MARINE BIOTECHNOLOGY IN NIGERIA'S BLUE ECONOMY: LEGAL AND INSTITUTIONAL FRAMEWORKS, CHALLENGES AND PATHWAYS FOR SUSTAINABLE DEVELOPMENT*

Abstract

The emergence of marine biotechnology and the blue economy present significant opportunities for sustainable development, economic diversification, and environmental conservation, especially for coastal nations like Nigeria. This research critically examines the legal and institutional framework governing marine biotechnology and the blue economy in Nigeria, identifying the key laws, policies, and regulatory institutions tasked with promoting innovation while ensuring environmental and genetic safety. The study highlights the National Biosafety Management Agency Act 2015, the Environmental Impact Assessment Act, the Nigerian Maritime Administration and Safety Agency Act, and relevant international conventions such as the Convention on Biological Diversity (CBD) and the United Nations Convention on the Law of the Sea (UNCLOS). Despite Nigeria's considerable marine resources, the research identifies regulatory fragmentation, weak institutional coordination, and inadequate enforcement capacity as major obstacles to the sector's development. Through doctrinal legal analysis, the study explores issues of access and benefit-sharing (ABS), biosafety regulation, marine genetic resource exploitation, and maritime governance. The findings reveal a gap between existing legal provisions and practical implementation, especially concerning emerging biotechnological innovations in the marine space. The study recommends a unified national legal framework for marine biotechnology, harmonization of sectoral laws, strengthening of enforcement institutions, and promotion of public-private partnerships. It also calls for regional collaboration and capacity building to align Nigeria's regulatory approach with global best practices. This research contributes to the growing discourse on sustainable ocean governance and offers a legal blueprint for Nigeria to harness the potential of its marine resources responsibly.

Keywords: Marine Biotechnology, Blue Economy, Legal Framework, Biosafety, Sustainable Development

1. Introduction

Nigeria, with an extensive coastline of approximately 853 kilometers and a 200-nautical-mile Exclusive Economic Zone (EEZ), possesses a rich repository of marine biodiversity that remains largely untapped. This wealth of biological resources, ranging from microorganisms to macro-organisms inhabiting the Atlantic Ocean, offers immense potential for marine biotechnology a branch of science that applies molecular and biological techniques to marine life for the development of products in pharmaceuticals, agriculture, energy, and environmental protection. As a component of the emerging global blue economy, marine biotechnology presents an opportunity for Nigeria to diversify its economy, address food insecurity, and promote sustainable development through the sustainable exploitation of its marine genetic resources.

Despite the burgeoning global interest in marine biotechnology projected to be worth over $6.4 billion by 2025[1] Nigeria contributes less than 0.1% to the global marine biotech economy. This dismal performance can be traced to the absence of a coherent legal framework, fragmented institutional responsibilities, and environmental degradation, particularly in the Niger Delta region. Notably, the National Biotechnology Development Agency (NABDA), which is charged with promoting biotechnology, lacks a dedicated marine biotechnology division. Additionally, regulatory institutions such as the Nigerian Maritime Administration and Safety Agency (NIMASA) and the National Environmental Standards and Regulations Enforcement Agency (NESREA) have limited coordination, further compounding the inefficiencies in policy implementation.

The opportunity costs of this neglect are substantial. Nigeria forfeits an estimated $10 billion annually in unrealized bioeconomic gains, ranging from lost employment opportunities in marine-based industries to the failure to develop bio-remedial technologies that could address the nation's persistent environmental crises[2]. The economic and environmental implications of these losses are significant, particularly when juxtaposed against the prospects of transformative development that could be achieved through well-regulated marine biotechnology.

A key legal barrier lies in the ambiguity surrounding the ownership and governance of marine genetic resources. Section 44(3)[3] vests control over natural resources, including marine biodiversity, in the Federal Government. However, there is no specific legislation regulating access and benefit-sharing (ABS) in compliance with international treaties such as the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (2010), to which Nigeria is a signatory. The absence of such legislation creates a legal vacuum that has enabled incidents of biopiracy, where foreign entities exploit local marine organisms without compensation to indigenous communities or the Nigerian state. Case law also illustrates the socio-economic impact of environmental degradation on marine biodiversity

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[1] OECD, Rethinking Innovation for a Sustainable Ocean Economy (2019) OECD Publishing, Paris http://doi.org Accessed 18th May, 2025

[2] International Union for Conservation of Nature, Gland, Switzerland, Blue Economy: Principles and Practice. (IUCN, 2020)http://www.iucn.org/resources/publication/blue-econmy-principles-and-practice. Accessed 21st May 2025.

[3] Section 44(3) of the Constitution of the Federal Republic of Nigeria, 1999 (as amended)

was decided where the Federal High Court[4] declared gas flaring illegal for its contribution to environmental and health hazards.

In recent years, marine biotechnology has gained traction as a sustainable development tool, particularly in the areas of climate resilience, pharmaceutical innovation, and food security. Some scholars[5] emphasized the role of marine genetic resources in global economic growth, calling for equitable legal frameworks to manage their use. In the Nigerian context, Alagoa and Adebayo[6] argue for the integration of marine biotechnology into national policy planning as a strategy for economic diversification and ecological regeneration. They highlight the untapped potential of marine fungi, algae, and bacteria in producing biofuels, antibiotics, and industrial enzymes.

