



# **Cross-Sector Ecosystem-Based Management Principles and Implementation Steps: The Nigerian Perspective**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## **ABSTRACT**

The complex economic, social, and environmental interactions in coastal areas require multi-sectoral approaches to understanding and designing effective management measures. The existing traditional management approaches fail to successfully identify economic, social, and ecological values and incorporate them into marine and estuarine ecosystems management. Therefore, there is a need for a holistic approach to help understand the socio-ecological system complexity and assist in policy and management of the marine and estuarine ecosystems. In recent years, Ecosystem-Based Management (EBM) has been relevant and implemented in many case studies of marine management and conservation of natural resources. However, there is a lack of consensus about its definition and key principles, which has affected its practical application in research. This article offers insight into EBM fundamental principles and steps to disaggregate ecosystems and resource management activities into a sequence of tangible levels of achievement and close the management gaps in the traditional approaches. We examined the principles and steps in EBM theoretical literature, covering a range of published sources across disciplines and continents. Based on the appearance frequency in literature, seven key EBM principles were identified and presented in this article. The steps to address the management gap in the traditional approaches and to implement EBM based on the identified principles were articulated further,

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especially in the Nigerian coastal management perspective. This article also examines the cases of implementation of EBM in the past and predicts the possible direction of EBM in the future if more attention is given to finding a center balance between its many principles and improving stability in its application in future research.

*Keywords: Ecosystem-based management; key principles; ecosystem services; socio-ecological system; coastal management.*

## 1. INTRODUCTION

The marine and estuarine ecosystems provide great intrinsic values globally [1]. There is no doubt about the pressure human activities have inflicted on several world ecosystems [2]. With the exploding population concentration in coastal areas, the ecosystems experience more significant depletion than ever [3]. The overexploitation and mismanagement of ecosystem services threaten the resilience and sustainability of the marine and estuarine ecosystems [4]. The existing traditional management approaches are widely insufficient as they focus on a single sector, despite multiple sectors in the socio-ecological system, and have failed catastrophically in managing the ecosystem services [3].

Many conservation-oriented approaches to managing marine ecosystem dynamics have evolved recently and have been adopted over the past century [5]. Despite these numerous approaches, there is still an ongoing problem in addressing the human impacts on the marine ecosystem dynamics [6]. As pressures on the marine ecosystem increase, the ecosystem's health is compromised [7]. Hence, there is a need to adopt more innovative approaches to managing and conserving the marine and estuarine ecosystems; one of these approaches is the Ecosystem-Based Management approach.

EBM is holistic and addresses the current and future challenges facing marine ecosystems using a broad management approach that emphasizes cumulative impacts on ecosystem services rather than in isolation [8]. EBM works across all sectors to manage species and ecosystem functions, economic activities, conflicting uses, pressures, stressors, and ecosystem dynamics sustainability [9]. It has gained international popularity recently because of the increasing emphasis on ecosystem connections. The EBM approach promotes ecological resilience and appropriate productive activities by advocating proper exploitation of the

ecosystem dynamics [5]. As a paradigm, the EBM approach is interdisciplinary as it addresses uncertainty and complexity [10]. EBM considers that the broader ecological system is the container of human societal systems, and all human activities depend primarily on the ecological system [8].

The effectiveness of EBM has led to multi-sectoral variations in its principles and implementations. Some of these variations include the Ecosystem Approach to Fisheries, Ecosystem Approach to Forestry, and more [3]. Each version of EBM comes with distinct underlying principles and implementation frameworks. These underlying principles are designed based on the parameters and indicators addressed in a particular problem situation [11]. However, the most dominant and widely accepted approach of EBM is in the natural resource conservation field.

