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The Blue Management: Adding Economic Value to Restoration Actions in Collapsed Ecosystems

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Abstract: This study presents a strategy for environmental management that aims to enhance efforts to restore threatened ecosystems. We review the exploratory system and classify the stakeholders and driving forces behind nature exploitation. Based on successful environmental management cases, we propose practical modifications for adding economic value to restoring collapsed ecosystems, resulting in the development of blue management. Blue management isolates specific stakeholders such as nature exploiters, governmental bodies, and nature scientists. We propose the division of nature users into large footprinting companies (funders), natural resources exploiters industry (managers), and subsistence exploiters (workforce) and emphasize the importance of increasing the interaction between nature exploiters and natural scientists to accelerate the restoration of threatened natural resources. Blue Management offers stakeholders practical alternatives for improving collapsed/threatened natural assets (ecosystems) based on economic, social, and ecological theories. It provides a summarized pathway for decision-makers to restore unproductive resources, avoiding the migration of the exploratory system to new pristine resources. In summary, blue management is a practical approach that combines economic, social, and ecological theories to restore threatened ecosystems. It offers decision-makers a pathway to restore unproductive resources while avoiding the exploitation of new pristine resources. Additionally, blue management has the potential to improve the research and development of technologies and systems related to nature restoration. We believe that this approach can help achieve the goals of the UN decade of ecosystem restoration and contribute to the sustainable use of natural resources.

Keywords: environmental management; ecosystem restoration; threatened natural resources; environmental footprint; blue economy

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1. Introduction

The continuous exploitation of natural resources to support human development and the growing global population is leading to an increase in anthropogenic footprints on Earth. This is causing large-scale defaunation and the collapse of natural resources [1–3], resulting in the loss of biological functionality and economic productivity of formerly productive ecosystems.

A common cause of resource overexploitation is known as the Tragedy of the Commons [4]—a theory with repeated social behavior affecting most terrestrial and marine ecosystems worldwide, given the historical competition for finite natural resources among different users in society. The Tragedy of Commons' consequences also results in direct economic benefits for users that have contributed to the environmental footprint. The profit and cultural development gained from this economic activity work as a positive reinforcement, then stimulate them to continue searching for new resources. As systemic relations currently stand, economic activity simply migrates to natural resources which are still functional and which boast profitable assets, discarding unproductive resources

and expanding anthropogenic footprints to unexplored resources. This migration creates a "defaunation gradient," commonly observed along a proximity gradient to urban centers [1,5–9]. Consequently, this creates a scenario wherein the most damaged ecosystems, in terms of biological functionality and economic productivity, are closer to the urban centers. In an opposite direction, the biological and ecological functionality of ecosystems increase with distance and difficulty of human access.

The capital sin of greed is directly related to the Tragedy of Commons; therefore, it must be intrinsically related to the environmental management of natural resources. Greed and survival instinct are the driving forces that stimulate predatory competition in the Tragedy of Commons [4], wherein the user who is most efficient in exploring resources wins the competition. Based on this statement, we suggest using greed as a driving force for restoration efforts, creating management solutions that add economic value to restoration actions for collapsed ecosystems. We aim to incentivize exploiters (economic sectors in society) to create recycled natural assets in collapsed ecosystems by proposing the potential for profit in these actions, avoiding the expansion of exploitation into the few remaining natural resources and fully functional ecosystems on Earth.

There is now an urgent, global need for governments to formulate innovative management strategies which acknowledge the finite nature of resources. The expansion of the traditional pattern of resources exploitation poses serious economic and environmental problems to a society, such as pests, invasive species, food security, and economic collapse [1,10]. Nowadays, the management of natural resources focuses mainly on sustainable development, a method that has been proven unsuccessful in controlling exploitation and the consequent effects of the Tragedy of the Commons. The current management system merely avoids rapid depletion or overconsumption of resources, while continuing to exploit resources until they are depleted. This offers few opportunities to hinder the migration of exploiters from exploited resources to new, preserved, and productive resources. An interesting concept that addresses economic value to the preservation of still functional resources is the blue economy [11]. Indeed, the blue economy concept encompasses various useful strategies scientific knowledge, and new technologies related to ecosystem restoration [11–16] grounding the present study. However, the blue economy is addressed to still functional resources and not to recycling, and reusing collapsed and overused environments.