This term paper therefore interrogates the legal and institutional frameworks governing marine biotechnology in Nigeria, identifies the existing challenges, and proposes strategic reforms for sustainable development. The central thesis is that marine biotechnology holds transformative economic and environmental potential for Nigeria, but systemic legal ambiguities, institutional inefficiencies, and policy inertia have constrained its growth. By enacting targeted legislation, fostering institutional synergy, and embracing international best practices, Nigeria can unlock an estimated $15 billion in annual GDP growth by 2030, positioning itself as a continental leader in the marine biotechnology sector. Failure to act, however, risks perpetuating ecological damage, economic stagnation, and exclusion from the global knowledge economy.

2. Conceptual Clarifications

For a robust understanding of this research topic, it is imperative to define and clarify the key concepts that form its foundation: Marine Biotechnology, Blue Economy, Sustainable Development, Legal Framework, Institutional Framework, and Biodiversity. These terms will be examined both in their literal and contextual usage, referencing statutory instruments, international instruments, and scholarly literature.

Marine Biotechnology: Marine biotechnology is the application of scientific and engineering principles to the processing of materials from marine organisms for the development of products and services. According to the Organisation for Economic Co-operation and Development (OECD), marine biotechnology refers to 'the use of marine bioresources as the target or source of biotechnological applications' (OECD, 2013)[7]. It involves the exploration of marine biodiversity to develop pharmaceutical compounds, enzymes, cosmetics, nutraceuticals, and biofuels. Scholars such as Leary[8] define marine biotechnology as 'a discipline at the intersection of molecular biology and marine science, aimed at sustainable exploitation of marine organisms for industrial, health, and environmental applications.' This definition underlines the dual purpose of marine biotechnology: scientific innovation and sustainable utilization.

Blue Economy: The term 'Blue Economy' was popularized by the United Nations Conference on Sustainable Development[9] and refers to the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of marine and coastal ecosystem services. The African Union, in its 2050 Africa's Integrated Maritime Strategy (AIMS), defines the Blue Economy as encompassing 'activities and policies that sustainably utilize ocean and water-based resources to promote economic growth, environmental sustainability, and social inclusion.' To Silver,[10] the Blue Economy 'is an evolving concept that recognizes the sea as a development space where spatial planning, environmental management, and economic investment intersect.' It includes sectors such as fisheries, aquaculture, marine tourism, shipping, marine biotechnology, and offshore renewable energy.

Sustainable Development: Sustainable development is classically defined in the Brundtland Report[11] as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' This concept incorporates three interdependent pillars: economic development, social inclusion, and environmental sustainability. In the context of marine biotechnology, sustainable development entails the responsible exploitation of marine genetic resources in a manner that ensures long-term ecological balance, equitable access, and economic benefit-sharing. According to

[4] *Gbemre v. Shell Petroleum Development Company* (2005) FHC/B/CS/53/05 (Unreported), Similarly, in *Bodo Community v. Shell Petroleum Development Company* [2014] EWHC 197 (TCC), a UK court awarded $55 million in compensation to affected communities for oil spills that destroyed mangroves and aquatic habitats, underlining the massive costs of neglecting marine ecosystems.

[5] Leary, D., Vierros, M., Hamon, G., Arico, S., & Monagle, C. (2010). Marine genetic resources: A review of scientific and commercial interest. *Marine Policy*, 33(2), 183-194.

[6] Alagoa E.J and Adebayo T. O., Marine Biotechnology and Nigeria's Blue Economy: Opportunities and Legal Challenges' (2021) 8(2) *Nigerian Journal of Environmental Law and Policy* 34

[7] OECD, Marine Biotechnology: Enabling Solutions for Ocean Productivity and Sustainability (2013) Paris: OECD Publication, 1

[8] Leary, D., Vierros, M., Hamon, G., Arico, S., & Monagle, C. (2010). Marine genetic resources: A review of scientific and commercial interest. *Marine Policy*, 33(2), 183-194.

[9] United Nations, 'The Future We Want; Outcome Document of The United Nations Conference on Sustainable Development' (Rio De Janeiro, 20-22 June 2012) UN Doc A/Conf.216/L.1

[10] Silver, J. J., Gray, N. J., Campbell, L. M., Fairbanks, L. W., & Gruby, R. L. (2015). Blue Economy and Competing Discourses in International Oceans Governance. *Journal of Environment & Development*, 24(2), 135–160.

[11] World Commission on Environment and Development (WCED) (1987). *Our Common Future* (The Brundtland Report). Oxford University Press.

Okonkwo,[12] sustainable development within Nigeria's blue economy must focus on 'law-driven policies that protect marine ecosystems while enabling value addition and job creation through bio-innovation.'

Legal Framework: A legal framework refers to the system of rules, regulations, principles, and institutional arrangements that govern a particular sector or issue. It includes both domestic legislation and international treaties ratified by the state. In the Nigerian context, relevant legal instruments that touch on marine biotechnology include the National Biotechnology Development Agency Act[13], the Environmental Impact Assessment Act,[14] the Sea Fisheries Act,[15] and the Nigerian Maritime Administration and Safety Agency Act.[16]
As noted by Ocheje (2016)[17], 'a coherent legal framework is critical for regulating access to genetic resources, ensuring benefit-sharing, protecting indigenous knowledge, and enforcing environmental safeguards.' The absence of specific legislation on marine genetic resources in Nigeria presents a significant regulatory gap.