## 2. THE DEFINITION OF EBM

There is no agreed definition of EBM. However, it has been defined by many researchers and organizations in many different ways based on disciplines and sectors [3]. For example, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) defines EBM as an approach that considers all the delicate and complex relationships between organisms of all sizes and physical processes that constitute the Antarctic marine ecosystem. Also, the United Nations Convention on Biological Diversity (CBD) defines EBM as the strategy for integrated management that promotes the conservation and sustainable use of living, water, and land resources in an equitable way. EBM deals with appropriate spatial and temporal scales, enhancing adaptive management of complex social-ecological systems and ensuring the control of the identified systems in an integrated way [9]. It is a scientific approach to providing critical directions in managing ecosystems [3]. The ecosystem-Based Management approach helps conservation managers understand that ecological

conservation problems can only be solved using natural and scientific methods [12].

EBM uses natural and scientific knowledge to project ecosystem changes and decision-making processes. It defines the limits of the ecosystem under study, its functions, and relationships within and outside the ecosystem [13]. EBM provides managers with in-depth knowledge about the societal structures, customs, attitudes, values, and laws that motivate human activities and alterations in and around the estuarine ecosystem area [13]. This assists managers in structuring management frameworks to achieve a well-articulated conservation system founded on the best available socio-ecological system knowledge [11]. It also allows planners and decision-makers to evaluate trade-offs and make informed decisions [3].

### 3. WHY EBM?

Through sustainability of critical ecosystem dynamics, EBM ensures that the various functions of ecosystems that support the human societal systems are delivered long-term [12]. Since all human societal systems are contained in the ecological system, the quality of human life depends on ecosystem services [3]. EBM also improves on important management approaches

that are in existence instead of trying to reinvent them [14]. Undoubtedly, the marine ecosystem dynamics, its functions, the alterations, the pressures and stressors, and the extent to which they are managed can be well studied and understood by the combination of natural and social sciences in EBM, and this also allows planners and decision-makers to evaluate trade-offs and make informed decisions [15].

Choosing EBM over other uncoordinated sectoral management approaches as the framework comes from its proven effectiveness, efficiency, and cost benefits [15]. Since EBM consists of natural and social science, coordination, and coordination among individuals, different agencies and authorities require time and money [11]. Hence, the cost increases as the communication chains are elongated and the scope of EBM is broadened. However, the cost is saved over the long term due to the coordination and cooperation among management agencies ensured by EBM [13]. Cost is saved when management agencies work sequentially to conduct research, training, monitoring, and surveillance. Hence, one joint team working on tasks instead of having two or more agencies working on overlapping tasks is the best in EBM [13].

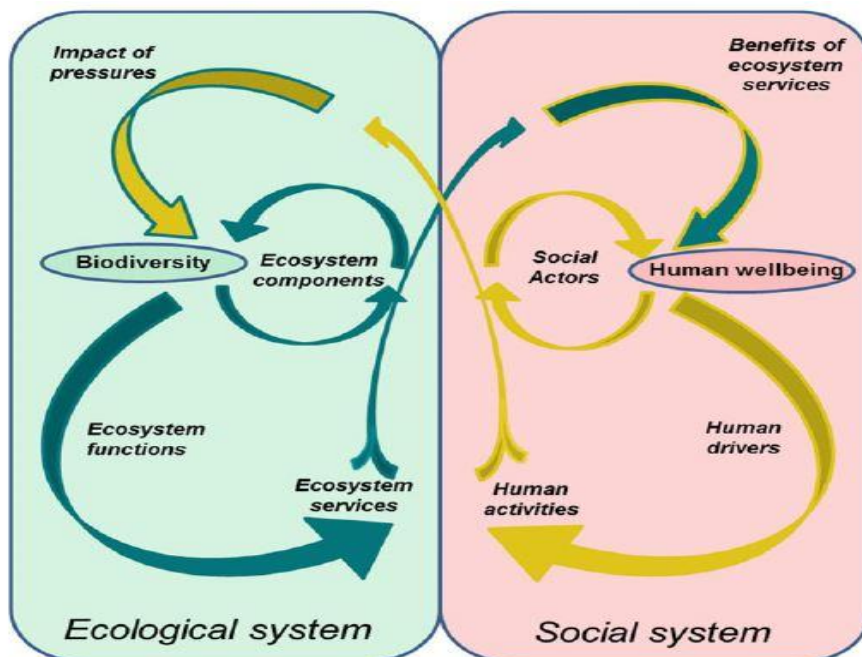


Fig. 1. An illustration of the ecosystem-based management concept and the link between the ecological and social systems (adopted and modified from (Gómez et al. 2016))

