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THEME: SECURING ANIMAL AGRICULTURE AMIDST GLOBAL CHALLENGES

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## ABSTRACT
*The only important food source in Nigerian fish value chain that is still predominantly gathered from the wild rather than farmed is shellfish. Nigeria is a coastal state with an 853 km coastline and a plethora of harvestable shellfish species. Coastal shellfish is a general term encompassing edible marine and brackish water invertebrates that, for the most part, have an exoskeleton or "shell" to support their body structures (exceptions include octopuses, squid, and most sea cucumbers). They include various species of crustaceans, molluscs and echinoderms. Because most shellfish species use a broadcast spawning technique, recruitment is inconsistent and often unpredictable. As a result, they are extremely sensitive to overfishing or natural disasters that deplete the critical mass of their spawning stock. The review covered the description and importance of shellfish resources, harvestable shellfish species and sustainable exploitation in Nigerian coastal waters. Nigeria can take advantage of the many consumers outside the country in Europe, Asia, and America who yearn for many of the shellfish species plentiful in our waters via sustainable use of coastal shellfish resources.*

**Keywords***:* Crustacean, Fisheries, Marine ecosystem, Mollusc, Ocean resources, Nigeria.

## INTRODUCTION
Coastal shellfish is a general term encompassing edible marine and brackish water invertebrates that, for the most part, have an exoskeleton or "shell" to support their body structures (exceptions include octopuses, squid, and most sea cucumbers). They include various species of crustaceans, molluscs and echinoderms. Crustaceans have segmented bodies protected by hard chitin shells and include shrimp, lobster, crayfish, crab, and krill, whereas molluscs have soft bodies divided into foot and visceral sections, and are divided into bivalves, cephalopods, and gastropods (Venugopal and Gopakumar, 2017; Moruf, 2020). The largest source of shellfish is coastal water, which is home to around 1000 species of crustaceans, 50000 kinds of molluscs, and 13000 species of finfish (Nybakken, 2001). Nigeria has a diverse range of water bodies, from the marine (Atlantic Ocean), to brackish waters (deltaic rivers and estuaries), to inland freshwaters. Although fisheries interest in coastal shellfish in Nigeria has been centered on the marine penaeid species harvested offshore by commercial trawlers, other economically important crustaceans and molluscs remain largely unexplored.Land reclamation, overfishing, and water pollution, all of which result in habitat degradation, are currently posing threats to the conservation of shellfish resources and their fisheries (Silva-Cavalcanti *et al.*, 2017). Deforestation of mangrove forests, poor land use practices, aggradation, and sewage water pollution are all common environmental changes along tropical coasts (Ivar do Sul *et al.*, 2014). In places where competent management is lacking, there is also a risk of overexploitation of natural resources and the collapse of environmental services. By reviewing the worldwide literature via Internet search engines, textbooks and theses, this study aimed to provide an overview of shellfish as harvestable resources, their position as critical ecosystem participants, and sustainable exploitation of coastal shellfish resources in Nigeria.

## IMPORTANCE OF COASTAL SHELLFISH
Shellfish are considered keystone organisms because their impact on the natural environment and other species in an ecosystem is disproportionately enormous. Some are “ecosystem engineers” because they significantly modify and create new habitat for other species by forming reefs (Strong *et al.,* 2015). Some clams and oysters aggregate into beds or reefs, modifying the nature and complexity of the substrate to form habitats for other species (Ysebaert *et al.*, 2019). Additionally, oyster reefs can sequester carbon, and

protect surrounding habitats like salt marshes from erosion, aiding carbon sequestration in these habitats (Ysebaert *et al.*, 2019). Shellfish are filter feeders, meaning that their natural feeding process removes particles and nutrients from the water column. Shellfish feed on phytoplankton, but can also accumulate marine biotoxins; chemical contaminants; and pathogenic microorganisms, such as bacteria and viruses; effectively removing them from the water column (Moruf *et al*., 2020a). Shellfish help control harmful algal blooms, such as red tide, by removing algal cells before they accumulate to harmful levels. Improved water quality makes the environment more suitable for vegetation and organisms that require high water clarity, such as eelgrass. The nooks and crannies of shellfish beds create structure and habitat for invertebrates and juvenile fish, which are a food source for predatory fish and other marine species (Heinonen and Auster, 2012). Healthy shellfish populations help to support finfish populations. Climate change will cause shoreline erosion, increased storm intensity and frequency, and coastal flooding. Shellfish help to minimize the impacts of climate change where shellfish beds stabilize sediments, helping to protect the shoreline from erosion and storms (Griffith and Gobler, 2020).

