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Effective Marine Protected Area Network in Lebanon

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List of Abbreviations

ACCOBAMS - The Agreement on Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic area
APAC - Appointed Protected Areas Committee
CBD - Convention on Biological Diversity
GBF – Global Biodiversity Framework
CITES - Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS - Convention on Migratory Species
DFW-MOA – Department of Fisheries and Wildlife, Ministry of Agriculture
EEZ - Exclusive Economic Zones
GFCM - General Fisheries Commission for the Mediterranean
ICZM - Integrated Coastal Zone Management in The Mediterranean
IMO - International Maritime Organization
IOE - Institute of the Environment
IUCN - International Union for Conservation of Nature
LEF - Lebanese Environment Forum
MPA - Marine Protected Areas
MCR - Marine and Coastal Resources Program
MoA - Ministry of Agriculture
MoD - Ministry of Defense
MoE - Ministry of Environment
MoPWT - Ministry of Public Works and Transport
NGOs - Non-Governmental Organizations
PINR - Palm Islands Nature Reserve
SPA/BD - Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention
SDGs - Sustainable Development Goals
TCNR - Tyre Coast Nature Reserve
UNCLOS - United Nations Convention on the Law of the Sea
UOB - University of Balamand

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I. Introduction and Framework

The intense human reliance on the natural capital supplied by seas and oceans has placed tremendous pressures on marine habitats and associated biological resources. The exploitation of these reserves has been undergoing an increase in intensity for the past few decades triggered by the incessant rise of the world's population. Current studies have shown the negative impacts of past and recent practices on the health of marine environments, sparking an increased concern for the sustainability of these ecosystems. Furthermore, estuarine and coastal ecosystems, considered biodiversity hotspots, are some of the most overexploited and threatened natural systems globally. The anthropogenic pressures on these systems including urbanization, seafilling, damming of rivers and pollution amongst many others are causing their collapse. Such loss of biodiversity as well as the loss of the essential ecosystem services they provide such as maintaining a successful fisheries sector, the filtering of water by submerged vegetation and wetlands, and food security are all being negatively impacted to the detriment of human society. In order to ensure the security of these vital biological resources and to prevent the complete deterioration of these natural habitats, countries worldwide have been adopting more conservative approaches to ecosystem protection. In this context, multiple treaties and conventions have been/are being signed and enacted to mitigate identified anthropogenic stresses. Countries from different regions of the world have been investing time, effort and financial resources to meet their obligations through the implementation of various conservation efforts that help safeguard and restore natural marine ecosystems.

II. Marine Protected Area Networks

Marine Protected Area (MPA) networks can be defined as systems of individual MPAs connected on multiple scales and sharing important levels of coordination amongst themselves to ensure a more effective approach in the protection of natural biodiversity and the enhancement of all its components. This approach has been considered of utmost importance when dealing with the protection and the conservation of wild environments and the regulation of human impacts on its resources.

a. Marine Protected Areas

One of the proven ways to ensure conservation and protection of marine biological resources is the establishment of MPAs. The World Conservation Union (IUCN) defined MPAs in 2008 as "parts of intertidal or subtidal environments, together with their overlying waters, flora and fauna and other features, that have been reserved and protected by law or other effective means". More specifically, MPAs are areas of seas, oceans, and estuaries where regulations are put in place to control human activity usually with the goal of protecting components of natural or cultural importance. Within this context, it became imperative to identify such zones as they can host a variety of ecologically and/or economically valuable organisms/habitats that are under immense pressure from anthropogenic interferences and need the protection of laws and regulations for their survival. Furthermore, it has been established that MPAs can bring in ecological, economic and social benefits when managed properly.

Conservation globally can be grouped into seven main categories based on the level of protection and should be considered when envisioning the establishment of an MPA (Table 1).

Table 1: Categories of protected areas. *(Dudley, 2013)*

Strict Nature Reserve	▪ Maximal level of protection with strict regulations on human interference. ▪ Created to protect biodiversity, and physical habitats. ▪ Areas represent reference for scientific use.
Wilderness Area	▪ Wide areas with little to no human interference. ▪ Protected to preserve their natural quality.
National Park	▪ Large natural areas established for the protection of large ecological processes. ▪ Allows regulated access.
Natural Monument	▪ Generally small areas established for the protection of an important natural monument. ▪ Often represents a good touristic location.
Habitat/Species Management Area	▪ Set for the protection of target species or habitat where regular intervention is needed for the up keeping of conservation.
Protected Landscape/Seascape	▪ Created in areas that evolved from the interaction of natural and human interactions. ▪ Its protection aims at conserving its ecological, biological, cultural and scenic value.
Managed Resource Protected Area	▪ Created with the goal of exploitation. ▪ Conserves resources to allow their sustainable use.

The classification of zones intended for protection depends on two main factors, one of which is defined by the goals set aside for the governance of these areas. The other depends on the characterization of the target area based on a universal frame of parameters used to determine the status of the location. These parameters include:

1. Geographical features

   Involves the identification of the different topographical features found in the studied sites, listing the different components that contribute to the area's significance. This evaluation will provide an outline for the approach needed for the protection of these landscapes.