## **4. METHODOLOGY**

### **4.1 Secondary Sources of Literature**

An extensive literature search was conducted to assess EBM adoption and application globally and in Nigerian environmental management practices. This search covered academia and government agencies concerned with environmental management in Nigeria. Most of the publication on EBM implementation is specific to fisheries management and species conservation, while little exists in coastal environmental management. The EBM publications were selected based on their recognition of the interconnectivity of environmental management's social, ecological, and governance systems. The publications selected gave attention to the institutional backdrops and human behaviours that underpin ecosystem management. These publications were from reputable journals, and information was also collected from local environmental management plans, project reports, and government policies. These publications and materials were organized for analysis based on their application and the principles followed in their implementations. The appearance of each principle in literature was recorded. The analysis shows over 24 EBM principles across the publications and resources examined, and only 7 principles appeared in the publications. The government agencies and resources consulted include Ondo State Oil-producing Areas Commission (OSOPADEC), Ministry of Housing and Development, Ilaje Area Office, Local Planning Authority, Ilaje, and Niger Delta Development Commission (NDDC). We examined the management history, land use patterns and changes, records of environmental management activities, and more. The retrieved data assisted in establishing the relationship between inclusive management activities, socio-ecological systems, and other institutional backdrops. All other publications and resources consulted are duly cited in this paper.

### **4.2 The Principles of EBM and how they Close the Gaps in Traditional Management Approaches**

EBM is an approach that fits into management activities at numerous scales and contexts, from small-scale to large-scale projects, and from site-

based projects to national policies and programs [8]. Research and management experience from around the world has demonstrated the importance of EBM and has informed the development of numerous core EBM principles. However, these principles are not static as they have been expressed differently in different contexts. The most reoccurring seven principles of EBM in literature across disciplines are.

#### **4.2.1 Principle 1: Adopting an integrated approach to ecosystem management**

EBM considers interactions and relationships between humans and the environment. There is a belief that there is a strong relationship between humans, land, and the sea [5]. The integrated approach of EBM stands in contrast with the sectoral resource management approach that has been in play by government agencies in developing and developed countries in the past [8]—disintegrated responsibilities and jurisdiction between government agencies are the bedrock of inefficient natural resources management [16]. By adopting a comprehensive approach to studying and managing human activities in ecosystems, EBM overcomes the shortcomings of sectoral management. EBM management philosophy integrates management activities across sectoral boundaries and strengthens the synergies between government agencies, partner organizations, and communities [5].

#### **4.2.2 Principle 2: Restoring and balancing connectivity between social and ecological systems**

In human societies and natural ecosystems, connectivity is a fundamental feature. If a part of an ecosystem is disturbed, the other system parts are affected directly or indirectly [17]. Understanding social and cultural connectivity is necessary to carry out EBM successfully. The estuarine ecosystem decision-making process and management are subjected to kinship ties, historical relationships, and cultural obligations [8]. Societal and ecological systems work hand-in-hand in communities where kinship and traditional ties dominate. Studying and understanding the patterns of this connectivity is crucial to the practical design of management networks [5], and the interactions that result from this connection should be incorporated into management decisions.

