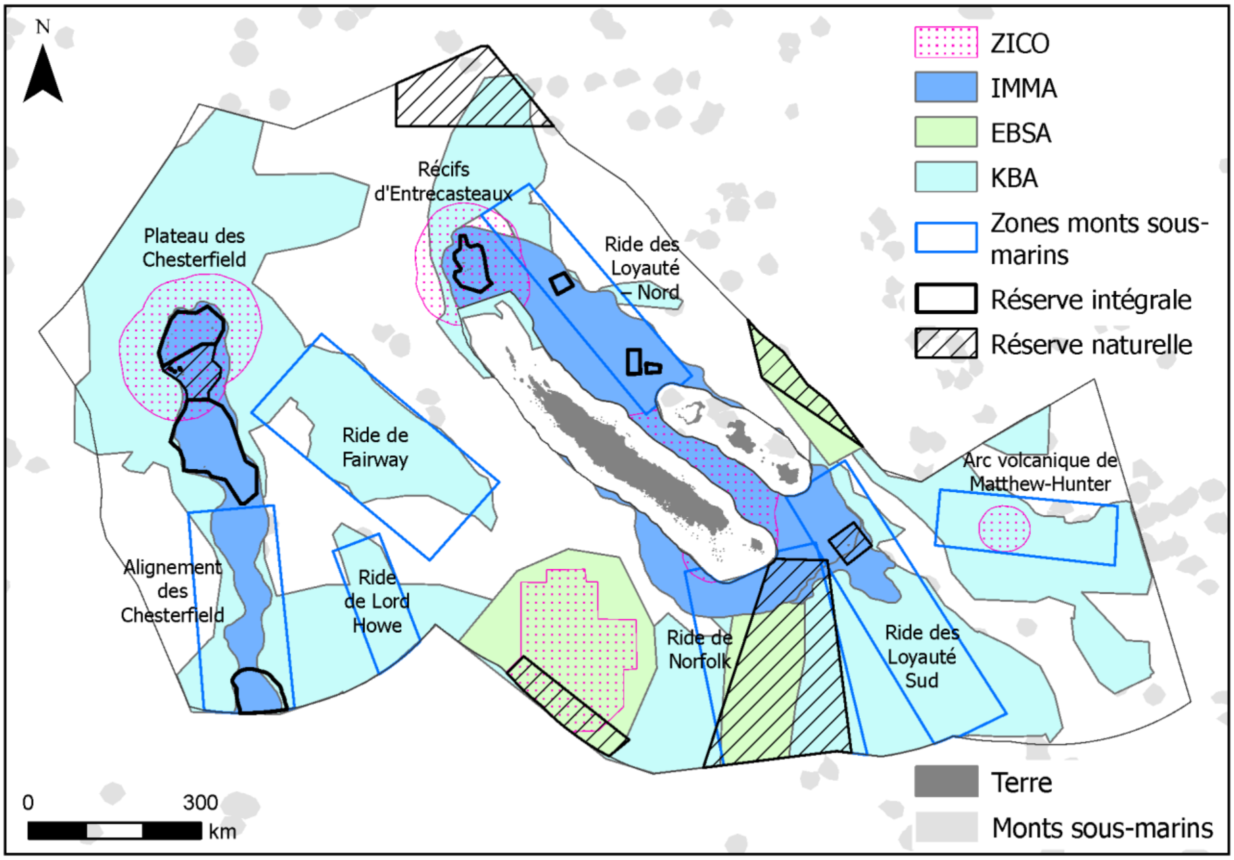


*Figure 19. Mapped areas of ecological importance in the CSNP with existing marine reserves (Section 2.4).*

Because ecological and species distribution data is necessarily limited in scope and geographic coverage, it has limited utility for MSP, unless used for spatial ecological modelling to extrapolate to the area of interest (Stamoulis & Delevaux 2015). One exception is aerial surveys which can cover large areas on the scale of MSP efforts. Laran et al. (2023) summarize the results of such surveys for marine mammals in the CSNP and other French territories (**Figure 20**).

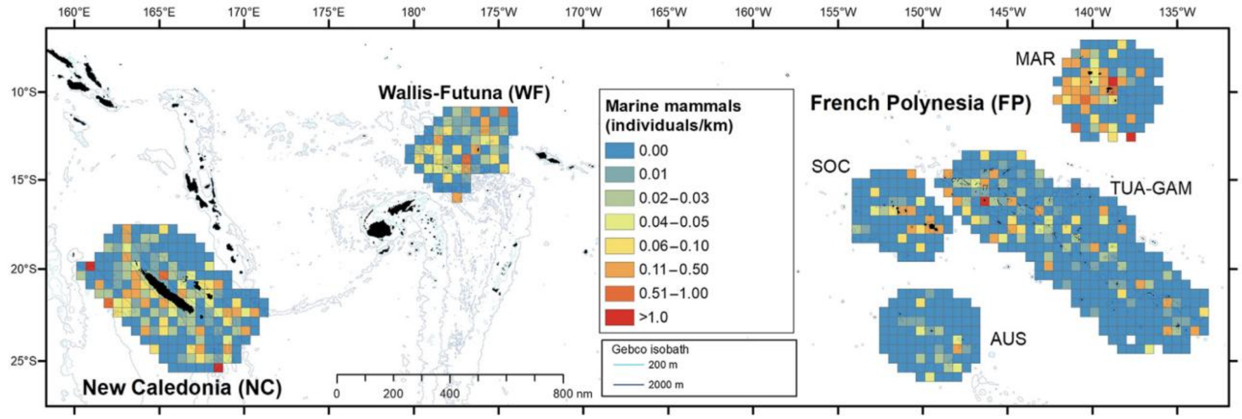


*Figure 20. Spatial distribution of marine mammals visually detected per kilometre in the three Pacific's subregions: New Caledonia, Wallis and Futuna and French Polynesia during REMMOA surveys. Each pooled on a 60 km × 60 km grid cell and given in individuals per kilometre (Laran et al. 2023).*

*Tuna*

The distribution of tuna, particularly albacore tuna (*Thunnus alalunga*), in the waters surrounding New Caledonia is of great ecological and economic significance. Albacore tuna are primarily targeted by longline fisheries, which operate extensively within the EEZ. These fisheries contribute significantly to local economies, meeting the local tuna consumption and resulting in no import of tuna, and are managed to ensure sustainability (Langley 2006). By 2019, total catches amounted to approximately 2,530 tonnes, with 80% of the catch going to the local market, 11% is exported to Japan, 7% to the U.S. (including American Samoa for canning), and 2% to Europe, reaching an economic value of 1,080 million Pacific francs (~9 million €) (Letourneur et al. 2023). The spatial distribution of albacore is influenced by oceanographic factors such as temperature and prey availability, which are critical for defining fishing zones (Domokos et al. 2007).

The SEAPODYM (Spatial Ecosystem and Population Dynamics Model) has been pivotal in projecting the impacts of climate change on albacore tuna within the New Caledonia exclusive economic zone (EEZ). This model integrates environmental variables, such as temperature and primary productivity, with tuna population dynamics to assess habitat suitability and predict future distribution patterns (Lehodey et al. 2008). Climate projections indicate a potential decline in albacore biomass in the New Caledonia EEZ by 2050, driven by rising sea surface temperatures and altered prey availability (**Figure 21**, Lehodey et al. 2015). These findings underscore the importance of adaptive fisheries management to address spatial shifts in tuna habitats, ensuring sustainable exploitation and ecosystem health.

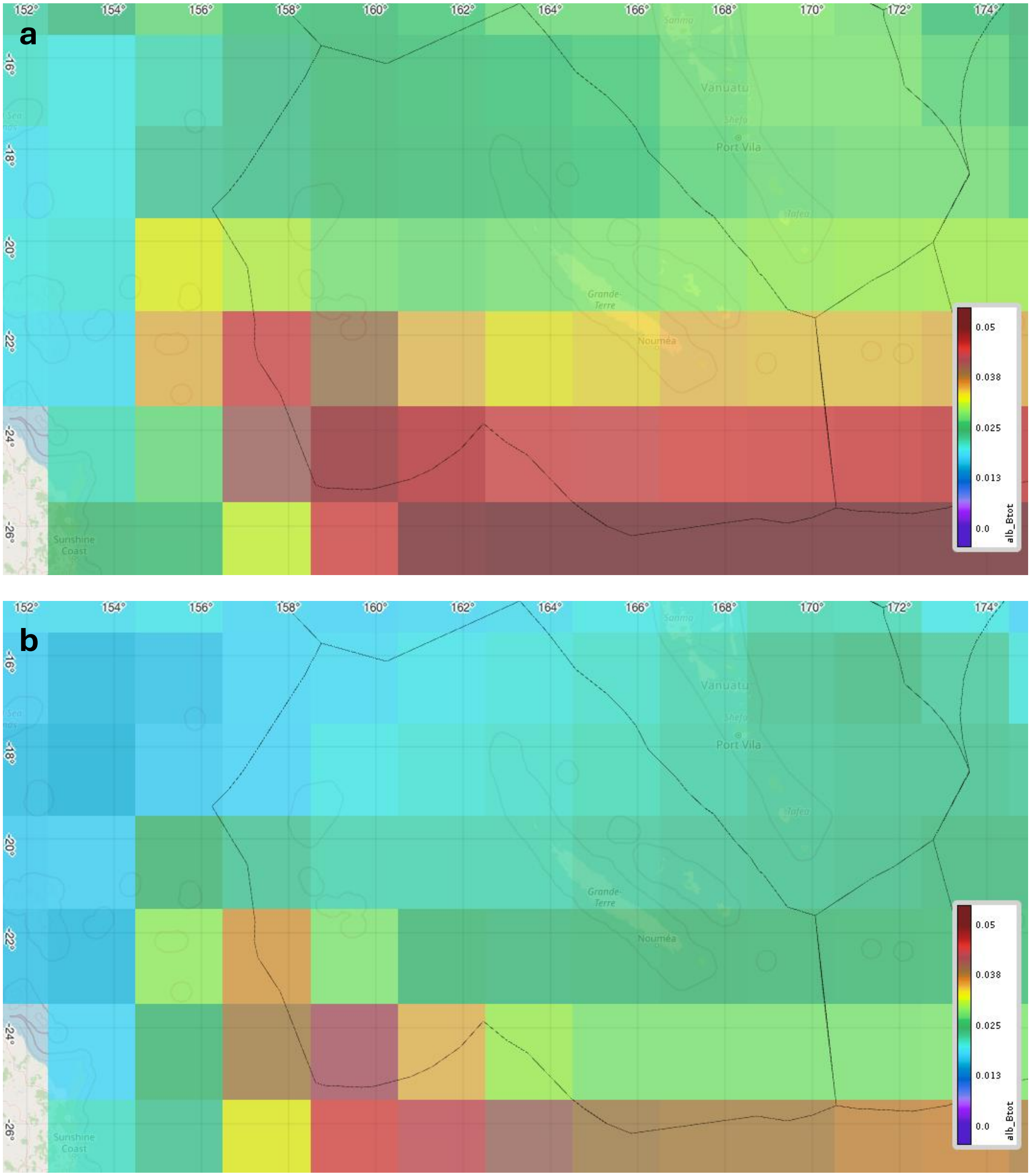


*Figure 21. SEAPODYM 2° model projection for Albacore tuna biomass (t/km2) in the New Caledonia EEZ for a) present (January 2025) and b) future (January 2050).*

### 2.2.3. Ecological connectivity

Connectivity, encompassing both animal movements and larval dispersal, is critical for effective MSP as it ensures the ecological coherence and resilience of marine ecosystems. Animal movements, such as migrations of fish, marine mammals, and seabirds, necessitate the creation of linked marine protected areas (MPAs) to maintain population stability and genetic diversity (Hooker & Gerber 2004). Similarly, larval connectivity—the dispersal of larvae through ocean currents—plays a vital role in sustaining fish stocks and replenishing coral reefs. Recognizing connectivity in MSP supports the design of protected area networks that maintain ecological processes, facilitate species persistence, and enhance ecosystem recovery from disturbances (Krueck et al. 2017). Incorporating connectivity metrics into MSP ensures the spatial arrangement of conservation and resource-use areas supports biodiversity and ecological sustainability across scales. Ecological connectivity is increasingly being built into MPA design and is recognized as important to biodiversity inclusive and implementing climate smart spatial planning (Carr et al. 2017, Balbar & Metaxas 2019).

*Animal movements*

Information on animal movements and identification of movement pathways (sometimes referred to as 'Blue Corridors') are essential for MSP to help identify places where human activities may block or disrupt these pathways (Gardner et al. 2024). Humpback whales are a good example with an important movement pathway identified between New Caledonia and New Zealand (**Figure 22**, Garrigue et al. 2015). Gardes et al. (2014) provide an example of how maritime traffic routes in New Caledonia overlap with turtle, whale, and shark movements (**Figure 23**).

*Figure 22. Movement corridor for South Pacific humpback whales between New Caledonia and New Zealand. Time of occupancy is defined as the total number of hours spent in each 100 km2 grid square divided by the number of whales in that grid square, and expressed in days/whale (Garrigue et al. 2015).*

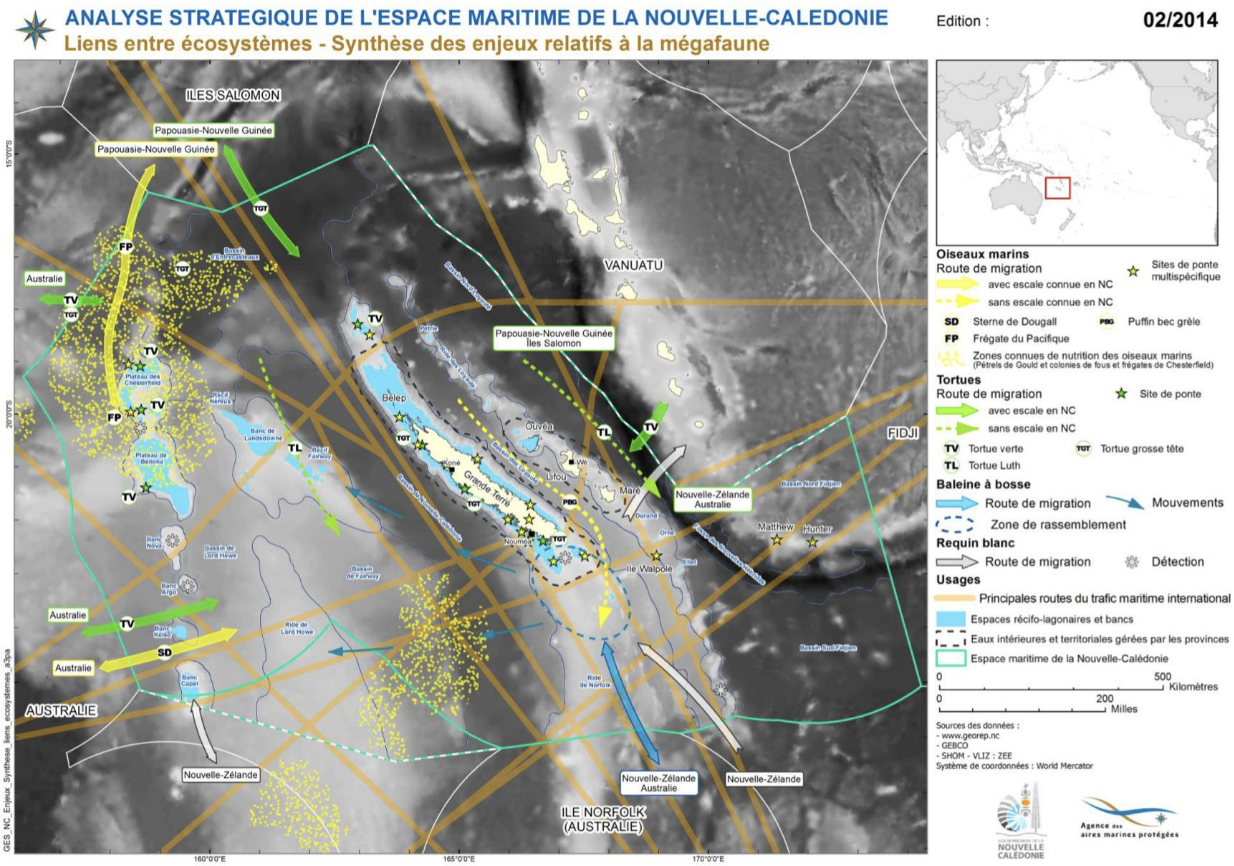


*Figure 23. Summary of potential conflicts between marine traffic and surface breathing marine megafauna (cetaceans and turtles)(Gardes et al. 2014).*

*Larval connectivity*

Patterns of larval connectivity in the CSNP are essential for maintaining the resilience of marine ecosystems and informing conservation strategies. Studies indicate that ocean currents play a significant role in transporting larvae, shaping population connectivity across reefs and seamounts (**Figure 24**, Treml et al. 2008). Research on the humbug damselfish (*Dascyllus aruanus*) demonstrates localized larval retention and dispersal influenced by physical oceanographic conditions, which highlight the importance of integrating biophysical models in MSP (Cuif et al. 2014, Kaplan et al. 2017). Larval connectivity plays a vital role in enhancing coral reef resilience to bleaching by enabling the replenishment of degraded populations through the dispersal and settlement of coral larvae from less-affected areas. This biological exchange supports genetic diversity and recovery potential, making larval connectivity a key factor in designing networks of resilient MPAs (Mumby et al. 2011). Additionally, the unique geographical configuration of New Caledonia creates a network of interconnected habitats, supporting the dispersal and genetic exchange of marine species (Cuif et al. 2014). These insights underline the necessity of incorporating larval connectivity data and juvenile critical habitat into the design of MPAs to enhance protection for early life stages.

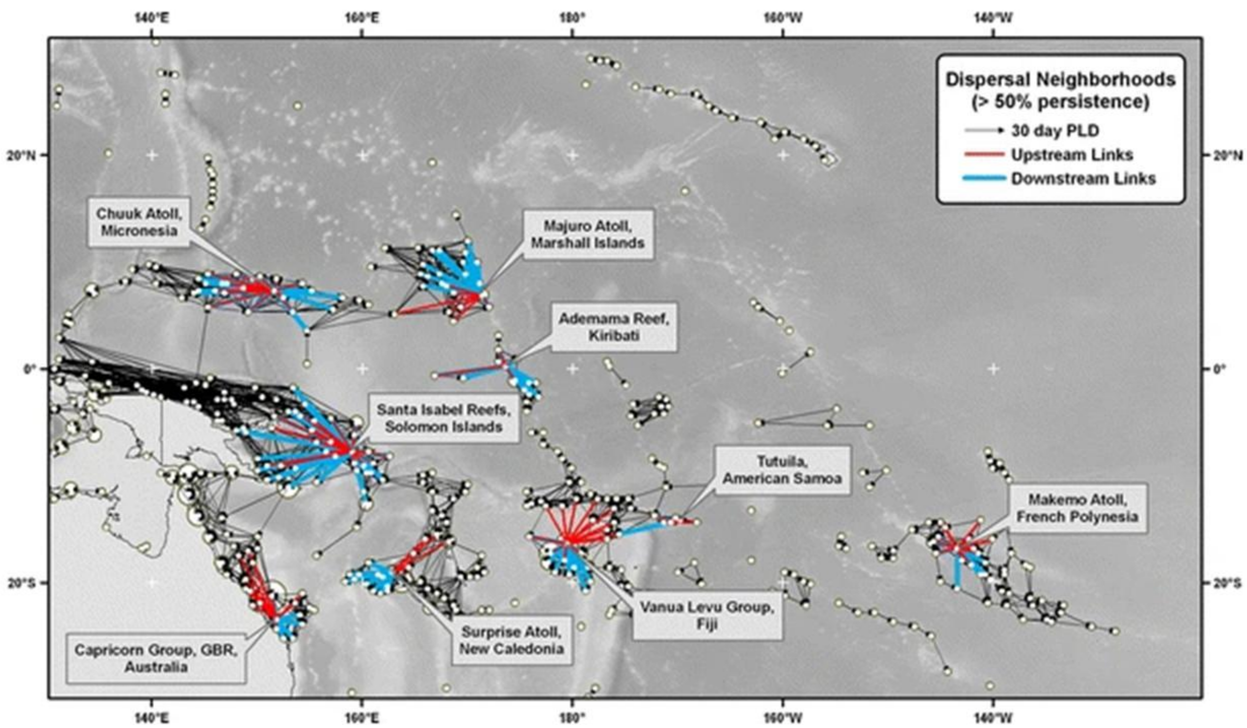


*Figure 24. Upstream and downstream dispersal neighborhoods. One dispersal connection upstream and downstream based on a 30-day PLD (Treml et al. 2008).*

### 2.2.4. Data gaps for ecological data

Many years of scientific marine biological surveys by a range of organizations in the CSNP has resulted in an abundance of high-quality data. However, much of it will not be available without a targeted effort to engage these stakeholders in the MSP process. Nevertheless, many of these data were incorporated in regional and global efforts to delineate key areas for biodiversity (EBSAs, IMMAs, IBAs) as described and mapped previously in this section forming synthesis products that represent areas of particular importance for biodiversity that are ideal for MSP design purposes.

Another data gap is marine animal movement patterns. Again, many of these data are in existence, but not available without the collaboration of local scientists. Ideally, this information would be integrated to produce movement corridors for species of interest.

Larval connectivity is another key data gap that is important for planning networks of marine reserves. To this date, there have been no population connectivity models conducted at the scale of the New Caledonia EEZ or the Coral Sea. Treml et al. (2008) provide an example of this approach at the scale of the tropical Pacific Ocean (**Figure 24**). Ideally these models could be updated and down-scaled to better represent larval connectivity in the CSNP.

Finally, limited long-term monitoring of species distributions and ecosystem shifts reduces the ability to assess climate-driven range shifts for key fisheries and marine biodiversity. Understanding coral reef resilience and adaptation mechanisms is also critical, particularly for ecosystems highly vulnerable to bleaching events and sea-level rise.

## *2.3. Human activities*

Human activities in the CSNP play a significant role in shaping its MSP strategies. Key activities include sustainable fishing, tourism, and shipping, which coexist with the Park's conservation goals. MSP frameworks aim to mitigate anthropogenic impacts such as overfishing, habitat degradation, and pollution from urban and industrial developments to ensure long-term sustainability and ecosystem health. The Park's zoning system seeks to integrate ecological data and stakeholder input to ensure a balance between resource use and marine biodiversity conservation. Collaborative approaches, including traditional ecological knowledge, further strengthen its management framework (Rodary 2024, Cleguer et al. 2015).

Because the Park encompasses marine offshore waters and does not include coastal waters, most human activities within the Park can be characterized by boat traffic patterns recorded by Automatic Identification Systems (AIS). These include commerce (shipping), passenger vessels (cruise ships), recreational or pleasure vessels, and fishing vessels (**Figure 25**).