In this theoretical study, we present the blue management protocol, a systemic approach to the mechanism of natural assets/resource exploitation and the interaction among stakeholders. The protocol is based on adding economic value to restoration actions for collapsed ecosystems. The overall aim is to optimize the restoration of exploited and unproductive ecosystems to a higher level of ecosystem functionality while protecting the Earth's remaining functional ecosystems.

2. Materials and Methods

To understand the traditional natural resource exploitation system and blue management as an alternative new cyclic system, it is necessary to define the relevant stakeholders and their roles, interactions, boundaries, as well as money and effort vectors among them. As this is a theoretical proposal, we will present and organize descriptions in flowcharts to define the traditional exploitation system and the proposed blue management cycle. In doing so, we are considering the ecosystem associated with the exploited resources as a stakeholder that generates the economic flow, rather than simply as a commodity or resource to be exploited.

Furthermore, we are presenting a literature review comparing references and existing concepts related to the preservation and restoration of natural resources and their relationship with the proposed blue management.

3. Results

3.1. Historical Management System

The current system for the exploitation of natural resources follows a traditional cycle that results in the depletion of natural resources (Figure 1A). The cycle starts with a functional natural asset (resource), and a group of nature exploiters who extract profits from the resource and compete for the resource (agents of the Tragedy of Commons). Then, the government withdraws a portion of the profit from the nature exploiters through taxes, fines, fees, and rebates, mostly related to environmental footprints. A government that provides the budget for (1) resource management, and environmental surveillance; and (2) for funding scientific projects from nature scientists [17–19]. Nature scientists, with their great impact on society and the public, tend to blame nature exploiters for the depletion of ecosystems and the subsequent environmental impacts. This casting of blame is one of the primary forces driving the government (decision-makers) to increase taxes and fines for the exploiters, who then compensate by extracting more commodities (resources), thus creating a cyclic mechanism where increased pressure from the government increases the exploitation of natural resources. This negative stimulus (reinforcement) often discourages exploiters from funding scientific projects related to preservation and discourages their interaction with nature scientists.

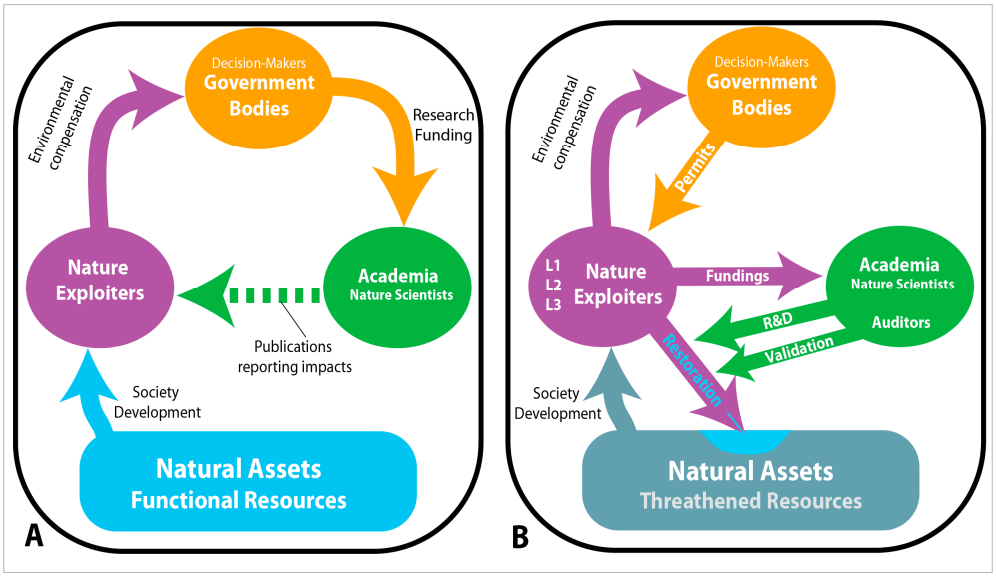

Figure 1. Flowchart highlighting the interaction among stakeholders in the exploitation of natural assets, with (**A**) the traditional cycle of the exploitation of functional resources; and (**B**) with the blue management with the modifications among the stakeholders to restore threatened resources, with three levels in the nature exploiters (L1, L2, L3).