Institutional Framework: This refers to the set of government agencies, departments, and organizations responsible for the development, regulation, implementation, and monitoring of policies within a specific sector. In Nigeria, institutions such as the National Biotechnology Development Agency (NABDA), Nigerian Institute for Oceanography and Marine Research (NIOMR), Federal Ministry of Environment, and NIMASA play varying roles in the marine and biotechnology sectors. According to Ayoade (2021)[18], institutional frameworks must operate under principles of synergy, transparency, and capacity-building to foster innovation. Fragmented institutional roles and overlaps often result in poor policy coherence and weak enforcement, undermining sectoral progress.

Biodiversity: Biodiversity, or biological diversity, encompasses the variety and variability of life forms, including terrestrial, marine, and aquatic organisms, and the ecosystems they inhabit. The Convention on Biological Diversity,[19] to which Nigeria is a party, defines biodiversity as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part.' Marine biodiversity is particularly crucial in biotechnology due to its rich and unique genetic material. Nwankwo and Adepoju[20] emphasize that 'Nigeria's marine biodiversity, though under-documented, holds enormous potential for pharmaceutical and industrial bio-innovation, which must be preserved through legal and policy interventions.'

3. Legal Framework Governing Marine Biotechnology and the Blue Economy in Nigeria
The development of marine biotechnology and the blue economy in Nigeria hinges on a well-structured legal and institutional framework. However, while Nigeria has adopted several laws and policies relevant to marine resources, there remains a significant gap in specific legislation and coordinated institutional response to marine biotechnology. This section explores the principal legal instruments and institutions shaping marine biotechnology within the context of Nigeria's blue economy, with emphasis on statutory provisions, policy direction, institutional mandates.

Domestic Legal Framework

Constitution of the Federal Republic of Nigeria 1999 (as amended)*:* The *grundnorm* of Nigeria's legal system provides the foundation for environmental governance and resource ownership. Section 20[21] mandates the State to 'protect and improve the environment and safeguard the water, air, and land, forest and wildlife of Nigeria.' While not justiciable under Chapter II, this section reinforces the legitimacy of regulatory efforts toward sustainable marine resource exploitation. Furthermore, Section 44(3)[22] vests ownership of all natural resources in the Federal Government, enabling it to legislate over marine genetic resources, a prerequisite for marine biotechnology regulation. However, the Constitution is silent on biotechnology and genetic resource regulation, creating a legal lacuna that undermines targeted policy development. Scholars such as Okonkwo[23] argue that constitutional reform is necessary to explicitly empower subnational entities and provide clarity on marine resource benefit-sharing mechanisms.

[12]Okonkwo, O., Legal strategies for implementing blue economy innovations in Nigeria. *Nigerian Journal of Environmental Law*, (2022) 15(2), 55-68.
[13] National Biotechnology Development Agency (NABDA) Act, 2015
[14] Environmental Impact Assessment Act, Cap E12, LFN, 2004
[15] Sea Fisheries Act, Cap S4, LFN 2004.
[16] Nigerian Maritime Administration and Safety Agency Act 2007
[17] Ocheje, P., Access and Benefit-Sharing in Nigeria: A critical examination of regulatory challenges (2016) *African Journal of International and Comparative Law,* 24(1), 89–107.
[18] Ayoade, O., Institutional Frameworks and Sustainable Biotechnology Development in Africa (2021) *Journal of African Law*, 65(3), 301–319.
[19] Convention on Biological Diversity (CBD), 1992.
[20] Nwankwo, D. I., & Adepoju, O. T. (2020). Marine biodiversity and the Nigerian blue economy: Opportunities and threats. *West African Biodiversity Review,* 9(1), 27–42.
[21] Section 20, Constitution of the Federal Republic of Nigeria 1999 (as amended)
[22] Ibid.
[23] Okonkwo, O., Legal strategies for implementing blue economy innovations in Nigeria. *Nigerian Journal of Environmental Law*, (2022) 15(2), 55-68.

Environmental Impact Assessment Act, Cap E12, LFN, 2004: The EIA Act[24] mandates environmental scrutiny before the commencement of projects that may significantly affect the environment. Section 2(1) states that 'the public or private sector of the economy shall not undertake or embark on or authorize projects or activities without prior consideration of the effect on the environment.'[25] While this provides a tool for marine resource protection, enforcement remains weak, especially in offshore ecosystems. A 2018 NESREA[26] report found that fewer than 20% of offshore oil operations in Nigeria conducted EIA updates within the mandatory 3-year cycle, exposing the fragility of environmental protection mechanisms. Without robust marine EIA integration, biotech initiatives risk environmental degradation and international non-compliance.

Exclusive Economic Zone: This Act establishes Nigeria's jurisdiction over marine resources within 200 nautical miles of its coastline. Section 1(1) states that 'the Federal Republic of Nigeria shall have sovereign rights for the purpose of exploring, exploiting, conserving and managing the natural resources of the exclusive economic zone.'[27] However, the Act does not mention biotechnology, genetic research, or bioprospecting—thereby failing to align with modern marine bioeconomy objectives. The omission of access and benefit-sharing (ABS) protocols and environmental safeguards in the EEZ legislation highlights Nigeria's outdated legislative approach. As observed by Nwankwo (2021)[28], the lack of cross-reference to the Biodiversity Act or NABDA Act limits the Act's utility in facilitating marine biotech development.