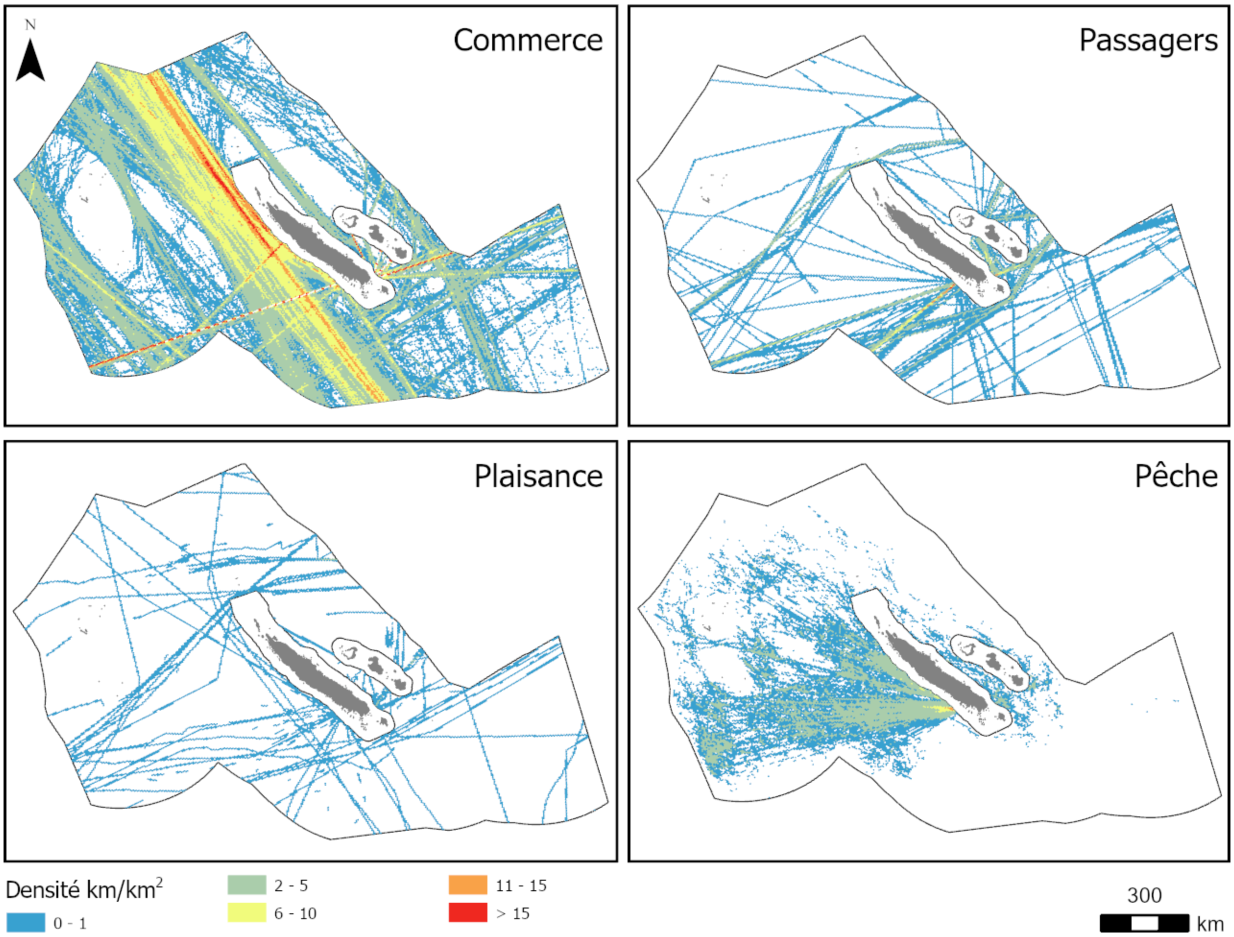


*Figure 25. Vessel densities from 2023 AIS derived vessel tracks for the four primary vessel categories active in the CSNP (Baletaud et al. 2024).*

### 2.3.1. Fishing

The New Caledonia domestic longline fleet began developing in 1983, with a significant increase in the number of vessels during the early 2000s. However, from 2003 onwards, a shortage of skilled labor led to underutilization of the fleet, forcing several fishing companies to cease operations. The number of vessels gradually declined until 2013, when the fleet stabilized at approximately 6 to 7 companies operating 16 to 18 active longliners annually (Anon 2021). By 2023, 16 licensed domestic longliners were active, though one ceased operations late in the year (Adecal Technopole 2024). All active vessels in 2023 were under 200 gross registered tons. The larger longliners, nearing 150 tons, could remain at sea for two or more weeks. Fishing campaigns averaged 12 days, with 8 days dedicated to fishing. In 2021, 347 fishing trips were reported, amounting to a total of 4,120 days at sea (Anon 2021).

The government of New Caledonia keeps records of effort and catch of the longline fleet, including spatial patterns. Offshore longline fleet catches in 2021 were primarily albacore tuna (1,774 t), followed by yellowfin tuna (624 t), striped marlin (97 t), bigeye tuna (59 t), and black marlin (34 t) as well as several other species (Anon 2021). In 2023, the total volume of landed catches was 2,391 tonnes, 89% of which were tuna, 6% billfish, and 5% other species (Adecal Technopole 2024). In 2023, most of the fishing effort was west of Grande Terre and in the southwest corner of the EEZ (**Figure 26**).

*Figure 26. Observer coverage rate compared to fishing effort in terms of number of hooks observed and reported (Adecal Technopole 2024).*

Global Fishing Watch (http://globalfishingwatch.org) is another source of up-to-date information on the spatial patterns of fishing effort inside and along the boundary of the Park. Global Fishing Watch analyzes vessel activity from Automatic Identification System (AIS) and Vessel Monitoring System (VMS) data, transmitted via satellite and terrestrial receivers. A fishing detection algorithm is applied to identify "apparent fishing activity" based on patterns of vessel speed and direction (**Figure 27**).

*Figure 27. Global fishing watch "apparent fishing effort" 2015-2024 from New Caledonia flagged vessels shown with existing marine reserves (Section 2.4).*

Based on the Global Fishing Watch data, during the period of 2015-2024, most of the fishing effort was distributed on each side of Grande Terre, as well as in the western portion of the CSNP near Chesterfield and Lorde Howe Ridge. Conversely, the New Caledonian longline fleet rarely visits the southeast and northeast portions of the maritime space (**Figure 27**). Though this data covers a much longer period, these patterns generally align with 2023 fishing effort reported by the New Caledonia Government (**Figure 26**). Interestingly, there is a low level of "apparent fishing effort" from foreign flagged vessels in these same areas as well as along the southwest boundary of the CSNP (**Figure 28**).

*Figure 28. Global fishing watch "apparent fishing effort" 2015-2024 from foreign flagged vessels*

### 2.3.2. Maritime transport

Nouméa occupies a strategic position on international maritime routes in the Pacific Ocean. It has been ranked as the second largest French overseas port and the tenth largest French port in 2018 with almost 11 million tonnes transported in 2019 (Anon 2019). Maritime traffic has grown by 10% over recent decades, with the cruise tourism industry increasing its stopovers fivefold, reaching 500 between 2007 and 2016 (Payri et al. 2019). The fleet of service vessels, including tugs and supply boats, has also expanded. Alongside this growth, the size of container ships and cruise liners has increased, and local maritime transport to peripheral islands now involves four ships (Payri et al. 2019). In 2023, the Autonomous Port of New Caledonia recorded its first traffic increase since 2016, with an 11.7% rise in total tonnage, bringing the volume of goods arriving in the territory to 4.45 million tonnes (Le Marin 2024).

Commercial vessels operating within New Caledonia's EEZ, primarily cargo ships and oil tankers, travel along well-established international shipping routes connecting key ports like Nouméa with regional hubs such as Brisbane, Sydney, and Suva. Their activity is concentrated along individual and specific east-west and north-south routes (Baletaud et al. 2024). The first includes highly used and narrow paths, such as the route between Brisbane and Nouméa, which accommodates approximately 150 ships per year, inter-island refueling routes between Grande Terre and the Loyalty Islands, and the route from Grande Terre to Fiji or Polynesia, with about 250 ships annually. The second is a less dense but more extensive north-south corridor, which accounts for the majority of traffic, with around 1,200 ships per year. Key maritime routes along these paths include the Brisbane–Nouméa route that passes north of the Capel Bank Integral Reserve, the north-south route traverses the southern horn of the Norfolk Ridge Natural Reserve, and a less dense north-south bypass shows notable activity near the southeastern tip of Chesterfield Reef (**Figure 29**, Baletaud et al. 2024). Ship traffic creates sound pollution in the ocean (Erbe et al. 2019) and presents a risk from collision to air-breathing marine animals and surface dwelling species (Nisi et al. 2024). Shipping activities can also significantly impact water quality and coral reef health through the release of pollutants such as oil, antifouling paints, ballast water contaminants, and marine debris, which degrade water clarity and introduce toxic substances. These stressors can reduce coral growth, impair reproduction, and increase susceptibility to disease (Sabdono et al. 2024).

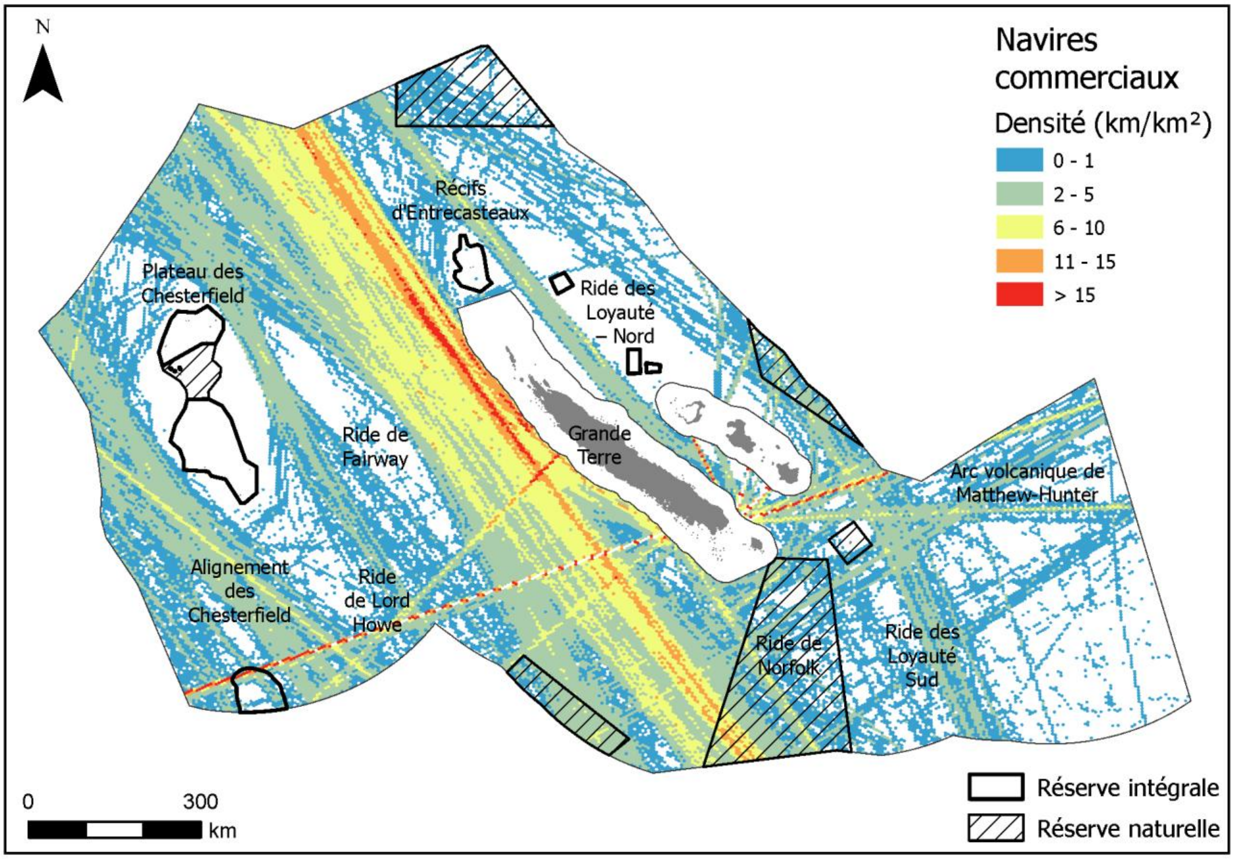


*Figure 29. Commercial vessel traffic density in 2023 (Baletaud et al. 2024) shown with existing marine reserves (Section 2.4).*

## 2.3.3. Tourism and recreation

In 2023, the first year of resumed cruise activity following the global COVID-19 pandemic, the Nouméa maritime terminal welcomed 343,703 cruise passengers, representing a 10% increase compared to 2019, the pre-COVID reference year (CCI NC 2024). This confirms Nouméa as the second-largest French cruise port. Passenger ships play a significant role in the maritime activity of New Caledonia's EEZ. While fewer in number compared to commercial or fishing vessels, they exert concentrated pressure on key areas, particularly around Nouméa and the Loyalty Islands (**Figure 30**). Their presence is highly seasonal, peaking between November and March during the high tourist season (Baletaud et al. 2024).

The maritime routes used by passenger ships intersect with several environmentally sensitive areas (**Figure 30**). The Brisbane–Nouméa route passes north of the Capel Bank Integral Reserve, while the Sydney–Nouméa route crosses the extreme north of the Norfolk Ridge Natural Reserve. Additionally, the Sydney–Vanuatu route cuts through the Norfolk Ridge Natural Reserve, and the Loyalty Islands–Vanuatu route intersects the New Hebrides Trench Natural Reserve. While the high season benefits the local economy, it also heightens environmental risks, including coral habitat degradation from groundings and pollution from maritime activities (Beletaud et al. 2024).

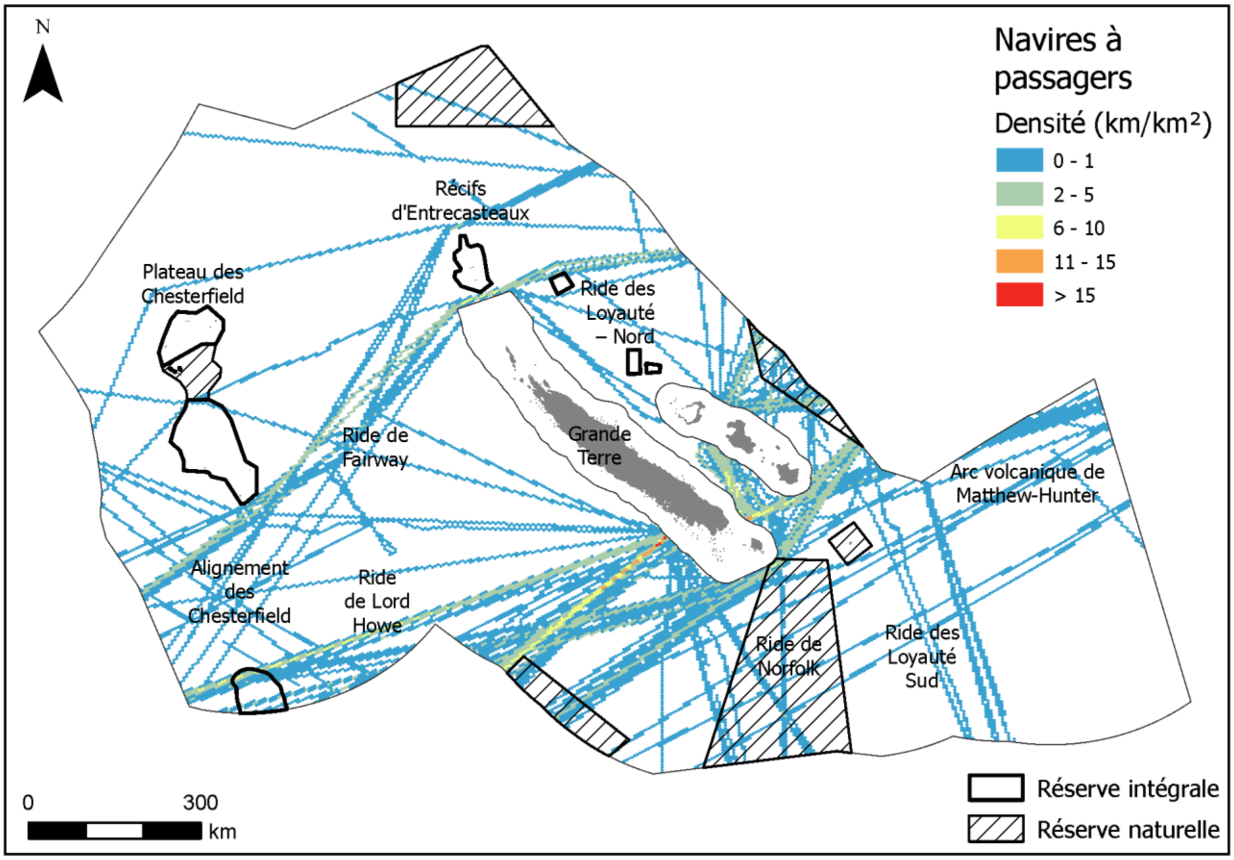


*Figure 30. Passenger vessel traffic density (Baletaud et al. 2024) shown with existing marine reserves (Section 2.4).*

## 2.3.4. Scientific Research

Scientific research within the CSNP is essential for understanding and conserving its vast marine biodiversity. Studies have focused on assessing ecological baselines, mapping coral reef habitats, and monitoring species like sharks, marine mammals, and seabirds that are crucial for ecosystem stability (Rodary 2024). Research initiatives also evaluate the impacts of anthropogenic activities, such as fishing and tourism, to inform adaptive management strategies. Collaborative efforts between local and international scientific institutions enhance data collection and analysis, fostering informed decision-making for marine spatial planning. These research activities ensure that conservation and sustainable use objectives are grounded in robust scientific evidence.

While much of the scientific information is held by the researchers and institutions conducting the studies, the Government of New Caledonia does provide locations of scientific research in the CSNP which can be considered illustrative though unlikely to be complete. According to this data, most scientific research has occurred in the Integral reserves (highest protection) of Chesterfield, Entrecasteaux, and the North Loyalty Ridge (**Figure 31**).

*Figure 31. Underwater survey and green sea turtle survey locations.*

## 2.3.5. Cultural Heritage and Indigenous knowledge

Whales and their environment hold a central place in Kanak culture, reflected in various events throughout the year. Tribal life is deeply structured and rhythmically aligned with natural phenomena. Research has shown that whales heavily utilize seamounts along their migration route between Antarctica and New Caledonia's South Lagoon, particularly the Norfolk Ridge and the Loyalty Ridge. On July 5, 2023, the Customary Senate issued an opinion following consultations with the Park and Fisheries Service (SPP) regarding the protection of 10% of the Park. The consultation highlighted significant shortcomings, particularly the insufficient consideration of southern seamounts and the absence of a fully protected reserve. These areas, strongly tied to priority conservation zones (EBSA, IMMA), are only partially covered by a nature reserve and remain accessible to maritime traffic. In response, the Customary Senate proposed expanding the reserve zones to 25–30% instead of 10%, emphasizing the need to protect whales, particularly through the conservation of seamounts, which are vital to both their survival and Kanak culture (**Figure 32**).

*Figure 32. Proposal for zoning of marine protected areas by the Customary Senate (pink) following their consultation in June 2023 as part of the objective of establishing 10% of the Park under strong protection.*

## 2.3.6. Data gaps for human activities

In 2018, the Government of New Caledonia passed regulations relating to professional tourism in the CSNP (Section 2.4). However, there is a lack of information on tourist activities in the Park. Information relevant to MSP would include the number of cruises and visitors accessing which areas of the Park. At this point it is not clear to what extent tourist activities are occurring, other than cruise ship offerings which do not provide access to the wilderness areas of the CSNP.

Information related to deep-sea mining resources was a focus of the 2014 data compilation for the CSNP (Gardes et al. 2014). Currently, the Government of New

Caledonia is considering a ten-year moratorium on deep-sea mining. Since the ban has not yet been implemented, there are presumably still mining activities under consideration. The type and location of potential deep-sea mining activities, after or in lieu of, a ban would also be useful for MSP. If this information is not available, then these activities cannot be considered as part of the planning process.

Another data gap relating to human uses are military zones and activities. The French Armed Forces in New Caledonia (FANC) play a pivotal role in safeguarding the nation's interests within the CSNP and the broader EEZ. Their primary responsibilities include national defense, protection of France's regional interests, and support for state policies in New Caledonia and Wallis et Futuna. Additionally, they conduct rescue missions and engage in cooperative efforts with neighboring states.

Furthermore, cultural sites and zones represent another potential data gap for MSP in the CSNP. Protecting native Kanak cultural interests in the Park is one of the objectives of the CSNP management plan. Other than the proposed protection zones put forward by the customary college (**Figure 32**), there is little information about the maritime areas important for the Kanak culture.

## *2.4 Managed areas and conservation planning*

### 2.4.1. Existing MPAs

In August, 2018 the government of New Caledonia designated 28,000 square kilometers of reserves across Chesterfield, Bellona, Entrecasteaux, Petrie, and Astrolabe (**Figure 33**). Of this total, 7,000 square kilometers are classified as integral reserves. This designation represents the highest level of protection under the International Union for the Conservation of Nature (IUCN). In these areas, all access and human activities are prohibited, except for scientific research, which must first be approved by a government order (PNMC 2018). The remaining reserve areas were classified as natural reserves. These natural reserves offer a slightly lower level of protection than integral reserves (IUCN category II). Certain sustainable activities, such as ecotourism, or traditional practices, may be permitted under specific conditions. These reserves aim to balance conservation with sustainable use, ensuring that human activities are managed to minimize their ecological impact. The combined area of these reserves accounted for 2.3% of the Park's surface area. In 2023, additional integral and natural reserves were added, increasing the total protected area to 10% of the total area of the Park (**Figure 33**).

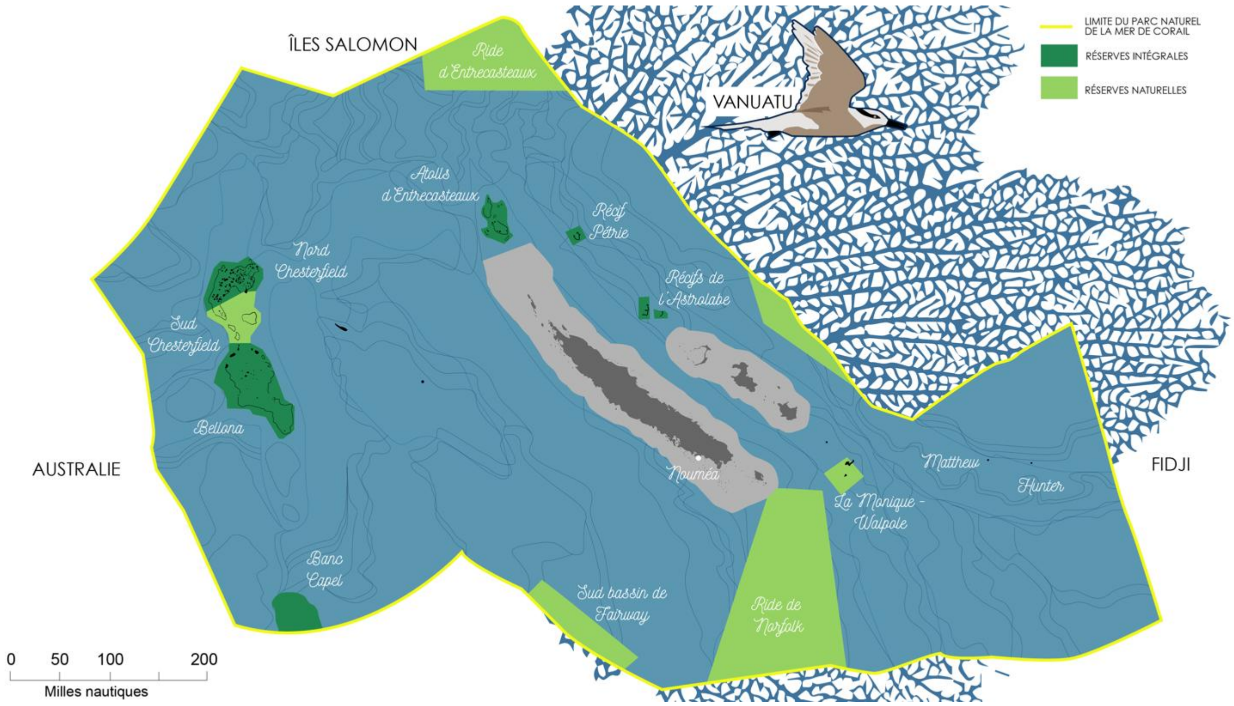


*Figure 33. Map of existing protected areas in the CSNP accounting for 10% of the total area.*

Furthermore, the Park has regulations relating to professional tourism, prohibiting access to any vessel with a capacity of more than 200 passengers. Expedition cruises may access natural reserves—but not integral reserves—under strict conditions and under permitting process, including compliance with specific guidelines and the presence of onboard observers, with a maximum of 200 passengers per vessel. These measures are designed to ensure that such expeditions do not harm biodiversity or the areas being explored.