In the traditional exploitation mechanism (Figure 1A), it is important to note that: when collapsing the resource automatically collapses the entire cycle, collapsing the economic sector, the government, and the entire society developed by exploiting the natural asset. Summarizing, the traditional exploitation cycle is a perpetual system that practically excludes efforts to restore exploited assets (resources) or collapsed ecosystems. Indeed, this system simply drives economic activity towards a new, functional, and profitable natural resource, discarding used resources as there is no profit (reward) in terms of restoration efforts.

3.2. The Blue Management

Suggested modifications to the interactions among stakeholders under blue management are illustrated in the flowchart in Figure 1B with the same stakeholders but with practical modifications in their interactions and roles.

The flowchart in Figure 1B illustrates the suggested modifications to the interactions among stakeholders under blue management. The modifications involve practical changes to the roles and interactions of the same set of stakeholders presented in the historical management system.

3.2.1. The Natural Resources in Blue Management

Blue management is a protocol aimed at restoring threatened or collapsed resources. The evaluation and classification of target sites to be restored represents the first step towards achieving this goal. It is important to note that restoration, as a tool, is not intended to reduce climate impacts; rather, it serves as a complementary approach to accelerate natural recovery in key areas following a disturbance [20].

After defining the boundaries of the target ecosystem to be restored in key areas, the next step is to assess its "preservation status" (as shown in Figure 2) based on the ecosystem's biological functionality and maximum potential in terms of biodiversity and biomass prior to the Anthropocene era. For instance, in the classification of preservation levels for marine MPA fields [21], collapsed ecosystems are categorized as marine areas below the "minimally protected" level. Figure 2 illustrates some characteristics of collapsed and still functional ecosystems (pristine), highlighting when the use of blue management or blue economy (traditional preservation methods) is recommended. It should be noted that the preservation and passive rewilding [16,22,23] of collapsed resources, currently used in the conventional management of natural resources, would take a long time, delaying the return of economic and biological functionality of the threatened asset, and potentially pushing the economic sector towards still functional resources.

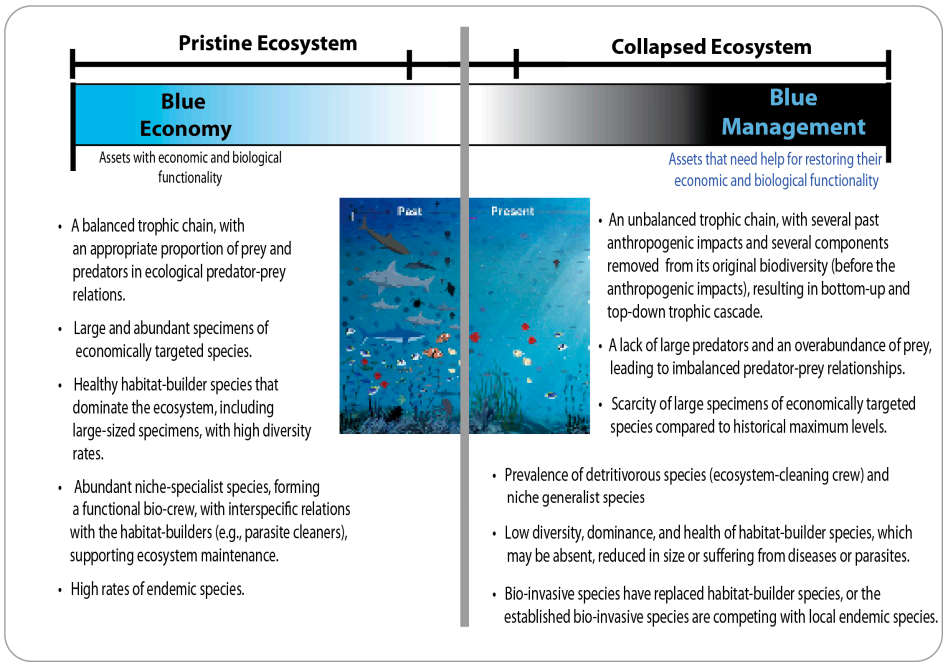

Figure 2. The ecological divergence between pristine and collapsed ecosystems for the classification of the natural resources to be restored. Highlighting where blue economy and blue management are applied.

