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Gap analysis evaluation of Nigeria's fish demand and production: Empirical evidences for investment in and policy development for offshore mariculture practices

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Abstract
Fisheries remain one of the greatest natural resources endowments of the marine environment that form the sources of seafood and revenue to coastal states. Thus the blue prints for the development and harnessing of the blue economy of most coastal states has always considered fishery management for the sustainable production of fish and seafood to adequately satisfy demand as vital for ensuring food security and earning foreign exchange via international trade in fishery resources. The study evaluated Nigeria's fish demand and production with a view to providing empirical evidence for or against the development of a national fishery policy for investment in and practice of offshore mariculture (practice of aquaculture at sea, ocean and coastal waters rather than on land only, as currently being done in Nigeria) in Nigeria. The study used gap analysis approach, augmented with ratio analysis to estimate the gap between fish demand and production in Nigeria using a 10 year (2008 – 2017) data obtained from the Food and Agricultural Organization (FAO). The result of the study shows that the average deficit in fish supply from local production over the period is 292348.6tons per annum while the average yearly demand is 1237000.0tons; implying that all the aquaculture and wide fishery output in Nigeria; failed to satisfy about 24% of the aggregate fish demand within the economy. It equally shows a Capture to fish-demand ratio is 0.56; implying that the wide capture sub-sector current supplies about 56% of local fish demand while the aquaculture sub-sector supplies only 20% of aggregate domestic fish demand. The result also indicates a gap of 277,041,960,000 naira between fish import expenditure and export earnings which represent excess fiscal resources spent in fish import over export per year. It was recommended that the government should develop a blue print for investing in and developing offshore mariculture in Nigeria.

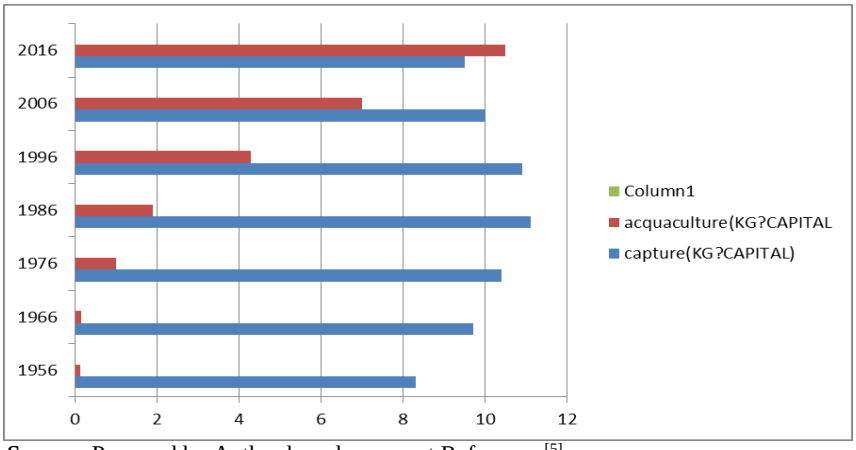
Keywords: Fish-demand, fish-production, gap-analysis, fishery-policy, offshore-mariculture

1. Introduction

Demand for fish in Nigeria is viewed as the quantity of fish and/or fishery resources that Nigerians are willing and able to purchase for purposes of consumption and use locally, at a given price over a given time period usually one year. Fish production in Nigeria is currently achieved through two main sources, namely, the capture fishery (capture) and aquaculture fishery (aquaculture) [1]. Fish capture refers to the aggregate quantity of fishery resources harvested from all wide sources by the state as the total output of the fishing effort (manpower, time, gears, trawlers etc) put into harvesting the wide fishery (freshwater and marine fishery) over the same period of time, usually one year. Fish capture in this context is exclusive of fishery resources harvested from aquaculture sources. Aquaculture fishery represents fish cultivated and or farmed in restricted, confined and/or enclosed fresh of brackish water ponds and harvested for use and/or sale at maturity [2]. In most blue economies, the relationship between the quantities of fish capture from wide fisheries and the output from aquaculture in one hand; and the demand for fishery resources on the other hand, usually influence public decision on fish import and export financing. Excessive fish output over level of local demand necessitates a decision in favour of export of fishery resources for foreign exchange while deficit or shortfall in fish output induces fish importation to curtail seafood shortages within the local economy. Apart from being sources of food for sustenance and healthy living whose lack and/or deficit in its supply causes hunger and death; fisheries particularly fresh water, coastal and marine fisheries remain very important maritime sector employer; employing

about 1,190,497 people and 13627 people as fishermen and fish farmers in the wide fishery and aquaculture respectively in Nigeria[3]. This is exclusive of the millions of indirect jobs created by the fishery value chain and trade. By implication, deficit in fish capture and/or supply drives the prices of the seafood high and induces hunger on the society. Thus, to develop capacity for sustainable supply of seafood to adequately feed the nation, guarantee food security; the empirical relations and/or variations between the local demand and production of fishery resources is importantly ascertained such that deficit and/or gap that might lead to food security challenges may be identified and bridged [4]. Such empirical relationships and/or variations may reveal need for investment in new fish production and breeding technologies as well as development of improved fishery management legislations and policies. For example, within an economy, an empirical evidence of excess production over demand indicates fish oversupply situation in the economy and implication for investment in fish processing, storage and preservation technologies as well as fish export for foreign income.