### 2.4.2. Proposed MPAs

In 2023, the Coral Sea Natural Park and Fisheries Service (SPNMCP) drafted a decree to extend the surface area of the CSNP under strong protection by more than 25.5% (**Figure 34**). The objectives of this decree were to provide specific ecosystems, such as seamounts, islands, and hydrothermal vents, with appropriate levels of protection. These initiatives included strengthening the protection of certain existing nature reserves, safeguarding seabird populations and their core feeding areas, and ensuring ecological connectivity for various pelagic species, both within New Caledonia and with neighboring countries. Additionally, it sought to preserve and promote cultural heritage, both tangible (e.g., historical and archaeological sites) and intangible (e.g., ancestral knowledge and customary pathways). Finally, these efforts aimed to enhance clarity in aligning protected area types with the categories defined by the IUCN (SPNMCP 2023). This proposal led to the existing 10% of strong protection but did not reach the initially proposed 25.5%.

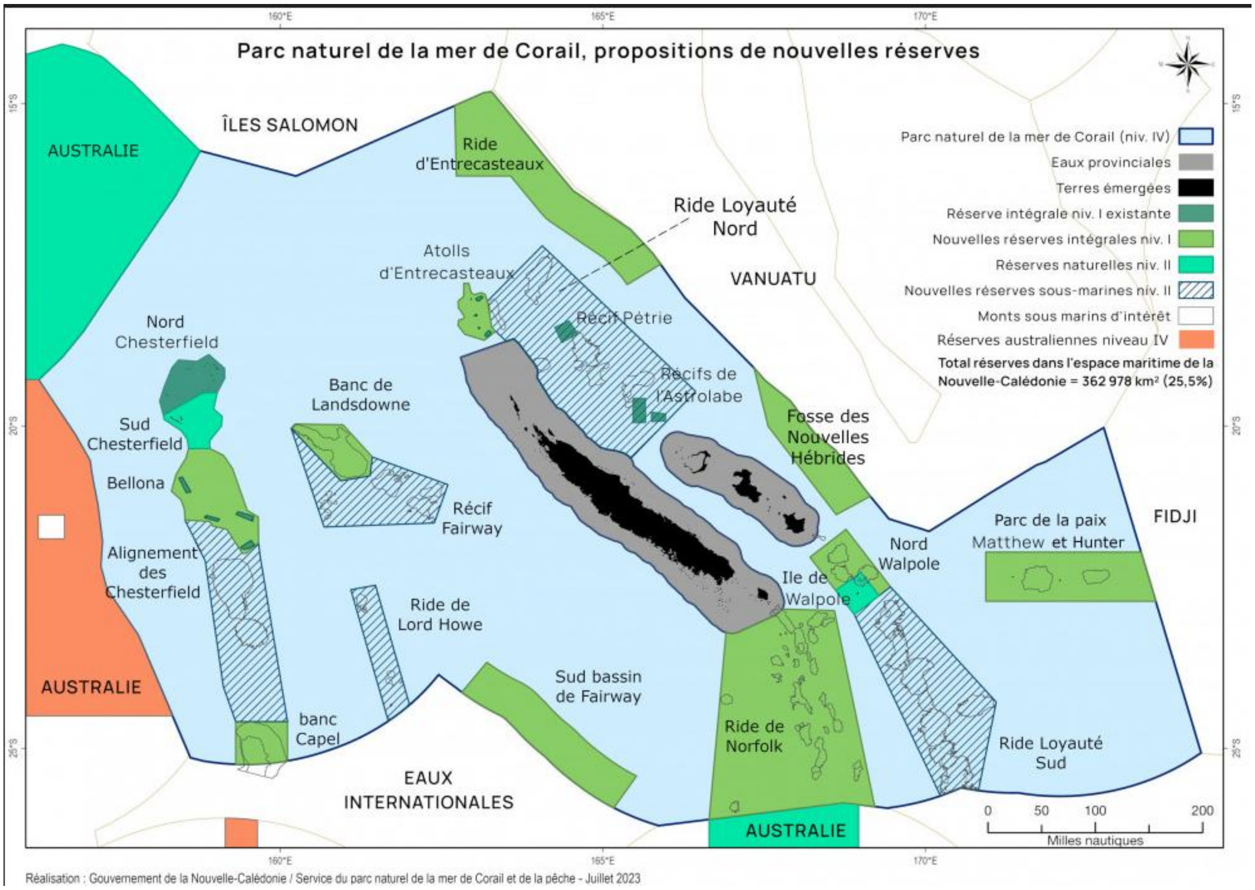


*Figure 34. Map of proposed protected areas in the CSNP totaling 25.5%, prior to designation of additional areas increasing protection to 10% of total area (shown in previous figure).*

### 2.4.3. Conservation planning

Conservation planning plays a fundamental role in MSP by ensuring that marine ecosystems are effectively managed to support biodiversity while balancing economic and social objectives. Through systematic conservation assessments, MSP integrates ecological data, habitat connectivity, and species distributions to design networks of Marine Protected Areas (MPAs) and other conservation zones (Margules & Pressey 2000). Conservation planning within MSP also accounts for threats such as overfishing, habitat degradation, and climate change, ensuring that spatial management measures are adaptive and resilient (Ban et al. 2013). By incorporating stakeholder engagement and socio-economic considerations, conservation planning helps minimize conflicts between different marine uses, such as fisheries, tourism, and energy development, while safeguarding essential ecosystem functions (Klein et al. 2010). This strategic approach enhances ecosystem resilience, supports sustainable livelihoods, and strengthens the long-term effectiveness of marine governance.

A group of researchers recently completed the first 3D spatial conservation planning exercise for the CSNP (Mathon et al. 2024). This study aimed to describe and model biodiversity on seamounts and deep island slopes while identifying three-dimensional protection solutions to meet the Convention on Biological Diversity (CBD) area targets (30% by 2030) within New Caledonia's EEZ. To achieve this objective, environmental DNA (eDNA), Baited Remote Underwater Video Systems (BRUVS), and acoustic echosounder data were collected from benthic and pelagic zones across 15 seamounts and island slopes, reaching depths of up to 600 meters. Utilizing this unique dataset, modeling techniques were applied to predict fish richness, abundance, biomass, and individual species distributions in three dimensions across island slopes, seamounts, and surrounding pelagic areas. Additionally, priority conservation areas were identified across three depth layers at the archipelago scale, ensuring that 30% of the spatial domain in high-biodiversity regions located within 600 m depth could be effectively protected (**Figure 35**, Mathon et al. 2024).

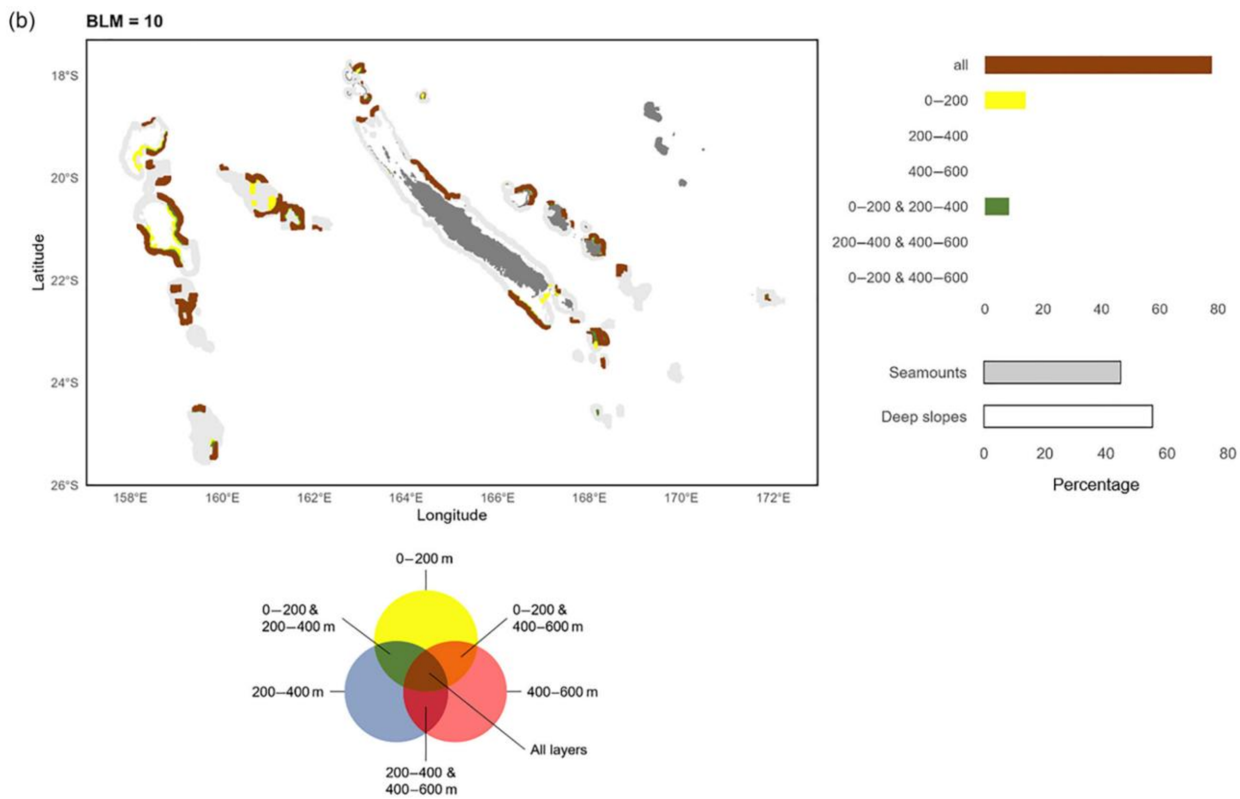

*Figure 35. Priority conservation areas in the CSNP across space and depth with BLM = 10 (best solution identified by technique for order of preference by similarity to ideal solution score) (colors, depth in meters at which each planning unit is prioritized, as shown by the Venn diagram; dark gray, land; light gray, planning units not prioritized by the solution; histograms, percentage of planning units across depth layers and habitats) (Mathon et al. 2024).*

## 3. Conclusions and recommendations

Stakeholder engagement in data collection for Marine Spatial Planning (MSP) is critical for integrating diverse knowledge sources, improving data accessibility, and fostering trust between sectors. While local communities, fishers, and conservation organizations provide essential ecological and spatial knowledge, the scientific community plays a key role in generating high-resolution environmental data through remote sensing, ecological surveys, and modeling. However, scientists are often hesitant to share data due to concerns over intellectual property, misuse, or loss of academic recognition (Tenopir et al. 2011). Establishing clear data-sharing agreements, incentives for collaboration, and proper citation protocols can help overcome these barriers and encourage transparency (Costello 2009). Additionally, co-developing research agendas with stakeholders fosters mutual trust and ensures that scientific data aligns with management needs. By integrating participatory science, community-based monitoring, and institutional data-sharing frameworks, MSP can leverage the best available science while promoting inclusivity and long-term marine governance success (Dunn et al. 2019).

We identified a range of stakeholders who could likely contribute data for MSP in the CSNP (**Table 1**). However, due to the short timeline available to conduct this conceptual study, there was not enough time to conduct sufficient stakeholder engagement. As a result, very little data was made available from local scientists, government agencies, and NGOs. Nevertheless, key datasets were accessed on the NC government geographic information portal (georep.nc) along with a range of global datasets and data available from published studies. An important set of human use data was available from a marine traffic study of the CSNP commissioned by Pew (Baletaud et al. 2024). Together, these available datasets satisfy many of the key elements needed for MSP and allow for a preliminary planning process.

Aside from existing data not currently available, we identified data gaps for each of the key data types required for MSP in the CSNP:

- Physical environment
    - Bathymetry data
        - Nearly 60% of the CSNP remains unmapped by sonar
    - Ocean chemistry
        - Lack of in-situ data collection but global models available
    - Climate change

        - Lack of fine-scale oceanographic and biophysical models that predict changes in sea surface temperature, ocean acidification, and extreme weather events at regional levels
- Ecological data
    - Marine species distributions
        - Exists locally but not made available
    - Marine species movement patterns
        - Exists locally but not made available
    - Larval connectivity
        - Need for higher resolution, regional models, validated with local data
    - Climate-driven range shifts
        - SEAPODYM provides estimates for tuna range shifts but high uncertainty at regional scale
        - Data and models lacking for other species
- Human activities
    - Tourism
        - Ecotourism cruises to natural reserves
    - Deep-sea mining
        - Lack of information on exploitation plans and/or potential areas
    - Military zones and activities
    - Cultural sites and zones

Some of the data gaps listed above could likely be addressed by comprehensive stakeholder engagement. Others point to a need for investment in scientific research particularly in the development of regional oceanographic and species distribution models informed by local data collection. Overall, this data collection and gap analysis process for MSP of the CSNP revealed the need for cooperation between those that collect and manage data in New Caledonia and identified a range of datasets that satisfy MSP needs which could be updated and supplemented in the future.

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# Chapter 3 - Analysis and zoning

## *1. Introduction*

Marine Spatial Planning (MSP) is a critical tool for managing the diverse and often competing demands on marine ecosystems while ensuring their long-term sustainability. By structuring human activities in the ocean, MSP facilitates balanced decision-making, reducing conflicts and promoting effective resource management. One of its key contributions is helping achieve Target 3 of the Global Biodiversity Framework by supporting the design of "ecologically representative, well-connected and equitably governed" Marine Protected Area (MPA) networks (Global Biodiversity Framework). Strategically placed MPAs help maintain ecological linkages between critical habitats in animal life cycles, such as migratory pathways, breeding grounds, and nursery areas, leading to enhanced biodiversity protection and greater resilience to climate change (UNESCO-IOC 2021).

Beyond conservation, MSP integrates ecological, socio-economic, and cultural considerations, ensuring that MPAs and other management zones function as part of a coherent, well-managed network. This process fosters collaboration among key sectors—including fisheries, tourism, and maritime industries—to reduce conflicts, enhance compliance, and support sustainable economic activities. A core component of MSP is zoning, which establishes a regulatory framework defining specific areas for particular uses or protections (Frazão Santos et al. 2020).

Effective MSP requires evaluating multiple scenarios and trade-offs to balance conservation, cultural areas of significance, sustainable use, and economic activities within New Caledonia's Exclusive Economic Zone (EEZ). A well-structured zoning approach can include:

- High-protection conservation zones (IUCN categories I and II) to safeguard critical habitats and biodiversity (Day et al. 2019).
- Cultural areas of significance zones.
- Sustainable use zones to regulate fishing, eco-tourism, and blue economy activities.
- Blue corridors for migratory species, designated fishing zones, and shipping lanes to reduce conflicts, maintain ecosystem connectivity, and enhance maritime safety.

Scenarios play a key role in this process by allowing decision-makers to anticipate future conditions under different policy, environmental, and economic assumptions. They help assess trade-offs, foster stakeholder buy-in, and guide zoning decisions to align with long-term sustainability goals.

Data and analytical tools underpin the MSP process, providing the foundation for evidence-based decision-making, conflict resolution, and the balanced integration of ecological, social, cultural, and economic priorities. A well-designed plan should reflect the diverse interests of ocean stakeholders (Zuercher et al. 2022, Ceccarelli et al. 2018) while ensuring that biodiversity protection remains a pillar of a resilient blue economy (Lubchenco et al. 2020, Benzaken et al. 2022).

This chapter builds on previous chapters and provides a demonstration of how various ways of integrating multiple datasets can help inform spatial zoning. **Chapter 2** focused on data collection, gap analysis, and defining current conditions (**Figure 1, Step 1**), this chapter moves forward by analyzing existing conditions to identify potential conflicts and synergies (**Figure 1, Step 2**) and evaluating alternative zoning scenarios (**Figure 1, Step 3**). To support decision-making, we present maps and graphical analyses that illustrate various scenarios and highlight key trade-offs in ocean management.

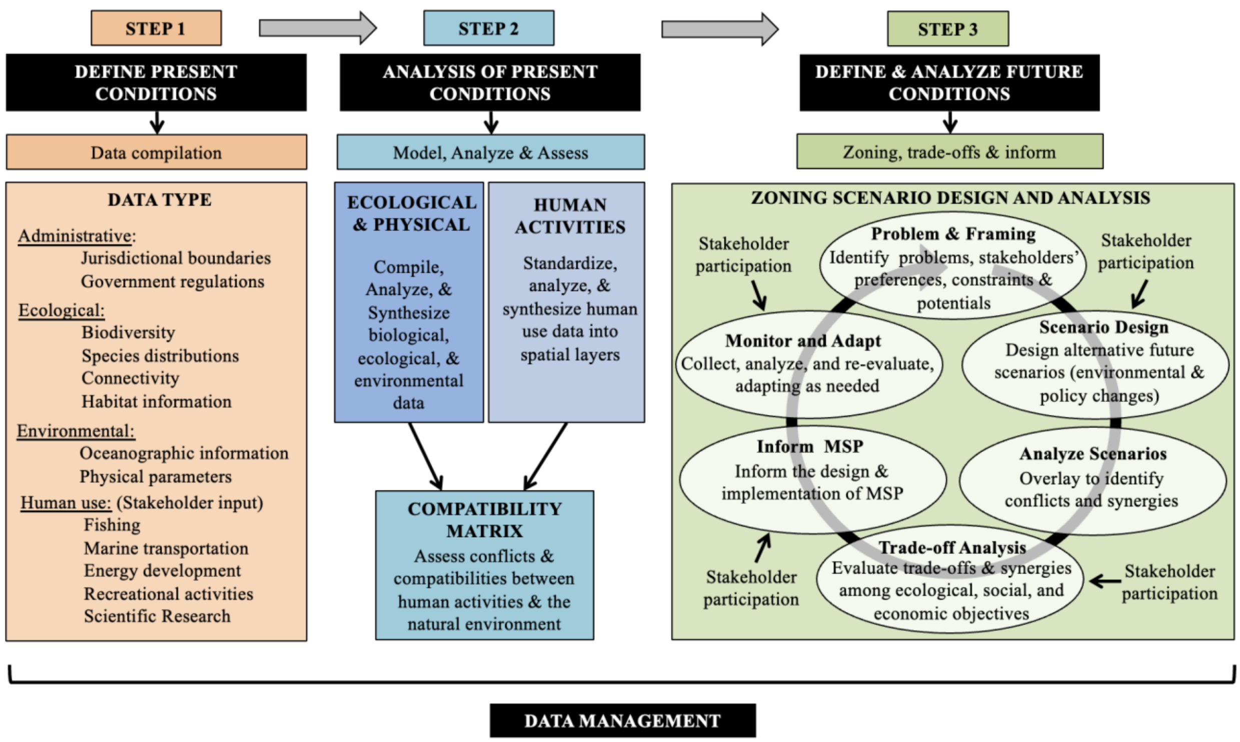


*Figure 1. Key steps for MSP analyses (adapted from Stamoulis and Delevaux 2015).*

## 2. Zoning Scenarios Design

In the Coral Sea Natural Park (CSNP), high-protection conservation zones currently cover 10% of the park, with plans to expand to 30%. As such, the Park can be considered as a network of zones with varying levels of protection for biodiversity. Some of these ocean zones encompass MPAs and areas designated for fishing, shipping, and tourism, becoming legally enforceable through MSP. To be effective, standardized zones with clear objectives and regulations are essential for effective MSP, and should align with the broader MSP vision. From a biodiversity conservation perspective, a network of protected areas should also align with scientific criteria for effective and ecologically coherent MPA network design (Rees et al. 2018, Gottlieb et al. 2020). Two important criteria for ecological coherence are connectivity (spatial configuration of MPAs/zones) and representativity (proportion of each conservation feature that is represented in protected areas).

📌 ***In addition, recent advances in biodiversity conservation and MSP thinking are broadening the area of interest to encompass more of the vertical extent of the ocean space from surface to seabed (Brito-Morales et al. 2022, Jacquemont et al. 2024).*** This is an extremely important point as the current CNSP zoning plan has no unifying zoning or regulatory framework. A "no disturbance of the seabed" (including depth parameters would have to be defined) and would be an example of a vertical zone throughout the entire range of the park. There are quite a few examples where MPAs have one, or several, regulations that apply throughout the entire MPA, and then a network of zones. These site-wide regulations may be applied to a limited vertical area or the entire waters of an MPA or park. This is an excellent tool to use in conjunction with a network of discrete zones.

While this shift from two-dimensional approaches to 3D multi-sectoral planning is critical for deep-sea areas, its integration remains limited globally, but is expected to improve with future MSP iterations (UNESCO-IOC 2021).