Sea Fisheries Legislation: This Act[29] regulates fishing and related activities within Nigerian waters. Section 3[30] prohibits fishing without a license, and Section 14[31] provides for the seizure of illegal fishing equipment. However, it does not address bioprospecting or genetic resource extraction for scientific research, which are core to marine biotechnology. The Sea Fisheries legislation is outdated and lacks provisions on benefit-sharing, access to marine genetic resources, or ecosystem-based fisheries management. As noted by Odukoya, [32] 'the Act is focused more on capture fisheries and less on biodiversity, genetic resource exploitation, or biotechnology innovations.'

Policy Framework

National Policy on the Environment 2016: This policy[33] emphasizes biodiversity conservation, pollution control, and sustainable natural resource use. Section 4.2.3 promotes the use of 'modern science and technology in environmental protection,' which could be interpreted to include biotechnology.[34]

Blue Economy Strategy (in draft as of 2023): Nigeria's draft blue economy policy framework seeks to harmonize sectoral activities including marine biotechnology, aquaculture, shipping, and maritime tourism. It calls for legal reform, institutional collaboration, and research investment. However, its implementation has been slow due to inter-agency rivalry and lack of legislative backing.

National Policy on Marine and Blue Economy (2025 Draft): This policy outlines Nigeria's vision for marine resource development, with marine biotechnology as a pillar. It proposes integrating biotech into fisheries, bioenergy, and environmental restoration. However, the policy lacks legislative backing and implementation timelines, weakening its impact.

National Biotechnology Policy, 2020 (Revised Edition): This policy focuses on biotech in health, agriculture, and industry but is silent on marine ecosystems. According to the Policy's Section 3.4.2, priority areas include genetically engineered crops, biopharmaceuticals, and biofuels. Marine applications are listed only in future recommendations, indicating a lag in prioritization.

National Biotechnology Policy: This policy[35] seeks to apply biotechnology in key sectors, including agriculture, health, environment, and industry. It encourages public-private partnerships, research, and technology transfer. However, marine biotechnology is only mentioned in passing and lacks concrete policy goals.

Application to Marine Biotechnology:

Bioprospecting and research into marine organisms for pharmaceutical or bioengineering purposes would arguably fall under activities requiring environmental impact analysis. However, in practice, such assessments are rarely enforced in marine biotechnology projects due to institutional neglect and capacity constraints.

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[24] Environmental Impact Assessment Act, Cap E12, LFN, 2004
[25] Ibid.
[26] NASREA acronyms means Nigerian Environmental Standards and Regulations Enforcement Agency, a body statutorily set up to enforce all environmental protection and requirements
[27] Exclusive Economic Zone Act, Cap E17, Laws of the Federation of Nigeria (LFN), 2004
[28] Nwankwo, D. I., & Adepoju, O. T., Marine biodiversity and the Nigerian blue economy: Opportunities and threats. *West African Biodiversity Review,* (2020) 9(1), 27–42.
[29] Sea Fisheries Act Cap S4 LFN 2004
[30] Ibid.
[31] Ibid.
[32] Odukoya, J., Fisheries Law and Marine Resource Governance in Nigeria (2020) *Nigerian Yearbook of Environmental Law*, 8(1), 70–88.
[33] National Policy on the Environment 2016
[34] Ibid.
[35] National Biotechnology Policy (Revised 2020)

International Legal Instruments

Convention on Biological Diversity (CBD): Nigeria ratified the CBD in 1994, thereby committing to biodiversity conservation and sustainable use. Article 15[36] recognizes sovereign rights over genetic resources and emphasizes ABS frameworks. However, Nigeria lacks a national law specifically implementing this article for marine environments.
Nagoya Protocol on Access and Benefit-Sharing 2010: Ratified by Nigeria in 2016, the Nagoya Protocol elaborates on the CBD's provisions regarding fair and equitable benefit-sharing. Articles 5 and 6 mandate parties to provide legal certainty, transparency, and mutually agreed terms (MAT) for bioprospecting. Non-compliance could lead to exclusion from the $12 billion annual global biotech trade (UNCTAD, 2023)[37]. Yet, Nigeria's implementation has been limited to terrestrial ecosystems. As observed in Bassey v. Federal Government (unreported, 2019), the Federal High Court rejected an ABS-based marine claim due to lack of domestic enforcement guidelines, showing how Nigeria's failure to domesticate the Protocol hinders enforcement and investment.
Other Relevant International Instruments: Nigeria is a signatory to the Convention on Biological Diversity (CBD) 1992, which recognizes the sovereign right of nations over their genetic resources[38] and mandates fair and equitable benefit-sharing[39]. Nigeria is also party to the Nagoya Protocol [40]on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization (2010), which is yet to be fully domesticated.