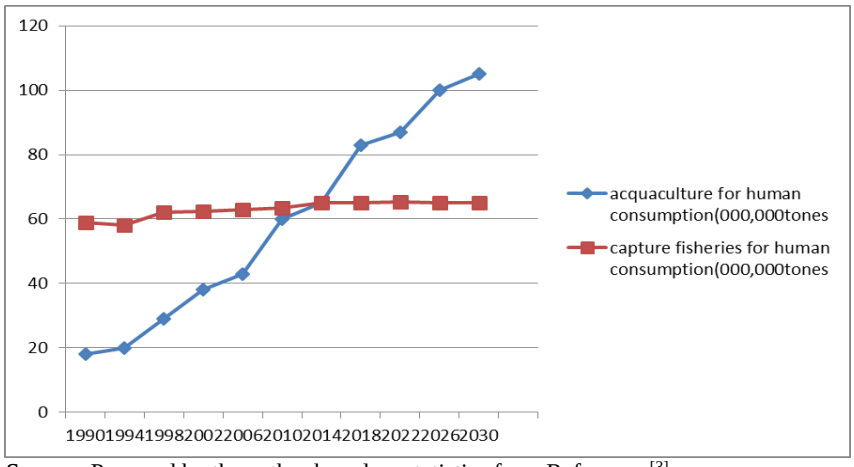
Notwithstanding the huge number of fishermen, fishing equipment, technology and fishery management policies deployed by the coastal countries to ensure self sufficiency in seafood production at least for optimal satisfaction of domestic demand from the wide fishery; there still persist incapacity and inability to meet the local demand for fishery products through captures from the wide fisheries (freshwaters and oceans). Statistical evidences from the Food and Agricultural Organization [5] an agency of the United Nations (UN) indicates a continuous declining trend in quantum of global fish capture from the wide fisheries inclusive of fresh water and ocean fisheries. The implication according to reference [5] is a depleting stock of World Ocean and fresh water fisheries. Thus despite the huge effort and investment made by operators to increase capture from the wide fisheries; the trend of output remained almost unchanged and unsatisfactory when compared with fish demand. The Food and Agricultural Organization [6] recommended aquaculture as the alternate strategy to bridging the gap between seafood demand and supply globally. Although fish production by aquaculture is not new; it however is rapidly developing to topple wide fishery as a major source of fishery resources being driven by the desire by economies to close the gap between demand and supply of fish and deflate threats to food security . Figure1 below shows comparative contribution of aquaculture and capture fisheries to fish for human consumption per capital between 1956 and 2016 by reference [7].



Source: Prepared by Author based on report Reference [5].

Fig 1: Relative contribution of aquaculture and capture fisheries to fish for human consumption

The Food and Agricultural Organization [3] projected that between 1990 and 2030; the trend of global fish output from capture fisheries will show significantly declining trends and/or stagnate while fish output from aquaculture will show a continuously increasing trend. See figure2 below:



Source: Prepared by the author based on statistics from Reference [3]

Fig 2: Global capture fisheries and aquaculture production 1990 – 2030

Empirical evidence as indicated in figures above indicates that capture fisheries as at 1956 satisfied almost about 90% of global demand for fishery resources but hit maximal all-time highest contribution to global seafood demand in 1986 from where diminishing output and decline in contribution of the capture fishery sector set in. The capture sector continues to decline in output and aquaculture output now seems to constitute the major source of global supply, showing a continuously increasing trend in contribution. By implication, the global food sector long anticipated the depleting trend of wide fisheries stocks causing decline in fish supply from the capture fisheries and made proactive investments in the aquaculture practices. Possibly, major aquaculture economies such as China and Vietnam, India, Indonesia, Australia, etc, proactively developed national legislations and investment policies to guide the sector, which have today shaped its practice to contribute significantly to the seafood needs of global economies today [8]. It is also observed that majority of the aquaculture outputs are from inland freshwaters and ponds; except for few countries that have ventured into active offshore mariculture fish production in the ocean and/or coastal waters [9, 10]. It is important to state that a major factor that drives the demand for fishery resources globally is the increasing trend in global population. With global per capital fish consumption at 13.3kg per annum; increasing trend in global population translates to increasing fish demand. Therefore space constraints and limitations in the inland locations and environmental factors become major constraints to improving inland aquaculture outputs. Thus the venture into the offshore or ocean sea areas for investment in mariculture practices to further increase fishery resources output in commercial quantities and satisfy global fish demand in line with increasing population trends. Table1 below compares global fish output from the inland freshwater aquaculture and offshore maticulture practice.

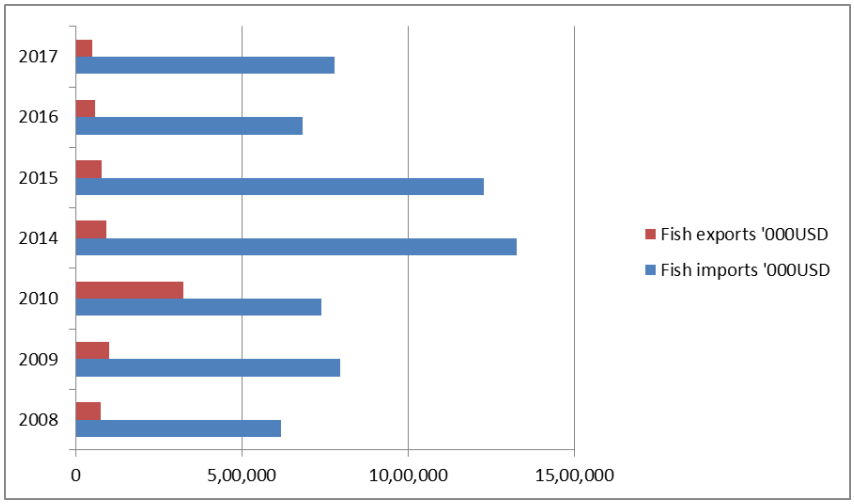
Table 1: World Aquaculture Output by Location/Environment

Aquaculture environment	2011	2012	2013	2014	2015	2016
Inland (Tonnes)	38600000	40200000	44800000	46900000	48600000	51400000
Marine/offshore	23200000	24400000	25400000	21800000	27500000	28700000
total	61800000	66400000	70200000	73700000	76100000	80900000

Source: FAO (2018)

The table indicates that about 35.2% of the contribution of aquaculture fish output was made from the offshore mariculture which is fish farming in the open sea by the cage system and other mariculture technology types while the rest 64.8% of the aquaculture fish output was from inland ponds sources. The implication of this is that investment in fish aquaculture at present seems to be concentrated on land and in coastal ecosystem which makes the impacts on the environment more severe. Recent development in offshore technology provides evidences that support commercial fish farming in the open ocean area in the Exclusive Economic Zones and coastal seas away from land which some global nations such as China, India, Vietnam, and Indonesia, Saudi Arabia, United Arab Emirates, Philippines, etc, have already commenced harnessing and cultivating in the drive to ensure adequate supply of fishery resources to meet ever increasing global demand [11]. While it is important that other maritime nations should consider harnessing part of their ocean environment for purposes of offshore mariculture use for commercial fish farming, we recommend development of legislative framework and policy to guide investment in and operations in the sub-sector. In commercial mariculture lies the answer to achieving equilibrium between demand for fishery resources and fish supply. As such, the emergence of any coastal state as an importer and/or exporter of fishery resources in the face of depleting stock of global wide fishery and declining capture; lies in her level of investment and management of the commercial offshore mariculture sub-sector.