The management objectives and their goals, as formulated by the consulting committee, are presented below (Government of New Caledonia 2018):

**1) Protecting natural and cultural heritage**

- O1: Protect ecosystems and their connectivity
- O2: Protect heritage, rare and migratory species
- O3: Define and recognize tangible and intangible cultural heritage
- O4: Preserving and optimize tangible and intangible cultural heritage

**2) Sustainable and responsible use**

- O5: Guarantee and support the development of responsible tourism
- O6: Guarantee and support local fisheries while respecting the resources and habitats
- O7: Reduce pressure from maritime transport to limit its impact
- O8: Prepare for future uses

**3) Good governance**

- O9: Ensure proper functioning of park authorities
- O10: Involve the public
- O11: Assess and report the effects of management plan implementation
- O12: Strengthen, optimize and pool resources

**4) A locally, regionally and internationally integrated park**

- O13: Work in harmony with local managers
- O14: Develop regional cooperation for the benefit of the Coral Sea region
- O15: Play a full part in international relations

We designed a portfolio of scenarios to demonstrate how MSP can support actionable management objectives within the CSNP. Those serve as demonstrations to inform discussion amongst decision-makers and foster local collaborations amongst different users, researchers, community members, NGOs, and decision makers. The proposed scenarios are linked to specific set of management objectives and briefly described below:

- To address the management objectives (O1-O4) under “*Protecting natural and cultural heritage”*, we considered the following scenarios:
    - <u>Existing MPAs scenario:</u> Evaluate current MPAs locations and examine how they prioritize ecological health, biodiversity protection, and cultural value (Section 3).
    - <u>Expansion of MPAs with deep-sea MPAs scenario:</u> Evaluate proposed MPA locations and examine how they prioritize ecological health, biodiversity protection, and cultural value (Section 3).
    - <u>Preserve cultural heritage scenario:</u> Evaluate proposed culturally significant protection zones and characterize the cultural heritage to explicitly embed cultural values in MPA-design (Section 3.2).
- To address the management objectives (O6-8) under “*Sustainable and responsible use”*, we considered the following scenarios:
    - <u>Designing blue corridors scenario:</u> Inform the design of blue corridors to limit potential conflicts between maritime transport and migratory species to protect seasonal migration routes and sensitive habitats (Section 4).
    - <u>Livelihood resilience zoning scenario:</u> Secure fishers livelihoods through zoning resource extraction based on projected climate change impact on fish stocks (Section 5).
- To address the management objective *O14: Develop regional cooperation for the benefit of the Coral Sea region*, we considered the following scenario:
    - <u>Transregional collaboration Scenario:</u> Assess neighboring activities around the CSNP border to identity countries to collaborate with and ensure compliance with the CSNP MSP rules (Section 6).

Zoning scenarios were developed based on data availability, fostering equity amongst local users, and with the goal to support ecosystem-based development. Ultimately, these are illustrative and should be co-created in partnership with local stakeholders to draft the MSP (see Chapter 1 for best practices).

## *3. Evaluating Existing and Proposed MPAs*

In 2023, the government of New Caledonia designated at least 10% of the park as “highly protected zones” (**Figure 2**). Existing reserves established in 2018 and new reserves added in 2023 consist of access restricted integral reserves (IUCN Category I) and natural reserves (IUCN Category II) with limited and sustainable human uses allowed under specific conditions (Day et al. 2019). This suite of fully and highly protected reserves target critical areas for the preservation of iconic species such as whales, dolphins, sharks, turtles, and seabirds, while also including reefs and seamounts—ecosystems that are as vulnerable as they are remarkable. In addition, a number of new MPAs were proposed for the CSNP during the consultation for the 10% target in 2023 that were not implemented (**Figure 2**). Along with integral reserves, these included deep water reserves (IUCN Category II) aimed at protecting shallow seamounts and pelagic habitats (> 500m in depth) while allowing fishing in surface waters (Day et al. 2019). Ultimately, the goal of many members of the CSNP management committee is to achieve Target 3 of the United Nations Convention on Biological Diversity’ (CBD) Global Biodiversity Framework by placing at least 30% of the park under a level of protection that effectively conserves areas of particular importance for biodiversity and ecosystem functions and services. We evaluate these proposed protection areas along with other information and integrate into future zoning scenarios to be considered during the MSP process.

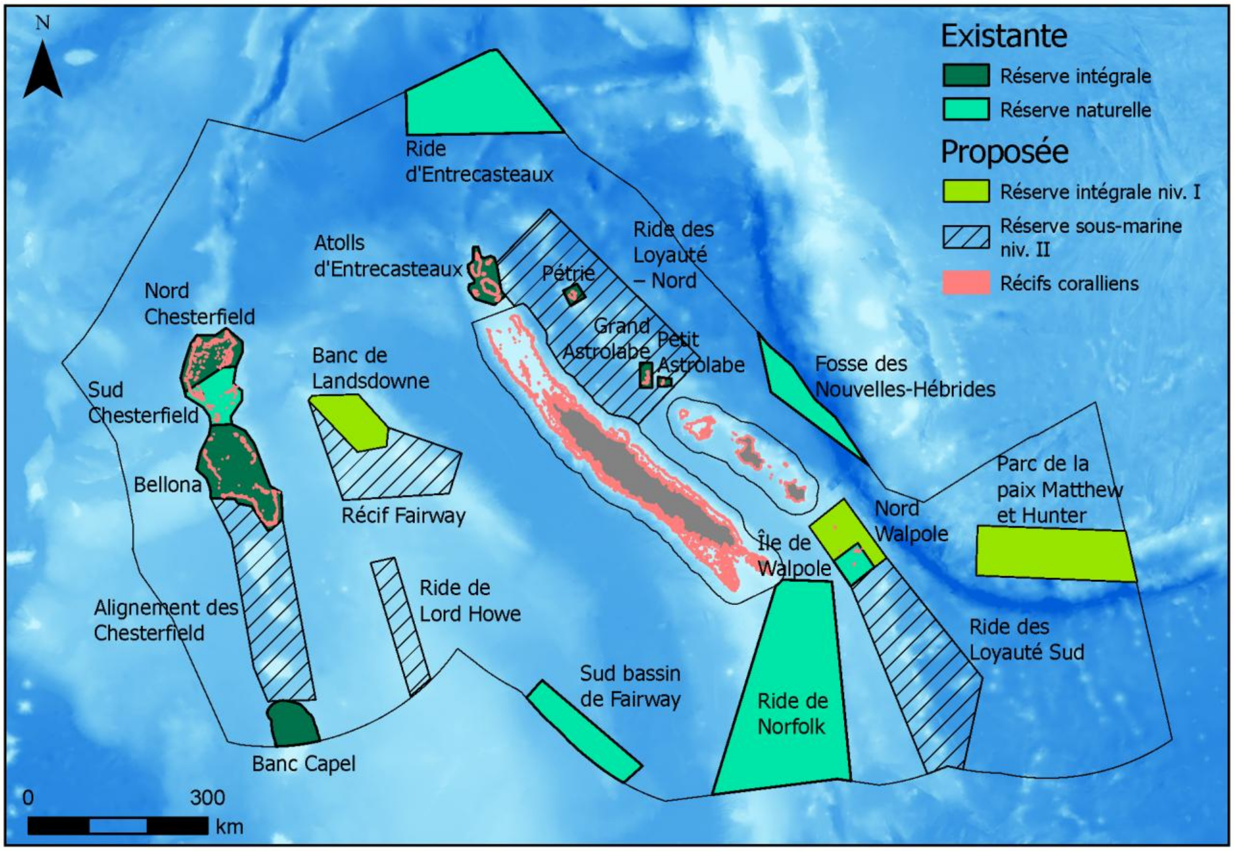


*Figure 2. Existing and proposed (2023) marine reserves of the CSNP and coral reefs.*

The proposed MPAs were primarily placed over seamounts and other geological features associated with high seabed and pelagic biodiversity to offer protection from future extractive industries including the potential for bottom fishing and seabed mining. In addition, shallow seamounts, banks and slopes and deep water ridges are known to be important feeding areas and navigation aids for long-distance migratory megafauna such as whales, turtles and sharks (Garrigue et al. 2015, Matley et al. 2025). The importance of vertical coupling between the seafloor and upper waters is becoming more apparent through recent research showing that food webs and ocean productivity in some areas is maintained through tightly coupled benthic-pelagic food webs (Griffiths et al. 2017, O'Leary and Roberts 2018). Seamounts can also function as "stepping stones" that enable coral reef fishes to disperse and could also be important during geographical shifts driven by global warming as has been found relevant for reef fish connectivity between the Coral Triangle and the Coral Sea Marine Park (Galbraith et al. 2024).

Although more deep water habitat and seamounts are being protected globally, only a small percentage are within MPAs (Jacquemont et al. 2024). Protection of seamounts is particularly important because they are often associated with Vulnerable Marine Ecosystems (VMEs) and have been found to take decades to recover from physical disturbance (Watling and Auster 2017). However, international calls for better representation for deep water ecosystems (Pew Charitable Trust 2024) have led to more MPAs being designated to increase the diversity and representation of habitats in large MPAs and national MPA networks (Lubchenco & Grorud-Colvert 2015), as well as increasing ecological connectivity (Althaus et al. 2016). Many nations with large marine EEZs have networks that include deep water canyons and seamounts with vulnerable corals and megafauna. New Zealand is an example as a neighbouring Pacific nation with many deep water areas contributing to the national MPA network (Helson et al. 2010). Large MPAs such as the Great Barrier Reef Marine Park and the US Pacific network of MPAs also include targeted protection for deep water habitats. Some MPAs, such as the Ascension Islands MPA in the South Atlantic which spans the entire EEZ, is primarily protecting seamount associated ecosystems (Weber et al 2025).

Stratified MPAs, such as proposed in the CSNP offer an innovative approach to marine conservation by protecting deep-sea habitats, such as seamounts and canyons, while allowing fishing in surface waters. These MPAs use depth-based zoning to prevent destructive bottom-contact fishing and seabed mining while maintaining sustainable pelagic fisheries. For example, the Emperor Seamount Chain MPAs in the North Pacific safeguard deep-sea corals and benthic biodiversity by prohibiting bottom trawling, while allowing surface longline fisheries targeting tuna and billfish (Auster et al. 2020). Similarly, the Northeast Canyons and Seamounts Marine National Monument in the U.S. Atlantic protects cold-water coral ecosystems on deep-sea seamounts, while permitting pelagic fishing for highly migratory species in upper waters (Auster et al. 2020). The Galápagos Marine Reserve follows a comparable model, closing deep-sea seamounts to bottom trawling while allowing regulated artisanal and commercial fisheries, ensuring a balance between biodiversity conservation and economic sustainability (Castrejón et al. 2024). These stratified MPAs demonstrate a practical approach to marine spatial planning, enabling the protection of deep-sea ecosystems while supporting sustainable fisheries and local economies.

In this section, we evaluate existing and proposed MPAs using a suite of metrics spanning special and unique areas (Section 3.1), biodiversity indicators, and cultural values (Section 3.2). Section 3.1 focuses on a comparison based on the overlap areas between ecologically important zones and MPAs, while Section 3.2 is centered on a comparison of biodiversity indicators (species count). These two approaches highlight different methods for integrating spatial data and demonstrate what is feasible for assessing MPAs.

For existing MPAs, the integral reserves of Île Longue, Îlot du Passage, and Mouillage n°1 are each less than 10 $km^2$ and located near each other in the Chesterfield Reef Complex. In 2023, the Sud Chesterfield Natural Reserve (5,549.7 $km^2$) was designated and encompasses these three small reserves (AMP 2025). In the following analysis, we evaluate the Sud Chesterfield Natural Reserve, though do not provide separate values for these small integral reserves it encompasses.

## 3.1. Evaluating Existing and Proposed MPAs in terms of Special or Unique areas

To evaluate the MPAs, we derived several metrics from existing and available datasets (Chapter 2). Efforts to compile biodiversity and species data have helped identify key areas for conservation. These designations, derived from synthesized information and based on globally accepted criteria, aid in prioritizing conservation efforts. Relevant examples for MSP within the CSNP include Ecologically or Biologically Significant Areas (EBSAs), Important Marine Mammal Areas (IMMAs), Important Bird and Biodiversity Areas (IBA/ZICO), and KBAs (Key Biodiversity Areas) (**Figure 3**). Each type of area is identified based on specific scientific criteria and can be used to value the biodiversity and uniqueness present in each MPA of the CSNP:

- **Ecologically or Biologically Significant Areas (EBSAs)** are ocean regions recognized under the Convention on Biological Diversity (CBD) for their ecological importance, including uniqueness, biodiversity, productivity, and significance for threatened species (CBD Secretariat 2009). They support marine ecosystem functioning and guide sustainable ocean management.
- **Important Marine Mammal Areas (IMMAs)** are key habitats for marine mammals, identified by the IUCN based on ecological significance. These areas highlight regions essential for feeding, breeding, and migration, aiding in marine spatial planning and conservation effort (Tetley et al. 2022).
- **Important Bird and Biodiversity Areas (IBAs/ZICO)** are globally significant sites for bird conservation, identified by BirdLife International. They provide critical habitats for threatened and range-restricted bird species, informing protected area designation and sustainable habitat management (Donald et al. 2019).
- **Key Biodiversity Areas (KBAs)** are sites of global importance for biodiversity, spanning terrestrial, freshwater, and marine ecosystems. Identified using IUCN criteria, they prioritize conservation efforts by protecting habitats crucial for species survival, ecological integrity, and ecosystem resilience (IUCN 2016, Edgar et al. 2008). In many cases, KBAs overlap IBAs.

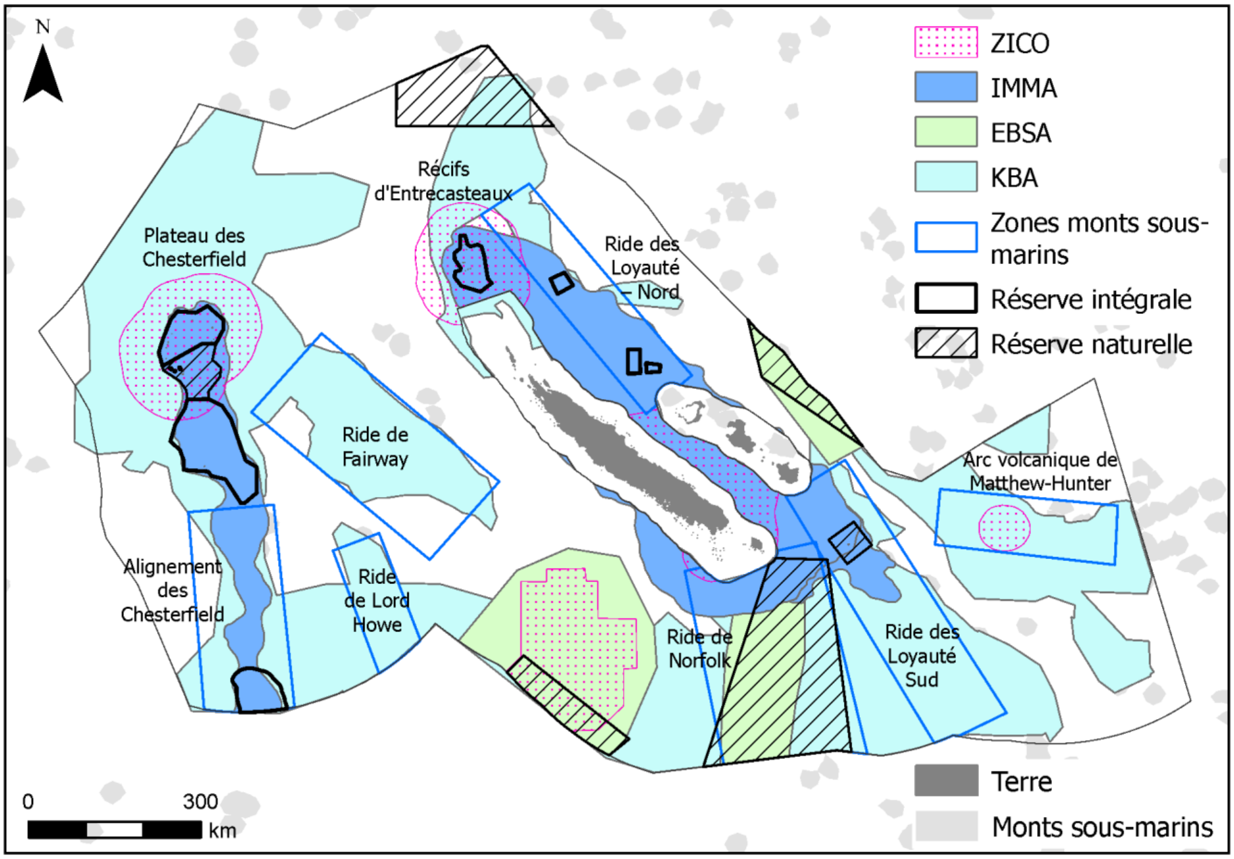


*Figure 3. Mapped areas of ecological importance in the CSNP with existing marine reserves.*

We computed the areas (km$^2$) of special or unique areas overlapping with each existing and proposed MPAs using ArcGIS and R software (**Figure 4** and **5, Tables C3.A1** and **C3.A2**).

We also considered habitat suitability of octocorals (deep water corals) using data for the CSNP sourced from Yesson et al. (2012). This global map is publicly available and relevant for MSP, as it serves as an ecologically important indicator for deep-sea habitats. Octocorals create complex habitat structures that support diverse macrofaunal communities including endemic fish and crustaceans, enhance nutrient cycling, sequester carbon and alter current flows (Baco et al. 2023). We selected the top 50% of suitability values for each of seven octocoral suborders modeled. These seven maps were then reclassified so that areas with greater than 50% suitability were considered high potential for octocoral presence. Finally, the presence maps were combined to derive a proxy for octocoral species richness. To estimate total area suitable for octocorals, we multiplied the number of grid cells within each reserve by the area of each grid cell (18.4 km$^2$) (**Figures 4 and 5**).

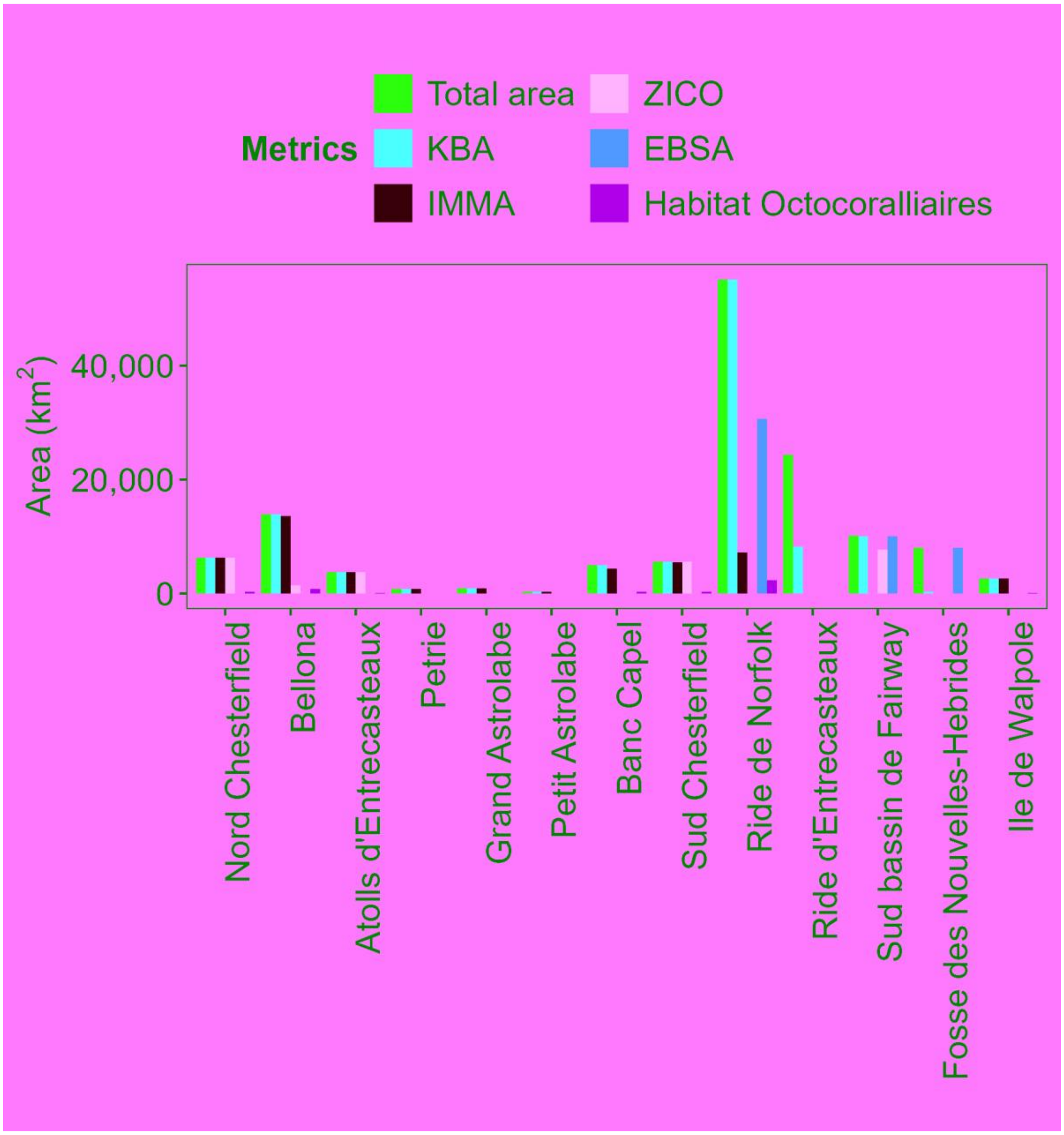


*Figure 4. Areas of ecological importance present in the existing MPAs.*

Many existing MPAs include at least two, if not more, of the special and unique areas (**Figure 4**). Among these globally designated zones, the KBA is the most extensive in the CSNP and every existing MPA overlaps it completely with the exception of the Ride d'Entrecasteaux (33%) and Fosse des Nouvelles-Hébrides (3%). IMMAs are the next most extensive type of global special and unique areas and are fully represented in 9 of the 13 existing MPAs evaluated here. The IBAs/ZICOs and EBSAs are more spatially limited and well represented in four and three of the existing MPAs, respectively (**Figure 4**).

The Ride de Norfolk MPA is by far the largest (55,166 $km^2$) and has the largest areas of KBA and EBSA. Ride d'Entrecasteaux (24,331 $km^2$) and Fosse des Nouvelles-Hébrides (7,997 $km^2$), while large, are each represented by only one type of global special and unique area. While Fosse des Nouvelles-Hébrides overlaps completely with an EBSA, Ride d'Entrecasteaux has only 33% representation of KBA (**Figure 4**). In terms of octocoral habitat suitability, Ride de Norfolk encompasses the largest area, followed by Bellona, Sud Chesterfield, Banc Capel, and Nord Chesterfield. The remaining MPAs have comparatively small areas of octocoral habitat (**Figure 4**).

Similar to the existing MPAs, many of the proposed MPAs align primarily with KBAs, except for the Ride des Loyauté Nord which has greater IMMA representation (**Figure 5**). IMMAs are also well represented in Alignement des Chesterfield, Ride des Loyauté Sud, and Nord Walpole. IBAs/ZICOs are represented in Ride des Loyauté Nord and Parc de la paix Matthew et Hunter, while EBSAs are not represented in any of the proposed (and not previously implemented) marine reserves. Of the proposed MPAs, Ride des Loyauté Nord has KBA, IMMA, and IBAs/ZICO represented while the remaining proposed MPAs are only represented by one or two of these globally designated areas. All proposed areas include suitable habitat for octocorals, with the exception of Parc de la paix Matthew et Hunter (**Figure 5**).