2. Biological features

Includes the characterization of the life within the studied area, and the relationships these organisms have with their surrounding environment (Table 2). This will permit the identification of key zones and species that contribute to the area's richness, and which must be included in the plan of protection.

Table 2: Criteria relevant for biological features.

Representativeness	Importance for rare or threatened species/ habitats	High diversity	Uniqueness/ Endemism	Importance for processes within the area
Naturalness	Integrity within its surrounding environment	Connectivity	Biogeographic Importance	Biological productivity
Sensitivity	International or national importance	Size	Comprehensiveness	Resilience
Dependency	Replication	Threats and risks	Management and protection	Scientific importance
Restoration	Aesthetic importance			

3. Cultural/Historical features

This feature is concerned with the examination of objects that contribute to the country's history, architecture, archaeology, engineering, and culture (Table 3). These structures are considered of immense value reflecting the heritage of their county, and therefore must be conserved to ensure their persistence through time.

Table 3: Criteria relevant for cultural/historical features.

Restoration	Aesthetic importance	Representativeness
Uniqueness	Ingenuity	Cultural and traditional use
Interchange of culture value	Indirect cultural value	Cultural heritage
Management and protection	Aesthetic importance	

4. Stresses and threats

This feature helps identify the different kinds of stressors the area is under, simplifying the process of developing a thorough conservation plan for the extraction and management of these disturbances.

5. Current conservation status

   By the identification of the level of conservation of the different zones in the area, it becomes easier to divide them into those that are already benefiting from some kind of protection, legally implemented or locally approved, and those that have zero levels of protection in place thereby further simplifying the process of designing the MPA.

By applying these classifying criteria, zones of importance can be identified, and can then be ranked according to the priority of their establishment which will facilitate the planning of the network by providing a clear outline for approaching the project.

However, recent studies have reflected a lower level of performance than was expected as a result of multiple factors:

- Inability to cover entire ecosystems including interdependent habitats.
- Insufficient area to sustainably accommodate for economic and cultural practices.
- Inability to account for different types of habitats due to size limitation.
- Inability to account for important sites that cover the life cycle of target species.
- Inability to protect migratory species.
- Inability to account for unexpected large-scale disturbances.

These complications, which one might assume are consequences of size restrictions, cannot be addressed by creating larger, individual MPAs due to the following setbacks:

- Reception of large quantities of marine pollutants like litter and microplastics.
- The current significant decrease in the resources of industrial and recreational fishing therefore transferring fishing pressures to areas near MPAs.
- Greater cost, management and coordination.
- Potential/perception of high fish biomass in large MPAs that encourages illegal fishing activities within the MPA boundaries.
- Need for high technology surveillance to prevent illegal fishing and other damaging activities, which is extremely costly.

To date, one proven effective method that counteracts these setbacks is the creation of a network system of individual MPAs connected together on various levels. Such networks factor both efficiency and minimal resource demands while meeting set objectives.

b. Marine Protected Area Networks

In 2011, several countries convened in Japan for what became known as the Aichi Declaration of 2011 where it was agreed that by the year 2020, 17% of terrestrial and inland water, and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, must become conserved through effectively managed connected systems of protected areas (Aichi Target 11). Following the Conference of Parties of the Convention on Biological Diversity (COP15 – CBD) in December 2022, the Global Biodiversity Framework (GBF) reached a global agreement “to protect and conserve at least 30% of the world’s land and ocean by 2030”, better known as GBF-Target 3. More specifically, Target 3 clearly states that “areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of

protected areas and other effective area-based conservation measures, …". Consequently, and with the commitments of the international community in COP 15 and the help of improved scientific data, the conservation of wildlife and rich environments, specifically those of marine nature, was pushed in the direction of increased connectivity creating networks of protected areas instead of distant isolated ones. Practical experience combined with continuous scientific assessments has proven the ability of protection networks to overcome the various difficulties brought upon by isolated MPAs. Furthermore, the application of networks has demonstrated its effectiveness in the mitigation of climate change effects through the integration of factors like replication and representativeness in the plan of its design. Through a wider representation of governance, economic, social, and ecological factors in a network, the level of investment and political will surrounding their establishment will become more effective ensuring a greater success level than that witnessed in isolated poorly supported MPAs.

c. MPA networks and environmental targets

As anthropogenic and natural pressures are increasing worldwide, environmental targets and objectives have been declared and signed by many countries in order to head towards sustainability while benefiting from ecosystem services. Thus, establishment of MPA networks will allow countries to meet their environmental targets under several conventions and agreements such as the GBF, the CBD, and the Sustainable Development Goals (SDGs) amongst others (Table 4).

Table 4: Contribution of MPA networks to international conventions.