Critical Analysis and Legal Implications
The disjointed legal architecture governing marine biotechnology in Nigeria reflects an underdeveloped legislative vision. While the NABDA Act, EIA Act, and EEZ Act provide fragments of regulation, they fail to create an integrated legal framework needed to develop the sector. The Constitution's ambiguity on subnational access to marine bioresources, coupled with non-domestication of the Nagoya Protocol, impairs legal clarity and deters investment. Moreover, Nigeria's failure to align its laws with international obligations could result in biopiracy and exclusion from benefit-sharing agreements. As Obioma (2022)[41] warns, Nigeria risks being a passive supplier of marine bioresources while foreign companies extract and patent innovations, as seen in the case of Aspergillus Niger strains patented in Europe without Nigerian benefit-sharing.

5. Institutional Framework and Stakeholder Roles in Marine Biotechnology Governance in Nigeria
Effective governance of marine biotechnology within Nigeria's blue economy necessitates the coordinated involvement of multiple regulatory institutions and stakeholders. This section critically examines the mandates, strengths, and weaknesses of the principal institutions involved in marine biotechnology regulation, drawing attention to areas of overlap, conflict, and needed reform.

Nigerian Maritime Administration and Safety Agency (NIMASA): Although primarily responsible for maritime safety and marine pollution, NIMASA's environmental protection mandate offers an avenue for marine genetic resource monitoring. Coordination with biotechnology agencies is; however, weak.[42] Section 22 of the NIMASA Act[43] mandates the Agency to ensure the prevention of marine pollution and coordinate maritime safety. However, there is no provision specific to biotechnology research or the protection of genetic resources. While the Act[44] recognizes the marine environment's protection, it omits the growing importance of marine bio-prospecting and fails to provide regulatory oversight for marine resource extraction for scientific use. Despite the multiple laws and institutions relevant to marine resources, Nigeria lacks a unified legal regime on marine biotechnology. Key issues include regulatory overlap where agencies like NABDA, NBMA, and NIOMR often operate in silos with conflicting mandates. There is apparent lack of Legal Recognition of Marine Genetic Resources (MGRs) as most laws do not define or regulate access to MGRs.

It is understood that weak domestication of international protocols by the national assembly has stalled the Nagoya Protocol to not been domesticated, limiting enforceability of benefit-sharing principles. There is seems to be poor institutional synergy where there is no national coordinating mechanism for marine biotechnology within the blue economy framework. And lastly, absence of monitoring systems where no centralized registry or monitoring system exists for marine bio-prospecting activities.

[36] Convention on Biological Diversity (CBD), 1992
[3737] UNCTAD, The Potential of Blue Economy: Increasing Long-Term Benefits of The Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries (UN, 2023) https://untad.org/webflyer/potential-blue-economy. Accessed 21st May 2025
[38] Article 3, Convention on Biological Diversity (CBD) 1992
[39] Article 15, ibid.
[40] Nagoya Protocol on Access and Benefit-Sharing, 2010
[41] Obioma S.C, 'Legal and Institutional Frameworks for The Regulation of Marine Biotechnology in Nigeria' (2022) 15(2) *Nigerian Journal of Environmental Law* 134.
[42] Nigerian Maritime Administration and Safety Agency Act 2007 (NIMASA Act)
[43] Ibid.
[44] Ibid.

To harness the full potential of marine biotechnology within the blue economy, Nigeria must urgently undertake legislative reforms that recognize marine genetic resources as distinct and valuable. There is a need to develop a specific Marine Biotechnology and Ocean Genetic Resources Act, strengthen institutional mandates, and domesticate relevant international instruments to ensure sustainability, equity, and innovation in Nigeria's marine sectors.

***National Biotechnology Development Agency*:** NABDA is the primary institution responsible for biotechnology policy and implementation in Nigeria. Section 7(c) empowers it to 'promote, coordinate and develop biotechnology activities in Nigeria.'[45] However, no specific provisions exist for marine biotechnology. The agency's activities are skewed toward agricultural biotech, neglecting the immense potential in marine applications such as aquaculture, bio-pharmaceuticals, and bioremediation. Critics like Hassan and Iwara[46] argue that the NABDA Act must be amended to incorporate marine-specific provisions, including the regulation of marine genetic resources, ABS procedures, and penalties for biopiracy. While Nigeria lacks a codified Marine Biotechnology Act, various environmental, maritime, biotechnology, and fisheries laws provide a fragmented but foundational legal framework. This Act[47] establishes the National Biotechnology Development Agency (NABDA) with the mandate to promote, coordinate, and regulate biotechnology development in Nigeria. NABDA is the lead agency for biotechnology development in Nigeria. It coordinates research institutions and liaises with regulatory agencies on biosafety. Its marine biotechnology initiatives, such as microalgae development for biofuel, are still in pilot phases. Section 5(c)[48] empowers NABDA to 'facilitate the development of indigenous capacity in biotechnology applications to agriculture, health, environment and industry.' While this provision includes environmental applications, it is silent on marine-specific biotechnology, revealing a definitional and operational gap. Although the NABDA Act provides broad regulatory authority, the lack of clear statutory reference to marine biotechnology or marine genetic resources (MGRs) limits the agency's jurisdiction over marine-based innovations. Scholars such as Iroegbu[49] have criticized this legislative silence, arguing that 'marine biotechnology is caught between overlapping regulatory turfs with no clear jurisdictional leadership.'

