The Contribution of Marine Protected Areas in Promoting the Consumption of Fish Resources and Supporting Food Security Policies in Algeria: Results of a Prospective Approach

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Abstract:

Achieving food security in its various dimensions is a priority of great interest to the public authorities in Algeria. In this context, it highlights the essential role of fish as a major source of essential proteins and nutrients in achieving food security. On the other hand, the growing demand for fish raises questions about the sustainability of marine fisheries and their ability to supply fish sustainably and to cope with growing demand year after year. Based on the foregoing, this paper, which seeks, through a forward-looking analytical study, horizon 2049, to highlight the significant role that marine protected areas can play as one of the most important tools for preserving marine ecosystems and increasing fish mass thereby contributing to food security and addressing the growing demand for this vital material in Algeria; The results have shown that there are significant potential possibilities for such reserves in Algeria if the appropriate conditions are met for their effective functioning.

Keywords: Marine protected areas; Fish mass; Food security; Algeria.

Jel Classification Codes: O13, O21, Q13, Q210.

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1. Introduction:

In today's times, most of the world's nations seek to achieve and maintain food security by seeking resources and mechanisms to sustain food security for the world's people, where are Marine protected areas (MPAs) are crucial tools for marine biodiversity conservation and sustainable utilization of marine resources through fisheries management (Boubekri & Borhane Djebar, 2016), It possesses qualifications and natural resources with excellence that play prominent economic and social roles, particularly the effective contribution to the protection of marine ecosystems and the increased supply of renewable fish as well as creating jobs and wealth, MPAs are characterized by interconnected socio-economic and ecological dynamics (Boubekri, Mazurek, Borhane Djebar, & Amara, 2022) and regulate fishing activity, which is a crucial strategic activity due to significant nutrition problems in the context of the dramatic increase in human populations in which this activity contributes to the provision of an important biological stockpile of fishery and plant resources for the purpose of human consumption as a catalyst for marine industries, it plays a role in achieving current and future economic development and thus contributing effectively to achieving food security and sustainability ,to properly enact MPAs and ensure that relevant outcomes can be defined for specific areas MPAs should first be defined appropriately according to their stage of establishment level of protection the measured outcomes, and the social and ecological conditions under which the MPA has been designated (Geneviev, Krueck, Ogier, Barrett, Dutton, & Hartmann, 2023) . With its distinguished geographical location and its 1280 km of coastline, Algeria holds a significant marine natural potential (Guedri & Chakour, 2016) But despite all these possibilities, the fishing sector has not played an important role in providing fisheries resources and managing fisheries well. By contrast, Algeria has not invested in coastal territories to establish Marine protected areas (MPAs) that contribute to the development of this sector (Guedri S. E., 2021), although there arelegal texts determining this.The "Taza" MPAs is the only one that contributes to the development of the fishing sector and fisheries resources, and successive Algerian Governments have therefore not focused on the establishment of other marine reserves, although they are very important for the development of the national economy.

The importance of this study is to highlight the role that Marine protected areas (MPAs) in Algeria can play through the preservation of marine ecosystems and increased fish mass production, the sustainability of marine fisheries and their ability to supply fish sustainably and to meet the growing demand for this biomaterial in order to contribute to the strengthening of Algeria's food security policies. This article attempts, therefore, to answer the question: What potential role can Marine protected areas (MPAs)play in upgrading the consumption of fish resources in Algeria in order to support Algeria's food security policies?

To answer to this question we have formulated the following hypothesis: Marine protected areas (MPAs) can contribute to the upgrading of the consumption of fish resources and thus support Algeria's food security policies by increasing and sustaining fish mass and thus contributing to food security and addressing the growing demand for this vital substance in Algeria, on the one hand, and on the other hand also contributing to the conservation of biodiversity and the deteriorating ecosystem as well as the effective management and management of marine fishing activity.

The descriptive analytical method was used in this research,using theoretical concepts of Marine Protected Areas, fish resources andfood security, as well as presenting mathematical equations demonstrating how this approach of Marine Protected Areascontribute to increasing fish production and thus supporting food security policies in Algeria in the long term, and alsoMicrosoft Excel data processing software has been used to draw diagrams.