Shellfish are also among the largest sources of animal protein in the world (FAO, 2016). Important shellfish such as shrimp, prawns, crayfish, lobster, and crab constitute one of the major sources of nutritious food for humans, providing an important amount of dietary protein and lipids in many countries (Moruf *et al*., 2020b; Lawal-Are *et al*., 2021). Moreover, most shellfish contain appreciable quantities of digestible proteins, essential amino acids, bioactive peptides, long-chain polyunsaturated fatty acids, astaxanthin, and other carotenoids, vitamin B12, and minerals (including copper, zinc, inorganic phosphate, sodium, potassium, selenium, iodine) (Venugopal and Gopakumar, 2017; Moruf *et al.*, 2021). The crude protein contents of Guinean Mantis Shrimp, *Squilla aculeata calmani* ranges from 24.33 % to 36.37 % depending on the body part enumerated (Lawal-Are *et al.,* 2018). Oleic acid among the monounsaturated fatty acids occupied the highest position in the Smooth Swim Crab, *Portunus. validus* (12.4682±0.25%); whereas timnodenic acid was the most concentrated among the polyunsaturated fatty acids, with value of 15.7234±0.25 % (Moruf and Lawal-Are, 2019). Some shellfish such as marine mussels have also been demonstrated to be promising sources of bioactive compounds that can be exploited for other uses in different industries (Grienke *et al*., 2014).

## HARVESTABLE SHELLFISH SPECIES IN NIGERIA

Nigeria is a coastal state with a coastline of 853km which lies between Latitude 4°10′ to 6°20′N and Longitude 2°45′ to 8°32′E; covering approximately 853 km, from the Seme border in Badagry to Ikang in Cross River State (from West to East) and gently descending into the Atlantic Ocean (Jimoh and Lemomu, 2010). Some of the coastal characteristics which are of importance to the Nigerian inshore demersal fisheries are the presence of thirty-six estuaries and the prominent Niger Delta which provides suitable habitat for shellfish resources (Jimoh and Lemomu, 2010). Table 1 and Table 2 respectively show the most commercially harvestable crustacean and mollusc species in coastal waters of Nigeria.

**Table 1**: **Notable harvestable crustacean species in Nigerian Coastal waters**

| Common Name | Scientific Name | Harvesting Source |
|---|---|---|
| Pink Shrimp | *Farfentepenaeus notialis* | Lagos Lagoon (6º 26′N and 3º 50′E) |
| Guinea Shrimp | *Parapenaeopsis atlantica* | Ondo Ayetoro Coast (6°301′N and 4°451′E) |
| Deep-Water Shrimp | *Parapenaus longirostris* | Okoro River Estuary (4º30’47”N and 7º38’25”E) |
| Tiger Shrimp | *Penaeus monodon* | Badagry Lagoon (6º25′415′′N and 2º60′43′′E) |
| Guinean Mantis Shrimp | *Squilla aculeata calmani* | Lagos Lagoon (6º26′N and 3º 50′E) |
| Gabon Shrimp | *Atya gabonensis* | Cross River (5º58’47’N and 8º 16′23’’E) |
| African Caridina | *Caridina africana* | Ondo Asumogha Coast (6°301′N and 4°451′E) |
| Guinea Swamp Shrimp | *Desmocaris trispinosa* | Epe Lagoon (6º29′6”N and 3º35′40”E) |
| Biocellate Prawn | *Leander tenuicornis* | Nkoro River, Niger Delta (4º45’N and7º 45’E) |
| Congo River Prawn | *Macrobrachium dux* | Orogodo River, Delta State ($6^0$12′N and $5^0$16′E) |