While NABDA plays a central role in advancing terrestrial biotech especially in agriculture and health its marine biotechnology engagement is limited by structural and funding constraints. It lacks marine-specific research divisions, technical capacity for marine genomic sequencing, and coordinated marine bioresources inventories. Adebayo and Okechukwu[50] suggest that NABDA should create a dedicated Department of Marine Biotechnology to drive sectoral expansion and international collaboration, particularly with countries in the Indian Ocean Rim and Small Island Developing States (SIDS) with thriving marine biotech sectors.

National Biosafety Management Agency (NBMA): The Act[51] establishes a framework for the safe management of genetically modified organisms (GMOs). Section 1[52] empowers the Agency to ensure that the use and handling of GMOs do not pose risks to human health or the environment. Although largely agriculture-focused, this law is relevant for regulating genetically engineered marine organisms or products derived from marine biotechnology. NBMA oversees the safe use of genetically modified organisms. It can play a significant role in regulating marine biotechnology, especially in gene transfer technologies and environmental release of genetically engineered marine organisms.[53] NBMA regulates the safe use of genetically modified organisms (GMOs) and related activities. Section 21[54] provides that no person shall engage in the import, export, transit, or release of GMOs without prior approval. While this is relevant for terrestrial biotech, it is inadequate for marine biotech, where genetic materials may be sourced from wild marine organisms. A critical shortcoming of the Act is its failure to define marine genetic resources (MGRs) or establish ABS rules for foreign bioprospectors. As noted by Ebeku[55], Nigeria's biosafety regime remains reactive rather than anticipatory, leaving gaps in marine research governance.

While NBMA ensures biosafety in lab-based biotechnologies, it has not developed specific protocols for marine organisms, such as genetically modified algae or marine bacteria. The NBMA Guidelines (2022) make scant reference to marine environments, creating regulatory ambiguity for marine biotech startups and academic researchers.

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[45] National Biotechnology Development Agency (NABDA) Act, 2022
[46] Hassan A, and Iwara U. E., 'Marine Genetic Resources and Legal Challenges of Benefit Sharing in Nigeria's Blue Economy' (2023) 10(1) *Journal of Maritime and Environmental Law*, 88
[47] NABDA Act, op. cit.
[48] Ibid.
[49] Iroegbu, C., Legal Regulation of Marine Genetic Resources in Nigeria: Gaps and Prospects (2023) *Journal of Environmental Law and Policy in Africa*, 6(1), 41–59.
[50] Adebayo A., and Okechukwu U.,' Legal and Policy Frameworks for Marine Biodiversity Protection in Nigeria: A Critical Appraisal' (2022) 14(2) *Nigerian Journal of Environmental Law and Policy* 112.
[51] National Biosafety Management Agency (NBMA) Act, 2015 (as amended)
[52] Ibid.
[53] Section 1, ibid.
[54] Ibid.
[55] Ebeku, KSA, Legal and Institutional Framework for the Protection of the Marine Environment in Nigeria' (2020) 34(1) *Journal of Environmental Law and Policy,* 45.

Experts such as Ezenwa[56] recommend that NBMA collaborate with the Nigerian Institute for Oceanography and Marine Research (NIOMR) to formulate marine-specific biosafety protocols, especially in the context of synthetic biology and environmental release trials.

Nigerian Institute for Oceanography and Marine Research (NIOMR): NIOMR, established under the Research Institutes Act, Cap R3, LFN 2004, is Nigeria's leading research institution for marine science. Its functions include marine biodiversity research, aquaculture development, and ocean monitoring. NIOMR's Aquaculture Biotechnology Department has pioneered work in genetic improvement of marine fish species and is capable of supporting broader marine biotechnology innovation. However, NIOMR lacks legislative authority to enforce biotech standards or supervise industrial biotech applications. Its activities are largely research-oriented and dependent on annual budget allocations. Its limited funding and outdated equipment hamper effective research in biotechnology. According to Ogbogu[57], a collaborative regulatory role should be formalized between NIOMR, NABDA, and NBMA to prevent institutional duplication and ensure coherent marine biotech development

Nigerian Environmental Standards and Regulations Enforcement Agency (NESREA)*:* Under the NESREA Act, 2007, NESREA is empowered to enforce environmental standards and protect Nigeria's natural resources. While not directly responsible for biotechnology, its enforcement role includes monitoring environmental risks arising from biotech applications. In practice, NESREA's involvement in marine biotechnology is marginal, mostly limited to pollution control and environmental impact assessment oversight. Section 7(c) of the NESREA Act provides the basis for intervention where marine biotech activities affect marine ecosystems, but there is no existing enforcement framework or technical capacity to evaluate biotech-specific impacts. A 2021 joint audit report by NESREA and the Ministry of Environment found that over 70% of private marine research activities in the Niger Delta operated without EIA certification or NESREA oversight highlighting regulatory laxity and coordination gaps.[58]

Federal Ministry of Science, Technology and Innovation (FMSTI): As the supervising ministry for NABDA and NBMA, FMSTI is responsible for strategic planning and national science policy coordination. The National Science, Technology and Innovation Policy (NSTIP) 2022–2030 recognizes marine biotechnology as a future priority but lacks specific milestones, funding commitments, or implementation pathways. Policy analysts like Yusuf and Kalu[59] recommend the development of a National Marine Biotechnology Strategy under FMSTI, in partnership with NIOMR and international development agencies, to create measurable targets and incentivize private-sector participation.