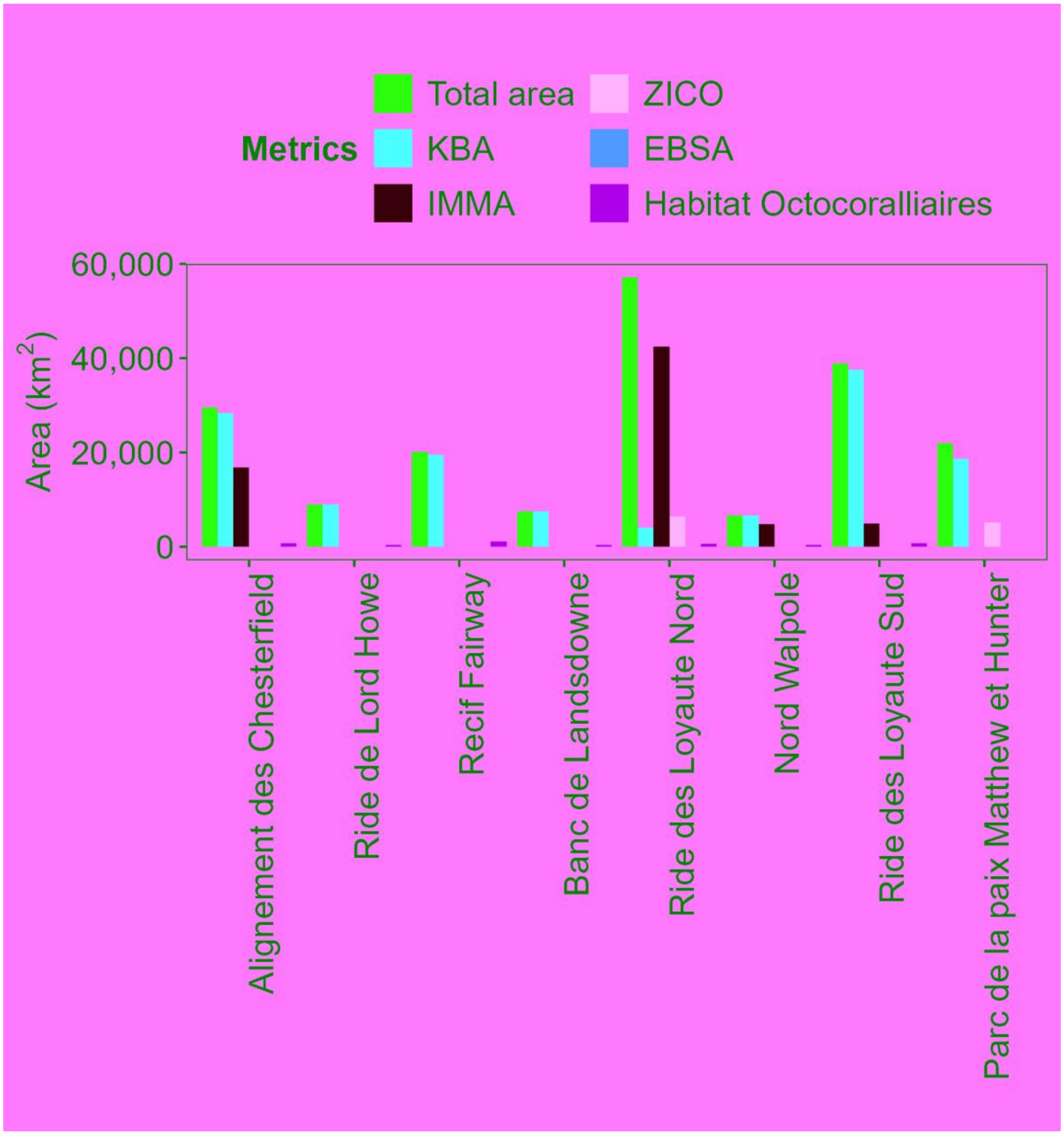


*Figure 5. Areas of ecological importance present in the proposed MPAs.*

Mathon et al. (2024) modeled several metrics related to fish community, including abundance for 45 fish species and genetic markers in benthic and pelagic waters down to 600 meters. This approach enabled the characterization of biodiversity on seamounts and deep slopes while identifying 3D protection strategies to support New Caledonia's goal of meeting the CBD area target. Spatial decision units were selected as priority based on high biodiversity criteria in a 3D space to achieve the protection of 30% of the modeled domain (**Figure 6**).

Many of the prioritized areas are protected within existing reserves, and most of the remaining areas are covered by proposed reserves in the CSNP. Specifically the deep water reserves Alignment des Chesterfield (3,021 $km^2$ prioritized) and Recif Fairway (2,274 $km^2$), as well as the proposed integral reserve Banc de Landsdowne (2,127 $km^2$). The other proposed integral reserves contain smaller prioritized biodiversity areas, 536 $km^2$ in Nord Walpole and 119 $km^2$ in Parc de la paix Matthew et Hunter. Notably, the boundaries Sud Chesterfield, Atolls d'Entrecasteaux, and Banc de Landsdowne do not entirely encompass the 3D biodiversity priority areas with small sections falling outside the boundaries. At a minimum, the boundaries of the proposed MPA Banc de Landsdowne should be adjusted to include the priority area near its current boundary.

*Figure 6. 3D priority areas based on various biodiversity targets (Mathon et al. 2024).*

***📌 Key finding: It is clear that the design of current and proposed MPAs was guided by the globally designated special or unique areas. As such, the current MPA network well represents all these key biodiversity areas in the CSNP, especially those including coral reefs. The one exception is the Ride d'Entrecasteaux MPA for which only a third of its area overlaps with a KBA. This area could be considered a conflict-free zone between biodiversity protection and fishing interests, since it is not an area currently important for fishing or likely to be in the future (Section 5).***

***The current MPA network of the CSNP provides protection for nearly all coral reefs, several deep seamount areas of interest, and 3D biodiversity priorities (considering a range of depths). The proposed MPAs fill gaps in protection for coral reefs (Nord Walpole), for seamount areas of interest, and 3D biodiversity priority areas (Figure 6). The deep-sea stratified MPAs proposed will protect these deeper habitats while allowing for fishing to occur in surface waters. As such, they provide an important compromise between park stakeholders to help achieve the 30% protection goal.***

## *3.2. Evaluating Existing and Proposed MPAs in terms of Biodiversity and Cultural values*

### 3.2.1 Biodiversity metrics

We evaluated the presence of rare and endangered species in existing and proposed MPAs. Using spatially explicit data, we summarized the number of deep-water bioregions, toothed whales, baleen whales, sharks and rays, and diversity of deep-sea corals within existing and proposed MPAs, according to the following steps and displayed the results in bar charts (**Figures 7** and **8**, **Tables C3.A1** and **C3.A2**):

- “The deep-water bioregions were classified using 30 environmental datasets from satellite and ship measurements, including depth, salinity, sea surface temperature, and chlorophyll alpha concentration” (**Chapter 2 Figure 18**) (Beger et al. 2020). We computed the number of deepwater bioregions represented in existing and proposed MPAs.

- We calculated the number of whales, sharks and rays, and sea turtle sightings (GBIF 2025, OBIS 2025) within existing and proposed MPAs.

- Octocoral (deep water coral) habitat suitability data in the CSNP (Yesson et al. 2012) were used to calculate the average number of octocoral suborders present within each reserve.

*Figure 7. Biodiversity metrics by existing MPAs.*

Most existing MPAs included 1-3 deep bioregions, though Fosse des Nouvelles-Hébrides included four and Ride de Norfolk included six (**Figure 7**). Ride de Norfolk also had the highest number of sharks and rays and toothed whale sightings. Atolls d'Entrecasteaux and Île de Walpole were also notable in terms of toothed whale sightings, while Nord Chesterfield and Bellona had the highest numbers of baleen whales. The Atolls d'Entrecasteaux had by far the highest number of turtle sightings while 8 of the 13 existing MPAs reported had 3-6 suborders of octocorals present (**Figure 6**).

The proposed MPAs all contained between three and four deep bioregions, with the exception of Ride des Loyauté Sud, which had seven (**Figure 8**). Récif Fairway and Ride des Loyauté Nord had the highest number of toothed whale sightings, followed by Ride des Loyauté Sud. According to these data, baleen whales were only sighted at Banc de Landsdowne and Nord Walpole. Sharks and rays were seen in highest numbers in Alignement des Chesterfield and Ride des Loyauté Sud and in lower numbers at all other proposed MPAs with the exception of Parc de la paix Matthew et Hunter. Sea turtles were seen in highest numbers at Alignement des Chesterfield while 2-5 suborders of octocorals are predicted in all proposed MPAs with the exception of Parc de la paix Matthew et Hunter (**Figure 8**).

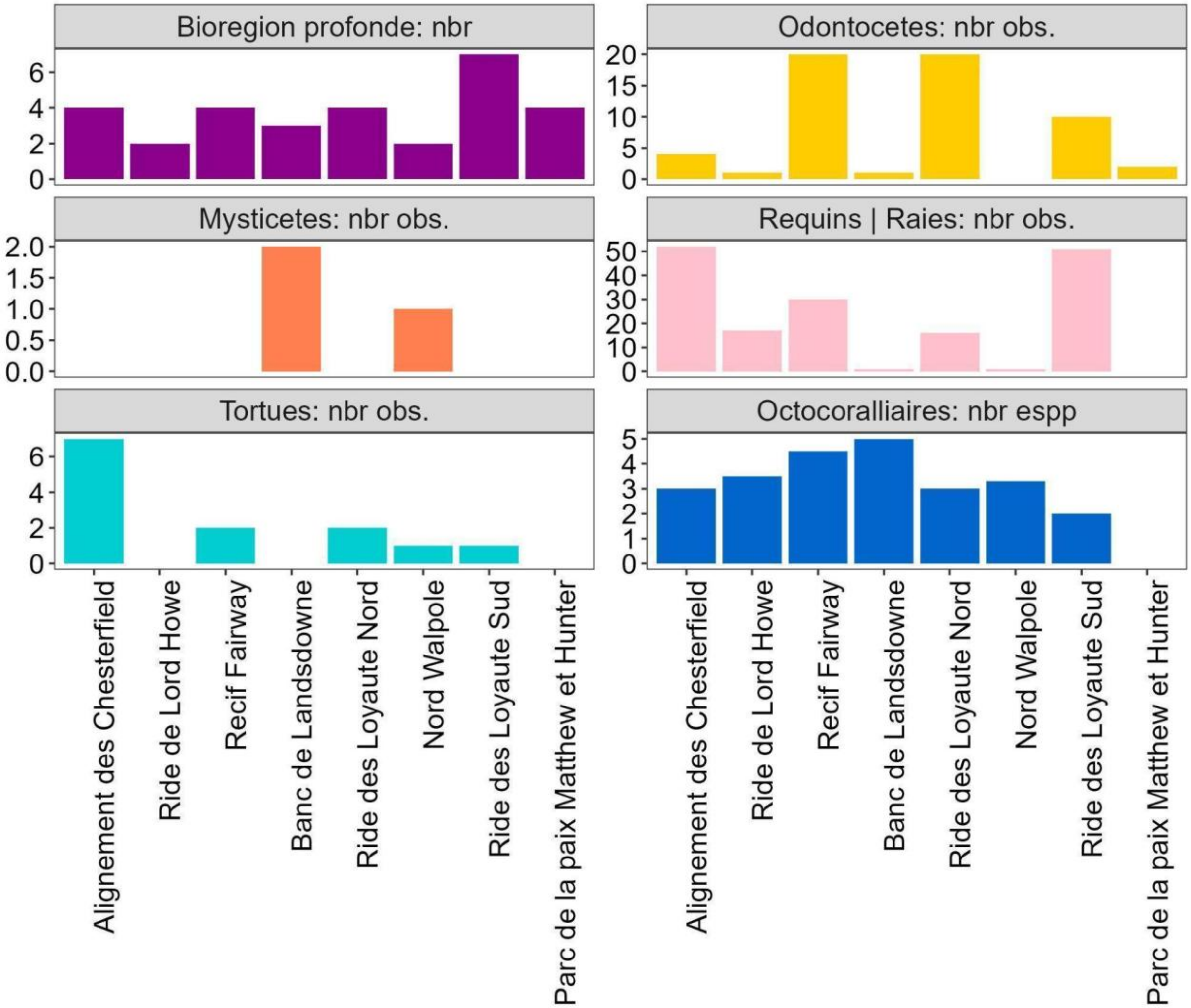


*Figure 8. Biodiversity metrics by proposed MPA*

📌 ***Key finding:*** ***The existing MPA network represents 18 of the 30 deep water bioregions present in the CSNP. When considering the proposed MPAs, this number increases to 26, with the remaining deep water bioregions located around the margins of the CSNP. Thus, if the proposed MPAs were implemented, the reserve network of the CSNP would have nearly complete representation of the deep water bioregions within its boundaries.***

The biodiversity count data available for this study were from global datasets (GBIF 2025, OBIS 2025) and represent a subset of what exists locally. Nevertheless, we showed good representation of these important species groups within the current and proposed MPA network. Generally, these species occurrence data overlapped with the globally designated biodiversity areas described in the previous section, lending credibility to these designated areas and the MPAs based on them.

Similar to the surface dwelling species, octocoral diversity was also found to be high among existing MPAs that include deep-sea areas as well as the proposed MPAs focused on deep-sea areas. This line of evidence (along with the 3D biodiversity indicators described in the previous section) indicates that the current and proposed MPAs are representative of deep sea biodiversity as well as shallower ecosystems.

### 3.2.2 Cultural values

In the customary Kanak beliefs system, the Ocean holds deep spiritual significance, including a resting place for the souls and the pathway of ancestral migrations connecting them to neighboring islands. Three marine species in particular, whales, sharks, and marine birds, symbolize Kanak customs and cultural identity (**Figure 9**) (*SCSNPP 2023*, Sabinot et al. 2021). Studies have demonstrated that migrating whales rely extensively on seamounts along their journey between Antarctica and New Caledonia's southern Lagoon, with critical stopovers along the Norfolk and the Loyauté .

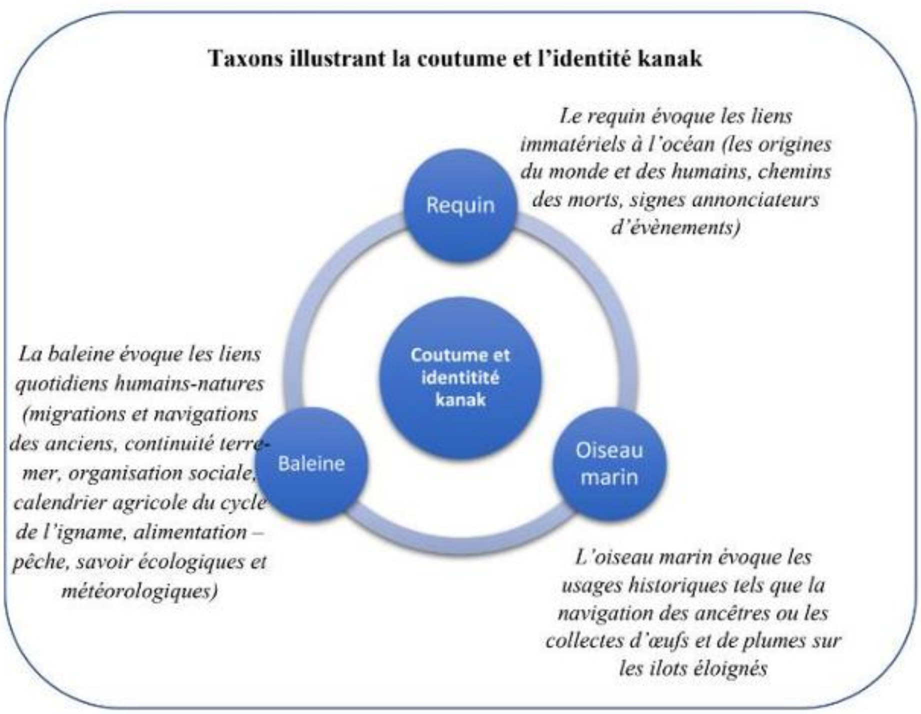


*Figure 9: Marine species important to Kanak customs and cultural identity (SPNMCP 2023)*

Following consultations with the Park and Fisheries Service (SPP) in 2023 regarding the protection of 10% of the Park's marine area, the Customary Senate identified critical gaps in the proposed conservation measures. Specifically, an inadequate consideration of key southern seamounts and the absence of a fully protected marine reserve. Although these seamounts are strongly linked to priority conservation areas—such as EBSA and IMMA—they remain only partially covered by a nature reserve and continue to be accessible to maritime traffic. In response, the Customary Senate proposed a substantial increase in protected zones, advocating for the expansion of reserve areas to 25–30%, with two culturally important zones (**Chapter 2 Figure 32**) (Pew Charitable Trust 2023).

The CSNP scientific committee recognised that too little space is given to the protection of pelagic areas used for feeding seabirds that nest within the Park. Seabird species sightings compiled by the Global Biodiversity Information Facility include 19 species that are pelagic feeders and listed as IUCN Red List of Threatened Species as either globally Vulnerable, Endangered, or Near Threatened (**Figure 10**, **Table C3.A3**). The CSNP supports a rich diversity of migratory globally threatened seabirds. More research is required to understand the high use areas for foraging using both scientific at-sea surveys, vessels of opportunity and satellite tracking of bird movement behaviour. Satellite telemetry data (47 datasets) are available to view (https://data.seabirdtracking.org/dataset) that show seabird movements within CSNP but these data could not be requested in time for this initial study. Satellite tracking reveals important connectivity between New Caledonia, Australia, and New Zealand for several albatross and petrel species, as well as more local excursions from colonies on Grande Terre for the Near Threatened Tahiti petrel (*Pseudobulweria rostrata*) and the non-threatened wedge-tailed shearwater (*Ardenna pacifica*). Models of feeding areas based on shearwater movements suggest a large foraging range with highest probability predicted east and west of the colonies on Grande Terre (Ravache 2020).

Based on existing and available datasets, we evaluated the presence of the culturally important species, whales, sharks and marine birds, in those areas and how they overlap with existing and proposed MPAs (**Figure 10**). Both culturally important zones are key areas for whales migration, birds and sharks.

📌 ***Key finding:* *Although a large portion of the southeast region is protected by the Ride of Norfolk MPA and could be protected under the proposed deep-sea MPA, the western cultural area has only a small portion placed under protection. Future work should consider how protecting those zones may help support conservation of culturally valued species while avoiding impact from shipping (Section 4) and potential future fishing activities (Section 5).***

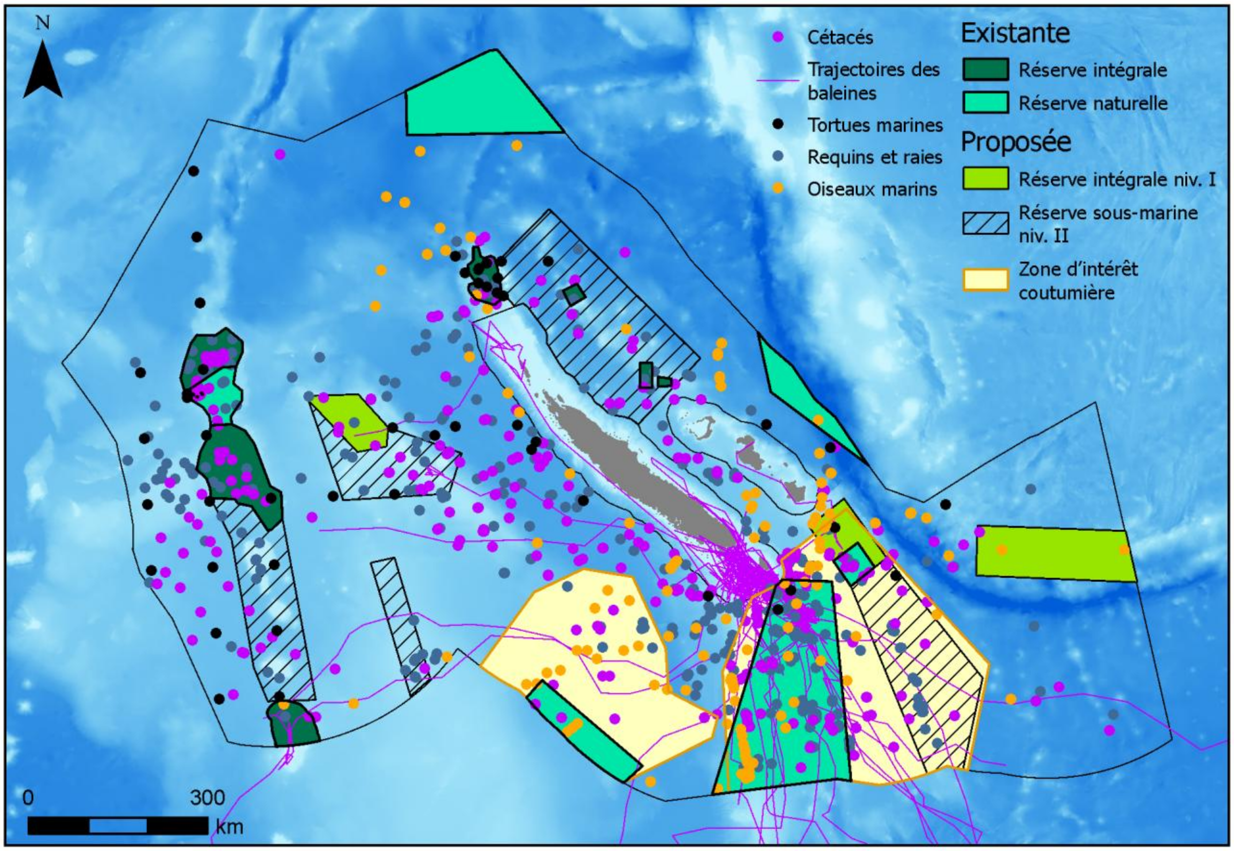


*Figure 10. Existing and proposed MPA coupled with culturally important areas, including biodiversity (e.g., turtles) and culturally valued species (sharks, globally threatened seabirds, and whales). Biodiversity datasets were clipped to the park boundaries, with the exception of whale tracks.*

## 4. Blue Corridor Scenario: Assessing risks from shipping traffic on migratory species

New Caledonia plays a vital role in the migration of whales across the Pacific, serving as a key habitat along the blue corridors—critical marine pathways that support the movement of migratory species. Humpback whales (*Megaptera novaeangliae*) from the Southern Hemisphere use these corridors to travel between their Antarctic feeding grounds and the warm, sheltered waters of New Caledonia, where they breed and give birth. The CSNP and surrounding MPAs provide crucial sanctuaries for these whales, ensuring safe passage.

Satellite tracking (Garrigue et al. 2015) of 34 humpback whales (16 females and 18 males) highlight long-distance connectivity between New Zealand and Australia EEZs. The data show a potential north-south migratory corridor along the Ride of Norfolk between breeding grounds in New Caledonia and feeding areas in New Zealand with one female travelling far south to the Southern Ocean. Females were frequently sighted swimming alongside their calf. The humpbacks moving between New Zealand and New Caledonia are thought to be one population (Garrigue et al. 2010) - the endangered Oceania subpopulation. Other movements have been documented between New Caledonia, Vanuatu and Tonga (Garrigue et al. 2011). Movement behaviour has highlighted the importance of seamounts for foraging along the long migratory journeys where "residence time significantly increased with proximity to shallow seamounts, while dive depth increased in the vicinity of seafloor ridges" (Derville et al. 2020).

Humpbacks have also been tracked moving between New Caledonia and East Australia. Several offshore breeding locations exist in the CSNP including the Chesterfield-Bellona archipelago with sightings in shallow inner-reef waters and offshore shallow banks, the south lagoon off the grande terre and the southern seamounts (Garrigue et al. 2020).