The preservation status is determined through the use of traditional ecological monitoring methods and target species classification. The target species are classified into categories such as habitat builders, functional, associated, pests, bio-introduced, and commercially targeted for food security and tourism purposes. The preservation status is evaluated using traditional ecological indexes, which assess diversity, abundance, and biomass. Low-impact ecological monitoring methods such as visual censuses are selected based on the ecosystem

type, marine domains, and taxon (e.g., [24–26]) and different concepts of ecological and economic target species per ecosystem [6,14,27–31].

Taking into consideration that what we are observing is exposed to a series of human manipulations, it is important to identify the ecological role of the absent species, searching for ecological imbalances and the effects of the bottom-up and top-down cascades [6,8,32] and searching for "The ghost of past anthropogenic impact" as raised in reference [9] while always considering the biodiversity that was previously recorded as inhabiting the target ecosystem, including the maximum recorded sizes of the absent economically target species.

Given that human manipulations impact the observed ecosystem, it is important to identify the ecological role of absent species and search for ecological imbalances and the effects of bottom-up and top-down cascades [6,8,32]. "The ghost of past anthropogenic impact" must also be considered [9]. In addition, the biodiversity that previously existed in the target ecosystem, including the maximum recorded sizes of the absent economically targeted species, should always be taken into account".

In conclusion, the key area in blue management is an ecosystem with low economic and ecological functionality, and the classification of its preservation status is the initial step in rehabilitating the threatened natural resource.

3.2.2. The Nature Exploiter in Blue Management

The modifications in blue management begin by addressing the issue of competition among nature exploiters for resource extraction, with the aim of avoiding the Tragedy of the Commons. This is achieved by segregating the nature exploiters (Table 1) (Figure 1B) into three levels: Level 1 comprises the large sectors as donors; Level 2 consists of ecosystem exploiters in the industry chain as managers; and Level 3 includes subsistence exploiters as the funded workforce. Under this categorization, the budget allocated for environmental compensation fees and rebates is partly directed towards restoration efforts, which are funded by the "Large sectors" (L1) to rehabilitate collapsed ecosystems and create new resources (natural assets) that are managed by the "Resource Manager" (L2). In turn, the Resource Manager hires "Subsistence Exploiters" (L3) for restoration activities, thus generating economic value and income (profit) for the nature exploiters (managers and subsistence exploiters), as well as marketing opportunities (an ecolabel) for the donor. This system entrusts the donor, as the economic power in the exploratory system, with the decision-making role in determining the destiny of collapsed ecosystems by driving budget allocation.

Table 1. Nature users divisions within blue management.

Nature Exploiters	**Level 1.** The larger industry chains are responsible for the significant environmental footprints on Earth, as they explore the most profitable commodities, usually starting the chain with raw natural resources. This group includes the energy industry chain (oil, gas, coal, etc.), including renewable energy (such as hydroelectric), the shipping industry, ports, and mining, among others.
	Level 2. The seascape and landscape exploiters. These are organized economic chains that extract profits by interacting directly with biodiversity in ecosystems. This group comprises the tourism trading industry, fishing industries (associations), real estate, livestock, and agriculture, among others.
	Level 3. The subsistence exploiters. These are traditional social groups that exploit the natural environment for survival using artisanal/traditional methods.