Convention/ Protocol	Description	Reference
Aichi's Biodiversity Targets of the Convention on Biological Diversity (CBD) Strategic Plan for Biodiversity 2011–2020	Consist of 20 specific targets to address and mitigate biodiversity loss across the globe.	Aichi-Targets-EN.pdf (cbd.int)
Convention of Biological Diversity (CBD) Post-2020 Framework. Conference of Parties 15 (COP15): Nations Adopt Four Goals, 23 Targets For 2030 In Landmark UN Biodiversity Agreement	Effective conservation and management of at least 30% of the world's lands, inland waters, coastal areas and oceans, with emphasis on areas of particular importance for biodiversity and ecosystem functioning and services. The GBF prioritizes ecologically representative, well-connected and equitably-governed systems of protected areas and other effective area-based conservation, recognizing indigenous and traditional territories and practices.	https://www.cbd.int/article/cop15-cbd-press-release-final-19dec2022
Sustainable Development Goals (SDGs)	Consist of 17 SDGs. They recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability specifically through goal 12: ensure sustainable consumption and production patterns, and goal 14: conserve and sustainably use the oceans, seas and marine resources for sustainable development.	THE 17 GOALS | Sustainable Development (un.org)
Protocol On Integrated Coastal Zone Management In The Mediterranean (ICZM)	It is the first legal international tool for the sustainable management and use of coastal zones, taking into account the importance of coastal ecosystems, the diversity of activities and uses and their impacts on the marine and coastal area.	ICZM Protocol | UNEPMAP

Convention/ Protocol	Description	Reference
Towards A Nature Positive Mediterranean - Policy Brief 2022	A policy that identifies transformations needed to reverse biodiversity loss, reduce impacts and restore and renew nature, thus achieving a Nature Positive goal by 2030 in the Mediterranean.	https://biodiversity-protection.interregmed.eu/fileadmin/user_upload/Sites/Biodiversity_Protection/horizontal_project/MBPC_Policy_Brief_2022__1_.pdf
United Nations Convention on the Law of the Sea (UNCLOS, 1982)	It lays down a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources.	United Nations Convention on the Law of the Sea (imo.org)
Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971)	It promotes the designation of wetlands of international importance as Ramsar Sites, the wise use of all wetlands in the territory of each country, and international co-operation with other countries to further the wise use of wetlands and their resources.	Convention on Wetlands of International Importance especially as Waterfowl Habitat. | UNESCO
Barcelona Convention for the protection of the Mediterranean Sea against pollution (1975/1995)	It is a regional convention to prevent and stop pollution from ships, aircraft and land based sources in the Mediterranean Sea. This includes but is not limited to dumping, run-off and discharges.	Barcelona Convention and Protocols | UNEPMAP
Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention (SPA/BD, 1995)	Implements the sustainable management of coastal and marine biodiversity through the creation, protection and management of Specially Protected Areas (SPAs), the establishment of a list of Specially Protected Areas of Mediterranean Importance (SPAMIs) and the protection and conservation of species.	SPA/BD Protocol | Regional Activity Centre for Specially Protected Areas (rac-spa.org)
Convention on Migratory Species (CMS, 1979)	It is an international agreement that aims to conserve migratory species throughout their ranges.	Convention on the Conservation of Migratory Species of Wild Animals (CMS) - Glossary - UNESCO World Heritage Centre

Convention/ Protocol	Description	Reference
The Agreement on Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic area (ACCOBAMS, 1996)	It is the first Agreement on cetacean conservation binding the Countries of these sub-regions, enabling them to work in cooperation to reduce threats on cetaceans.	Introduction | Accobams
The UNESCO Convention on the Protection of Cultural and Natural Heritage (1972)	This convention relates the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two.	https://whc.unesco.org/en/conventiontext/
The UNESCO Man and the Biosphere Programme	The MAB programme is an intergovernmental scientific programme that aims to establish a scientific basis for enhancing the relationship between people and their environments. It combines the natural and social sciences with a view to improving human livelihoods and safeguarding natural and managed ecosystems, thus promoting innovative approaches to economic development that are socially and culturally appropriate and environmentally sustainable.	https://en.unesco.org/mab
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973)	It is an international agreement designed to ensure that international trade in animals and plants does not threaten their survival in the wild.	https://cites.org/sites/default/files/eng/disc/CITES-Convention-EN.pdf
International Maritime Organization (IMO)	It is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships.	https://www.imo.org/
General Fisheries Commission for the Mediterranean (GFCM)	It is a regional fisheries management organization. With 22 member countries & the EU,	https://www.fao.org/gfcm/en/

Convention/ Protocol	Description	Reference
	its main objective is to ensure the conservation and the sustainable use of living marine resources as well as the sustainable development of aquaculture in the Mediterranean and in the Black Sea.	

d. State of marine biodiversity and fisheries in Lebanon

When it comes to coastal and marine ecosystems, anthropogenic pressures have caused a remarkable alteration in these habitats and the socio-economic services they provide. The Lebanese Coastal Zone (CZ) is greatly affected by overpopulation and privatization of the Maritime Public Domain (MPD). In addition, marine ecosystems are under the stress of erosion, sea-filling, pollution, solid waste dumpsites and wastewater discharges. However, exploitation of natural resources through marine fishing and uncontrolled recreational activities remain an important challenge to overcome. One additional critical factor to all these marine organisms is climate change and its repercussions such as the rise Sea Surface Temperature (SST), Sea Level Rise (SLR), Non-Indigenous Species (NIS), ocean acidification and ocean deoxygenation.

According to the literature, marine biodiversity in Lebanon can be reported as follows:

- Phytoplankton: 385 species.
- Zooplankton: 783 species.
- Macrophytes: 243 including 29 NIS species.
- Zoobenthos: 1,072 marine invertebrates recorded, 156 of which are exotic.
- Ichtyofauna: 367 species.
- Marine mammals: seven species.