However, growing maritime traffic and anthropogenic noise pose risks, including ship strikes and habitat disturbance. Nouméa is a key Pacific maritime hub, it has been ranked as the second largest French overseas port and the tenth largest French port in 2018 with almost 11 million tonnes transported in 2019 (Anon 2019). Maritime traffic has grown by 10% over recent decades, with the cruise tourism industry increasing its stopovers fivefold, reaching 500 between 2007 and 2016 (Payri et al. 2019). Commercial vessels, mainly cargo ships and oil tankers, follow established east-west and north-south routes, including the heavily trafficked Brisbane–Nouméa corridor and a broader north-south passage with around 1,200 ships annually (Baletaud et al. 2024).

## *4.1. Conservation strategies to manage blue corridors*

Conservation initiatives, such as blue corridor protection efforts, aim to mitigate these threats by (Johnson et al. 2022):

- Promoting sustainable shipping practices, including speed reduction during migration season
- Reducing underwater noise pollution, including reducing vessel speed and using technology to detect the presence of whales, and
- Designating key marine areas as no-go zones during peak migration seasons and Areas To Be Avoided.

Strengthening these protections is essential for safeguarding New Caledonia's role as a critical link in the Pacific's whale migration network.

To inform where protection rules for blue corridors may be needed, we assessed where main shipping routes intersect with whale migration routes, contributing to sound pollution and collision risks for marine species.

In this section, we highlight areas of conflicts between important endangered species (whales and turtles) and shipping traffic and illustrate how managing blue corridors and MPAs can serve as policy tools to mitigate those conflicts in a MSP process.

The data indicates a strong connectivity with Chesterfield and Banc Landstowne and Récif Fairway area for turtles and whales (**Figure 11**). Whales migrate along three pathways away from the southern lagoon of the Grande Terre (**Figure 11**):

- A south-west pathway,
- A southern highway, and
- The south-east pathway.

These results highlight the importance of implementing blue corridor management policies to reduce the pressures of maritime traffic on migratory species and enhance their protection within the MSP framework.

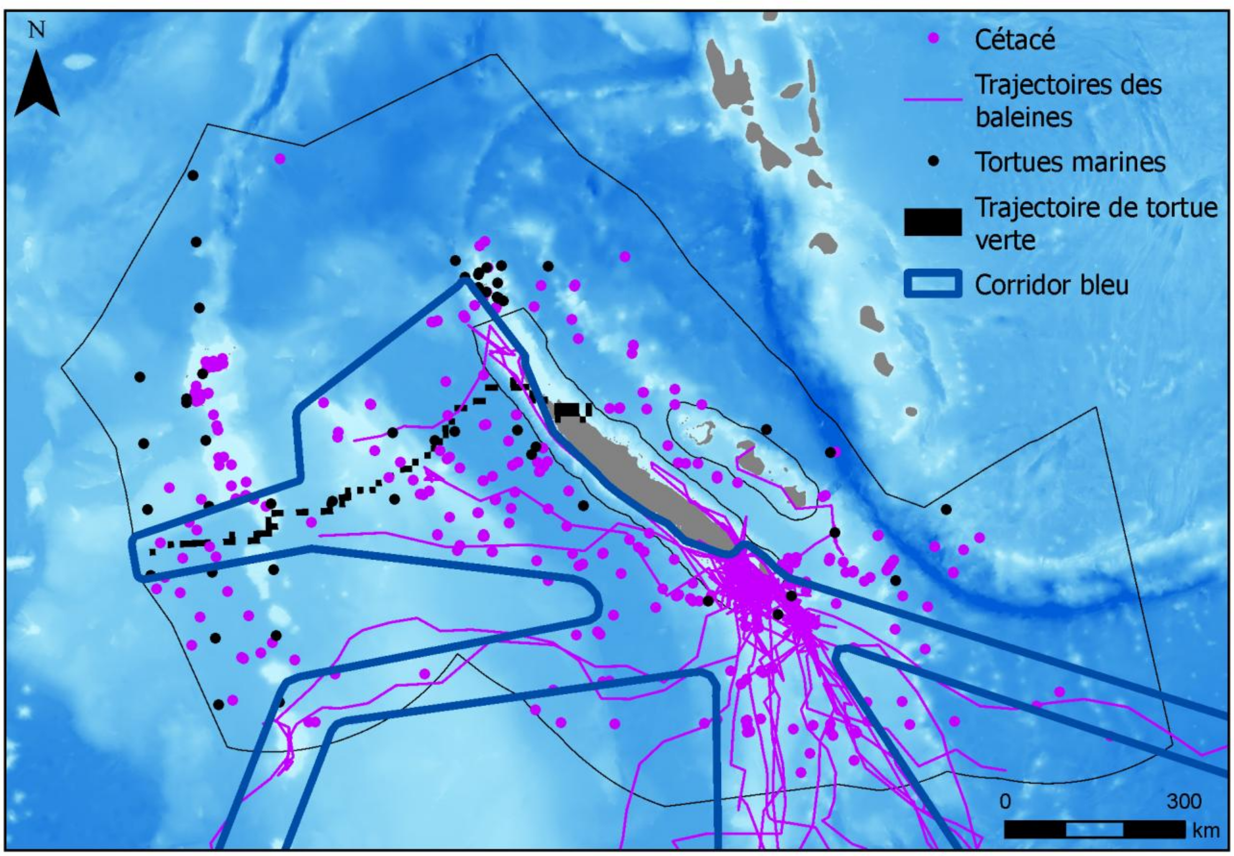

*Figure 11. Identification of blue corridors based on whale (Garrigue et al. 2015) and green sea turtle (OBIS-SEAMAP 2022) movements and sightings (GBIF 2025, OBIS 2025)*

Then, we evaluated where shipping traffic routes may conflict with those blue corridors (**Figure 12**). We found that the north-south cargo route crosses turtles and whales migration routes as they move from the great lagoon surrounding the Grande Terre towards Australia.

***📌 Key finding:*** ***These patterns suggest the need to consider blue corridors related policies to limit or slow down vessel traffic in those regions during migration periods (Figure 12). The zone of conflict could be considered implementing seasonal restrictions, mostly around vessel speed during migration months to reduce collision risk. Special focus should be directed to the the southern part of the EEZ, particularly around Fairway and Norfolk, which is also a high traffic zone and a key migratory route (Figure 12). This information suggests strengthening rules attached to the Norfolk MPA management plan related to protecting this blue corridor. For instance, designing rules that re-orient traffic or implement speed restrictions during breeding seasons to minimize risk of collision and underwater noise disturbance when the animals travel to and from New Zealand and the South Pole.***

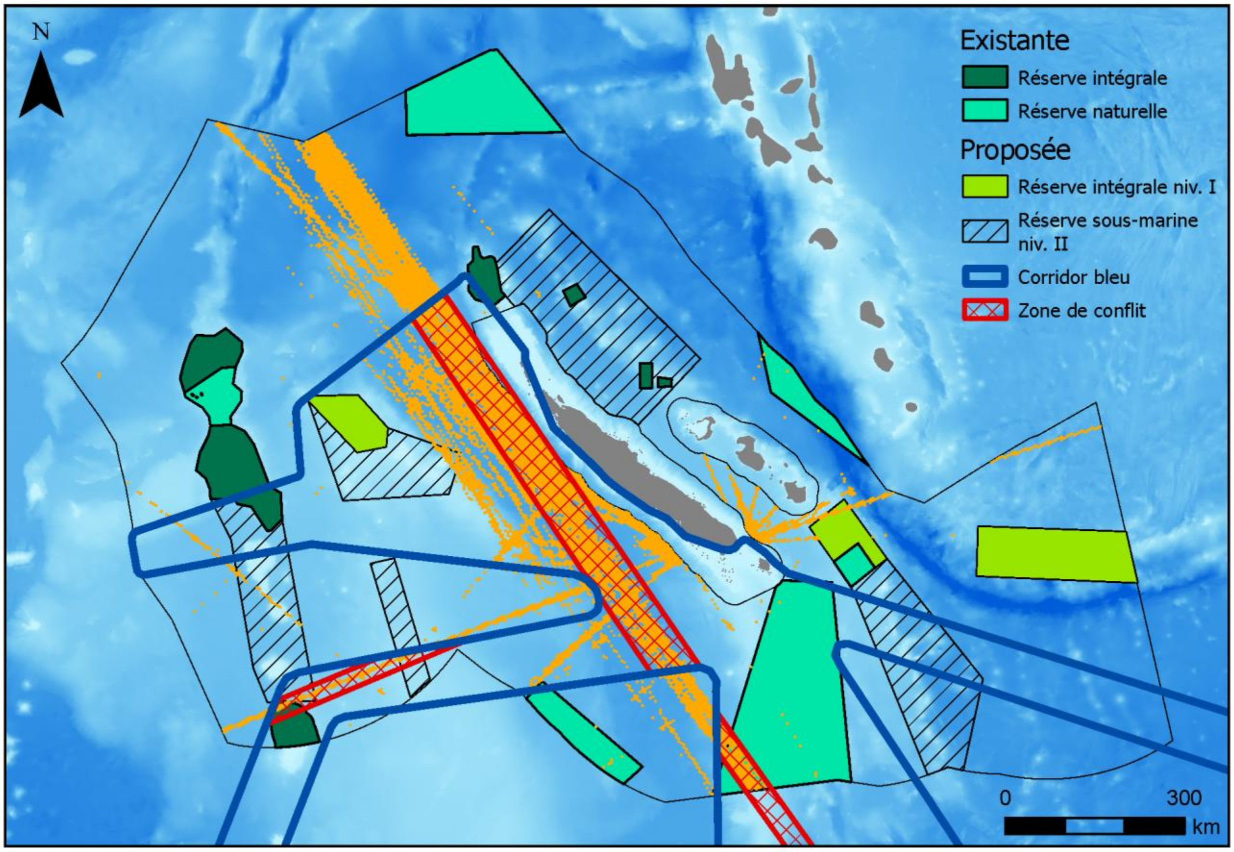

*Figure 12. Conflicts and management options when compared with high vessel traffic and existing reserves. Note vessel traffic is clipped to park boundaries.*

## *5. Livelihoods Resilience Scenario: Assessing climate change impact on tuna stock and fishing livelihoods*

Commercial tuna fisheries in New Caledonia are a source of livelihoods and ensure a stable seafood supply, making the protection of this blue economy sector a key priority for MSP. The New Caledonia offshore fishing fleet consists of 18-20 licensed longliners, operating around 5 million hooks annually (Letourneur et al. 2023). All vessels were under 200 gross registered tons, with larger ones staying at sea for over two weeks. Fishing trips averaged 12 days, with 8 dedicated to fishing (Anon 2021). In 2021, the fleet completed 347 trips, totaling 4,120 days at sea (Anon 2021). By 2019, total catches amounted to approximately 2,530 tonnes, with 80% of the catch going to the local market, 11% is exported to Japan, 7% to the U.S. (including American Samoa for canning), and 2% to Europe, reaching an economic value of 1,080 million Pacific francs (~9 million €) (Letourneur et al. 2023).

Government records track fleet effort and catch, with 2021 offshore longline catches dominated by albacore tuna (1,774 t), followed by yellowfin tuna, striped marlin, bigeye tuna, and black marlin (Anon 2021). In 2023, total landings reached 2,391 tonnes, comprising 89% tuna, 6% billfish, and 5% other species. Most fishing occurred west of Grande Terre and in the southwest EEZ (SPNMCP 2024).

Given the importance of the commercial fisheries sector, we dedicate this section to examining the sector in the broader CSNP context under current and future conditions. Balancing sustainable fisheries management with marine conservation goals to ensure that fishing activities do not undermine the ecological integrity of MPAs requires understanding these interactions and where they occur. Additionally, assessing climate change impacts on fisheries helps anticipate shifts in fish stocks and habitat conditions, guiding adaptive strategies to support both biodiversity and local livelihoods. This key point illustrates the need for an "Adaptive Management" approach to MSP. However, there needs to be the legal framework and authority to make changes to the MSP plan when there are early signals that there are shifts in fish stocks, habitats and species' ranges. Addressing these challenges through data-driven MSP and stakeholder engagement is essential for ensuring a resilient and sustainable marine environment.

## *5.1. High fisheries value areas and MPAs*

Global Fishing Watch (globalfishingwatch.org) provides real-time data on fishing effort within and along the Park's boundary by analyzing AIS and VMS vessel activity using a fishing detection algorithm that identifies apparent fishing activity based on vessel speed and direction (**Chapter 2 Figure 27**). We delineated a zone of where the top 10% of cumulative fishing effort from the ten year period of 2015-2024 across the EEZ to identify the highest intensity fishing areas (**Figure 13**). For the most part, high intensity fishing areas are located between the Eastern side of the Grande Terre and near the Loyauté and the central West zone of the EEZ, around the Chesterfields and the seamounts outside existing protected areas (**Figure 13**). Notably, there is a gap in fishing effort around Banc de Landsdowne. There are also some detections of high fishing effort in several fully protected MPAs, like Nord Chesterfield, Atolls d'Entrecasteaux, Walpole, and Astrolabe.

***📌 Key point :  These could be misclassified though field investigation and/or local engagement is recommended. Specifically, these maps should be shared with the longline fishers to determine if they represent actual fishing activity and if so, what are the reasons for lack of compliance in these areas.***

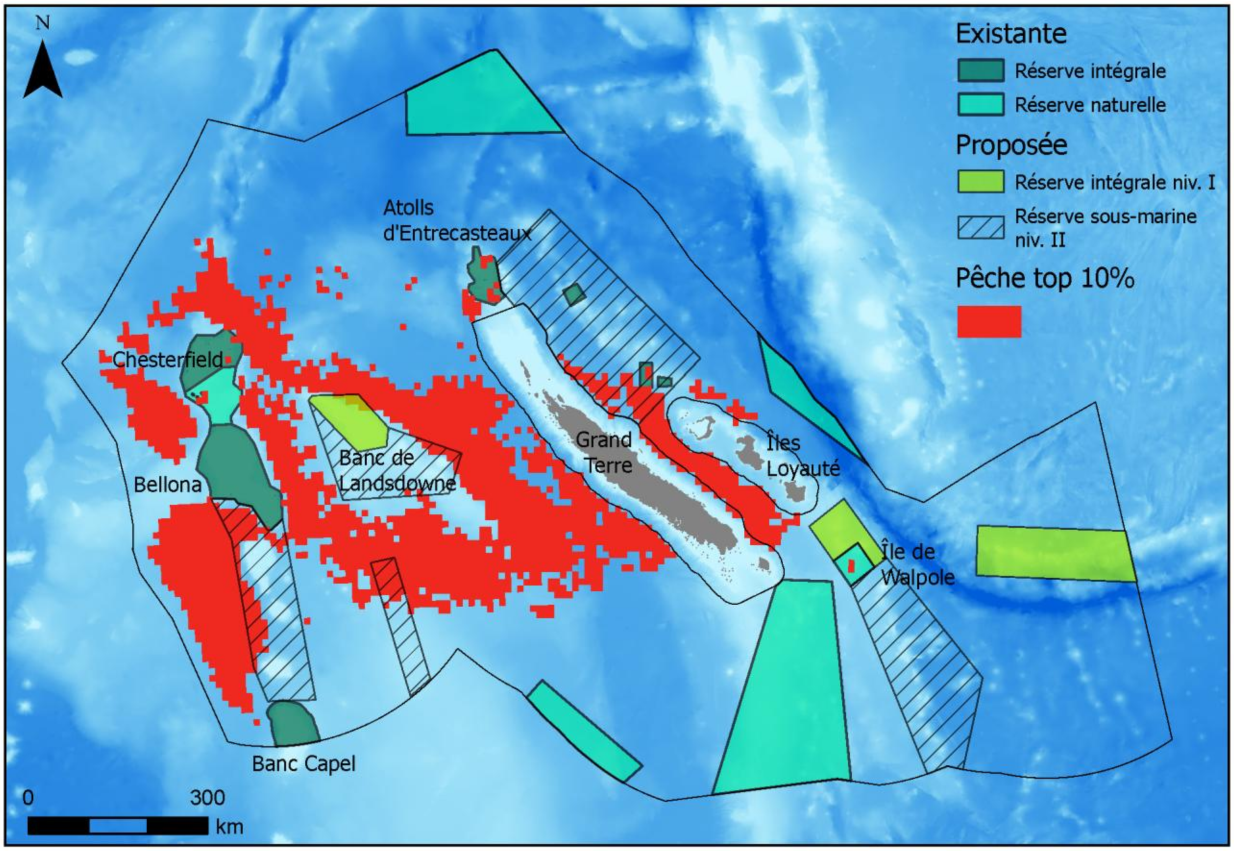


*Figure 13. Top 10% highest intensity fishing areas shown with existing and proposed MPAs. **

## 5.2. Climate resilient fisheries zone

Climate smart MSP relies on spatial assessments of risk, vulnerability, and exposure to identify areas most threatened by climate impacts, such as sea-level rise and shifts in species habitat ranges.

***📌 Key point : Risk and vulnerability mapping plays a crucial role in this process, using mapping tools to pinpoint social-ecological systems most at risk, helping guide targeted adaptation strategies.***

In this section, we demonstrate how by integrating these assessments, MSP can proactively secure local livelihoods and enhance social-ecological resilience amid changing climate conditions.

Albacore tuna (*Thunnus alalunga*) play a crucial ecological and economic role in the waters surrounding New Caledonia, where they are primarily targeted by longline fisheries within the EEZ (Langley 2006). Their distribution is influenced by oceanographic factors like temperature and prey availability, shaping key fishing zones

(Domokos et al. 2007). The SEAPODYM model has been instrumental in assessing climate change impacts on albacore populations, integrating environmental variables to predict future habitat shifts (**Chapter 2 Figure 21**) (Lehodey et al. 2008). Projections suggest a decline in albacore biomass in the New Caledonia EEZ by 2050 due to rising sea surface temperatures and changing prey dynamics, highlighting the need for adaptive fisheries management to sustain both the fishery and ecosystem health.

We overlaid the current high effort fishing areas with the projected change in albacore tuna biomass to evaluate how fishing effort may change (**Figure 14**). The large projected shift in abundance of albacore to the south of the EEZ and an overall reduction in stock throughout the EEZ suggest that fishing effort could also shift south (**Figure 14**).

***📌 Key finding : The proposed deep sea MPAs in the southern part of the EEZ offer an opportunity for fishers to adapt to climate change while still protecting the habitat that supports the pelagic ecosystem above it. Some of the areas that may become more fertile fishing grounds may be located further from the processing ports, which may increase costs of operation. This type of analysis could benefit from more advanced research to refine the model predictions and local consultations with local fishers to discuss livelihood resilience programs to support this type of climate adaptation.***

*Figure 14. Map of highest intensity fishing effort overlaid with modeled tuna stock (Lehodey et al. 2008). a/ Current - mean 2015-2024, b/ Future - mean 2045-2054.*

## *6. Regional Collaborations*

The CSNP management plan emphasizes the importance of regional collaboration in addressing transboundary challenges and enhancing shared capacity. To support this goal, we analyzed Global Fishing Watch data to map fishing pressure outside New Caledonia's EEZ (**Figure 15**). The data reveal high fishing activity along the borders with Vanuatu, Solomon Islands, southeast international waters, and Fiji. These findings reinforce the need for stronger partnerships with neighboring nations to co-manage resources, establish transboundary MPAs, and enforce compliance with existing protected areas. Notably, the Ride de Norfolk adjoining Australia's Norfolk MPA, a critical whale migration corridor (**Figure 11**), exhibits no fishing pressure, highlighting effective enforcement (**Figure 15**). However, considerations of shipping traffic and transnational collaboration to manage shipping pressure in those areas is critical to ensure conservation success (**Figure 12**).

Importantly, visualizing fishing pressure at the regional scale reveals the effectiveness of the CSNP at limiting extraction (**Figure 15**). Large areas of the CSNP are not fished and with only 16 licensed fishing vessels ( SPNMCP 2024), the New Caledonia longline fishery is a sustainable fishery that entirely provides for local consumption, ensuring food security.

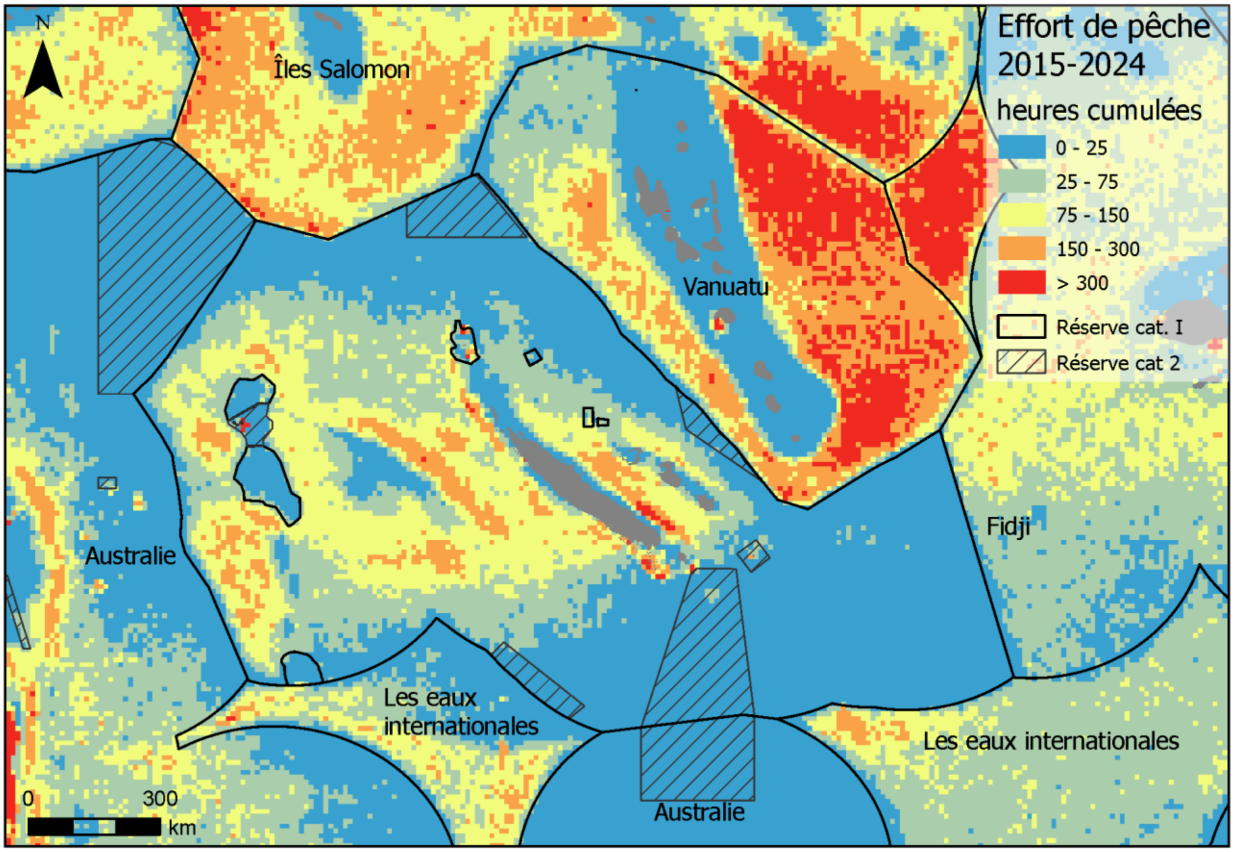


*Figure 15: Fishing effort around NC EEZ with existing MPAs.*

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# Chapter 4 - Key Takeaways, Recommendations and Next Steps

**Chapter 1** defines MSP as a multi-phase approach requiring deep local engagement from all actors connected to blue spaces. **Chapter 2** identifies the key data to inform the MSP process and to highlight data gaps. **Chapter 3** uses these data to illustrate several types of zoning approaches to achieve the management objectives of the CSNP. We conclude this report with some key actionable recommendations related to zoning, research, and partnerships priorities.