2. Contribution of marine protected areas (MPAs)to supporting food security policies: theoretical approach.

Marine protected areas are defined as the recognized geographical space of the oceans and seas and their management by legal or other effective means(Kennedy & Aschenbrand, 2023), fully protected MPAs do not allow any fishing mining dredging or dumping activities and the biodiversity benefits of fully protected MPAs are well documented (Geneviev, Krueck, Ogier, Barrett, Dutton, & Hartmann, 2023). As defined by convention on Biological Diversity: «Any particular area in or near a marine environment, as well as Covered with water, flora, fauna and cultural features protected by law or any other law Other means window, including use, which means that this coastal and/or marine biodiversity benefits from a high level of protection those around it»(Chakour S. C., 2015, p. 57) .The legal framework to establish MPA has been widely discussed through multiple international forums and conferences and included in various instruments as a conservation measure of marine biodiversity(Oktivana, 2023), and MPA may be described as an area designated to protect marine ecosystems processes habitats and species including the essentials of marine biodiversity and which can contribute to the restoration and replenishment of resources for social(Boubekri & Borhane Djebar, 2016). The following objectives are the main objectives of MPAs:

- MPAs are therefore not only a boon for fishing activity but also for tourism, where the economic impact is instantaneous (the impact of MPAs is immediate)(Chakour S. C., 2015);
- According to the International Union for Conservation of Nature and Establishment of Protected Areas, MPAs are a means of optimizing marine resources and have significant benefits and benefits in achieving food security (Guedri, Bendehiba, & Bousalem, 2020);
- One of the fundamental aims of establishing MPA is to protect habitat and marine biodiversity and

improveviable fisheries(Oktivana, 2023).

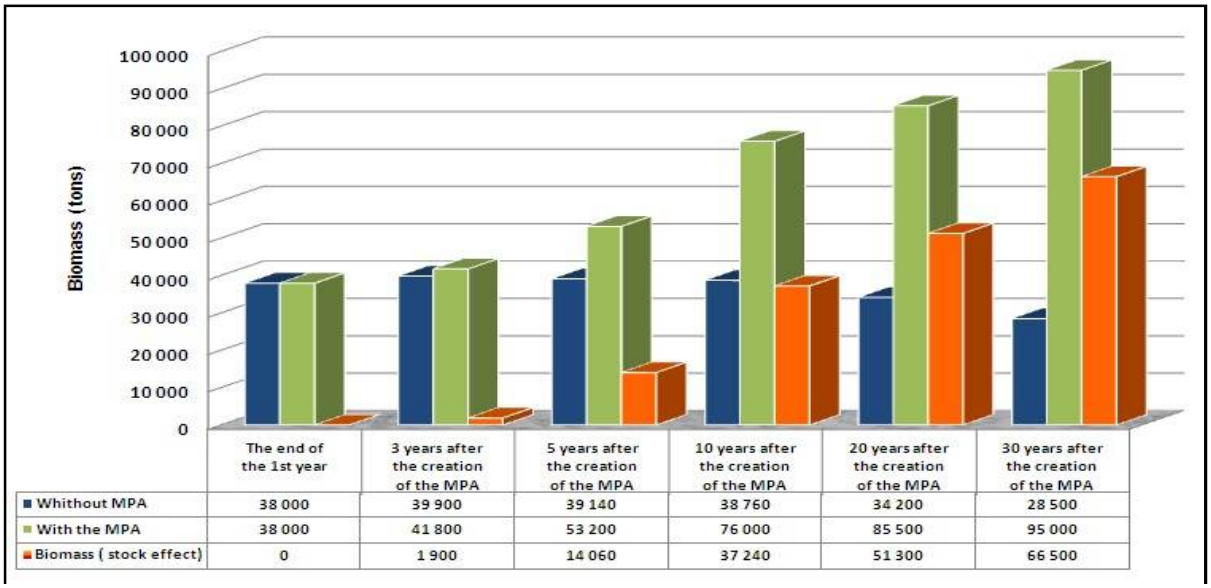
Based on the above, marine protected can contribute to achieving food security through:

- Impact on abundance of diversity size and biomass: MPAs are rapidly increasing biomass as well as increasing the abundance of many marine resources in the long term, by reducing the mortality of these resources and protecting them from various negative impacts. MPAs are also natural nurseries where plant and animal resources are rapidly growing and growing;
- Improving fish breeding rates: Increasing and improving the reproductive capacity of various marine organisms is most important for MPAs, as these improve breeding conditions and rebalance the proportion of female male sexes, which naturally increases and improves breeding capacity in marine communities;
- Contributing to the conservation of fish biodiversity MPAs contribute to the conservation of the biodiversity of fishery resources, by protecting scarce as well as endangered resources and fish such as whales, dolphins... etc. MPAs also serve to provide different species of fish to the consumer;
- Protecting fish's genetic diversity: marine ecosystems contain multiple species of fish genetic diversity is essential for each fishery species to protect its bioactivity, reproductive, interbreeding, disease and pest resistance, and resilience to environmental changes. And considering that human activities affect the biological characteristics inherited from fishery resources, for example, marine fishing activity targets a particular type of fish, or large-scale fish species, which gradually reduces their number, helping small-scale fish and other species to multiply;
- Protecting the sensitive cycle of the life cycle of fish resources: Marine reserves contribute to protecting the sensitive and critical stages of the life cycle of fish resources (larvae and micro-fish) and thus serve to ensure the continuity of different fish species of different ages.

2.1 Impact of Taza MPA on Fish Stocks:

From the benefits and benefits of marine protected areas (MPAs) to fisheries(Guedri & Chakour, 2015), fish that have multiplied within MPAs will extend to protected waters (Chakou & Guedri, 2014), increasing the number of fish available to fishermen and of course increasing the level of fish stocks outside the protected area(Guedri & Chakour, 2015), and thus increase the capability of marine fishing In addition, protectors allow the goal of sustainability of fishery resources and thus fish production and thus secure sustainable economic return for fishers(Guedri S. E., 2017), and in the Mediterranean, anthropogenic pressures on the marine environment are very pronounced with one of the fastest lateralization dynamics in the world (Chakour & Dahou, 2009). We will explain the impact of inventory on the biomass of Taza MPA Jijel State through the following figure:

Fig N° 1: Impact of inventory on the biomass of Taza MPA, Jijel State



	The end of the 1st year	3 years after the creation of the MPA	5 years after the creation of the MPA	10 years after the creation of the MPA	20 years after the creation of the MPA	30 years after the creation of the MPA
Whithout MPA	38 000	39 900	39 140	38 760	34 200	28 500
With the MPA	38 000	41 800	53 200	76 000	85 500	95 000
Biomass (stock effect)	0	1 900	14 060	37 240	51 300	66 500

Source: (Chakour & Chaker, 2014).

Through the above figure 01 we note that:

- ✓ Marine protected area (MPA) affect Biomass fisheries positively Fish stock increases in an escalating manner when MPA are established from the first (01) year;
- ✓ The fish mass on the MPA three (03) years after its establishment is estimated to be 41800 tons compared to a previous mass below the MPA is estimated to be 39900 tons, an increase in fish stocks by 1900 tons, up to **4.76%** from production without MPA;
- ✓ And the fish mass expected five (05) years after the MPA was established is estimated at 53200 tons and below the MPAs was estimated at 39140 tons, an estimated increase of 14060 tons, up to **35.92%** from production without MPA;
- ✓ Over the 10 year period, an estimated 76000 tons of fish mass is projected with the MPA at an estimated half mass an 38760 tons below MPA and thus an increase in fish stock of an estimated 37240 tons, up to **96.07%** from production without MPA;
- ✓ For 20 years, the expected fish mass is estimated at 85500 tons within the MPA, corresponding to an estimated amount of 34200 tons below the MPA, any increase in fish stock estimated at 34270 tons, up to **108.88%** from production without MPA;
- ✓ For 30 years, we are expecting an estimated fish mass of 95000 tons within the MPA, which is approximately four times the expected mass below the MPA, estimated at 28500 tons, with any difference in fish stock estimated at 66500 tons, up to **233.33%** from production without MPA.

Through the foregoing, we have found that marine reserves provide greater fisheries resources that may amount to more than three times the area without a marine protected area (MPAs) and thus contribute to

supporting Algeria's food security policies.