#### **4.2.3 Principle 3: Maintaining healthy, productive, and resilient ecosystems**

The main focus of the Ecosystem-Based Management approach is to maintain ecosystem dynamics, functions, and key processes to improve capacity and maintain resilience and productivity over time [11]. In 2010, Clarke & Jupiter published a guide for conservation practitioners in the Tropical Western Pacific. In this guide, Clarke & Jupiter explained how EBM was used to maintain healthy, productive, and resilient estuarine ecosystems in Babeldaob Island, Palau. The Babeldaob EBM initiative promoted collaboration and communication between the government, scientists, community leaders, and other stakeholders. In the Babeldaob case study, the rural communities highly depended on natural resources for their livelihoods and well-being, which made them highly vulnerable to ecosystem degradation and natural resource depletion. Thus, a marine reserve was founded on the island to increase the reserve's abundance of species and natural resources. This measure reduced the increase in overexploitation and enhanced ecosystem services growth, thus strengthening the ecosystem's health, productivity, and resilience.

Only a healthy ecosystem can provide a full range of benefits to humans; the dynamic relationships within, among, and between species and their abiotic environment, as well as the physical and chemical interaction within the environment, determine the resilience and functioning of the ecosystem [12]. EBM recognizes the importance of ecosystems in supporting sustainable livelihood and meeting basic human needs. Hence, it is best adapted to achieve long-term protection, restoration, and conservation of the ecosystems and their functions above their short-term economic or social goals.

#### **4.2.4 Principle 4: Incorporate social, cultural, and economic values**

Socio-economic surveys are considered valuable to measure natural resource value and cultural significance adequately. Incorporating social, cultural, and economic values requires understanding the local socio-economic conditions and identifying the impacts of potential management measures [18]. In Kubulau, a city in Fiji, EBM was used in incorporating these values into management actions. The Kubulau Marine Authority was to establish protected marine

areas. This led to a survey and obtaining data about where people fish, how much it costs to travel there, the kind of fish they catch, and the price they sell to estimate the opportunity cost of different protected areas. The result assisted in designing protected area networks that minimized hardship to fishers by closing off areas with optimal fisheries benefits and opening up areas with minimal potential loss. This reduced costs to local communities and maintained access to productive, resilient fishing areas.

Consideration of human use and the values of ecosystems is essential in management planning and implementation. An approach to EBM that recognizes the economic, social, and cultural importance of continuous use of resources is necessary because of the area's high level of resource dependence while ensuring that these resources are available in the long term. To some extent, the use and management of resources depend on the economic costs and benefits [9]. To get the local community support for management measures, there is a need to identify and communicate the costs and benefits of conservation and implement mechanisms that ensure the benefits flow to the local communities.

#### **4.2.5 Principle 5: Including stakeholders through participatory governance**

Participatory management is essential in EBM. Involving and engaging stakeholders in the planning process helps find standard solutions to problems [19]. Managing human activities in ecosystems is a more significant problem with different dimensions, variations, and implications [17]. In the guide published by Clarke & Jupiter in [8], it was explained that the regular meeting of a core group of EBM stakeholders in Palau helped improve interactions between NGOs and various government agencies. Also, in Macuata Island, Fiji, bringing stakeholders together helped identify conflicts and synergies between their respective roles and activities. Furthermore, the coastal and inland villagers' participation in the decision-making process raised awareness of the water quality impacts of logging and burning in the coastal catchment.