All the pressures on marine resources are translated as pressure on the fisheries sector, a sector that employs about 6,500 persons in Lebanon organized in syndicates and cooperatives. Based on the EastMed report of March 2013, Mediterranean fish catches have decreased by 15% since 2007. As for Lebanon, targeting juveniles, high fishing pressure, destruction of shallow productive habitats through seafilling, pollution and many other factors are causing drastic depletion of fish resources, and increasing the vulnerability of an already highly susceptible sector. Moreover, and due to security and safety concerns, fishermen are not allowed to fish beyond the six nautical miles further impacting access to the resource and the income of fishermen.

Regarding catch/effort data, the Department of Fisheries & Wildlife at the MOA (DFW-MOA) has been collecting information through its Fish Landing Operational Utility for Catch Assessment (FLOUCA-Web) system from all major fishing ports on the Lebanese coast since 2014 and reporting the results to the General Fisheries Commission for the Mediterranean (GFCM) and FAO. Such catch/effort data can be requested from the DFW-MOA through official correspondence.

e. Marine Protected Area Networks in Lebanon

Lebanon's Marine Protected Area Strategy of 2012 published by the MoE proposed 18 sites including four deep-water sites. The Strategy also mentioned that the declared and projected MPAs fall under an MPA network without detailing neither requirements nor needs to reach that goal. In order to create a more resilient network, other locations are recommended to be taken into account such as the artificial reefs in Aabdeh (North Lebanon), Barbara and Jounieh (Mount Lebanon) and Saida (South Lebanon) that were deployed to enhance marine biodiversity and contribute to blue economy activities.

Therefore, under the project entitled "Conducting an evidence-based national Non-State Actors Campaign on Marine Protected Areas Network" funded by the European Union and implemented by the Lebanese Environment Forum (LEF) and the Marine and Coastal Resources Program at the Institute of the Environment at the University of Balamand (MCR-IOE-UOB), this document is prepared as a guide for the establishment of an effective MPA network in Lebanon's Exclusive Economic Zones (EEZ) for the sustainable conservation of Lebanon's coastal and marine biodiversity and ecosystems.

III. Designing a successful Marine Protected Area Network

a. Scaling Up: From Isolation to Connectivity

The creation of MPAs has been considered an efficient method to conserve natural environments and threatened organisms. Through the declaration of specific zones as protected areas, and with the formalization of regulations and restrictions, governments and involved organizations have created spaces that enable the protection of natural ecosystems and the species residing in them. This has also provided the basis for furthering the scientific understanding of natural systems enabling the development of healthier practices and rules that govern the interaction of people with their surroundings.

Nonetheless, and in light of recent advancements of scientific knowledge in this field, it became clear that limiting the protection of the natural environment to isolated locations and the complete or partial disregard of its neighboring areas can result in severe reduction of conservation efficiency and the possible need for doubling these efforts to reach the specified goals. In order to overcome this obstacle, which is mainly driven by the isolation of the areas under focus, a wider integrative approach must be adopted. This is achieved through the development of networks linking target areas with each other making sure that all processes and individuals that require protection fall under the jurisdiction of these locations or the bridges that tie them together.

The structure of an MPA network can be divided into three important elements covering multiple machineries within the protected areas themselves:

1. Socio-economic networks

   Possible by the establishment of a well maintained network of communication and the coordination between the different MPAs in the system. This would allow the proper sharing of data at critical times eliciting appropriate reaction to certain scenarios.

2. Ecological networks

   Through spatially connecting the individual MPAs in a system which permits the success and continuity of target ecological and biological processes needed for the survival of the ecosystem as a whole. This form of connectivity would ensure maximum preservation of the target species/area by ensuring that all aspects of its life cycle and processes are contained within the protected zones.

3. Management based networks

   Which is achieved through the development and unified implementation of management and regulatory tools throughout the entire network ensuring the consistency of the documentation and monitoring processes. This in turn would give scientific value to the collected data. Furthermore, this form of networking calls for the unification of legal frameworks, such as permits and regulations, to ensure the protection and management of the entire system.

Accordingly, the establishment of a well maintained and maximally efficient MPA network will require the integration of these three forms into one big structure. This will provide the required parameters for the flourishing of both the physical environment and the biological organisms residing in it:

- Socially: resolving and managing conflicts related to natural resources and ensuring their sustainable use.
- Ecologically: ensuring marine ecosystem functions by including both temporal and spatial scales.
- Economically: facilitating the efficient use of resources by focusing efforts on a large connected area rather than duplicating the efforts on several small individual MPAs. In addition, MPA networks are considered a cost effective means of protecting large-scale processes while delivering local benefits.

Networking is then achieved through the linkage of these isolated zones. This will allow systems to benefit from a range of enhancements which can be grouped under two main categories.

1. Those concerned with “Biophysical and Ecological” occurrences:
   - Better coverage of valuable and representative marine habitats.
   - Improved protection of migratory or wide range species.
   - Improved protection of species of special interest (e.g., threatened and vulnerable species) as well as exploitable species.
   - Mitigation of the effect of nearby regions by the creation of a buffer zone around the core protected area.
   - Expanded coverage of habitat space to cover different life stages of target organisms.
   - Enhancement of fisheries through successful larval spread or fish spillover into neighboring areas.
   - Better provision of ecosystem services to people.