3.Method and Tools:

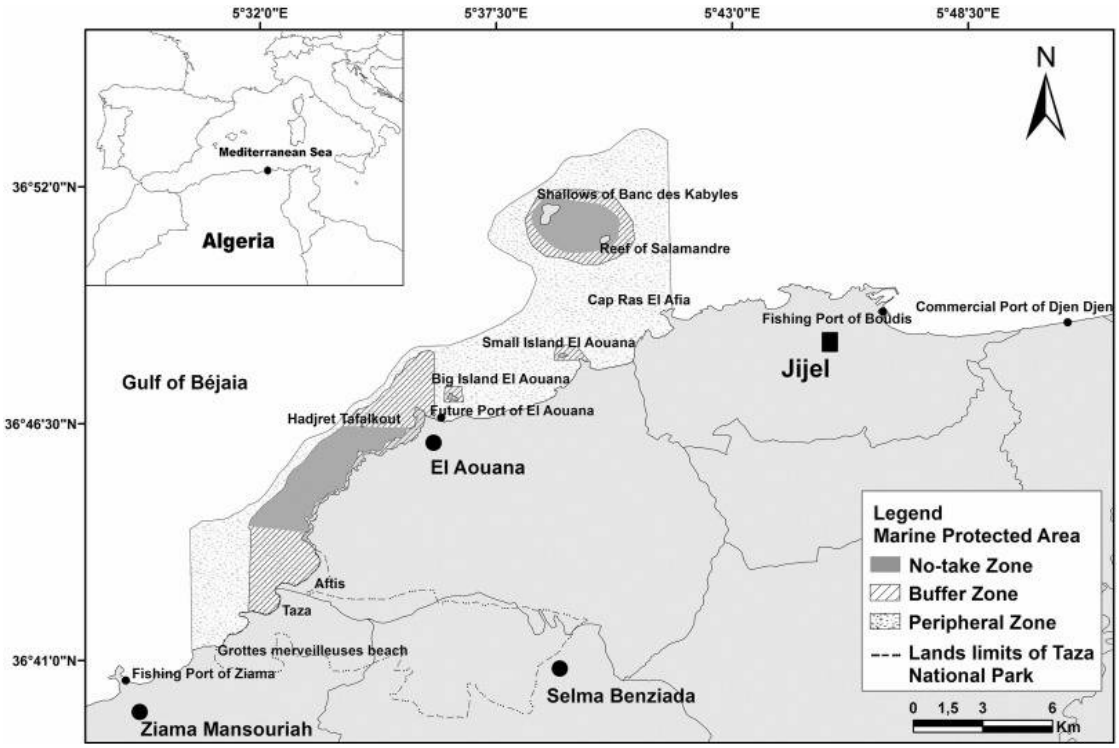
We used the analytical descriptive method in this study, using theoretical concepts of Marine protected areas (MPAs)and fisheries resources, as well as a computational experience showing how the establishment of Marine protected areas (MPAs)in Algeria contributes to increasing fish production in order to achieve food securityin these vital resources.

3-1 Case study (the future MPA of Taza):

The MPA of Taza is considered a maritime extension of the National Hangar of Taza, Jijel State The latter extends over an area of 837 hectares and is one of the national coastal barns located at the national level the Taza MPA is located in the eastern part of the gulf of Bejaia ,with an estimated coastal length of 31.4 km and is divided according to UNESCO's Ocean and Human Programmer for Biosphere Reserves where each reserve must contain three zones divided as follows (Guedri S. E., 2017) **:**

- **No-take zone**: called the Total Protection Zone, its role is to restore biodiversity, as well as to increase the stockpile of fishery resources;
- **Buffer Zone**: the Relative Protection Zone, often for environmental learning activities, is called recreational activities;
- **Peripheral zone**: where you are urging the local population to make sustainable use of the natural resources of the area, we find fishing activity from the activities permitted within it, and the next form shows the limits of the Taza MPA.

Fig N° 2:Map showing location and zoning plan of the future MPA of "Taza", Algeria.



Source:(Boubekri et al , 2018).