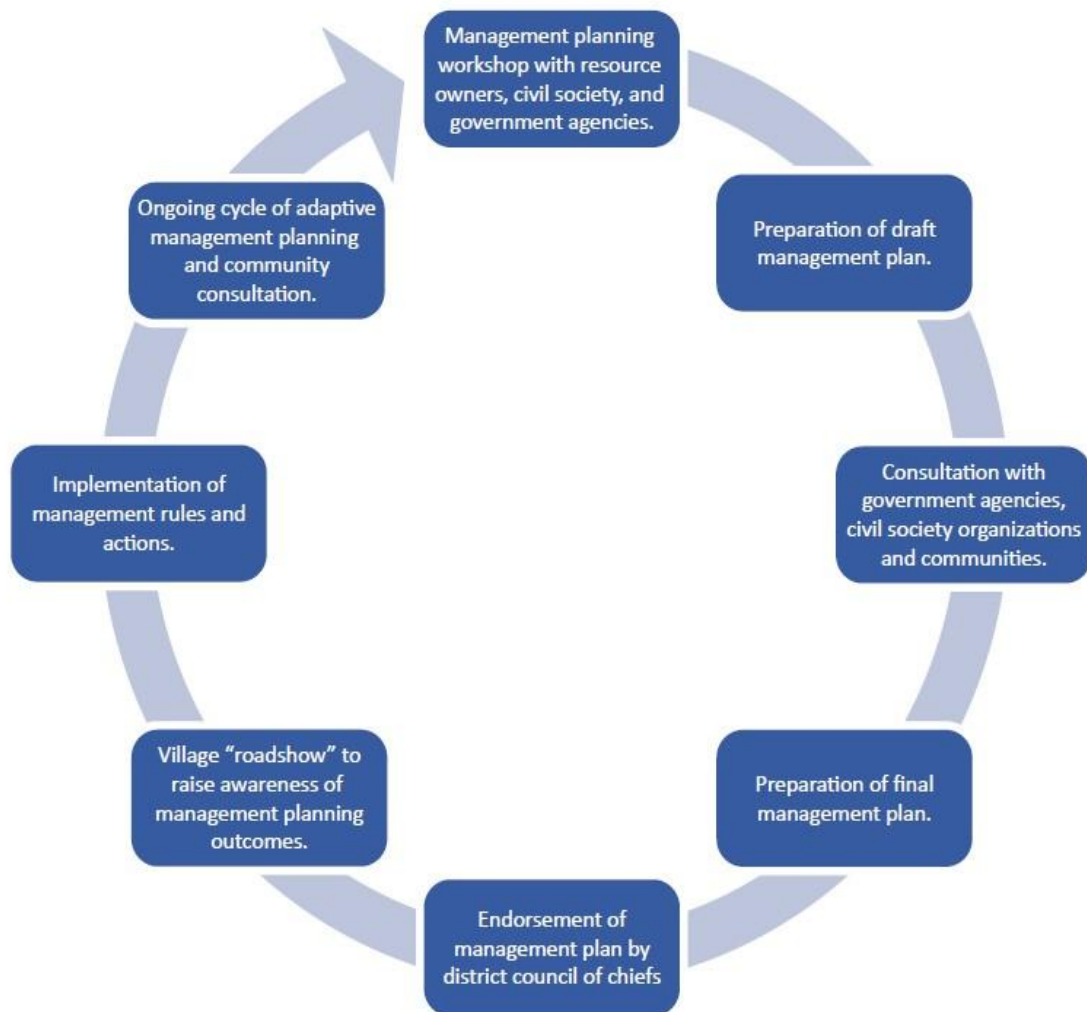
The involvement of the full range of expertise, local communities, and stakeholders to facilitate sharing of management responsibilities will go a long way in improving ecosystem health. For an effective management system, responsibility should be shared between external parties and

decision-makers [18]. This provides a platform for inclusive planning and decision-making, enhancing efficiency, transparency, and accountability [18]. Participatory governance also helps identify strengths and conflicts between their respective roles and activities [9]. To ensure long-term prospects, the planning process should identify, respect, and reinforce the roles of traditional leaders and provide avenues for intensive community engagement with the residents [10].

**4.2.6 Principle 6: Identifying uncertainty and planning for adaptive management**

In EBM, continuous learning and monitoring over time help recognize uncertainty and adaptive

management measures [20]. The level of uncertainty involved in ecosystem processes and dynamics functions is complex and variable, increasing with the level of human activities [18]. A consistent learning process that helps adapt methodologies and management practices to manage ecosystems is necessary [20]. As new scientific and socio-economic knowledge becomes more available and solid, the effectiveness of management measures is improved over time [11]. This necessitates a need for flexible decision-making structures for an adaptive management approach to work efficiently and to give space for timely management responses to information about the ecosystem, its health, alterations, and exploitations.