- Development of monitoring protocols across the MPA network allowing data sharing and comparison across all sites to determine trends and status of resources.

2. Others concerned with "Administrative and Pragmatic" procedures:
    - Maximization of the potential of MPAs creating a more desirable investment for stakeholders.
    - Effective expansion of individual MPAs by virtue of ensuring a proper communication system within the network body.
    - Development of more adequate management systems of individual MPAs through sharing skills and previous experiences among the different stakeholders.
    - Improvement of socio-economic conditions through the creation of new employment opportunities.
    - Development of legal and institutional frameworks needed to deliver and sustain MPA networks.
    - Identification of management actions needed to address ecological processes and negative impacts that occur beyond the boundaries of any single MPA.
    - Consensus building on common issues.
    - Institutionalization of mechanisms for proper, efficient administration and management actions.
    - Ensure sustainable financing and adaptive management approaches.

MPA networks are one of the tools that can help protect the marine environment while enabling its sustainable use. While they have an essential role in protecting and restoring biodiversity, they can also be important tools for fisheries management. The main contribution of such networks to fisheries lies in their capacity to act as areas of growth for adults (larger fish produce more eggs), for the spillover of juveniles and for the export of eggs and larva that greatly benefits fisheries by re-establishing and conserving sustainable stocks on the long term. Such benefits though take years to occur.

Depending on the characteristics of the MPA and/or the MAP network, and the type of fisheries occurring in the targeted area, a range of management options may be identified through integrated approaches grouping fisheries and MPA managers. These, for example, may differ in the degree of restriction they place on fishing operations in the vicinity of protected areas and the risk such operations pose to achieving the conservation objectives. Applying the best available evidence should make it possible to identify where such risks may exist, and where these could be reduced through the introduction of management measures so that they are appropriately mitigated. A range of potential management options and scenarios may be identified to explore potential trade-offs and preferences. Any preliminary assessment or data review will help to inform the risk profile for a particular fishery and propose realistic scenarios that strike a balance between conservation and socio-economic objectives. Such contribution to fish stocks will not

succeed if not coupled with proper fisheries management tools including enforcement of fishing laws and regulations.

Consequently, the change from MPA isolation to connectivity will provide an important push towards the propagation of biodiversity and the progression of an environmentally aware society that will lead to a more sustainable marine ecosystem. This in turn will have positive implications, not only to fisheries, but also to a wide range of blue economy activities.

b. Choosing the Right Zones

For an MPA network to be properly planned, individual MPAs lying within its boundaries must be carefully chosen according to specific criteria. These sites must include relatively intact natural areas that should be considered representative to the region of interest. In addition, those chosen locations must provide a maximal diversity of the resources targeted. One added benefit is the presence of better socio-economic values in the area of interest as this will bring about better time and financial management of the network. Factors to take into consideration when identifying prospective MPA sites include but are not limited to the following:

1. Ecological
    - Zones must provide “Superior Habitat Quality” being adequately representative of the bigger region.
    - Zones must contain the “Highest” or best possible combination of “Biodiversity” capable of maintaining a well-developed food web that can support the ecosystem.
    - When specifically targeting “Fishery Enhancement”, choose locations with the highest fish abundance integrating zones of feeding, spawning and larval migration.
    - Zones must be studied to identify “Favorable Ocean Currents” that aid the survival of larvae of target organisms.
    - Zones must be of “Sufficient Size” to account for all regions of importance to species within the protection program.

2. Practical
    - Zones must be chosen based on local “Social Acceptance” to avoid tensions between the people and the administrative teams and organizations.
    - Zones must be chosen in areas that are “Practical to Manage”, taking into consideration the feasibility of establishing and monitoring them.
    - Zones must allow the best possible “Management Quality” ensuring the possibility of implementation and maximized effectiveness.

Based on applicable laws, a well-connected MPA network system needs to be created by the responsible authority. In addition, a committee/working group may be formed from representatives of individual MPAs within the network having a main role the suitable development, execution, and continuity of the structure over time.

c. Network Design Guidelines

After selecting the target zones, the next step is linking them together. As a rule, connections must have a purpose. When two regions that share no specific continuity of biogeochemical processes are linked, the efficiency of conservation will most probably remain static. Whereas zones that share mutual provisions, like those that support spawning grounds, larval dispersion routes, and juvenile nurseries, must be linked to allow the success of these processes and the emergence of the best possible outcome from these grounds. These linkages introduce a purpose to the creation of networks and significantly enhance the efficiency of the entire system.

It is important to note that following the establishment of the linkages between the different selected zones, protection and management must be enforced through legal regulations to mitigate and control anthropogenic practices.

This linkage process, otherwise known as the creation of a network, must include:

1. Representation

   When choosing to protect a type of ecosystem across a large area, locations to be incorporated in the network must reflect the majority of the characteristics of the region. In the context of marine ecosystems, areas that support species' diversity and life cycles (spawning, larval dispersal, nurseries, feeding grounds amongst others), those that present habitat diversity, and others that cover oceanographic, bathymetric and geological features must be incorporated within the structure to extract the optimal outcome from the protection. The conservation must cover at least 20% - 30% of each chosen habitat type.