4. Results and discussion:

4.1Contribution of marine protected areas (MPAs)to the promotion of consumption of fish resources and food security in Algeria:

Protected areas are defined by the Algerian legislator as a territory that enjoys a legal status of protection in order to promote the conservation and sustainability of the Biodiversitythese areas are geographically defined and belong to one or more municipalities(Messali & Chakour, 2018).In this element, we will try to address the experience of the MPA Taza Marine area protected, as a leader model in Algeria under the auspices of the World Organization for the Protection of Nature (WWF), and then try to disseminate the findings of this experiment on all the Algerian coastal strip, where there are the same characteristics and at all levels;

Algeria's coastline extends over a large area of 1600 km and the area allocated for fishing activity is approximately 9.5 million hectares(Guedri & Chakour, 2015); Algeria also has a diverse and significant biological potential and an important reservoir of fish resources estimated at more than 1984 of high commercial and food value, as artisanal Small-Scale fisheries are a primordial and very diverse activity in the Mediterranean (Boubekri, Caveen, Borhane Djaber, Amara, & Mazurek, 2018), also within Marine Protected Areas (MPAs).

And fish consumption in Algeria is characterized by a significant decrease in comparison with the population, According to statistics from the Ministry of Fisheries and Fisheries Resources, Algeria's annual per capita consumption for 2012 was estimated at 4.112 kg/population compared to an estimated 37.1 million per year. and the standard consumption level required of this substance by the World Health Organization is estimated at 6.2 kg per year(Guedri S. E., 2017), a decrease in consumption due, inter alia, to fluctuating fisheries

production, population development, lack of a culture of improving the social status of fishermen and fisheries professionals, exports and imports of fisheries, as well as high prices for such fisheries and difficult access to consumers in some areas. The exploitation of Algeria's fisheries has gone through several stages through natural fisheries(Guedri S. E., 2017).

In this part of the article, we will try to present our simulation results by setting out two scenarios as follows:

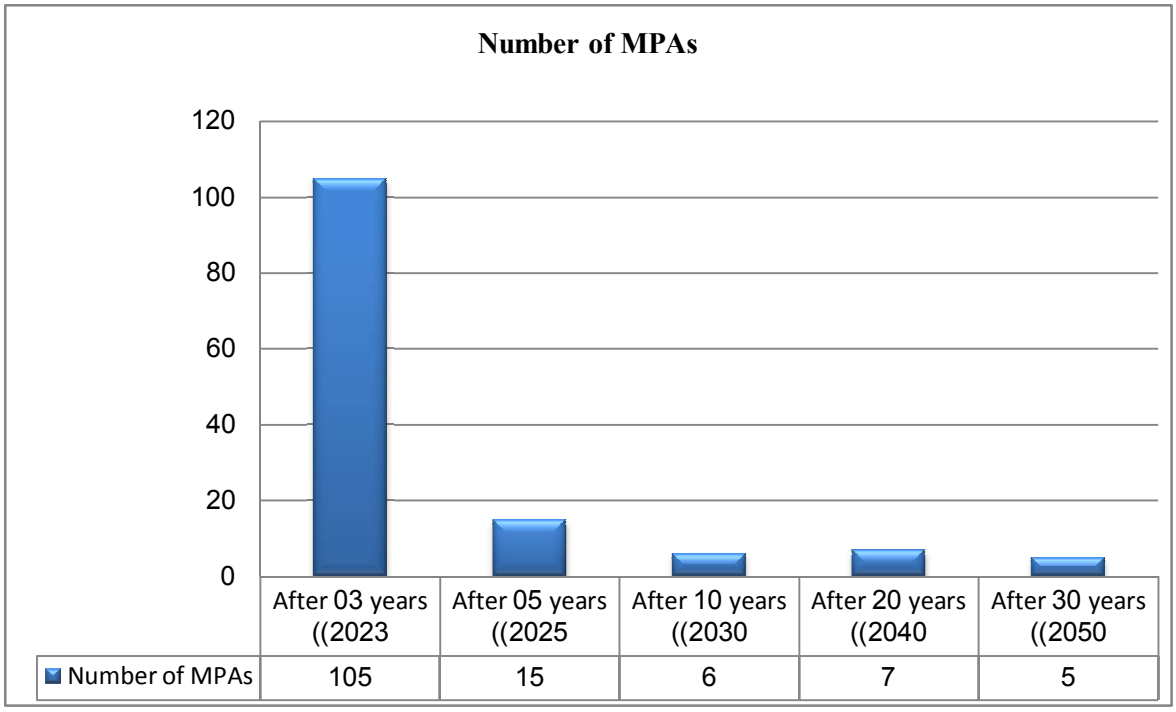
- Number of marine protected areas (MPAs) required to reach World Health Organization's (WHO) consumption rate;
- The establishment of a marine protected area (MPAs) in all 14 coastal states (thus creating 14 MPAs).