**Fig. 2. Continous learning, monitoring, and planning for adaptive management cycle (adapted from Principles and Practice of Ecosystem-Based Management (Clark & Jupiter)) [8]**

#### **4.2.7 Principle 7: Leveraging all relevant forms of traditional, local, natural and scientific knowledge**

Generally, the planning and decision-making process requires all forms of relevant information, including scientific and local knowledge, as does EBM. The ecosystem and the societal system are complex, and it is a daunting task to effectively understand the alterations from human impacts and design management responses [19]. Hence, the need for all-inclusive knowledge and relevant information. For the development of effective management strategies, information is needed from all spheres of life. Local and scientific knowledge about ecosystem dynamics and functions should be fused. This knowledge will generate new information and ideas about the ecosystem and test the effectiveness of each management measure through the use of scientific principles and research methods.

#### **4.3 Cross-Sector Environmental Management in Nigeria**

The Nigerian ecosystem faces much pressure from anthropogenic forces. The present policy structure fails to give utmost concern to inclusive environmental management and fails to recognize the interconnectivity of the socio-ecological systems [21]. The nation's challenge has been further exacerbated by the extraction of natural resources in the Niger Delta region. As the country with the largest crude oil production capacity in Africa, it is now dealing with the issue of oil spills in the many communities in the Niger Delta [22]. This problem has resulted in social dissatisfaction among the local populations, which have been denied their means of subsistence and well-being. The ecosystem functions that support their livelihood, which spans the deltas and consists of fishing and agricultural operations, are fast becoming unhealthy, and their integrity is compromised [22].

Stressors and pressures on the ecosystem in Nigeria are never-ending. The recent unrest in the coastal communities has necessitated a paradigm shift in ecosystem management if food and water security is to be achieved in the long term. One of the recent interventions is the Ogoni land Clean-up project, a collaboration between the Federal Government of Nigeria and the United Nations Environment Program (UNEP) to protect the Ogoni coastal ecosystems from oil

spills. This collaborative management effort has already produced significant successful outcomes in protecting and restoring ecosystem integrity [23]. It established the missing link between social, ecological, and environmental and used stakeholder participation as the key strategy to make and implement decisions.

The success track of this project suggests that effective ecosystem management is possible in Nigeria if thorough multi-sectoral and holistic management measures are adopted. It proves that leveraging all relevant forms of traditional, local, scientific, and natural knowledge in structuring management policies is vital to the success of management plans. Since the EBM approach considers the connectivity and relationships in all the environmental systems, it is essential to incorporate it in ecosystem decision-making in developing countries like Nigeria, where tribal, cultural, institutional, and belief differences exist.

#### **4.4 Steps in Implementing EBM Principles**

With the EBM principles being in different contexts, their implementation must be designed to suit each specific need and the region where they are being implemented. In this article, the following implementation steps of EBM are considered crucial in Nigerian coastal management decision-making.

##### **4.4.1 Identifying and involving the stakeholders**

Managing the estuarine dynamics requires addressing the full range of activities causing alterations to the ecosystem [24]. Effective EBM requires that all stakeholders be recognized at total capacity and be informed of every strategic decision in planning and management [17]. Identifying the stakeholders requires understanding the nature and extent of the problem and the management process. Stakeholders are the individuals, groups, or organizations concerned whose rights and interests may be affected during the process; influence, authority, or power is relevant to the management process; or expertise and resources are relevant to the management exercise. Coastal management activities in Nigeria should build partnerships. This partnership could be possible by distributing and integrating management activities across all sectors. Stakeholders become partners directly engaged in management activities, and their



roles and responsibilities are clearly defined; and bring about proper coordination, improved efficiency, and shared solutions to ecological problems [11].