## *1. Management Recommendations*

MSP is a powerful tool for balancing ecological, cultural, and economic priorities, minimizing conflicts, and fostering synergies among ocean users (Frazão Santos et al. 2020, Wedding et al. 2024). In New Caledonia, scenario planning and tradeoff analysis are essential for guiding resource management decisions that ensure both biodiversity conservation and human well-being (**Table 1**). Together, the scenarios considered here meet all relevant management objectives at least partially, except for working in harmony with local managers. We interpret this as aligning CSNP zones with existing zoning of the territorial waters, which we were not able to address here, though strongly recommend (**Table 1**).

*Table 1: Summary of how the scenarios considered in chapter 3 help meet CSNP management objectives: fully (dark blue), partially (light blue), management gap (pink), or not applicable (white). The rows in grey show management objectives that were not addressed in Chapter 3 though could be mapped with local stakeholders. Several objectives related to good governance were not directly relevant to zoning and were not included here.*

| **Zoning scenarios:** | **Existing MPAs** | **Proposed MPAs** | **Blue Corridor** | **MPAs + Blue corridors** | **Livelihoods Resilience** |
|---|---|---|---|---|---|
| Protect ecosystems and their connections | | | | | |
| Protect heritage, rare and migratory species | | | | | |
| Define and recognize tangible and intangible cultural heritage | | | | | |
| Preserving and optimise tangible and intangible cultural heritage | | | | | |
| Guarantee and support the development of responsible tourism | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Guarantee and support local fisheries while respecting the resources and habitats | | | | | |
| Reduce pressure from maritime transport to limit its impact | | | | | |
| Prepare for future uses | | | | | |
| Involve the public | | | | | |
| Work in harmony with local managers | | | | | |
| Develop regional cooperation for the benefit of the Coral Sea region | | | | | |
| Play a full part in international relations | | | | | |

This report underscores the importance of diverse zoning strategies to accommodate multiple stakeholders, emphasizing the role of both shallow and deep MPAs in safeguarding key habitats, biodiversity, and migratory species in New Caledonia's EEZ. New Caledonia has already demonstrated strong conservation leadership by establishing large-scale MPAs, protecting critical habitats such as coral reefs and deep-sea ecosystems. However, as MSP evolves, it is necessary to extend protections beyond static MPAs, recognizing that many marine species migrate across vast distances (**Table 1**). This means developing management measures in pelagic areas to protect those blue corridors, connect nursery grounds located in existing or proposed MPAs and ensure safe travel corridors for key species (**Table 1**).

An innovative approach to conservation in New Caledonia is the use of stratified MPAs—depth-based zoning strategies that protect deep-sea habitats (e.g., seamounts, canyons) while allowing pelagic fishing in surface waters (**Table 1**). Such approaches have been successfully implemented elsewhere in the world, demonstrating that vertically zoned MPAs can balance marine conservation with fisheries management.

Beyond conservation, MSP must also address the needs of people, ensuring that ocean space is managed for cultural preservation, local livelihoods, and the blue economy. For Indigenous Kanak communities, the ocean holds deep spiritual and ancestral significance, making it essential to incorporate cultural values into MPA design (**Table 1**). Recognizing culturally significant species and sacred sites can strengthen local governance and sovereignty, fostering greater community engagement and compliance.

Regional and cross-sectoral collaboration is crucial for managing transboundary environmental challenges, such as shipping traffic, fishing pressure beyond the EEZ, and migratory species protection. The shipping sector, while essential for inter-island connectivity and economic trade, also impacts marine biodiversity. Defining shipping lanes and restricted zones will be critical to protect blue corridors while maintaining maritime operations (**Table 1**). International cooperation will be necessary to extend blue corridors beyond the EEZ, ensuring broader Pacific-wide conservation efforts. Additionally, by excluding foreign fishing fleets from the EEZ, the CSNP limits fishing pressure within its borders, compared to neighboring countries, and acts as a large MPA within the larger Pacific Ocean.

Lastly, New Caledonia's small but essential commercial fisheries sector plays a critical role in seafood security and local employment. However, climate change is reshaping fishing grounds and altering sea temperatures, mean sea level, and storm patterns, which could jeopardize access to traditional fishing areas. Proactively adapting MSP to these changes by setting aside dedicated fishing zones, incorporating local fishers' preferences, and using climate impact projections will help ensure equity, secure livelihoods, and foster sustainability (**Table 1**). The design of blue corridors must also consider potential conflicts or synergies with the fishing industry, which were not considered in depth in chapter 3 and thus should be the object of future local engagement (**Table 1**). More attention also needs to be dedicated to the development and zoning of sustainable tourism if that becomes a sector that local stakeholders and the government of New Caledonia (**Tableau 1**).

Integrating these recommendations into MSP will help foster greater community engagement, compliance, and long-term success in managing marine resources.

## *2. Data and research priorities*

A successful MSP process requires high-quality, reliable data to inform decision-making. The first step is to assess data quality and identify gaps, ensuring that datasets are accurate, complete, and spatially and temporally relevant.

To strengthen MSP implementation, the following data priorities should be addressed:

- **Improving ecosystem and biodiversity datasets** – Enhance knowledge of species distributions, habitat connectivity, and ecological resilience, particularly how species move between habitats and the role of blue corridors in enhancing MPA networks.
- **Integrating global and local datasets** – Global datasets offer broad-scale insights but are often static, outdated, or coarse. Local datasets provide finer details but may lack long-term consistency. Merging these through integration to better understand biodiversity distribution, ecosystem connectivity, climate change impacts, and human activities will improve MSP reliability.
- **Developing management-ready data products** – The Institut de Recherche pour le Développement (IRD) can play a key role in synthesizing ecological, socio-economic, and oceanographic data into GIS layers, habitat suitability models, and risk assessments that provide policymakers with clear, actionable insights (e.g., Mathon et al. 2023). Transparent data-sharing mechanisms should also be established to facilitate collaboration across research institutions, government agencies, and stakeholders.

- **Studying climate change adaptation** – Understanding long-term impacts of sea level rise, ocean acidification, and shifting ocean productivity will help refine dynamic zoning strategies. For example, shifting ocean productivity patterns will have implications for feeding grounds for whales, birds, sea turtles, and tuna, among others.
- **Exploring human dimensions** – Research on community reliance on marine resources, cultural ties, and governance structures will ensure equitable MSP outcomes.
- **Harnessing Earth Observation Systems** – Monitoring should leverage emerging technologies, such as satellite surveillance, Unmanned Aerial Vehicles, and AI-driven analytics, while also exploring citizen-science monitoring programs to support data-driven MSP decisions.

## *3. Building multi-partnerships to support MSP*

A collaborative approach is essential for successful MSP implementation. Partnerships should include:

- **Local researchers and institutions** (e.g., IRD) – Providing science-driven insights and long-term ecological monitoring.
- **Shipping and fisheries industries** – Helping to define commercial priorities, minimize conflicts, and ensure compliance.
- **Customary representatives and Indigenous communities** – Ensuring traditional knowledge and cultural heritage shape conservation efforts.
- **Civil society organizations and NGOs** – Enhancing public engagement, advocacy, and capacity building.

By fostering collaboration across sectors, MSP can become a holistic, adaptive, and community-driven process that balances ecological protection, economic interests, and cultural values.

## *4. Next Steps*

To advance New Caledonia's MSP process, the following key actions should be prioritized:

1. **Stakeholder Engagement & Co-Designed Zoning** – Using the analyses conducted in this chapter, engage stakeholders in a participatory zoning process to build a shared vision for the CSNP. **Table 1** (pink areas) highlights the scenarios that did not engage local stakeholders and thus serve a demonstration for future engagement. Co-designed zoning will increase buy-in, compliance, and long-term effectiveness.

    - *Strengthen IRD's role* - as the primary research agency in the territory, IRD can support MSP by synthesizing key datasets into management ready data products
2. **Comprehensive Spatial Mapping** – Fully integrated ecological, economic, and socio-cultural factors are fully mapped to identify conflict zones and optimize conservation and resource use decisions (Hammar et al. 2020).
3. **MPA Network Design & Scoring** – Develop a systematic approach for MPA network design, incorporating MPA scoring criteria that evaluates:
    - Representation, connectivity, and ecological resilience within the network.
    - Implementation of blue corridors to enhance species mobility.
    - Management effectiveness and protection levels.
    - Identifying priority areas for new MPAs or adjustments to existing boundaries to align with GBF Target 3 goals. For instance, consider expanding the proposed Banc de Landsdowne natural reserve slightly to include the prioritized biodiversity area outside its boundary.
    - Providing recommendations for implementation based on ecological, socio-cultural, and economic trade-offs. Consider Banc de Landsdowne and Récif Fairway for designation based on ecological importance and the fact that they do not conflict with current fishing areas.
4. **Harmonizing Territorial Waters & CSNP** – Strengthen the connection between nearshore and offshore ecosystems, particularly the Lagoon around the Grande Terre, which serves as a nursery habitat (**Table 1**).
5. **Addressing Bycatch & Species Protection** – Develop targeted strategies to mitigate shark bycatch (SPNMCP 2024, Calderwood et al. 2020)
6. **Strengthening Regional Cooperation** – Expand transboundary partnerships with neighboring Pacific nations to address shared ocean challenges, such as fishing pressure, shipping impacts, and the protection of blue corridors.

By advancing these steps, New Caledonia's MSP framework can effectively integrate science, traditional knowledge, and adaptive management, ensuring a sustainable and resilient future for its marine ecosystems and communities.

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# Appendix

*Table C2.A1. List of data relevant to MSP of the CSNP obtained for this study.*

| Catégorie | Sous-catégorie | Titre | Identifiant | Type geo | Source |
|---|---|---|---|---|---|
| Écologique | Biodiversité | Zones clés de biodiversité (KBA - Key Biodiversity Areas) marine | KBAs_mar.shp | polygone | https://georep-dtsi-sgt.opendata.arcgis.com/maps/934b1cad2b9045d8ac2c4d7b0a524f2e/about |
| Écologique | Espèces envahissantes | Zones espèces envahissantes de l'espace maritime | Invasive_spp_ter.shp | polygone | https://georep-dtsi-sgt.opendata.arcgis.com/maps/39db2a057458481f87d4fe94e8b981df/about |
| Écologique | Habitat | Les aires marines d'importance écologique ou biologique (EBSA - Ecologically or Biologically Significant Marine Areas | NC_MSP.gdb\EBSA | polygone | https://www.sprep.org/attachments/VirLib/Global/ecologically-biologically-significant-marine-areas-ebsa-cbd-2014.pdf |
| Écologique | Habitat | Récifs coralliens - Allen Coral Atlas | reefextent.gpkg | polygone | https://allencoralatlas.org/ |
| Écologique | Habitat | Couverture benthique - Allen Coral Atlas | benthic.gpkg | polygone | https://allencoralatlas.org/ |
| Écologique | Habitat | Bioregions des eaux profondes | SWP_Deepwater_Bioregions_technical_analysis_final_28.03.18 | polygone | https://www.sciencedirect.com |

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| Écologique | Habitat | Biorégions associées aux récifs | SWP_REEFS-ASSOCIATED_technical_analysis_for_report_19.12.17 | polygone | https://www.sciencedirect.com/ |
| Écologique | Répartition des espèces | Adéquation de l'habitat pour 7 sous-ordres d'Octocoralliaires | Multiple | raster | https://onlinelibrary.wiley.com |
| Écologique | Répartition des espèces | Espèces caractéristiques de la zone maritime | Species_of_interest.shp | point | https://georep-dtsi-sgt.opendata.arcgis.com |
| Écologique | Répartition des espèces | Zones importante pour la conservation des oiseaux (IBA - Important Bird Areas) | NC_MSP.gdb\IBA | polygone | https://datazone.birdlife.org |
| Écologique | Répartition des espèces | Zones Importantes pour les Mammifères Marins (IMMA) | NC_MSP.gdb\IMMA | polygone | https://www.marinemammalhabitat.org/ |
| Écologique | Répartition des espèces | Modélisation de la répartition du thon - SEAPODYM | Multiple | raster | https://pccos.spc.int/ocean-catalogue/seapodym-2deg-model-projection |
| Écologique | Répartition des espèces | Présence des mammifères marins lors des relevés aériens | DonneesPelagis_Mar_mammal.shp | point | https://pelabox.univ-lr.fr/pelagis/PelaObs/ |
| Écologique | Répartition des espèces | Présence des oiseaux marins lors des relevés aériens | DonneesPelagis_Birds.shp | point | https://pelabox.univ-lr.fr/pelagis/PelaObs/ |

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| Écologique | Répartition des espèces | Présence des grands poissons et des tortues lors des relevés aériens | DonneesPelagis_Fishes_turtles.shp | point | https://pelabox.univ-lr.fr/pelagis/PelaObs/ |
| Écologique | Répartition des espèces | Plages de nidification et déplacements des tortues marines | Multiple | point/ligne | https://seamap.env.duke.edu/swot |
| Limites administratives | ZEE | Zone Économique Exclusive (ZEE) de la Nouvelle-Calédonie | NC_EEZ.shp | polygone | https://georep-dtsi-sgt.opendata.arcgis.com |
| Limites administratives | Zones protégées | Limites du Parc Naturel de la Mer de Corail | Coral_park.shp | polygone | https://georep-dtsi-sgt.opendata.arcgis.com |
| Limites administratives | Zones protégées | Réserves du parc naturel de la mer de Corail | NC_MPAs.shp | polygone | https://georep-dtsi-sgt.opendata.arcgis.com |
| Physique | Bathymétrie | Bathymétrie du parc naturel de la mer de Corail de sondeurs acoustiques multifaisceaux (100m) | Synthese_NCaledonieZEENC_100m_BATHY.tif | raster | https://georep-dtsi-sgt.opendata.arcgis.com |
| Physique | Bathymétrie | Données bathymétriques à une résolution de 15 secondes d'arc provenant de GEBCO | gebco_2024_n-10.5908_s-28.8721_w153.3691_e178.8574.tif | raster | https://www.gebco.net/ |
| Physique | Bathymétrie | Modèle numérique de Terrain marin SHOM à 100 mètres | MNT_NC100m_TSUCAL_GEO_refNM_ZNEG_V1.0.grd | raster | https://georep-dtsi-sgt.opendata.arcgis.com |

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| Physique | Chimie de l'océan | Salinité, température, nitrate, phosphate, silicate, pH, fer, oxygène dissous ($O_2$) | Multiple | raster | http://www.bio-oracle.org/ |
| Physique | Cyclones | Base de données cycloniques | Base_de_donnes_cycloniques.shp | ligne | https://georep-dtsi-sgt.opendata.arcgis.com |
| Physique | Géomorphologie des récifs | Atolls de Nouvelle-Calédonie | Multiple | polygone | https://www.sciencedirect.com |
| Physique | Géomorphologie des récifs | Géomorphologie des récifs - Le Millenium Coral Reef Mapping Project (MCRMP) | Reef_geomorphology.shp | polygone | https://georep-dtsi-sgt.opendata.arcgis.com |
| Physique | Géomorphologie des récifs | Géomorphologie des récifs - Allen Coral Atlas | geomorphic.gpkg | polygone | https://allencoralatlas.org/ |
| Physique | Géomorphologie des récifs | Récifs éloignés | remote_reefs.shp | polygone | https://georep-dtsi-sgt.opendata.arcgis.com |
| Physique | Géomorphologie du fond marin | Répartition mondiale des monts sous-marins et des knolls | Seamounts.shp | point | https://data.unep-wcmc.org/datasets/41 |
| Physique | Géomorphologie du fond marin | Petits monts sous-marins | seamounts_modeled.gdb | point | https://agupubs.onlinelibrary.wiley.com |
| Physique | Géomorphologie du fond marin | Carte mondiale des caractéristiques géomorphologiques du fond marin (GSFM) | Multiple | polygone | https://www.sciencedirect.com |

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| Physique | Géomorphologie du fond marin | Zones d’intérêt des monts sous-marins | NC_MSP.gdb\Seamount_areas | polygone | Sébastien LAGARDE (Baletaud et al. 2024) |
| Physique | Terre (îles) | Terres émergées | emergent_lands.shp | polygone | https://georep-dtsi-sgt.opendata.arcgis.com |
| Utilisation humaine | Culturel | Zone d'intérêt Coutumier | NC_MSP.gdb\ZIC | polygone | Sébastien LAGARDE (Baletaud et al. 2024) |
| Utilisation humaine | Historique | Vestiges de l'espace maritime | Sites_d_int_de_l_espace_maritime.shp | point | https://georep-dtsi-sgt.opendata.arcgis.com |
| Utilisation humaine | Loisir | Trafic des navires de plaisance d’après les données AIS de 2023 | AIS_traffic_density | raster | Sébastien LAGARDE (Baletaud et al. 2024) |
| Utilisation humaine | Pêche | Effort de pêche apparent en Nouvelle-Calédonie 2015-2024 | NC_2015_2024_sum2.tif | raster | https://globalfishingwatch.org |
| Utilisation humaine | Pêche | Effort de pêche apparent étranger 2015-2024 | NC_FN_2015_2024_sum.tif | raster | https://globalfishingwatch.org |
| Utilisation humaine | Recherche scientifique | Stations de suivi du Réseau d'Observation des Récifs Coralliens (RORC) | RORC_stations.shp | point | https://georep-dtsi-sgt.opendata.arcgis.com |
| Utilisation humaine | Recherche scientifique | Sites suivi du Réseau d'Observation des Récifs Coralliens (RORC) | RORC_sites.shp | point | https://georep-dtsi-sgt.opendata.arcgis.com |

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| Utilisation humaine | Recherche scientifique | Transects tortues vertes dans l'espace maritime | Grn_turtle_trans.shp | ligne | https://georep-dtsi-sgt.opendata.arcgis.com |
| Utilisation humaine | Recherche scientifique | Stations subaquatiques (par méthode) de l'espace maritime | UW_surveys.shp | point | https://georep-dtsi-sgt.opendata.arcgis.com |
| Utilisation humaine | Tourisme | Trafic des navires à passagers d'après les données AIS de 2023 | AIS_traffic_density | raster | Sébastien LAGARDE (Baletaud et al. 2024) |
| Utilisation humaine | Transport maritime commercial | Trafic des navires commerciaux d'après les données AIS de 2023 | AIS_traffic_density | raster | Sébastien LAGARDE (Baletaud et al. 2024) |

*Table C2.A2. Data from Gardes et al. (2014).*

| **TITRE** | **RESUME** | **MOTS CLES** | **TYPE GEO** | **IDENTIFIANT** |
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| Limites de la mer de Corail | Limite de la mer de Corail définie par le Commission Océanographique Internationale | Mer de Corail Commission Océanographique Internationale limites | ligne | REF_OPAC_Mer_corail_IHO_pol_wgs84 |
| Espaces récifo-lagonaires de Nouvelle- Calédonie | Emprise et type géomorpholoqieu des structures récifo-lagonaires présents dans la ZEE et les eaux territoriales de Nouvelle-Calédonie. | récifs coralliens atolls bancs récifs continentaux récifs d'îles océaniques | polygone s | PHY_NC_Espace_recifo_lagonaire_AAMP _pol_wgs84 |

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| Courantologie de surface | Les grands systèmes de courants de surface (0-200m) dans l'Espace maritime de la Nouvelle-Calédonie. | courantologie générale courant sud équatorial courant est australien | polygone | PHY_NC_Courantologie_surface_AAMP_pol_wgs84 |
| Espaces benthiques de référence | il s'agit de grandes zones benthiques potentiellement homogènes du point de vue des conditions physiques et environnementales qui correspondent à une synthèse des différentes informations relatives à la qualification des « habitats benthiques potentiels » de l'Espace maritime. | écosystèmes profonds classification benthique paramètres physiques | polygone s | PHY_NC_Espaces_benthiques_reference_AAMP_CI_pol_wgs84 |
| Analyse prédictive d'habitats favorables à l'espèce de corail froid (cnidaire) Enallopsammia rostrata | Analyse des habitats prédictifs d'une espèce de corail froid à partir des données de l'environnement. Calcul d'une probabilité de présence d'habitats favorables à l'espèce. | écosystème profond analyse prédictive Corail froid Enallopsammia rostrata | polygone | BIO_NC_Enallopsamia_rostrata_modelisation_DG_pol_WGS84 |
| Analyse prédictive d'habitats favorables à l'espèce de corail froid (cnidaire) Enallopsammia rostrata | Définition explicite des facteurs abiotiques favorables à l'installation et à la croissance de l'espèce L'application du modèle statistique en mode inverse, à partir de cartes de facteurs environnementaux, permet de déterminer, parmi les zones pour lesquelles des données biologiques ne sont pas disponibles, celles potentiellement favorables à la présence de L'espèce | écosystème profond analyse prédictive Corail froid Solenosmilia variabilis | polygone | BIO_NC_Solenosmilia_variabilis_modelisation_DG_pol_WGS84 |
| Analyse prédictive d'habitats favorables pour 1 à 7 sous-ordres d'octocoralliaires (cnidaires) | Définition explicite des facteurs abiotiques favorables à l'installation et à la croissance de un à 7 sous-ordres d'octocoralliaires L'application du modèle statistique en mode inverse, à partir de cartes de facteurs environnementaux, permet de déterminer, parmi les zones | écosystème profond analyse prédictive Octocoralliaires | polygone | BIO_NC_Octocoralliaires_profonds_modelisation_YESSON_pol_WGS84 |

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| | pour lesquelles des données biologiques ne sont pas disponibles, celles potentiellement favorables à la présence des sous-ordres | | | |
| Indice de biodiversité potentielle en sous- ordres d'octocoralliaires | Indice de diversité basé sur la présence potentielle de 1 à 7 sous-ordres d'octocoralliaires | Niveaux d'enjeux Indice de biodiversité Octocoralliaires | polygone | BIO_NC_Enjeux_critere_biodiversite_octocoralliaires_AAMP_pol_wgs84 |
| Morphologie des fonds marins | Représentation de la bathymétrie des fonds marins à partir du modèle numérique de terrain du gouvernement de Nouvelle-Calédonie (DTSI) | Modèle numérique de terrain bathymétrie | lignes | PHY_NC_Morpho_fonds_representation_AAMP_ln_wgs84 |
| Diversité des habitats benthiques | Diversité des habitats benthiques évaluée sur la base de critères de masses d'eau, topologie et du type de substrat | Diversité des habitats topologie masses d'eau tyoe de substrat | polygone | ECO_NC_Diversite_habitats_benthiques_025_AAMP_pol_wgs84mercator |
| Indice de sensibilité des milieux profonds | Indice de sensibilité basé sur la probabilité de présene d'habitats favorables à la présence de coraux froids, espèces sensibles à de nombreuses pressions | Niveaux d'enjeux Indice de sensibilité coraux froids | polygone | BIO_NC_Enjeux_critere_sensibilite_profond_AAMP_pol_wgs84 |
| Synthèse des enjeux de conservation des écosystèmes profonds | Définition des niveaux d'enjeux sur la base des critères de diversité des habitats et des espèces, de productivité et de vulnérabilité | écosystème profond enjeux de conservation productivité vulnérabilité biodiversité | polygone | BIO_NC_Enjeux_profond_maille_025_AAMP_pol_wgs84 |
| classification de la topologie des fonds marins | Les fonds marins sont classés en 13 classes en fonction de la profondeur, de la pente et d'indices de topologie. | Modèle numérique de terrain profondeur pente Indice topographique de position | polygone | PHY_NC_Classification_morpho_fond_CI_pol_wgs84 |