In Nigeria, available statistical evidences indicate that the Country's capacity to satisfy local demand through capture fisheries cum aquaculture suffers setback each year as she continues to expend huge fiscal resources in fish import to meet domestic demand. For example the reference [3] quantified the financial resources spent by Nigeria in fish import in comparison to her earnings from fish export between 2008 and 2017 as shown below:



Source: Prepared by the author based on FAO (2018) statistics.

Fig 3: Financial Expenditure on fish import and Fish Export earnings in Nigeria

The pictograph shows an insignificant paltry export earnings from fish export compared to huge capital flight inducing expenditure on fish imports over the period; an indication that the local demand for fishery products in Nigeria over the years is only being satisfied through fish imports from foreign markets as the capture from the local fishery sector has shown deficit and unable to satisfy local market demands. It is important to assert that giving the general decline in capture from wide fishery sources globally; these imports by Nigeria are possibly from the aquaculture fish outputs of nations such as China that has made reasonable investment in the aquaculture and offshore mariculture fish farms. Another take away from the pictograph is that even Nigeria's current investment and output in aquaculture has not been able to help her limit her expenditure on fish imports through improved output that could help meet the local market demand. The evidence supports the argument of dwindling productivity of capture fishery sub-sector and the non commercial nature of the aquaculture sub-sector, despite huge fishing efforts expended by both private sector investments and public regulatory agencies in the sectors aimed at improving the potentials, harvest and performance of the sub-sectors to meet the very high demand of fishery resources and seafood in Nigeria. The resultant effect is that over the years, Nigeria's fish output has continued to show deficit and inadequacy compared to the quantum of domestic demand for fishery resources, fishing effort, and population growth. See Table2 below.

Table 2: Fish output, fishing effort, demand for fish and projected population of Nigeria for selected years

Year	(i) Capture			(ii) Aquaculture		(iii) Total fish output (tons)	(iv) Projected Fish Demand (tons)	(v) Projected population	(vi) Output-population ratio (tons/capita)
	Output (tons)	effort		Output (ton)	effort				
		No. of Fishing Fleet	No. of Fishers	Output	No. of fish farmers				
2009	598210	61284	-	152796	-	751006	1,120,000	147100000	0.0051
2010	616981	61435	1,519,627	200535	12190	817516	1150000	151200000	0.0054
2011	635486	61435	-	221128	-	856614	1180000	155500000	0.0055
2012	668754	61135	1,884,139	253898	13627	922652	1220000	159900000	0.0058
2013	721355	61435	16432,226	278706	13827	1000061	1250000	164400000	0.0061
Mean	648157	61405	1,682331	221412.6	13215	869569.8	1184000	1556200000	0.0056

Sources: (i), (ii), Adapted from Food and Agricultural Organization Reports (FAO, 2000 and FAO, 2017) (vi) calculated by the author.

Table 2 summarizes the relationships among demand for fishery resources, fish output and fishing effort in both capture fisheries and aquaculture in Nigeria for selected years 2009-2013. Evidence from table2 shows an average deficit of 314,430.2tons in local output to satisfy demand for fishery resources in Nigeria. This supports the earlier reference [5] report of higher fiscal resources for fish import than export earnings in Nigeria as the deficit represents fish demand which cannot be satisfied from the inadequate output of both the wide fishery and aquaculture. Thus despite huge fishing effort, fish output remain inadequate. The capture fishery employed an average of 648157 vessels (both motorized and non motorized ships) to fish the waters while the average capture and/or output for the period was 648157 per year; implying a mean output per ship effort of 10.555tons/ship(10,555KG) per year. This is poor compared to the quantum of fiscal investment required per year to harness per ship to water for fishing purposes. The relationship between fishing effort and output also shows an output of 0.39tons/labour (390kg/labour) for capture fisheries and 16.75tons/labour(16750kg/labour) for aquaculture. The indication is that each fish farmer in the aquaculture sub-sector is more productive than those employed in the wide fisheries. Thus redirecting investment in fishing to get more fish farmers involved in the sector than fish hunters in the wide fishery will certainly improve fish output in Nigeria. However, giving the continuous growth in population in Nigeria and with fish consumption in Africa and Nigeria put at 9.9kg per capital, Nigeria needs to invest heavily in commercial aquaculture practices rather than the current subsistence aquaculture practices in inland ponds. Offshore mariculture offers the opportunity for Nigeria to develop commercial fish farming aimed at revising the current ugly trend of capital flight inducing fish import to meet deficit in production. Developing the offshore mariculture sub-sector will equally reposition the country as an exporter of fishery products given her versed coastlines and exclusive economic zones. The study is therefore cast to provide empirical evidences for investment in and development of offshore mariculture practices and policies using augmented gap analysis approach in order to reposition the country to adopt a deterministic approach in developing capacity to meet her local fish demand while aiming to generate jobs for her citizens as well as earn huge revenue through fish exports.

2. Brief Review of Literature

2.1 Offshore Mariculture Concept, origin, Practices and global trends

Offshore mariculture is defined as the practice of cultivating and/or culturing seafood (fishery resources and marine plants) in the ocean environment or coastal waters using cage technology (offshore cage system) [9]. It involves commercial production of fish, seafood and marine plants in farms situated in the open Ocean and/or coastal sea environment using cages and other forms of variedly designed offshore technology crafts that constrains the fish and/or organisms being cultivated from straying into the wide. A Japanese, Kokichi Mikimoto was credited with developing mariculture practices in Japan in 1896. Reference [9] agrees that offshore mariculture originated in Japan about four (4) decades back focusing on the cultivation of high-value marine species, fish stocks facing the danger of extinction due to overfishing; species that cannot be cultivated in land or fresh water aquaculture system but which have high market demand. At inception, offshore cage technology system was mainly used for the practice of mariculture [12]. A basic advantage offered

by the system is optimum utilization of the offshore environment with adequate water circulation to constantly aerate the cages and drive off wastes while avoiding the challenges of shore pollution, marginal water quality, and vandalism common in land pond system and fresh water aquaculture. Mariculture however is faced with problems of logistics since water crafts (ships) are needed to supply the primary input materials and transport the output from the farms to shore-based market locations. Though this practice is faced with seasonal catastrophes such as hurricanes, wave actions and storms and has been associated with pollution of the oceanic waters by its waste discharges [9, 13]. The profitability potentials occasioned by the commercial outputs which guarantees food security to the society favours investment decision in mariculture. See figures2 and 3 below showing mariculture technology systems in use for open Ocean seafood cultivation.