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|---|---|---|
| Niger River Prawn | *Macrobrachium felicinum* | Akor River, Abia (5°34829'N and 7°34468'E) |
| Brackish River Prawn | *Macrobrachium macrobrachion* | Badagry Lagoon (6º25′415″N and 2º60′43″E) |
| African River Prawn | *Macrobrachium vollenhovenii* | Lagos Lagoon (6º 26′ N and 3º 50′E) |
| Estuarine Prawn | *Nematopalaemon hastatus* | Okoro River Estuary (4º30'47"N and 7º38'25"E) |
| Rockpool Prawn | *Palaemon elegans* | Ilaje Estuary, Ondo State (50º50'N and 40º45'E) |
| Blackegg Prawn | *Palaemon species A* | Ondo Ayetoro Coast (6°301′N and 4°451′E) |
| Zaire Prawn | *Palaemon maculatus* | Nkoro River, Niger Delta (4º45'N and7º 45'E) |
| Creek Shrimp | *Palaemontes africanus* | Ilaje Estuary, Ondo State (50º50'N and 40º45'E) |
| Mangrove Shrimp | *Alpheus pontederiae* | Bonny Estuary, Niger Delta (4°45'N and 7°05'E) |
| Companion Shrimp | *Exhippolysmata hastatoides* | Cross River Estuary (4°30'N and 8°30'E) |
| Banded Shrimp | *Lysmata uncicornis* | Nkoro River, Niger Delta (4º45'N and7º 45'E) |
| Estuarine Prawn | *Nematopalaemon hastatus* | Ondo Ayetoro Coast (6°301′N and 4°451′E) |
| Brackish Water Prawn | *Macrobrachium macrobrachion* | Ondo Ayetoro Coast (6°301′N and 4°451′E) |
| Spiny Lobsters | *Panulirus regius* | Off Lagos Coast (6°39'56″ N and 3°39'37″E) |
| Locust Lobsters | *Thenus orientalis* | Off Lagos Coast (6°39'56″ N and 3°39'37″E) |
| Lagoon Crab | *Callinectes amnicola* | Lagos Lagoon (6º 26′N and 3º 50′E) |
| Smooth Swim Crab | *Portunus validus* | Lagos Harbour(6°44'19″N and 3°40'47″E) |
| Deep Sea Crabs | *Chaceon atopus* | Off Lagos Coast (6°39'56″ N and 3°39'37″E) |
| Lagoon Land Crab | *Cardiosoma armatum* | Abule-Agege Creek (6º 26' N and 3º 23'E) |
| Hairy Mangrove Crab | *Sesarma huzardi* | Abule-Agege Creek (6º 26' N and 3º 23'E) |
| Purple Mangrove Crab | *Goniopsis pelii* | Abule-Eledu Creek ($6^0$31'N and $3^0$23'E) |
| African fiddler crab | *Uca tangeri* | Abule-Eledu Creek ($6^0$31'N and $3^0$23'E) |

Source: Adapted and modified from Moruf and Adekoya (2018) and Moruf (2020)

**Table 2**: **Notable harvestable mollusc species in Nigerian Coastal waters**

| Common Name | Scientific Name | Harvesting Source |
|---|---|---|
| Mangrove oyster | *Crassostrea gasar* | Badagry Creek (6°43'29"N and 3°36'33"E) |
| West African Clam | *Galatea paradoxa* | Itu Creek (5°39'0"N and 8°1'0"E) |
| Ark clams | *Anadara senilis,* | Upper Bonny Estuary (4°47'N and 7°15'E) |
| Donacid clams | *Egeria radiate* | Forcados River (5°18'31"N and 6° 10'27"E) |
| Edible periwinkle | *Tympanotamus fuscatus* | Abule-Agege Creek (6º26' N and 3º23' E) |
| Periwinkle | *Pachymelina aurita* | Lagos Lagoon (6º 26′N and 3º 50′E) |
| Murid snail | *Thais haemastoma* | Takwa Bay, Lagos (5°40'N and 7° 09'E) |
| Cockles | *Cardium costatum* | Bonny Estuary, Niger Delta (4°45'N and 7°05'E) |
| Cuttlefish | *Sepia officinalis* | Off Lagos Coast (6°39'56″N and 3°39'37″E) |
| Apple snail | *Pila ovata* | Niger Delta Estuary ($5^0$05'N and $6^0$50'E) |

**Source**: Adapted and modified from Moruf and Adekoya (2018) and Moruf (2020)

## SUSTAINABLE EXPLOITATION OF COASTAL SHELLFISH RESOURCES IN NIGERIA

The environmental cost of fishing, for instance impact on habitats, bycatch, bait species and the risk of ghost fishing, is also gaining increased attention. Furthermore, the unregulated dynamic of exploiters is to push the resources to overexploitation, and even when regulated, exploiters have been very successful at modifying their behavior so that regulations are less effective than anticipated. The most successful institutions at maintaining sustainability have been small-scale community or private ownership (Villamagna *et al.*, 2013). Sustainable shellfisheries development can be achieved through responsible fishing, which considers rational fishery management objectives that address a range of issues including the status of the resource, the health of the environment, post-harvest technology and trade, as well as other economic concerns, social benefits, legal and administrative support. In the case of shared resources, a co-ordinated approach to responsible fisheries management is essential.

## CONCLUSION

Coastal shellfish is the only important food source in the fish value chain that is still primarily gathered from the wild rather than farmed. With the sustainable exploitation of coastal shellfish resources, Nigeria can take advantage of the many consumers outside the country in Europe, Asia, and America who yearn for many of the shellfish species plentiful in our waters.

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