2. Replication

   It is highly recommended that at least three examples of each marine habitat type should be protected in each MPA forming the network. These replicates should be spread out to provide a type of safeguard against unexpected disasters (natural or anthropogenic) guaranteeing the survival of the protected feature. This is possible by ensuring that other locations not affected by the unforeseen degrading source contain this feature and maintain its protection. The creation of replicates in a protected ecosystem heightens conservation efforts for target species. This happens by allowing the existence and evolution of the same species in similar but distant ecosystems creating populations with genetic richness through process of exchange and breeding across the linkages provided. This would generate a certain degree of resilience within the populations dwelling in the network enhancing their chance of survival in the face of changing environments, especially impacts of climate change. Viewed scientifically, the existence of replicates will make it possible to apply statistical tests that can evaluate the efficiency of the network. This will provide basis for further developing the MPA network by identifying its failings and refining them. Nonetheless, it is imperative to ensure that the creation of replicates does not exceed the monitoring and surveillance capacity of the system to avoid financial and technical strains.

3. Connectivity, Viability and Resilience

Linking locations in a broad region must permit the continuity of the activities and processes taking place in its ecosystem. MPAs should be placed with a maximum distance of 15-20km between them to be functional. Thus an evaluation of the existing habitats and the processes occurring within them must be performed in order to develop a proper classification of the system. This would ensure the existence of a self-sufficient cycle within the MPA network not dependent in any way on what lies beyond its borders therefore shielding it from various changes that might be taking place. Therefore, the viability of a system depends on the proper distribution and maintenance of this type of stability. This will provide a foundation for the creation of a resilient system, where habitats and the organisms residing in them demonstrate a degree of resistance and adaptability to large-scale and long-term changes specifically those brought upon by climate change.

4. Size and Shape

The selection of the borders of protected zones must factor the surrounding area into the development plan of the MPA and subsequent network. Activities that take place within the reach of the protected region might impose adverse effects of features that are targeted for conservation. To overcome this "edge effect" each MPA must include a buffer zone that protects its components from the interference of forces beyond its reach. This is best achieved through usage of simple shapes like squares and rectangles to maximize interior protection. Buffer zone size will be dependent on the area that needs protection, the surrounding sources of impact, and the available area for integration within the MPA.

5. Critical Areas

Within the design, it is crucial to protect areas with critical value like spawning or nursery grounds, and areas that provide high species aggregation. Zones that provide resilience against climate change, such as areas of upwelling, or those with organisms capable of adapting to change, must also be included to provide a higher success rate to the network.

IV. Best Practices for Network Implementation

The advancement and endurance of an MPA network will particularly depend on its design, implementation, and management. Nonetheless it can be dependent on simple factors that can affect its coherence and subsequently its efficiency:

1. Clarity of Objectives

   The establishment of direct, transparent objectives for the network will provide credibility and will facilitate the monitoring and planning of activities throughout the lifetime of the system. These objectives can fall under three broad title: 1) ecological, 2) economical, and 3) socio-cultural. The specifications on what the system is built to protect, what are the outcomes expected with their economic benefit, and how the involvement of the surrounding community is planned will provide a clear outline for the development of the network as a whole. It is important to note that the goals set must not go beyond what is feasible to achieve and should demonstrate a balanced approach.

2. Long-term Political Commitment

   Ensuring the survival of the network depends on the sturdiness of its formation, including the local political attitude, and the legal framework utilized for its establishment. One way to guarantee this survival is through the enactment of laws and policies that provide the established networks with much needed protection and care.

3. Community and Stakeholders

   It is imperative when aiming for the maximization of network efficiency to involve the surrounding community and stakeholders in all process involved in the creation and implementation of an MPA network. The approval and support of these components will provide a sturdier basis for the network to be built upon. Furthermore, community-based monitoring systems, integrating reward-based operations and proper information sharing with the multiple MPAs will enhance the development of the system as a whole.

4. Exploiting Available Information

   The establishment of an MPA network must depend on adequate scientific studies that rely on up-to-date information and results. However, the data should not be limited to the scientific or socioeconomic aspects, but it should also include traditional knowledge provided by the local community, which can in turn increase their support of the project, and provide an enriched insight when historical data is missing. This is very important when dealing with the “shifting baseline” concept, where stakeholders base their goals on preserving the current deteriorated state of the ecosystem instead of restoring healthier ones. The collection of historical data will provide a more accurate picture of the ecosystem conserved. If new data is presented during or after the planning, it can be integrated in an inclusive and adaptive management plan.

5. Inclusive and Adaptive Management Plan

   It is important to develop an inclusive and adaptive management plan that encompasses the different scales of administrations (national, regional, and local) when creating a

network of protection. This is supported by the designation of teams for the individual MPAs that follow up on regulations and ensure their proper application. The developed management plan should also be flexible to changes that might occur during the processes of planning and execution, where it should allow the integration of changes in goals derived by different data inputs and research developments. This will promote the independent growth of the network and the continuity of the management framework.

V. Further Considerations

In order to ensure sustainability of the network, other issues should be considered in the planning and design phases.