Source: Adapted from Barfield *et al*. (2018).

Fig 4: HDPE Mariculture Floating Cage Technology

Source: Adapted from FAO (2015)

Fig 5: Mariculture in Flaoting HDPE Cage Farm (Tabuk Fisheries Company) off the Red Sea coast of Saudi Arabia in the northern coastal province of Tabuk with about 19 meters diameter and installed with anti-bird nets

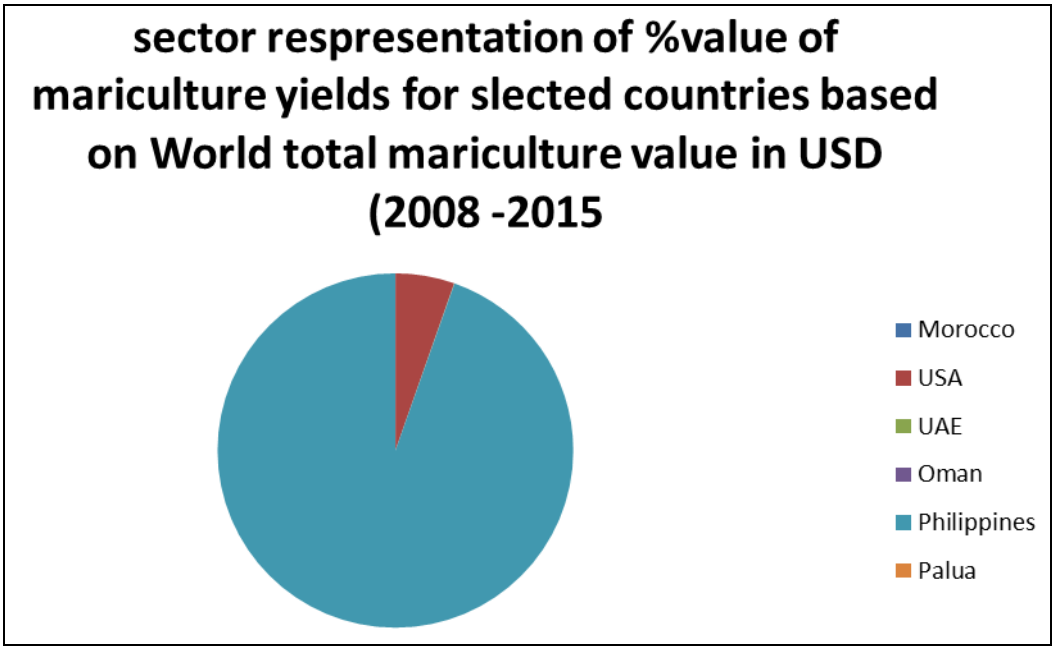
Reference [11] notes that the trend of practice of mariculure is increasingly growing globally caused by factors such as increasing demand for fishery resources and seafood, space and environmental constraints faced by inland aquaculture farmers limiting the outputs and productivity of the farmers, commercialization opportunity offered by the mariculture fish farms and the need to ensure food security by global nations. Leading global suppliers of fishery resources such as China, India, Indonesia, etc have reasonably invested in mariculture, particularly in the coastal waters where large mariculture farms produce fishery resources in commercial quantities. The annual seafood production to satisfy local demand and for export is not is guaranteed in these Countries through the mariculture farms rather than being left for the probability of fish hunters ability to make adequate catches from the wides fishery. In the United States of America too, offshore mariculture is in practice in the Coastal states

In the U.S.A, while coastal states have allowed the practiced mariculture within their limits (about 3 nautical miles to offshore from the coastlines), such that in 2016, mariculture practiced within state-controlled coastal water zones produced seafood worth about 1.6billion United States dollars; representing about 20% of seafood production in the United States. However, the Federally controlled waters offshore (about 200 nautical miles from the three miles zone of the coastal states) hold greatest potentials for mariculture and commercial seafood farming but has remained restricted to operators as permits are required from the federal authorities who have over the years cited pollution of the ecosystem of the oceans as reasons for the restrictions until recently when permits were granted for the setting up of large mariculture farms offshore [13, 10]. Reference [11] observes that the United Arab Emirates (UAE, Morocco, Palua, Philippines among others have equally made mild developed policies for harnessing the ocean waters within their regions of controls for offshore mariculture practices and have made mild profit yielding investments in mariculture practices. See Table3 below for the trend of tons of fish output from mariculture farms and the fiscal values for selected Countries.

Table 3: Global Total Mariculture Production and Value Data for Selected Countries (aggregated for the period 2008 -2015)

Country	Morocco	USA	UAE	Oman	Philippines	Palua	Global
Mariculture Output (Tonnes)	335631	1450160	6831	2530	19840292.54	197.80	205,573,553000
Value(USD)	15259000	8507981900	33396230	13671220	15,924840030	1066110	516051631000

Sources: Prepred by Authors based statistics from Barfield *et al.*, (2018) and FAO (2017).