4.2 Number of marine protected areas (MPAs) required reaching World Health Organization's (WHO) consumption rate (6.2 kg/year per person):

Based on the World Health Organization's per person fish consumption level of 6.2 kg/year, according to figure 03 above, Algeria's per person consumption rate during 2019 was only 3,478 kg/year, for an estimated 104880 tons of population estimated at 43 million. In order to achieve the World Health Organization's (WHO) estimated at 6.2 kg/ year per person, we need to produce 186962.62 tons of fish, which shows the role of marine protected areas (MPAs) in providing fisheries resources as shown in the next figure, with the following hypotheses:

- First hypothesis: the increase in the population follows a sequential calculation of its first limit *x=43 (in 2019),*and basis *r=1.*
- Second hypothesis: aquaculture growth rate of all kinds *= 0%.*
- Third hypothesis: Persistent production of blue surface fish, his contribution to the rate of achievement is consistent at 6.2 kg/ year per person.

Fig N° 3:Number of Marine protected areas (MPAs) required achieving a rate of 6.2 kg/year per person



Source: realized by the authors, based on results of treatment with EXCEL.

Through the above figure, we note that over the next three (03) years, in order to reach the amount required for Algerian per person consumption in year according to the World Health Organization's (WHO) annual fish consumption rate, we need to establish approximately one hundred and five (105) marine protected areas (MPAs) in Algeria's coastal states by 2023, corresponding to that within fifth (05) years ahead that is by 2025, we note that the number is dropping to almost fifteen (15) MPAs, while in the next (10) years by 2030 we note that the number of MPAs is estimated at six (06) , while during (20) years and thirty (30) years of the next we note that the number required will decrease to seven (07) MPAs in the horizons of 2040 and five (05) MPAs in the horizons of 2050 respectively. This shows the impact of these marine protected on the long-term increase of fish mass.

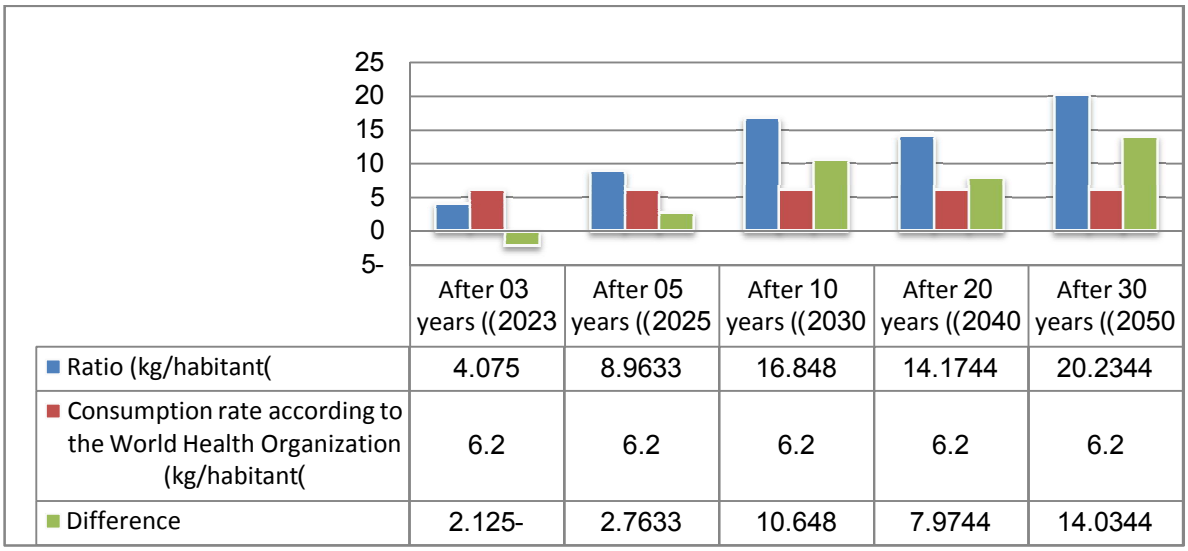
4.3 The rate of fish consumption if a marine protected areas (MPAs) is established in each coastal state:

In this part of the study, we will maintain the same previous hypotheses:

- First hypothesis: the increase in the population follows a sequential calculation of its first limit *x=43 (in 2020),*and basis *r=1.*
- Second hypothesis: aquaculture growth rate of all kinds *= 0%.*
- Third hypothesis: Persistent production of blue surface fish, his contribution to the rate of achievement is consistent at 6.2 kg/ year per person.