Traditional Resource Holders and Local Communities: Local communities in coastal and riverine areas play a key role in conservation, resource identification, and ethnobotanical knowledge relevant to marine biotechnology. However, they are often excluded from regulatory processes and do not benefit from bio-prospecting conducted on their lands. The Nagoya Protocol emphasizes Prior Informed Consent (PIC) and Mutually Agreed Terms (MAT) as conditions for access to traditional knowledge. Yet, Nigeria's current legal framework fails to enforce these rights in marine contexts. As argued by Akinyemi,[60] failing to involve local stakeholders undermines social equity, contravenes international obligations, and disincentivizes local cooperation. Future reforms must prioritize community inclusion in marine biotech policies and ensure fair benefit-sharing.

Institutional Gaps and Overlaps: A Critical Appraisal

Nigeria's institutional arrangement for marine biotechnology is characterized by jurisdictional overlap between NABDA, NBMA, NESREA, and NIOMR, leading to unclear mandates and inefficient regulation. Policy Disconnection, with marine issues under the Ministry of Environment, and biotech oversight under FMSTI, is causing fragmented governance. It is worthy to note that funding and capacity gaps, especially in NIOMR and NABDA, which limits research, monitoring, and enforcement. And lack of interagency coordination, despite overlapping mandates in biosafety, research, and resource management have trailed the successful implementation of biotechnology development and blue economy in Nigeria. To address these, a Marine Biotechnology Regulatory Council (MBRC) should be established via legislation to unify regulatory oversight, coordinate stakeholder roles, and enforce national and international standards.

6. Challenges of Marine Biotechnology Regulation in Nigeria

The regulation of marine biotechnology in Nigeria presents several critical challenges that impede sustainable development, technological advancement, and compliance with international best practices. These challenges span legal, institutional, socio-economic, and technical dimensions, and they pose a threat to the effective harnessing of the blue economy.

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[56] Ezenwa, U.O., 'Harnessing Nigeria's Marine Resources for Economic Development: Legal and Policy Perspectives' (2021) 12(2) *Nigerian Journal of Maritime Law,* 88.

[57] Ogbogu, 'Legal and Institutional Frameworks for Marine Biodiversity Conservation in Nigeria: Challenges and Prospects' (2023) 11(2) *Nigerian Journal of Environmental Law and Policy*, 102.

[58] Ibid.

[59] Yusuf A., And Kalu T., 'The Blue Economy and Sustainable Development in Nigeria: A Policy and Legal Assessment' (2024) 3(1) *African Journal of Environment and Energy Law,* 55.

[60] Akinyemi. A., 'Harnessing the Blue Economy for Nigeria's Sustainable Development: Legal and Policy Imperatives' (2022) 14 (1) *Nigerian Journal of Maritime Law and Governance*, 45.

Absence of a Comprehensive Legal Framework: Nigeria currently lacks a dedicated legal instrument specifically addressing marine biotechnology. Existing laws such as the National Biosafety Management Agency Act, 2015, the Environmental Impact Assessment Act, Cap E12, LFN 2004, and the Research Institutes Act, Cap R3, LFN 2004 only offer fragmented provisions that tangentially touch on marine biotech. This legal vacuum leads to regulatory ambiguity. For instance, there is no statutory guideline for the development or commercial release of genetically engineered marine organisms (GEMOs), nor is there legal clarity on the status of marine bioresources as intellectual property or common heritage. Ezenwa and Bello[61] argue that this lack of specificity undermines investor confidence and exposes Nigeria to biopiracy and non-compliance with the Convention on Biological Diversity (CBD) and its Nagoya Protocol.

Overlapping Mandates and Interagency Conflicts: As earlier discussed, multiple agencies such as NABDA, NBMA, NIOMR, NESREA, and FMSTI have overlapping roles with unclear lines of authority. This regulatory congestion often leads to duplication of efforts, delayed approvals, and poor accountability. For example, while NABDA promotes biotechnology, NBMA regulates biosafety, and NESREA monitors environmental impacts there is no harmonized protocol for inter-agency collaboration, resulting in policy incoherence. A 2022 report by the Nigerian Institute of Policy and Legislative Studies (NIPLS) recommended a harmonized inter-ministerial framework for blue economy governance with specific provisions for marine biotechnology oversight.

Inadequate Technical and Human Capacity: The technical requirements for regulating marine biotechnology including genomic analysis, biocontainment measures, and oceanographic data modelling are not widely available in Nigeria's public sector institutions. Most regulatory agencies lack trained personnel in marine genomics, synthetic biology, or bioprospecting. NIOMR and NABDA suffer from insufficient laboratory infrastructure, while NBMA lacks trained marine biosafety assessors. This impairs the evaluation of new marine biotech products or genetically modified marine organisms (GMMOs). According to Yusuf and Kalu[62], Nigeria must invest in workforce training and establish Centers of Excellence in marine biotech research and regulation to build capacity.

Poor Enforcement of Environmental and Biosafety Standards: Although NESREA is mandated to enforce environmental laws under the NESREA Act, 2007, its presence in coastal and marine zones is limited. Many marine research and industrial sites operate without Environmental Impact Assessments (EIAs), and there is no standardized monitoring of marine biotech experiments. The National Biosafety Regulations, 2017 fail to include marine-specific biosafety risk assessment protocols. This regulatory shortfall increases the risk of environmental contamination, biodiversity loss, and unregulated commercial exploitation. Oluwaseun[63]notes that weak enforcement has already led to overexploitation of marine bioresources, particularly algae and crustaceans, in the Niger Delta and Gulf of Guinea regions.