The key ecosystem to be restored (recycled asset) should be privately owned, and the resource manager is accountable for managing, protecting, and inspecting it. Indeed, several successful experiences demonstrate the preservation efficiency of zoning and isolating the resources for single users, for instance, the concept of private natural resources [33–37] where landlords preserve natural reserves for specific usages. The privatization of the sea and marine zoning [25,38–41] is another successful management strategy used in different marine resources. In blue management, collapsed and unproductive marine sites

can be isolated for the use of specific economic sectors, such as the creation of marine protected areas (MPAs) and marine parks [21] for the use of the tourism industry or recreational fishing groups (within the Blue Tourism concept [42]). In the concept presented here, restoration managers (L2) who undertake ecological improvement and restoration of natural resources should receive tax waivers as positive reinforcement for applying blue management for restoration.

Another successful economic strategy is ecological labels [43–45], which creates positive reinforcement as marketing for companies (L1) that fund restoration actions, adding economic value to the products and services extracted from the restored resource (such as ESG, carbon credits and biodiversity credits).

In the proposed management strategy, one of the advantages is the social impact of engaging subsistence exploiters (L3) in active restoration actions ading economic value for the workforce of traditional human communities that evolved by exploiting natural resources for mere survival. Through the involvement of subsistence exploiters in restoration activities, they can acquire new skills and knowledge, which can lead to improved livelihoods and overall well-being through the generation of income.

3.2.3. The Nature Scientists

In the proposed management system, nature scientists (Figure 1B) will work in collaboration with resource managers. Positive reinforcement for their involvement in the restoration process should be in the form of research grants and job positions that support scientific projects for restoration and environmental assessment, with a focus on projects that increase profits for the exploiters while restoring the ecosystem. This is crucial as profit is necessary for the sustainability of the system and to prevent any disruptive actions from occurring. Blue management aims to increase empathy towards restoration activities among nature scientists and the public.

Nature scientists play a pivotal role in blue management as they are responsible for the initial ecological monitoring to identify key areas for restoration, as discussed earlier. They also validate, verify, or reject the functionality of restoration actions, and provide information on the extended cost-benefit analysis of each restoration plan [46]. This analysis aids in defining the break-even or profit time based on the restoration investment by the nature exploiter and/or governmental body.

Another important role of this stakeholder is ecological gardening and ecological aquaculture, using the well-described technologies for farming target species and gardening (reintroducing) those produced species in the key area [7,16,47–54]. An important role in controlling the re-introduction using only native species (population) that naturally occur and inhabit the target ecosystem to be restored, avoiding interferences in the genetic flow of metapopulations and congeners. With special attention to producing and reintroducing target habitat-builder and natural habitat-cleaner species.

Another crucial role of the nature scientist stakeholder in blue management is to engage in ecological gardening and ecological aquaculture using well-established technologies for farming target species and reintroducing them into the key restoration area [7,16,47–54]. It is crucial to control the reintroduction by using only native species that naturally occur and inhabit the target ecosystem to avoid interference in the genetic flow of metapopulations and congeners. The nature scientist should pay special attention to producing and reintroducing target habitat-builder and functional species (as natural habitat-cleaner species), to reduce the trophic-cascade consequences of historical human threats. By carry this out, the nature scientist can contribute to the restoration of the target ecosystem and enhance the overall biodiversity and resilience of the ecosystem.

3.2.4. The Government in Blue Management

As the primary decision-makers in society, government bodies hold the power to restore collapsed ecosystems and attract industry funds to actively restore important natural ecosystems or assets. This approach can improve economic sectors such as tourism,

fishing, and real estate value while also reducing poverty by creating positive reinforcement for the large nature exploiters to direct their budget towards subsistence exploiters. In other words, government bodies can leverage the blue management concept to create positive rewards for nature exploiters and nature scientists, thereby increasing economic input into society.

The key role of the government in the blue management concept is to create laws and permissions for directing the budget from environmental compensation directly from nature users towards restoration efforts. Successful budget-flowing strategies have been achieved for protecting and restoring collapsed resources using this approach [1,37,55–62]. Additionally, the government can grant permission for the use of ecologically friendly artificial assets (habitats) to create new habitats for reintroducing and protecting new biodiversity such as fishing resources. This follows the blue engineering concept, [25,41,63–65] where subaquatic construction must have high habitat heterogeneity to support diverse marine life and be gardened (by L2 and L3) to accelerate restoration using reintroduction (outplanting) of target species.