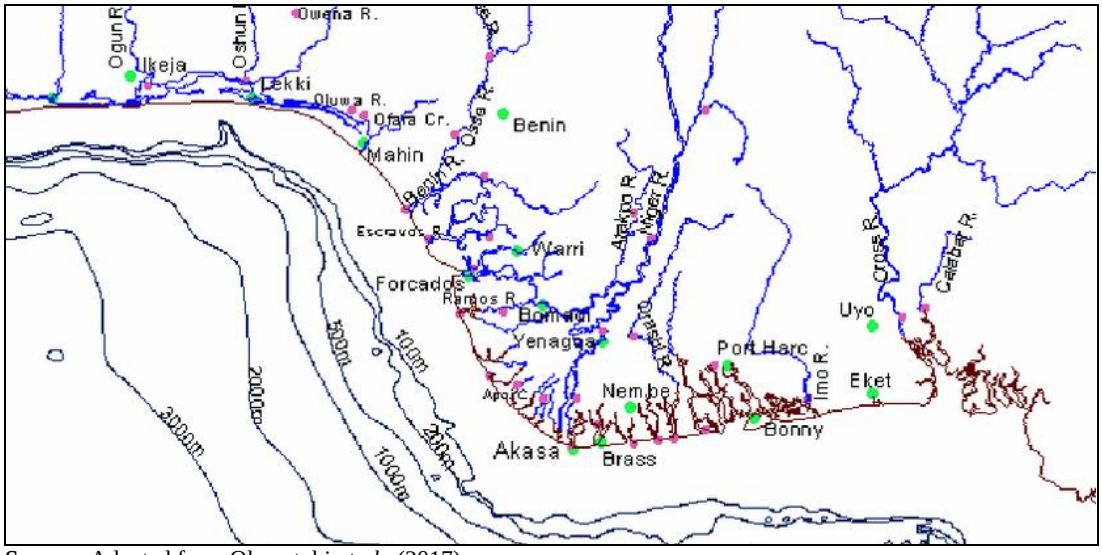
Source: Prepared by Authors

Fig 6: Pictograph of Yield From mariculture for selected countries as a % of World Aggregate

As aforementioned, the U.S is in the process of granting permit for offshore mariculture farming to selected farms in the Federal waters so most outputs from the marine as presented are from the state controlled zones. Philippines which has made considerable investment in mariculture earned as much as 15.9billion United states dollars from the sub-sector between 2008 and 2015 alone [11].

2.2 Supportive Evidences to the Potentials of Mariculture Practice in Nigerian

The Nigeria marine ecosystem is believed to well suitable for mariculture practices given its richness in marine biodiversity and the preponderance of fishes of various species and kinds with high promising potentials of commercial production and output if the practice of mariculture is adopted and organized. Nigeria has a coastline of 853 kilometers which borders and Exclusive Economic Zones (EEZ) of 12 nautical miles and 200 nautical miles respectively. The total marine ecosystem area covered by the country's EEZ is 37,900KM^2. By implication, she has a very large ocean sea area supportive of commercial mariculture practice [6]. See Figure below for chart of the Nigeria marine ecosystem for which offshore mariculture practice within could improve fish output to satisfy domestic demand in Nigeria.



Source: Adapted from Oluwatobi *et al.*, (2017)

Fig 7: Map of Nigeria's Coastal Zone and EEZ baseline for Offshore Mariculture Development

Reference [14] observes that the Nigerian marine ecosystem is rich in fish species of various kinds which supports the development of mariculture for commercial production of the species. The table below is a summary of selected fish types and nutritious species with high market value and demand found in the area that can supportively be cultivated.

Table 4: Selected fish species Finfish and Shellfish in the Nigerian Marine Ecosystem with potentials of being produced in Commercial quantity through mariculture practice, Survival Salinity Ranges and feeding behavior of each Fish Group/Type

Fish Specie	Salinity range for survival and optimum Breeding	Feeding behavior and preferred feed type(s)
T. rendalli *T. nilotica* *T. galilaea* *T. zillii* *O. niloticus* *S. melanotheron* *O. mossambicus*	Sea water with salinity range between 0-26	Detritus, feed supplements, Algae, phytoplankton,
C. nigrodigitatus	Salinity range between 0-26	Palm-kernel-cake, Bivalves, Groundnut-cake
M. bananensis *L. grandisquamis* *L. dumerilii* *M. curema*	Salinity range between 0-35	Phytoplankton, detritus, algae, and supplementary feeds
C. lazera *C. gariepinus*	Salinity range between 0-25	Omnivorous, supplementary feeds
P. durarum	Salinity range between 0.5-35	Plant and animal originated Detritus feeds
E. fimbriata (Bonga)	salinity range between 0-35	Phytoplankton
E. lacerta	Between 1-26	Predatory

Source: Modified from Oluwatobi *et al* (2017)

According to FAO (2007), other finfish and shellfish species that are found thriving in the waters of the region and which can be cultivated are members of the supra-thermocline (sciaenids) families which include: Sciaenidae, *Pseudotolithus spp*, Grunts (*Brachydeuterus spp*), Catfish (*arius spp*), Tuna, Shinynose, *sardinella spp*, *ethmalosa spp*, Baracudas (*Sphyraenidae*), *Carangidae* (Jack fish), Caranx hippos, etc.[6, 15, 16].