Weak Protection of Traditional Knowledge and Local Participation: The absence of clear legal mechanisms for protecting traditional marine knowledge undermines equitable access and benefit-sharing (ABS), in violation of the Nagoya Protocol, to which Nigeria is a party. Most coastal communities are unaware of their rights under international law and are excluded from decision-making on marine resource access. There is also no functioning national ABS registry or benefit-sharing mechanism for marine genetic resources. As a result, bioprospecting often proceeds without prior informed consent (PIC), leaving local communities uncompensated and disenfranchised. Akinyemi[64] suggests that integrating traditional ecological knowledge (TEK) into marine biotech policy would promote ethical research, enhance conservation, and fulfill Nigeria's international obligations.

Lack of Strategic Funding and Private Sector Incentives: Marine biotechnology is a capital-intensive sector requiring sustained investment in R&D, infrastructure, and human capital. Nigeria's current National Science, Technology and Innovation Policy (2022–2030) identifies marine biotech as a future focus but allocates no specific funding or fiscal incentives for private investors or startups. Without government-backed grants, tax reliefs, or public-private partnerships (PPPs), marine biotechnology in Nigeria risks remaining a purely academic pursuit with little commercial application. The Industrial Development (Income Tax Relief) Act, Cap I17, LFN 2004, though capable of granting pioneer status and tax holidays, has not yet been extended to marine biotech industries—an omission that discourages innovation.

7. Conclusion and Recommendations

This research examined the legal framework and institutional mechanisms for regulating marine biotechnology within the broader context of Nigeria's blue economy. The findings show that while Nigeria possesses significant marine biodiversity and economic potential, the legal and institutional infrastructure governing marine biotechnology is grossly inadequate and

[61] Ezenwa, U and Bello M., 'Strengthening Legal Frameworks for Marine Biotechnology Governance in Nigeria' 14(1) *Nigerian journal of Maritime and Coastal Law*, 102.
[62] Yusuf A., And Kalu T., 'The Blue Economy and Sustainable Development in Nigeria, op. cit.
[63] Oluwaseun, A. O., The Legal Challenges of Marine Biodiversity Protection in Nigeria's Coastal Waters' (2021)11(2) *Nigerian Journal of Environmental Law and Policy*, 87.
[64] Akinyemi. A., 'Harnessing the Blue Economy for Nigeria's Sustainable Development: Legal and Policy Imperatives,' op. cit.

fragmented. Existing laws such as the National Biosafety Management Agency Act, 2015, Environmental Impact Assessment Act, and NESREA Act offer only piecemeal regulation and do not comprehensively address the unique challenges posed by marine genetic resources. Furthermore, Nigeria has not yet developed a unified policy for marine biotechnology, nor does it have a dedicated regulatory authority exclusively focused on marine-based scientific and industrial innovations. This results in a multiplicity of overlapping mandates across agencies like NABDA, NBMA, NIOMR, and NESREA, leading to policy incoherence, enforcement challenges, and regulatory gaps. The situation is further exacerbated by the lack of technical capacity, insufficient funding, minimal stakeholder awareness, and inadequate protection of indigenous knowledge and access-and-benefit sharing (ABS) mechanisms. The study also observed that Nigeria's obligations under international instruments such as the United Nations Convention on the Law of the Sea (UNCLOS), the Convention on Biological Diversity (CBD), and the Nagoya Protocol on Access and Benefit-Sharing remain largely under-implemented in the marine biotechnology context. In conclusion, for Nigeria to meaningfully participate in the global marine biotechnology revolution and sustainably harness its blue economy potential, there is an urgent need for a well-articulated legal and institutional framework that is proactive, science-driven, inclusive, and consistent with international norms. By implementing these recommendations, Nigeria can strengthen its legal regime, attract investment, safeguard its marine resources, and assume a leadership role in marine biotechnology across West Africa and beyond.

To overcome the challenges identified, the following strategic interventions are proposed:
Enact a Marine Biotechnology Act: The National Assembly should draft and pass a specialized Marine Biotechnology Regulatory Bill that clearly defines marine bioresources, establishes regulatory protocols, and outlines institutional responsibilities.
Establish a Marine Biotechnology Regulatory Council (MBRC): A unified coordinating body should be created under law to harmonize the functions of NABDA, NBMA, NIOMR, and NESREA in marine biotech governance.
Develop Marine-Specific Biosafety Protocols: NBMA, in collaboration with NIOMR and international partners, should publish biosafety risk assessment standards tailored to marine environments and organisms.
Operationalize Access and Benefit-Sharing (ABS) Mechanisms: The Federal Government should establish an ABS registry and enact regulations to enforce Prior Informed Consent (PIC) and Mutually Agreed Terms (MAT) for bioprospecting activities.
Promote Capacity Building and International Collaboration: Nigeria should partner with UNESCO's Intergovernmental Oceanographic Commission (IOC) and the African Union's African Biosciences Initiative to train local scientists and regulators.
Provide Incentives for Private Sector Investment: Include marine biotech enterprises under the Pioneer Status Incentive Scheme to attract local and foreign investment, and integrate marine biotech into the national industrial roadmap.