3.2.5. Summarizing the Blue Management Protocol

The role of each stakeholder in the blue management protocol is summarized in Figure 3.

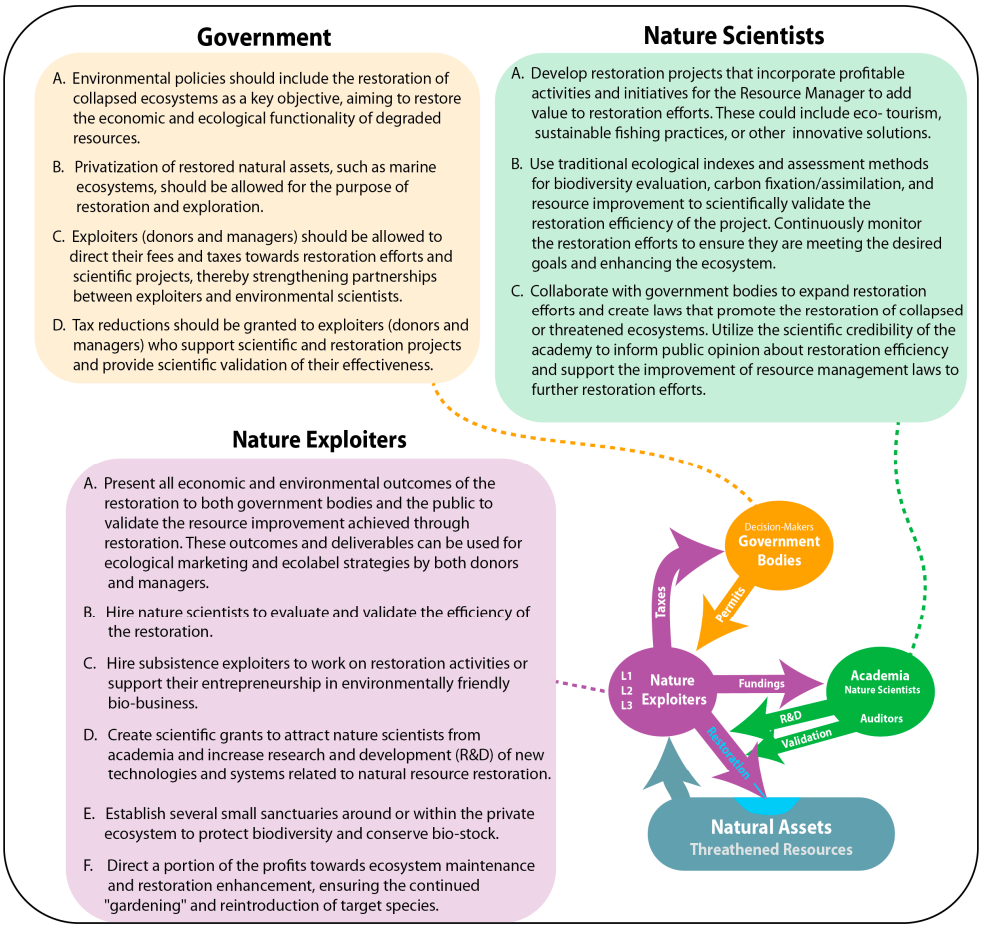

Figure 3. The summarized role of each stakeholder in the blue management concept.

To facilitate the implementation of blue management, we propose a six-step approach (Figure 4) to encourage nature users to engage in strategic blue businesses that add value to restoration actions and increase profitability. Blue Management is directly applicable to the restoration of blue natural Capital [66], including coral reefs, rocky shores, oyster beds, mangroves, and riparian zones in rivers and lakes. By improving profitability in

sectors such as tourism, fishing, real estate, farming, and land-owning blue management can contribute to the restoration of these ecosystems.