1. Social and Economic

By gaining the support of the local community, a stronger foundation will be created for the improvement of the entire system. This can be done by the production of easy-to-understand reports on the socio-economic and ecological benefits of creating the MPA network, and proving to the local community and the target authorities that the creation of protected areas and scaling up towards a network will provide more benefit to the region such as the increase in ecosystem services and lower management costs per unit area. This should be accompanied by spreading awareness and educating the general public on the importance of protecting environments and biological diversity. Gaining the support of the local community is a delicate process that, if not approached properly can result in a negative feedback on the system. The goals set for the network must then be realistic and should not surpass the capabilities of the system. Furthermore, when communicating the anticipated benefits to the public, the focus should be diverted from pure economic outcomes to a more futuristic ecological approach.

2. Monitoring and information management

The system should consider developing scientific skills and introducing training programs to monitor MPA networks effectively. This will allow long-term assessment of the state of the network, identifying gaps and taking the necessary measures to refine the network system. Furthermore, information management should ensure the proper storage of information and provide data access across and among MPA networks. Thus, systems should be developed to provide both historical and new data for each MPA to all institutions and individuals that may be grouped for better coordination and management of the network as a whole.

3. The Governance System

During the creation of interconnected structures on large scales, it is important to develop a detailed configuration for the different tasks expected in the system. Therefore, the governance system must include technical, legal, executive, and social activities divided across proper teams and authority figures. Consequently, the creation of a hierarchy for each MPA and for the network itself is imperative. These should then be unified across the entire network, ensuring communication among the different MPAs. In addition, the

legal aspect should be identical throughout the whole network to allow proper implementation of tasks in an even approach across the individual MPAs. Such governance structure must be flexible enough to adapt to changes in the field while the enforcement of regulations must be supported by penalties to ensure that the public abides with them. It is important to also consider the creation of a reward system to engage the public in the process of implementation.

4. Financial

An integral part to the process of developing an MPA network is how self-sufficient its financial plan is. Costs and expenditures should be shared among involved stakeholders, Non-Governmental Organizations (NGOs), and interested community members with sufficient outcomes to allow continuous financial support. A cost-effective financial strategy for the network, built-in with transparent reporting on economic inputs and outputs should be devised. Detailed understanding of cost demands, identification of potential sources of income in addition to the identification of potential funding sources to help reduce management costs must be integral to the design. This will allow the appropriate tracking of the different processes occurring within each MPA and maintaining the integrity of the network as a whole.

VI. Indicators of success

Based on the creation and assessment of multiple MPA networks worldwide, some criteria for the evaluation of their success were established. MPAs are dynamic structures that work on different levels; ecological, social, administrative, and financial to ensure the protection of the target features, therefore the indicators used for the correct evaluation of these systems must factor the following levels of functionality.

1. Involvement of Stakeholders

The most important factor that points towards the success of the design, and which without the system will fail, is the involvement of the stakeholders. The engagement of stakeholders in the evaluation of the network through the assessment of their performance relative to the needs of local residents provides a doorway for the active commitment of these groups to the MPA network. Preferably, all stakeholders should be engaged. However, due to the difficulty of involving all groups and in many cases the limitations in resources, specific blue economy groups should be targeted whose involvement is imperative for the success of the MPA network.

2. Enforcement and Compliance

The monitoring and management systems of an MPA network should include methods and frequency of surveillance of the individuals that utilize these protected marine resources. Therefore, the evaluation of the level of commitment to these regulations and how well they provide protection to the ecosystem reflects the degree of success of the MPA network.

3. Leadership

   Teams that embody leadership within an MPA network are one of the main incentives for the structuring of the network and for the determination of its sustainability. Therefore, it is important to create a detailed evaluation process to gauge the efficiency of such leadership which is required to produce regular assessment reports, identify failings and introduce appropriate corrective measures.

4. Surveillance

   Included in the management plan for the MPA network should be approaches that evaluate the practicality of these methods in the field. They should account for different levels of functionality at ecological, social, governance, and financial levels.

5. Conflict Resolution

   It is important for the network to include an efficient strategy for dealing with challenges. Conflict resolution techniques must be integrated within the management plans to overcome obstacles that might hinder the efficiency of conservation.

Furthermore, the assessment of the success of the MPA network should be consistent and carried-out at regular periods. This will prevent the static view of achievements as they change over time. This assessment should be accompanied with updates on ecological, social and economic states concerning the performance of the network in order to integrate the findings into the inclusive and adaptive management plans. It is important to highlight that learning from failures in MPAs will not improve all MPAs in the network since the establishment of MPAs usually depends on the socio-cultural, political, and legislative context in which the MPA is established.

VII. Estuaries

Estuaries represent areas where running fresh water of terrestrial origin meets with salt water from seas and oceans, creating a unique zone that offers a distinctive collection of organisms and habitats. Being a transitional ecosystem connecting land and sea, estuaries represent invaluable structures responsible for the balanced maturation of both fresh water and marine ecosystems. They provide zones for various biological, chemical processes and are thus considered the most productive ecosystems on earth.