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| typologie des reliefs sous-marins | classification des reliefs des fonds marins à partir de la profondeur de leur sommet et leur hauteur absolue. | Relief mont sous-marin Dôme Colline | polygone | PHY_NC_Reliefs_sous_marins_CI_AAMP_pol_wgs84 |
| Masses d'eau à proximité du fond | A partir du MNT du gouvernement et de la classification des masses d'eau du le CSIRO, un répartition spatiale des masses d'eau à proximité du fond a été générée | Masses d'eau CSIRO Modèle numérique de terrain | polygones | PHY_NC_Masses_eau_fond_Banc_Kelso_Capel_CSIRO_AAMP_pol_wgs84 |
| Indice de productivité des milieux profonds | Dans des milieux profonds, généralement peu productifs, les zones de plus forte productivité peuvent être liées à trois facteurs : une forte productivité primaire de surface, la présence de reliefs peu profonds qui interagissent avec les masses d'eau environnantes et la présence de coraux froids et/ou d'éponges créant un habitat favorable | Niveaux d'enjeux Indice de productivité biologique phytoplancton Effet d'île coraux froids | polygone | BIO_NC_Enjeux_critere_productivite_profond_AAMP_pol_wgs84 |
| Stations de prélèvements géologiques | géoréférencement des points de prélèvements d'échantillons géologiques | échantillons géologiques | points | US_NC_Stations_echantillonage_geol_DIMENC_pol_wgs84mercator |
| Stations de prélèvements biologiques | Stations de prélèvements biologiques réalisés pendant les campagnes Tropical Deep Sea Benthos et les campagnes ZoNéCo. | Tropical Deep Sea Benthos BDD Océane Stations de prélèvement | points | US_NC_Stations_echantillonage_bio_MNHN_pol_wgs84mercator |
| Relevés sismiques | Trajets des relevés de sismique réflexion réalisés au sein de la ZEE et dans la zone d'extension du plateau continental | Sismique réflexion trajets des campagnes | lignes | US_NC_Sismique_navigation_ZONECO_ln_wgs84mercator |
| Emprise des relevés multifaisceaux dans la ZEE | Emprise des relevés multifaisceaux réalisées dans la ZEE et pour lesquels des données de bathymétrie et de réflectivité | sondeur multifaisceaux Emprise Réflectivité | polygones | US_NC_Sonar_emprise_synthese_ZEE_AAMP_pol_wgs84mercator |

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| | ont été acquises | | | |
| Emprise des relevés multifaisceaux dans la zone d'extension du plateau continental | Emprise des relevés multifaisceaux réalisés dans la zone d'extension du plateau continental et pour lesquels des données de bathymétrie et de réflectivité ont été acquises | sondeur multifaisceaux Emprise Réflectivité | polygone s | nav_Tasman_Frontier_v02_zoneco |
| Potentialités en ressources halieutiques profondes | Evaluation d'un niveau de connaissance à partir de l'effort de pêche et des des potentialités en ressources à partir des CPUE moyennes. | pêche palangrière de fond ressources helieutiques ZoNeCo Vivaneau Beryx | polygone s | US_NC_Peche_profonde_palangre_stat_ZONECO_pol_wgs84mercator |
| Potentialités en ressources vivantes autres qu'halieutiques | ressources issues du vivant autres qu'halieutiques | écosystème profond ressources issues du vivant | polygone s | US_NC_Ressources_vivantes_zones_potentielles_DIMENC_AAMP_wgs84 |
| Zones potentielles à hydrocarbures | Définit les contours du continent Zealandia dont la nature et l'histoire géologiques sont favorables à la présence d'hydrocarbures | ressources en hydrocarbures | polygone s | US_NC_Hydrocarbures_zone_potentielle_exploitation_DIMENC_pol_wgs84ercator |
| Zones potentielles à encroûtements et à nodules polymétalliques | Identification des zones favorables à la présence d'encroûtements et de nodules en fonction de la profondeur | encroûtemenfs réflectométrie nodules polymétalliques | polygone s | US_NC_Encroutements_nodules_zones_potentielles_DIMENC_pol_wgs84 mercator |
| Zones potentielles à encroûtements | Zones couvertes par le sondeur multifaisceaux et où la réflectivité du fonds est supérieure à 1,65 valeur la plus faible caractérisant un fond induré. En dessous de cette valeur, présence de sédiments meubles qui ne peuvent pas être des encroûtements. | Encroûtemenfs réflectométrie | polygone s | REF_NC_Mosaique_acoustique_GOUVNC |

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| Zones potentielles à sulfures | Zone favorable à la présence de dépôts sulfurés massifs | sondeur multifaisceau zone de subduction zone d'expension océanique bassin nord fidjien sources hydrothermales | polygone | US_NC_Depots_sulfures_zone_potentielle_DIMENC_pol_wgs84mercator |
| Calcul d'une moyenne annuelle de biomasse en necton | A partir de données de l'environnement (t°, salinité, O2) et d'un modèle biophysique, calcul d'une biomasse moyenne en necton par volume sur l'année | écosystème pélagique Modèle biophysique SEAPODYM | polygone | BIO_NC_Necton_Biomasse_CPS_pol_wgs84 |
| Calcul d'une moyenne de biomasse en necton en été | A partir de données de l'environnement (t°, salinité, O2) et d'un modèle biophysique, calcul d'une biomasse moyenne en necton par volume en été | écosystème pélagique Modèle biophysique SEAPODYM | polygone | BIO_NC_Necton_Biomasse_CPS_pol_wgs84 |
| Calcul d'une moyenne annuelle de biomasse en necton en hiver | A partir de données de l'environnement (t°, salinité, O2) et d'un modèle biophysique, calcul d'une biomasse moyenne en necton par volume en hiver | écosystème pélagique Modèle biophysique SEAPODYM | polygone | BIO_NC_Necton_Biomasse_CPS_pol_wgs84 |
| Biorégionalisation pélagique de la ZEE de Nouvelle-Calédonie | Biorégionalisation pélagique de la ZEE de Nouvelle-Calédonie sur la base de données physiques et biologiques | écosystème pélagique Modèle biophysique biorégionalisation | polygone | BIO_NC_Thon_Germon_Regionalisation_AAMP_pol_wgs84 |
| Effort, captures et rendements des principales espèces capturées par la pêcherie pélagique | Effort de pêche, captures et rendements des principales espèces capturées par la pêcherie pélagique : thon blanc, thon jaune et espèces accessoires commerciales (thon obese, mahi-mai, marlin noir, marlin bleu, marlin rayé, marlineau, espadon, requin mako, saumon des dieux, thazar du large, voilier). | pêche pélagique données déclaratives thon espèces accessoires | polygone | US_NC_Peche_palangre_statistiques_declaratives_2000_2010_CPS_AAMP_pol_wgs84 |

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| | Données déclaratives issues des fiches de pêche transmisses entre 2000 et 2010 par les navires de pêche pélagique, agrégées par carré statistique de 1° de côté. | | | |
| Effort, captures et rendements des espèces accessoires capturées par la pêcherie pélagique | Effort de pêche observé, captures et rendements des requins d'intérêt particulier (requins marteau, requins renard, requin mako à nageaoires longues, requin océanique à nageoire ronde, requin à haute dorsale), des requins gris, des requins toutes espèces confondues et des espèces accessoires rejettées (44 espèces).<br><br>Données issues des programme d'observation réalisés à bord des navires de pêche pélagique entre 2001 et 2010, agrégées par carré statistique de 1° de côté. | pêche pélagique observations embarquées espèces accessoires captures accidentelles | polygone | US_NC_Peche_palangre_statistiques_observation_2000_2010_CPS_AAMP_pol_wgs84 |
| Indice de diversité des captures effectuées par la pêcherie pélagique | Indice de diversité des captures de requins et indice de diversité des captures totales observées, obtenus par comparaison de la diversité observé à l'échelle d'un carré stastistique avec la diversité observée à l'échelle de l'ensemble de la ZEE. | pêche pélagique diversité spécifique observations embarquées | polygone | US_NC_Peche_palangre_ind_div_captures_2001_2010_CPS_AAMP_pol_wg s84 |
| Ports d'attache de la flotille palangrière pélagique de Nouvelle-Calédonie | Nombre de navires palangriers rattachés aux ports de Nouméa et de Koumac, en 2013 et en 2002 | pêche pélagique flotille ports | points | US_NC_Flotille_peche_hauturiere_AAMP_pt_wgs84 |
| Principales zones pêche de la pêcherie pélagique | Zones de pêche concentrant 95%, 75% et 50% de l'effort de pêche déclaré par les navires pélagique dans la ZEE de | pêche pélagique effort zones de pêche | polygone | US_NC_Peche_palangre_zonage_effort_2000_2010_CPS_AAMP_pol_wgs8 4 |

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| | Nouvelle-Calédonie entre 2000 et 2010. | | | |
| Captures accidentelles de mammifères marins, oiseaux et tortues par la pêcherie péagique | Nombre d'individus capturés par espèce ou groupe d'espèces.<br><br>Données issues des programme d'observation réalisés à bord des navires de pêche pélagique entre 2001 et 2010, agrégées par carré statistique de 1° de côté. | pêche pélagique captures accidentelles | points | US_NC_Peche_palangre_captures_accidentelles_observées_2001_2010_CPS_pt_wgs84 |
| Indice composite pour spatialiser les priorités de conservation des écosystèmes pélagiques | Indice composite calculé à partir des données issues des observations à la mer (2001 - 2010) et des fiches de pêche (2000 - 2010) pour spatialiser les enjeux de conservation des écosytèmes pélagiques.<br><br>L'indice composite est construit à partir de trois critères : diversité spécifique, vulnérabilité et production. | Ecosystèmes pélagiques enjeux de conservation indice | polygone | BIO_NC_Enjeux_pelagique_AAMP_pol_wgs84 |
| Niveaux d'enjeu pour le plancton végétal et les proies des thons | Indice composite construite à partir des données de couleur de l'eau du programme MODIS et des concentrations en micronecton issues du modèle SEAPODYM | Productivité biologique télédétection modèle biophysique SEAPODYM micronecton | polygones | BIO_NC_Indice_productivite_plancton_necton_025_AAMP_pol_wgs84 |
| Fréquence d'occurrence des cyclones | Données statistiques de fréquence des cyclones en Nouvelle-Calédonie | Cyclones La Nina El Nino | polygone | PHY_NC_Frequence_cyclones_AAMP_pol_wgs84 |
| Pêche en milieu corallien | effort de pêche et captures par taxon de l'activité de pêche pratiquée sur les récifs coralliens des îles éloignées par la flottille professionnelle déclarée | pêche récifale bénitiers poissons holothuries langouste | points | US_NC_Peche_milieu_corallien_SMMPM_pol_wgs84 |

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| sites de nidification des oiseaux marins | Sites de nidification répertoriés dans l'espace maritime de Nouvelle- Calédonie et dans les eaux sous compétences provinciales | Oiseaux marins sites de nidification ZICO typologie comportement alimentaire | points | ECO_NC_Sites_nidification_especes_AAMP_pt_wgs85 |
| voies de passages dans la ZEE sans arrêt (tortue Luth, puffin bec grèle) | Des espèces ont été observées au sein de l'espace maritime de la Nouvelle-Calédonie, uniquement en phase de transit au cours de leur migration. Aucune observation de ces espèces à terre pour la nidification ou la ponte n'a été effectuée à ce jour. | corrirdor de migration puffin à bec grèle tortue Luth | lignes | BIO_NC_Migrations_especes_AAMP_ln_wgs84 |
| migrations (flêches épaisses) tortues vertes, grosses têtes, baleines, requins, frégates | Synthèse des voies de migration identifiées pour des espèces de baleines, d'oiseaix marins, de tortues, et de requins entre la Nouvelle-Calédonie et les pays alentours. La plupart des études ont été menées à l'aide de marquages satellites, acoustiques ou marquages traditionnels. | marquage satellite marquage traditionnel tortue verte tortue grosse tête requin blanc frégate du pacifique baleine à bosse | polygones | BIO_NC_Migrations_especes_AAMP_pol_wgs84 |
| zones de détection du requin blanc | Détection dans l'espace maritime de Nouvelle-Calédonie, de requins blancs marqués en Nouvelle-Zélande | Carcharodon carcharias grand requin blanc marquage satellite | points | BIO_NC_Detection_especes_AAMP_pt_wgs84 |
| Zones d'alimentation des oiseaux marins à partir de données de marquage | suite à des opérations de marquage réalisées en 2012, des zones préférentielles de nutrition d'adultes de 4 espèces (2 fous, 2 frégates) au cours de la nidification ont été identifiées. | marquage satellite Chesterfield fou brun fou à pieds rouges frégate du pacifique frégate ariel | polygones | BIO_NC_Zones_Alimentation_Fous_Fregates_CEBC_pol_wgs84 |
| Transport maritime international | Principales voies de transport maritime obtenues à partir des données volontaires de navires de la flottille mondiale correspondant à 11% des | transport maritime international | densité de points | Shipping_NC |

| | | | | |
|---|---|---|---|---|
| | navires de plus de 1000 tonneaux actifs en 2005. | | | |
| Risque lié au trafic maritime international | Zones de trafic élevé à proximité des récifs coralliens, provoquant un accroissement potentiel des pressions | trafic maritime risque de pollution | lignes | US_NC_Risque_trafic_maritime_AAMP_pol_wgs84 |
| Lignes de charters touristiques | Principales lignes de charter identifiées transitant ou atteignant les îles éloignées de l'espace maritime | charter tourisme fréquentation îles éloignées | lignes | US_NC_Lignes_Charter_Touristiques_AAMP_pol_wgs84 |
| Liens traditionnels entre les îles éloignées et la grande terre | Liens traditionnels mentionnés dans les travaux sur l'histoire traditionnelle de la Nouvelle-Calédonie | tradition usage coutumier | lignes | US_NC_Liens traditionnels_AAMP_pol_wgs84 |
| Epaves recensées dans les îles éloignées | Nombre d'épaves répertoriées sur chacune des îles éloignées de l'espace maritime | Epaves Marine à voile Deuxième guerre mondiale | points | US_NC_Epaves_secteurs_AAMP_pol_wgs84 |
| Sites en série de Nouvelle-Calédonie inscrits au patrimoine mondial | Une partie du lagon de Nouvelle-Calédonie a été inscrit au patrimoine mondial de l'UNESCO pour sa diversité récifale et ses écosystèmes associés. Six zones ont été inscrites au patrimoine mondial. Ce service cartographique représente les limites des zones du lagon calédonien inscrites. Sont également visibles les zones tampons marines (isobathes -100m à -500m) et terrestres (bassins versants débouchant dans les zones inscrites dites "zones de bien"). Les emprises englobent ces 3 zones pour chaque zone de bien. | UNESCO patrimoine mondial bien en série récif biodiversité écosystèmes | Polygones | GES_NC_patrimoine_mondial_DTSI_pol_RGNC91 |

| | | | | |
|---|---|---|---|---|
| Projet du Parc naturel de la mer de Corail en Nouvelle-Calédonie | Projet de Parc naturel de la mer de corail en Nouvelle-Calédonie constitué de l'Espace maritime de la Nouvelle-Calédonie, des îles et îlots qui y sont compris, ainsi que du sol et du sous-sol de l'Espace maritime | Espace Maritime Iles et îlots Masse d'eau Sol et sous sol | polygone | GES_NC_Projet_mer_corail_AAMP_pol_wgs84 |
| Site Australien de la Grande Barrière de Corail, inscrit au patrimoine mondial | Parc Marin de la Mer de Corail, créé en 1975 et fait partie du plan d'action national pour la biodiversité. Il a été inscrit au patrimoine mondial de l'UNESCO en 1981 | Grande Barrière de Corail Patrimoine mondial UNESCO | polygone | GES_AUS_Patrimoine_mondial_DSEWPaC_pol_GDA1994 |
| réseau d'AMP australien | Zones de protections dans les eaux sous compétence du gouvernement central Australien. Comprend la Coral sea réserve et le temperate east network | Commonwealth Marine Reserves Mer de Corail Gilford Ile de Lord Howe Ile de Norfolk | polygone | GES_AUS_Proposition_AMP_mer_corail_DSEWPaC_pol_GDA1994 |

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*Table C3.A1: Existing MPA values*

| nom | type | surface km2 | périm km | profondeur moyenne | KBA km2 | KBA % | IMMA km2 | IMMA % | ZICO km2 | ZICO % | EBSA km2 | EBSA % | 3D bio km2 | 3D bio % | biore gions | odonto cetes | m et |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nord Chesterfield | Intégrale | 6,310 | 334 | -347 | 6,320 | 100 | 6,313 | 100 | 6,320 | 100 | 0 | 0 | 860 | 13 | 3 | 0 | |
| Île Longue | Intégrale | 6 | 11 | -53 | 6 | 100 | 6 | 99 | 6 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Îlot du Passage | Intégrale | 3 | 7 | -36 | 3 | 100 | 3 | 100 | 3 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Mouillage n°1 | Intégrale | 6 | 10 | -9 | 6 | 100 | 6 | 100 | 6 | 100 | 0 | 0 | 3 | 46 | 0 | 0 | |
| Bellona | Intégrale | 13,894 | 517 | -272 | 13,892 | 100 | 13,615 | 98 | 1,383 | 10 | 0 | 0 | 4,217 | 30 | 3 | 1 | |
| Atolls d'Entrecasteaux | Intégrale | 3,730 | 279 | -466 | 3,741 | 100 | 3,738 | 100 | 3,741 | 100 | 0 | 0 | 528 | 14 | 3 | 11 | |
| Pétrie | Intégrale | 764 | 111 | -1,124 | 766 | 100 | 766 | 100 | 0 | 0 | 0 | 0 | 139 | 18 | 1 | 0 | |
| Grand Astrolabe | Intégrale | 847 | 124 | -1,151 | 847 | 100 | 847 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | |
| Petit Astrolabe | Intégrale | 323 | 74 | -1,042 | 323 | 100 | 323 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| Banc Capel | Intégrale | 4,924 | 272 | -688 | 4,940 | 100 | 4,316 | 87 | 0 | 0 | 0 | 0 | 338 | 7 | 1 | 1 | |
| Sud Chesterfield | Naturelle | 5,521 | 345 | -507 | 5,522 | 100 | 5,499 | 100 | 5,522 | 100 | 0 | 0 | 1,109 | 20 | 3 | 3 | |
| Ride de Norfolk | Naturelle | 55,166 | 1,034 | -1,598 | 55,134 | 100 | 7,149 | 13 | 0 | 0 | #### | 56 | 1,537 | 3 | 6 | 41 | |
| Ride d'Entrecasteaux | Naturelle | 24,331 | 682 | -4,440 | 8,236 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | |
| Sud bassin de Fairway | Naturelle | 10,131 | 519 | -2,781 | 10,065 | 100 | 0 | 0 | 7,659 | 76 | #### | 100 | 0 | 0 | 1 | 2 | |
| Fosse des Nouvelles-Hébrides | Naturelle | 7,997 | 598 | -5,336 | 252 | 3 | 0 | 0 | 0 | 0 | 8,046 | 100 | 0 | 0 | 4 | 0 | |
| Île de Walpole | Naturelle | 2,579 | 203 | -1,361 | 2,579 | 100 | 2,575 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | |

*Table C3.A2: Proposed MPA values*

| nom | type | surface km2 | périm km | profondeur moyenne | KBA km2 | KBA % | IMMA km2 | IMMA % | ZICO km2 | ZICO % | EBSA km2 | EBSA % | 3D bio km2 | 3D bio % | biore gions | odonto cetes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alignement des Chesterfield | Sous marins niv. II | 29,604 | 899 | -1,844 | 28,327 | 96 | 16,810 | 57 | 0 | 0 | 0 | 0 | 3,021 | 10 | 4 | 4 |
| Ride de Lord Howe | Sous marins niv. II | 9,014 | 530 | -1,187 | 8,936 | 99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| Récif Fairway | Sous marins niv. II | 20,189 | 757 | -1,001 | 19,515 | 97 | 0 | 0 | 0 | 0 | 0 | 0 | 2,274 | 11 | 4 | 20 |
| Banc de Landsdowne | Intégrale niv. I | 7,570 | 364 | -453 | 7,570 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 2,127 | 28 | 3 | 1 |
| Ride des Loyauté Nord | Sous marins niv. II | 57,192 | 1,026 | -2,979 | 4,069 | 7 | 42,414 | 74 | 6,433 | 11 | 0 | 0 | 154 | 0 | 4 | 20 |
| Nord Walpole | Intégrale niv. I | 6,645 | 394 | -1,415 | 6,645 | 100 | 4,812 | 72 | 0 | 0 | 0 | 0 | 536 | 8 | 2 | 0 |
| Ride des Loyauté Sud | Sous marins niv. II | 38,923 | 893 | -2,766 | 37,577 | 97 | 4,900 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 10 |
| Parc de la paix Matthew et Hunter | Intégrale niv. I | 21,936 | 691 | -2,692 | 18,716 | 85 | 0 | 0 | 5,156 | 24 | 0 | 0 | 119 | 1 | 4 | 2 |

*Table C3.A3: Threatened seabird species in the CSNP*

| Seabird species | Common name | Red Listed |
|---|---|---|
| *Calonectris leucomelas* | Streaked Shearwater | NT |
| *Diomedea epomophora* | Southern Royal Albatross | VU |
| *Diomedea exulans* | Diomedea exulans | VU |
| *Nesofregetta fuliginosa* | Polynesian Storm Petrel | EN |
| *Phoebetria palpebrata* | Light-mantled Albatross | NT |
| *Procellaria cinerea* | Grey Petrel | NT |
| *Pseudobulweria rostrata* | Tahiti Petrel | NT |
| *Pterodroma arminjoniana* | Trindade Petrel | VU |
| *Pterodroma brevipes* | Collared Petrel | VU |
| *Pterodroma cervicalis* | White-necked Petrel | VU |
| *Pterodroma cookii* | Cook's Petrel | VU |
| *Pterodroma inexpectata* | Mottled Petrel | NT |
| *Pterodroma leucoptera* | Gould's Petrel | VU |
| *Puffinus bulleri* | Buller's Shearwater | VU |
| *Puffinus carneipes* | Flesh-footed Shearwater | NT |
| *Puffinus griseus* | Sooty Shearwater | NT |
| *Sternula nereis* | Fairy Tern | VU |
| *Thalassarche bulleri* | Buller's Albatross | NT |
| *Thalassarche eremita* | Chatham Albatross | VU |