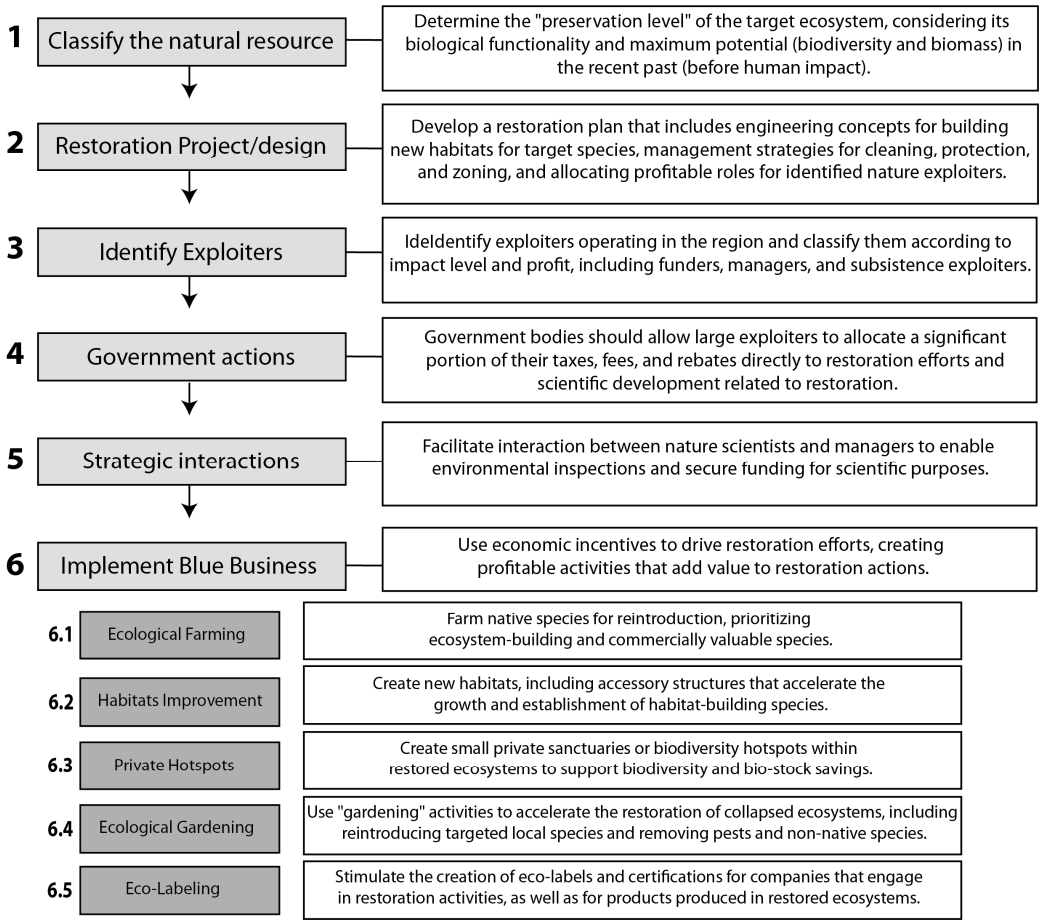

Figure 4. The proposed six steps for achieving the blue management and the five suggested blue business for adding economic value to the restoration.

4. Discussion

4.1. Importance of Blue Management

This study highlights a systemic issue within society whereby natural resources and associated ecosystems are cyclically threatened and exploited, leading to the abandonment of used ecosystems. This cycle is responsible for many problems in the Anthropocene, including defaunation, mass extinction, and ecosystem collapse [1,6,7,67]. These historical anthropogenic impacts and their consequential environmental imbalances have direct impacts on economic sectors of society, resulting in economic and social crises. Cumulative anthropogenic impacts, with top-down and bottom-up trophic cascade effects [6,8,32], and have returned to human society throughout history in the form of diseases [68–70], pests in agriculture [52], depletion of food resources [71,72], depreciation in the real estate industry [73], jeopardization of the tourism industry [74], the fishing activities [5,72,75], electric power plants [76], and more. In other words, many problems in society have emerged as consequences of historical and overlapping exploratory cycles, as illustrated in this study.

Taking into consideration that natural resources are limited, and some ecosystems and their associated biodiversity are at significant risk of extinction [1,67,77], modern society is relying on scientific stakeholders to propose alternatives to the conventional exploitation cycle. In this study, representing the scientific stakeholder, we suggest a protocol that employs economic strategies to transform greed, which is the primary driver of the Tragedy of the Commons [4], into a means of restoring collapsed ecosystems.