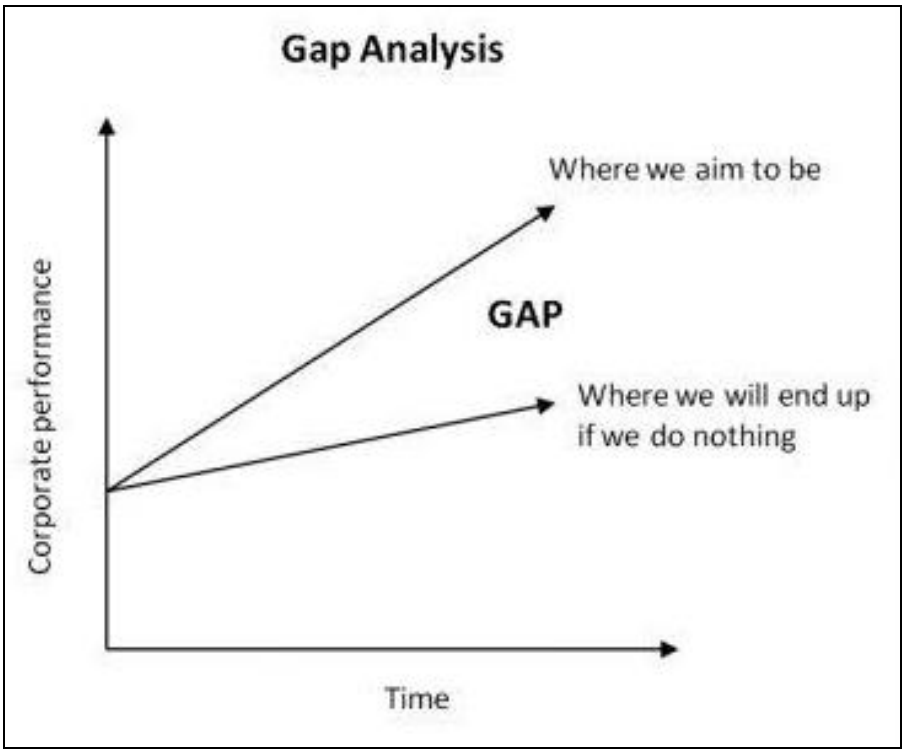
3. Materials and Methods

The Food and Agricultural Organization (FAO), an agency of the United Nations (UN) publishes statistical reports and the conditions of fisheries and aquaculture of various global nations as sources of fishery resources and seafood to the global community. Historical survey method was used to obtain time series data of capture (C_f) and aquaculture (A_f) fish output in Nigeria from various editions of FAO year book covering the period 2008 to 2017. The aggregate annual fish output ($C_f + A_f = F_{ao}$) was determined covering the same time period. The demand for fishery resources (D_f) the projected population (P_N) in Nigeria were obtained from the Department of fishery, Ministry of Agriculture publications covering the period between 2008 and 2017. To determine the necessity of investment in mariculture for fish production in commercial quantity to meet fish demand in Nigeria; there is need to determine the significance of the difference (gap) between aggregate fish output (($C_f + A_f = F_{ao}$) and fish demand (D_f) over the period. This is also needed to determine target quantity of fish output from the investment in mariculture practices needed to close the gap between fish output and demand for fish in Nigeria. Thus we used the gap analysis method augmented by the ratio analysis to analyze the data obtained. Ratio analysis was used to measure the aggregate fish output ($C_f + A_f$) to population (P_N) ratio per annum. The financial resources used for import and earned from export of fishery resources over the period was compared as basis for envisaging the benefits of mariculture development from the point of view of international trade in fishery resources.

3.1 Gap Analysis

Gap analysis is a management tool used in identifying the existence of gap (differences and or deviations) from performance targets/goals by comparing actual performance with potential and/or desired performance [17]. Thus, gap analysis assesses the current performance for purposes of determining differences between the current performance and target and/or desired performance with a view to improving the current performance to meet up with the potential or desired target by closing the identified gaps and/or differences.

The fishery policy of Nigeria made clear her drive to achieve food security by massive investment in agriculture to enable her be safe sufficient in food production and even for export. Thus, it is assumed that to achieve this target, the basic quantity of fish output that the sub-sector must target to produce each year as benchmark must be equivalent of annual domestic demand for fishery resources. To produce for export purposes, this basic benchmark quantity which evidences the fact that the aggregate fish output satisfies local demand for fish becomes the basis for projecting the quantum of export quantity to produce. We therefore opine that the demand per annum of fish in the economy represents the fish output benchmark that the Nigeria fishery policy tends to, in order to produce enough to satisfy demand. Any deficit or shortfall in this benchmark quantity (D_f) when compared with aggregate output ($C_f + A_f$) for the year or over the period represent a gap; implying that current output performance is inadequate and unacceptable. Being unacceptable, processes are put in place to drive output to increase to meet up with and/or move beyond benchmark/demand. See figure6 below for a pictograph explaining of the concept of gap analysis clearer.



Source: Adapted from www.sixsigmatraining.com/gap-analysis.html

Fig 8: Pictograph Explanation of gap Analysis Concept

But considering Nigeria's current fish output from both capture and aquaculture sources, Country's output seems below her fish production possibilities frontier. Given her endowment with ocean water resources and marine ecosystem; she can produce to reach fish production possibilities frontiers by first determining the existence of gap in current output level and fish demand as empirical basis for developing investment interest in mariculture using gap analysis as tool.

Ratio analysis was also used to measure the ratio of fish output to population growth among others. These were aimed at determining if available empirical evidences supports investment in mariculture practices in Nigeria for commercial fish output to meet up with growing fish demand.

4. Results and Discussion

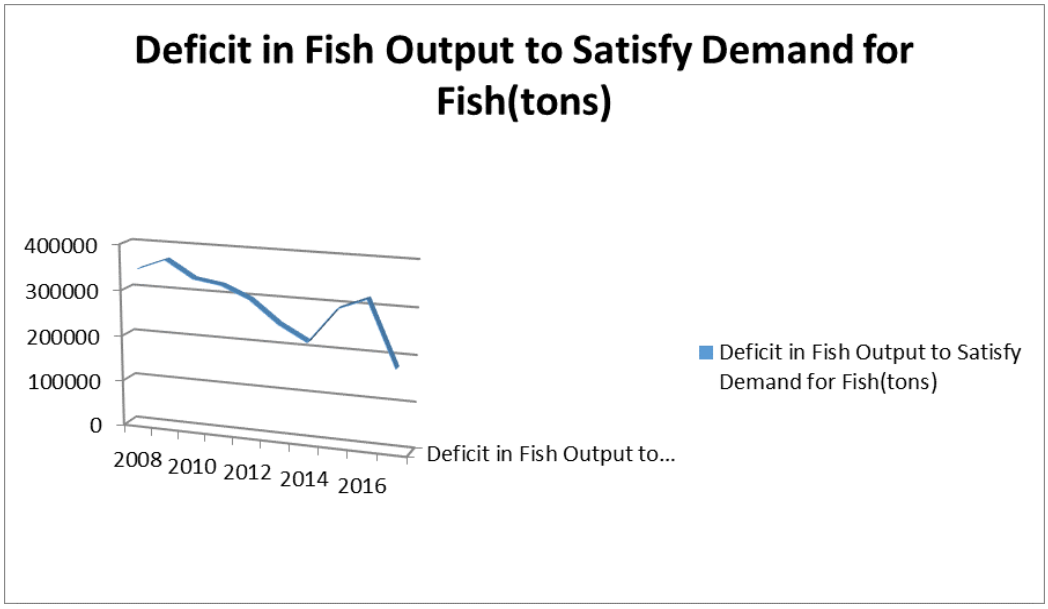
Table 5: The Yearly Gap between Fish demand and Production (output) in Nigeria (2008-2017)