Estuarine ecosystems provide a variety ecological, cultural/social, and economic benefits to their surrounding region. Different types of organisms coming from both marine and freshwater habitats use estuarine systems as foraging grounds, for mating purposes, as nurseries, or as migratory corridors allowing such species to complete their life cycles. Estuaries also contribute to the preservation of coastal zones by maintaining a continuous flux of sediments that counteracts the degrading action of waves on shores. Wetland, soils, coastal vegetation and sea grasses also act as natural buffers between the land and ocean, absorbing floodwaters from land and storm surges from the ocean. Additionally, these zones play an important role in the detoxification and filtration of nutrients and other pollutants carried into coastal areas by water

drainage systems. The ecosystem surrounding an estuary benefits in part from the regeneration of nutrients that occurs via rivers, where continuous input of nutrients is supplied to replenish these areas supporting the diversity of life dependent on these systems.

Moreover, and with the support of scientific evaluation, it has been shown in California that conservation of these valuable ecosystems, particularly when aiming to enhance fishery reserves, has resulted in the evident recovery of fish stocks with economic benefits to the fishing sector. Historically, estuaries are considered important cultural hubs attracting different types of human activities including fishing, aquaculture, foraging, recreation and trade amongst others. Moreover, unique estuarine habitats make them valuable laboratories for scientists and students providing grounds for scientific studies. In addition, estuaries are a resource for building materials, medicine and food sources making such areas attractive to human settlements. This traditional relationship between humans and the natural environment of estuaries provides an essential value to these locations that must be preserved and managed carefully through maintaining a level of sustainability.

From an economic point of view, estuaries are tourist attractions providing valuable revenues, and since they provide habitats for a broad array of marine diversity, they also hold and economic value to commercial fisheries. Furthermore, they act as natural buffers for natural hazards born at both land and sea by absorbing floodwaters and storm surges.

Globally, the conservation of estuaries is significantly beginning to gain support through increased scientific attention and through their inclusion in plans for the restoration of natural marine environments. Evidently the inclusion of estuaries in MPA networks will prove to be fruitful through the increase of fish stocks, the lessening of degradation in coastal areas, the support of healthier marine and fresh water ecosystems, and the overall improvement in the functionality of MPAs. The fact that networks greatly depend on connectivity for their establishment, it becomes imperative to incorporate estuaries in any MPA network to guarantee maximum output and effectiveness of coastal and marine conservation programs.

VIII. Legal Framework

The establishment of MPAs and MPA networks is a process that differs legally from one country to another. Protected areas in Lebanon can be declared by individual laws promulgated by parliament upon the suggestion of the MoE as in the Palm Islands Nature Reserve (PINR) declared by law 121 of 1992, and Tyre Coast Nature Reserve (TCNR) declared by law 708 of 1998. Nevertheless, Law 444 of 2002 Code of the Environment provided additional legal pathways for specifically declaring reserves and considers the protection of beaches, marine areas and biodiversity. It also includes the establishment of a national plan on environmental protection, environmental impact assessment (including prevention of marine pollution), strategic impact assessment while also establishing penalties and responsibilities on violations of the law. To further strengthen protection and conservation measures in the country, law 130 of 2019 was enacted to define the categories of protected areas at national level, to establishing the creation, governance, management and budget of nature reserves, and to also establish sanctions for violations of the nature reserve system. Within this framework, these areas can be divided into

five distinct categories characterized by distinct levels of protection and regulations on the use of resources within them and are as follows:

1. Nature Reserve
   Established through the development of law by the MoE with the aim of protecting the natural environments of these areas, terrestrial or marine, assisting with the persistence of important habitats and organisms.

2. Natural Sites and Monuments
   Established via decrees developed by the MoE for areas containing no less than one site presenting natural or cultural significance.

3. Protected Forests
   Protected sites established by the Ministry of Agriculture (MoA) in accordance with the Conservation of Forest Resources Law (L. 85 of 1991).

4. Hima
   Protected sites established by the decision of local Municipalities employing a system based on "Community Based Nature Resources Management".

5. Natural Parks
   A new category that entails vast areas that can be inhabited where the natural resources within it are used based on systems that combine "sustainability of use" and "firm conservation".

Within established nature reserves, a proper hierarchy is developed following the requirements of Law 130 of 2019 where the MoE is responsible for the appointment of a local committee tasked with managing the protected area. This Appointed Protected Areas Committee (APAC) is formed of representatives of local stakeholders, local authorities, scientific experts, and NGOs. Field rangers are hired to perform day to day activities, assist in research and development actions and to support the implementation of laws and regulations in concert with the internal security forces.

Even though the MoE is mandated to oversee the proper management of MPAs, other ministries also have roles in ensuring their protection and sustainability. Marine transportation within and around MPAs falls under the jurisdiction of the Ministry of Public Works and Transport (MoPWT), fisheries and their sustenance under the MoA, while safety and security is mandated to the Ministry of Interior and Municipalities, the Ministry of Defense (MoD) and the Lebanese Armed Forces.

Nonetheless, and according to current legislation, it is unclear whether an MPA network can be declared by law. It therefore remains essential to assess the capacity of the Lebanese legislative process to legally declare an MPA network and to explore the possibility to introduce amendments to current legislation required to provide networks with an independent legal status. Such a status will allow the allocation of human, material and financial resources as well as the solicitation of funds for the sustainability and success of such networks.

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