Specifically, we propose converting the collapsed ecosystem into a new asset or resource that can be re-explored. This approach ensures that if a particular economic sector in society can generate profits after restoring a specific ecosystem, the trend of entire sectors migrating to unexplored, pristine natural resources is avoided. In other words, blue management facilitates the implementation of a social-economic "behavioral enrichment" [78] for economic sectors, which prevents them from continually moving away from unproductive resources to pristine sites. By recycling and reusing newly restored sites, this approach ensures that the economic sector is hindered from migrating to unproductive sites constantly, and then fulfilling the objectives of blue management.

4.2. Blue Management and Its Role in Achieving a Blue Economy

Blue management was developed to provide practical solutions for achieving the blue economy concept, proposed at the Rio Conference in 2012 [11]. The blue economy is not limited to marine resources but includes terrestrial and aquatic ecosystems (such as rivers and lakes) and is part of the broader green economy. This concept encompasses various aspects of national and global governance, economic development, and environmental protection and sustainability in the economic exploration of natural resources [10,44,79].

Several theories presented in blue management have been proposed by the blue economy, such as blue tourism, blue engineering, eco-labels, ecological aquaculture, ecological gardening, and the "Blue fishing" industry [44]. The aim of the blue economy and its assimilated concepts is to ensure sustainable economic exploration of still functional ecosystems. On the other hand, blue management aims specifically to add economic value to the restoration of collapsed (or collapsing) ecosystems, using Porter's value chain theory [80] literally.

In summary, the blue economy and its assimilated concepts aim at sustainable economic exploration, while blue management focuses on adding economic value to the restoration of collapsed ecosystems. Both approaches are essential for achieving the goal of environmental protection and sustainability in the economic exploration of natural resources.

4.3. Maslow's Hierarchy, Blue Management, and Underdeveloped Countries

The establishment of blue management highlights important concerns related to environmental compensation, footprints, and Maslow's hierarchy of needs. The majority of global biodiversity is concentrated in tropical ecosystems, such as rainforests, coral reefs, and mangroves [81,82], which are predominantly located in underdeveloped countries with high levels of corruption among government and natural resource users.

In most countries worldwide, the customary method of punishing imprudent nature users is through fees or rebates, used as a form of environmental compensation/mitigation [1,37,55–62]. However, in these underdeveloped countries, such fees and rebates rarely return as a means of environmental restoration. Instead, they work as a positive stimulus for corrupt government bodies, as the environmental compensation budget is often embezzled or assimilated into the state, thereby transforming environmental disasters into profitable events for politicians and government bodies. Thus, greed once again becomes the driving force, encouraging corrupt governments to continue the defaunation of productive ecosystems.

In addition, Maslow's hierarchy of needs indicates that individuals under the basic needs level, which includes many impoverished individuals in underdeveloped countries, are rarely concerned with environmental preservation at the level seen in developed countries, where entire populations have surpassed the basic needs level. This is because the exploitation of natural resources is a survival need for individuals at the basic needs level, and this survival instinct can drive irresponsible exploitation. Therefore, the strategy used in developed countries, which conditions the improvement of education and human development to ensure environmental preservation [83], has failed in underdeveloped countries for decades. It is important to face the reality that corrupt and poverty-stricken countries have remained underdeveloped, threatening the tropical Earth's biodiversity, due

to erroneous and naive global management strategies that keep conditioning environmental preservation on education and human development.

Under blue management, it is imperative that society acknowledges that the approach of conditioning social development as a prerequisite for environmental protection has been ineffective, and that we need to break the cycle of repeating the same mistakes while hoping for a different outcome. The implications of blue management are significant in terms of creating effective solutions for curbing defaunation in underdeveloped countries. The budget from environmental compensations by large global nature exploiters should be directed towards restoration efforts in these underdeveloped countries, which can significantly increase profits for a large number of subsistence nature explorers that live in these tropical ecosystems. This would provide economic incentives for restoration practices, thus transforming the survival instinct of the subsistence nature explorers into a driving force for restoration actions of the most diverse ecosystems on Earth.

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