Year	(i) Actual Capture output (tons) = (C_f)	(ii) Actual Aquaculture output (tons) = (A_f)	(iii) F_{ao} = (C_f + A_f) (tons)	(iv) Fish Demand (D_f)	(v) Projected population (P_N)	(vi) Supply Gap or Deficit per annum (tons)
2008	601368	143207	744575	1090000	143000000	345425
2009	598210	152796	751006	1,120,000	147100000	368994
2010	616981	200535	817516	1150000	151200000	332484
2011	635486	221128	856614	1180000	155500000	323386
2012	668754	253898	922652	1220000	159900000	297348
2013	721355	278706	1000061	1250000	164400000	249939
2014	759828	313231	1073059	1290000	169100000	216941
2015	710331	316727	1027058	1320000	173900000	292942
2016	734731	306767	1041498	1360000	178800000	318502
2017	916284	296191	1212475	1390000	183300000	177525
				1237000.0		292348.6

Sources: (i), (ii), (iv) $ (v) adopted from FAO (2000), FAO (2017), FAO(2010). (iii)$(vi) were calculated by the authors.

The result on Table5 above was presented to reveal the yearly gaps (differences) in fish production from all sources (both aquaculture and wide fisheries) and the aggregate demand for fishery resources in Nigeria between 2008 and 2017. The result shows that for all the years between 2008 and 2017, there existed deficit and/or short fall in fish supply from all local production sources when aggregated with the highest deficit of 368,994tons of fish recorded in 2009 and the minimum short fall in supply of 177525tons recorded in 2017. The average deficit in fish supply from local output over the period is 292348.6tons of fish per annum while the average yearly fish demand is 1237000.0tons. This implies that with the all the aquaculture and wide fishery investments available in Nigeria; for each year, the Nigeria fishery sub-sector is unable to satisfy about 24% of the aggregate fish demand within the economy. The economy must thus resort to import of that amount of fishery resources to avert challenges of in food security and avoid inflation in seafood prices which deny low income family access to fish food with the consequent result of malnutrition, hunger and disease. Giving the increasing trend in population, in the coming years, the trend in supply gap (deficit) is expected to continue and/or deepen; inducing more imports of fishery resources with the associated disadvantages including capital flight, except there

is serious investment in the sector, particularly and aquaculture and/or mariculture sub-sector with the target of bridging the gap between the levels of current output and demand. See figure5 below for clearer view of the trend of deficit in fish production in Nigeria to meet domestic demand for fishery resources.



Source: Prepared by Authors.

Fig 9: Trend of Fish Output Deficit

The trend is indicative of the probabilistic nature of the capture sub-sector which adopts a fish hunting approach; an approach which is not realistic as there always exists uncertainty as to whether adequate capture will be made that can satisfy demand. Thus while demand for fish is certain in the economy as it must occur, production and/or supply to satisfy demand locally is a game of probability which eventually leads to deficits each year. Aquaculture as practiced in Nigeria currently is in the inland and has proved as shown in the results as equally lacking in capacity to bridge the demand-output gap. The empirical evidences supports the development of mariculture as it offers a deterministic approach to fulfilling the desire of producing fishery resources in commercial quantities and in a controlled manner, adequate to bridge the yearly fish-demand-output deficit.

Table 6: Determining the Significance of the average Gap (difference between Fish Demand and Output between 2008 and 2017.

Variable	Mean	N	Gap[mean Difference] $=D_f - F_{ao}$	Std deviation	t-cal.	df	P-value (2-tailed)	F_{ao}/D_f *Ratio*
F_{ao} D_f	944651.4000 1237000.0000	10 10	292348.60	60226.00	15.30	9	0.000	0.76
Variable	Mean	N	Gap[Difference of Mean] $=D_f - C_f$	Std deviation	t-cal.	df	P-value	C_f/D_f *Ratio*
D_f C_f	1237000.0 696332.80	10 10	540667.2	47028.00	36.3	9	0.000	0.56

Source: Authors Calculation

Table6 above was determined to test the significance of the gap (differences) between fish demand and fish production within the 10 year period covered in the study since the decision to invest in alternative fish production practices to bridge the shortfall in output might be influenced by the significance and/or otherwise of the gap between demand and supply. The result shows a mean fish output from all sources (mean of capture and aquaculture output aggregate) of 944651.40tons per annum and mean yearly fish demand of 1237000.0tons. This shows a gap (mean difference) of 292348.60tons representing the shortfall and deficit in fish production with a standard deviation of 60226. A t-value of 15.30 and p-value of 0.00 at 9 degrees of freedom shows that there exist a significant gap between demand for fish and fish output in Nigeria. The implication of its significance is the empirical evidence that the situation cannot be allowed to continue as it puts fiscal and food security toll on the local economy. Fish-output to fish-demand is 0.76; indicating that local fish production and output (from all sources) can only satisfy 76% of local aggregate fish demand.

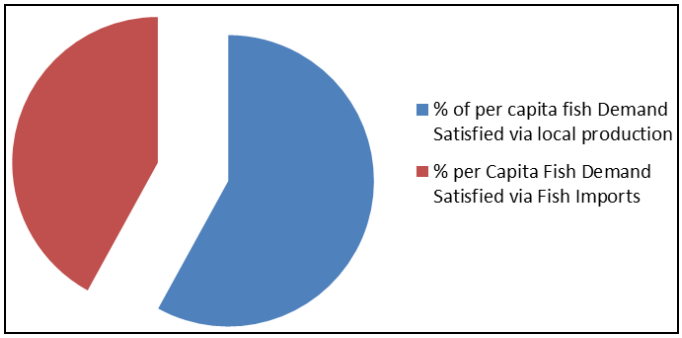
The Table6 above also shows that the mean yearly fish capture from wide fishery alone (fresh water and ocean fisheries) is 696332.80tons as against mean fish demand of 1237000.0 as afore-stated. The mean gap between capture and demand is 540667.2tons with a standard deviation of 47028.0. The t-value is 36.3 and p-value is 0.07 with 9 degrees of freedom; showing a very significant gap between the duo. Fish-Capture to fish-demand ratio is 0.56; implying that the wide capture sub-sector current supply about 56% of local fish demand while the aquaculture sub-sector supplies only 20% of aggregate domestic fish demand. We may infer that the current trend of aquaculture practice in land and fresh water ponds in Nigeria has not support commercial output of fish to satisfy demand. This provides a further empirical evidence for investment in and development of mariculture practice to ensure commercial fish production in Nigeria.