#### **4.4.2 Identifying ecosystem values**

Understanding species, habitats, and ecosystem processes in management is essential. Every ecosystem has its own (natural, economic, social, and cultural) values. Biological and local ecological knowledge helps identify the values and the threats associated with each value [16]. The knowledge will help to develop targeted conservation measures. Stakeholders and partners should develop a shared understanding of ecosystem dynamics' natural values. These values are represented on a map to assist stakeholders in visualizing the ecosystem's natural values and facilitating subsequent spatial planning and management [13].

Considering these economic, social, and cultural values during the management process is crucial in Nigeria, with over 200 tribes and enormous socio-cultural differences. These three values are centered around human activities. Hence, understanding humans' place in the ecosystem will help us understand the drivers of alterations in the ecosystem dynamics and constraints on management responses [19] in Nigerian coastal areas.

#### **4.4.3 Understanding management context**

Having a clear understanding of decision-making processes can significantly enhance the effectiveness of EBM. Management context should be understood and defined. Stakeholders, partners, and managers must identify opportunities to relate their decision-making process to the region's existing laws, policies, programs, and institutions [8]. It is ideal for investigating the rules and policies dealing with species protection and protected areas [5], pollution control, environmental impact assessment, mining, and more within the region. When the stakeholders understand that resource tenure is fundamental for conservation and resource management initiatives, they will work towards gaining a clear understanding of the tenure system's legal status—and this will help to resolve the conflicts over the management of coastal areas of interest.

Community mapping could identify overlapping tenure systems and management areas to solve

the management problem further. Any potential conflicts occurring in the areas will be identified, and adaptive management measures could be designed to cater for the conflicts. This step could be used to understand the management context more clearly by using maps to describe key stakeholders with particular interests in specific management areas and to analyze decision-making processes related to ecosystem services management. Maps can also be used to represent historical and present ecosystem service uses and as a basis for incorporating estuarine management into land-use planning. Techniques for traditional management should also be described and assessed. Government agencies' rights, roles, responsibilities, traditional rulers, and local communities should also be studied and understood. This will help identify strategic issues and priorities, guide subsequent development, and strengthen collaborative relationships between key decision-makers [10].

#### **4.4.4 Identifying key management institutions**

Many relevant existing institutions must be involved in the management process, and new institutions should be established where necessary [3]. Existing institutions are the entities that have a full range or partial authority to influence the use and management of the ecosystem dynamics, and they may include federal, state, or local government, traditional leaders, resource owners, and non-government organizations [5]. Before establishing a new institution, it is essential to carefully consider if it is needed, to what extent it will be helpful to the management process, and whether any existing institutions could perform their functions. Existing institutions should also be strengthened internally by providing scientific and technical advice, training, liaising with stakeholders and partners to secure funding and support, and other capacity-building measures [9].

#### **4.4.5 Identifying goals, targets, and threats**

Identifying the goals and targets in the management planning process is vital. The goals and targets should reflect the interwoven and complicated nature of the estuarine ecosystem and its multiple values. This will be the basis for identifying threats, pressures, and stressors and help classify management actions [18]. Identifying goals and targets should involve stakeholders, resource owners, management agencies, and experts with prior scientific and traditional knowledge to ensure collaborative



planning [17]. A well-laid-out target births a well-structured management action. Therefore, the management goals and targets should be specific, measurable, feasible, and time-bound. They should reflect the local capacity while capturing the key values of the ecosystem, its functions, the threats, maintaining health, and improving resilience. These goals and targets should be monitored strictly to measure the progress of the management process over time [20].