Based on previous hypotheses and after addressing our findings, we have reached the result of our research and explained in the following figure:

Fig N° 4:Fish consumption rate if one marine protected areas is established In each Coastal state (14 coastal states)



	After 03 years ((2023	After 05 years ((2025	After 10 years ((2030	After 20 years ((2040	After 30 years ((2050
Ratio (kg/habitant(	4.075	8.9633	16.848	14.1744	20.2344
Consumption rate according to the World Health Organization (kg/habitant(	6.2	6.2	6.2	6.2	6.2
Difference	2.125-	2.7633	10.648	7.9744	14.0344

Source:realized by the authors, the result of our research, treatment with EXCEL.

These Through Figure N.4 above, we found that if one of marine protected areas (MPAs) is established in each coastal state (14 coastal states) and after 03 years (in 2023), there will still be an estimated fish consumption deficit:- 2.125 kg/per person in year, but 05 years after the establishment of the MPAs (in 2025) the consumption rate rises to 8.9633 kg/per person in year (taking into account the increase in population), thus achieving an estimated surplus of +2.7633 kg/per person in year and 10 years after the establishment of a MPAs in each coastal state (in 2030), the consumption rate during the year rises to 16.848 kg per person, which will generate a surplus of +10.648 kg/per person, and the same for other scenarios until we reach an estimated surplus of +14.0344 kg/per person in year in the Horizons of 2050.

These findings demonstrate the significant role marine protected areas (MPAs) can play in this areas, as well as the potential to strengthen the balance of payments by exporting surplus resources.

5. Conclusion:

Marine protected areas (MPAs) play important and significant economic roles because of their contribution to the sustainability of fishing activity and the provision of a large amount of fish and marine resources, it also contributes to increasing national income and levels of economic output, creating functional opportunities and stable income for individuals, preserving biodiversity and protecting it from the risk of pollution, and is a tool to enhance food security by providing, increasing and upgrading consumption of fishery resources,MPAs have demonstrated their capability to supply a variety of benefits and profits in the Mediterranean basin, Algeria's public authorities must give great importance to the establishment and sustainability of these MPAs by disseminating the experience of the Taza MPA,it contains a large coastal territory rich in biodiversity and which has achieved positive results in this field, especially since one of the most

important problems of the lack of fisheries resources and the lack of their sustainability in Algeria is the absence of MPAs.

Results: Through this study

- ✓ we have found that Algeria's establishment of 5 marinesprotected areas (MPAs) in the horizons of 2049 leads to the global rate of fish consumption recommended by the World Health Organization, estimated at 6.2 kg/per person in year, this rate can also be achieved by establishing 7 MPAsin the horizons of 2040, That is the impact of the establishment of MPAs is long-term;
- ✓ If one marine protected area (MPA) is established in each coastal state (14 coastal states) we will achieve a surplus fish consumption during the year estimated at 14.0344 kg/ per person in the horizons of 2049, and also surplus at10.648 kg/ per person in year in the horizon of 2029, this confirms the first result which is that the effect is in the long term.

Recommendations: we propose in order to reach these results:

- Accelerate the establishment of marine protected areas (MPAs) to protect and increase fishery resources and to protect biodiversity in order to achieve food security in these vital resources;
- Emphasis should be placed on activating and updating specific legal texts of activities within MPAs by working to control fishermen's quotas and various activities to avoid various conflicts and engaging fishermen and local peoplewhile making decisions regarding MPAs;
- Control of various tourism and fishing activities within MPAs;
- Involve various experts and university elites from professors and researchers in preparing decisions and laws concerning MPAs and work to create academic and professional specializations for MPAs in universities, research centers and vocational training centers;
- Work on the good and effective functioning of MPAs, especially as international environmental forums call today for the need to adopt the blue economy of managing water resources in sustainable ways.

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