Table 7: Using Ratio Analysis to determine the Proportion of per capita fish demand satisfy-able via local output and per capita deficiency satisfied via imports

Year	F_{ao}| P_N Ratio (tons/capita) = fish demand per capita satisfied from local production	Fish demand Kg/capita satisfied from local output	Actual annum fish demand per capita (Kg/capita)	Deficit = Fish demand per capita not satisfied from domestic output
2008	0.00520	5.2	9.9	4.7
2009	0.00510	5.1	9.9	4.8
2010	0.00541	5.4	9.9	4.5
2011	0.00551	5.5	9.9	4.4
2012	0.00577	5.8	9.9	4.1
2013	0.0061	6.1	9.9	3.8
2014	0.00635	6.4	9.9	3.5
2015	0.00591	5.9	9.9	4.0
2016	0.00582	5.8	9.9	4.1
2017	0.00661	6.6	9.9	3.3
Average	0.00578 (57.8%)	5.78 (58%)		4.12 (42%)

Source: Prepared by Authors.

Table 7 above examines the implication of the current state and level of production in Nigeria on each individual consumer of seafood within the country. The Food and Agricultural Organization (FAO, 2017) puts the fish demand per capita in African Countries at 9.9kilograms per annum. Table7 however indicates that given the current level of output in Nigeria, the per capita access to fish from local production is an average of 0.0058tons (5.8kilograms) per years. Compared with the disaggregate demand for fish (i.e. consumption/demand per capita) of 9.9kg per year, there is an average gap or difference of 4.12kg per annum. Thus viewed from per capita consumption point, Nigeria only satisfy 58% of each individual's yearly fish need from local production. The deficit of 42% yearly per capital fish need is currently being imported. See the Figure below for a clearer picture.



Source: Prepared by authors

% OF PER CAPITA Fish Demand Satisfied from Local Outputs and Imports

Table 8: Comparing Fiscal Resources Spent in Fish Import with Revenue earned from Fish Export Trade over the Period

Variable	Mean	Gap[mean Difference] Fishimport - *Fishexport (USD)*	Std deviation	t-cal.	P-value (2-tailed)
Fishimport('000USD)	881,140.6	769561.00	306610.9	6.64	0.001
Fishexport ('000USD)	111,579.6				

Source: Author's calculation

Table8 estimated the difference in fiscal resources employed in importing fish by Nigeria and revenue earned from fish export over the years. While an average of 881,140,600USD (317,210,616,000naira) was spent on fish imports per year, an average of 111,579,600USD (40168656000.00 naira) was earned from fish export showing a gap of 769,561,000USD (277,041,960,000.00 naira) between fish import expenditure and fish export revenue. A t-value of 6.64 against p-value of 0.001 shows a significant difference between the two, implying excess fish import expenditure over export revenue. This empirical evidence is indicative of an unfavorable balance of trade in fishery resources skewed against Nigeria. The reversal of this is only dependent on the level of investment in made in the sector to produce fishery resources in commercial quantity and offshore-mariculture offers this alternative. The gap of 277,041,960,000 naira between fish import and export finances represent excess fiscal resources spent in fish import over export per year is more than double the budgetary allocation of 135.54billion naira (about 1.56% of the 2017 budget) for the entire agricultural sector in Nigeria. If no serious investment policy is developed to harness the ocean water resources of the Country to enhance fishery resources production in commercial quantity to bridge the existing gap in demand and output which is significant; this trend of import expenditure will continue to re-occur to the disadvantage of the nation. To bridge the gap therefore, we need to look at the rates of change of demand, fish production (capture and aquaculture outputs), and possibly population and import expenditure as basis for determining the quantity of as benchmark production/output target for the Country.

5. Conclusion

Empirical evidences from the findings of the study suggest that the total fish output from both capture and aquaculture sources over the years has been unable to satisfy the demand for fishery resources in Nigeria as it has only supplied about 76% of aggregate fish demand. The deficit of about 24% is continually being imported with enormous fiscal implications, capital flight and inflation. It is equally obvious from the result of the findings that given the rates of change of fish output from capture and aquaculture sources in relation to the rates of change of demand for fish and population; Nigeria can never be able to bridge the current gap of about 24% of aggregate domestic demand by continuing to adopt the current probabilistic approach to fish production via capture. It therefore implies that investment must be made to an alternate more deterministic fish production approach for purposes of harvesting output in commercial quantity that can bridge the existing and produce for export. This once achieved will

equally eliminate the fiscal gap of 277,041,960,000.00 naira been spent extra as expenditure for fish to satisfy local demand and save the nation the necessary revenue needed for capital investment in the sectors of the national economy. Mariculture (system of aquaculture at sea rather than in inland and freshwater ponds) offers a deterministic approach alternative to commercial fish output in Nigeria.

6. Recommendations

Based on the empirical evidences in the results and findings of the study; it is recommended that:

(i) Government should make it a priority to develop mariculture policy blue print as guide for the investment in and practice of mariculture as a strategy developing further, the Nigerian blue economy.

(ii) Investment in mariculture should have as benchmark output target the 24% deficit output currently being imported. Having this is the basis, it can then project to produce more for export in the international market,

(iii) Government should through the responsible agencies and ministries determine and map out mariculture zones, within the sea locations and coastal zones in the Nigeria EEZ of the Atlantic see area.

(iv) Government should develop a blue print for investment in the mariculture zones detailing the roles for private sector investment and Public private partnerships in the development of the zones.

(v) Environmental Impact Assessment should be conducted in each established mariculture zone to analyze issues of environmental concerns and provide guidelines to operators for prevention and control of environmental pollution.

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