#### **4.4.6 Establishment of management strategies**

Sophisticated management approaches and strategies are essential in EBM. Procedures should be established and closely linked to the goals and targets [13]. These strategies should be the one that leads every goal and target to completion. Management strategies should be detailed, and the information level must reflect the management capacity of the relevant management institutions that will oversee the process. Each plan must be developed to reflect the full range of the ecosystem values, alterations, functions, and actions relevant to the management of the ecosystem [8]. Management strategies will identify the sources of alterations and set rules to tackle them. This is a way of responding to the modifications by seeking to regulate human activities that negatively affect the integrity of the ecosystem and the delivery of its functions [25]. These strategies must be community-centric; a strong link must exist between the strategy, goals, target, and community under study to encourage local monitoring and reporting.

#### **4.4.7 Implementation of management actions**

Implementing management actions demands careful attention. There needs to be a timeframe for each action, and the managers should know their responsibility to avoid overlapping responsibilities or interests and time wastage [13]. Periodical monitoring and review mechanisms should be put in place upon implementation. There should be moves to ensure compliance, awareness-raising, surveillance, and enforcement of management rules to achieve desired results. Ecosystems management plans and activities sometimes demand many resources; hence consideration should be given to appropriate sustainable and cost-effective financing models [16]. Before implementing management plans, there should

be a shared understanding of responsibilities between stakeholders, partners, government agencies, and managers. Each party needs to understand its role in the management process clearly. This might be formalized through Memoranda of Understanding (MoU) or binding management agreements.

#### **4.4.8 Formulation of education and communication programs**

Education and communication play a vital role in EBM. Ecosystem-Based Management approaches prioritize well-planned education and communication programs to raise awareness about ecosystem dynamics, functions, values, alterations, pressures, and stressors and encourage behavioral or policy change to ensure management, capacity building, and improved resilience [8]. Traditional and innovative means of education and communication are both essential and should be used in passing information and enriching the stakeholders' knowledge about management issues [10]. Innovative communication means include DVDs, news article articles, conceptual diagrams, radio or tele-messaging, using local and regional celebrities to attract interest, documentaries, incorporating environmental themes into popular radio and television programs, integrating conservation principles into the school curriculum, hosting public events, and more [11]. To ensure effective communication, the concerned agencies and institutions should allocate adequate time and money to education and communication activities in project proposals and work plans.

#### **4.4.9 Setting priorities for monitoring and research**

In any plan implementation process, it is necessary to put monitoring measures in place. To measure the effectiveness of management plans, key indicators are to be monitored continuously to improve the effectiveness of management approaches over time, within and beyond the management area [18]. The monitoring program should be directly linked to the management goals and targets, assess the predetermined goals and targets, evaluate the deviations from the initial plans and targets, and take necessary actions to bridge the gap [17]. A series of indicators should be set to measure the ecosystem function delivery, health, and management effectiveness. The monitoring plans must span the whole management cycle and be

integrated into adaptive management [13]. The procedures should also be designed so that their scope fits perfectly and does not exceed the management context to ensure consistency in the monitoring process within the available resources and capacity [20].

## 5. CONCLUSION AND RECOMMENDATIONS

Ecosystem-Based Management (EBM) has been relevant in coastal conservation and marine resource management. However, there is still a lack of consensus on what defines EBM and its fundamental principles. This limitation has been a great hindrance to its adoption and implementation process and has also brought about some contemplations on its application and effectiveness in marine conservation. This article attempts to contribute to the relevance of EBM and bridge the gap of variations in the principles by systematically selecting major EBM publications that explicitly use EBM and streamlining all these principles to develop a clear and distinct list of principles and steps in resource management to assist in incorporating EBM into the socio-ecological systems management and decision-making process. This article recommends nine key implementation steps of EBM based on the identified principles and their relativity to the Nigerian coastal ecosystem management.

This article shows that EBM is an evolving approach and will continue to gain more stability and relevance in marine ecosystem management as long as there are attempts to streamline its implementation principles. Finally, A comprehensive review and analysis of the implementation of EBM in the past will stabilize its application in research and solidify its definition and representation in this present time. The principles that are listed in this article are reflections of EBM efficiency and have contributed to achieving an up-to-date definition of EBM.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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