The Assessment Of Production Levels and The Algerian Fishing Fleet In The Western Mediterranean

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Abstract
Around the world, fishing is a significant industry that supports economies and food security of countries. Given the current circumstances of partial and insufficient fishery data in Algeria, it is imperative to begin an inventory of fishing activity and its statistics among Algeria's major harbours. The purpose of this study is to establish a description on the state of the fishery at the level of 13 maritime ports, including 06 maritime sectors (Ain-Temouchent, Oran, Mostaganem, Chlef, Algiers, and Tlemcen) where the state of knowledge is very limited. Also, the current work was conducted to generate information that facilitates the understanding of the functioning of the fishery including data on the fleet and total production of the 05 major fishery groups (small pelagics, large pelagics, demersals, crustaceans and molluscs). The methodology consisted of an analysis of data from the official reports of the fisheries directorates, on statistics from 06 maritime sectors and 13 ports in central and western Algeria between 2010 and 2015.
Our findings indicate that both, the fishing activity of the fleet segments increased during 2015, as well as the quantity of vessels (trawler and sardine fleet). Among the results, we found a production rate of 85% of small pelagics followed by 10% of demersal, 2% of crustaceans and molluscs and lastly only 1% of large pelagics with a total fleet size of 1799 gears and a maximum of 49584.43 tonnes in the 13 harbours combined in 2015.
Statistical analysis demonstrates a strong correlation between mollusks and demersals ($r>0.80$), as well as between crustaceans and small pelagics ($r>0.60$). However, no significant relationship was found between large pelagic species and other fish groups. Furthermore, principal component analysis (PCA) reveals correlations between trawlers and demersals, small pelagics, molluscs, and crustaceans, indicating the use of this gear for catching these fish in Algeria. Conversely, tuna seiners and large pelagics display a correlation. The findings contribute to a better understanding of Algerian fisheries, highlighting key aspects such as fleet composition, production rates, and intergroup correlations.
Keyword : Fleet, Algreian fishing, fishing gears, Landig, harbours, Mediterranean region.

1. Introduction

Since the early days, in the Mediterranean and the Black Sea there have been an important fisheries activities (FAO, 2018). In the area nowadays, a wide range of fishing gear is used by industrial, semi-industrial, and small-scale fishers. Mediterranean and Black Sea fisheries generally do not have monospecific stocks and instead use a diversity of benthic and pelagic fish stocks, as well as shellfish. Fishing has long been important in the Mediterranean and Black Ocean, as these are semi-enclosed seas without many exclusive economic zones (EEZs), so stocks are frequently shared by vessels from several nations.

The Food and Agriculture Organization compiles annual reports on international official landings, which are gathered by national statistics authorities at the country level (FAO). The reliability of each member country's fisheries landings data has a considerable impact on the accuracy and potential discrepancies of FAO statistics.

The nations with the biggest fishing capacity in gross tonnage (GT), accounting for 60% of the total. These nations are Turkey, Italy, Egypt, and Tunisia, in decreasing order of significance. Small pelagic fish (herrings, sardines, and anchovies) make up the majority of catches. Across the GFCM (General Fisheries Commission for the Mediterranean) area of application, Turkey continues to dominate capture fisheries production (321 800 tonnes, or 26% of total landings, down from 31% previously recorded), followed by Italy (185 300 tonnes) (FAO, 2018).

The fishing fleet is unevenly spread throughout the GFCM application region, with the eastern Mediterranean having the highest percentage of vessels (30.6%), followed by the central Mediterranean (26.4%), the western Mediterranean (17.3%), and the Black Sea (17.3%). Greece (65 700 tonnes and 5%) and Algeria (96 300 tonnes and 8 %) continue to contribute the same percentages to landings. When compared to Tunisia (185 300 tonnes) and Croatia (74 400 tonnes) both exhibit an increase (from 7 to 9 % for Tunisia and from 3 to 6 % for Greece). Spain saw fewer landings overall (78 200 tonnes, decreasing from 8.5 % to 7 % of the total). (FAO, 2018), The viability of the Mediterranean maritime fishery

is increasingly threatened due to the low productivity of overexploited stocks, the weak economic performance of fisheries and the supply unattractive jobs, between This has resulted in a decrease of 30% in the number of fishing units active in European Union Mediterranean fisheries over the period 1995–2016 (Maynou., 2020).

With a coastline that stretches more than 1,280 km and a marine region that offers about 9.5 million hectares for fishing, Algeria's fisheries and aquaculture resources have significant economic potential. Fishing statistics have been studied in several areas of the Algerian coastline, among others by Furnestin (1961), Simonnet (1961), the western Algerian region by Dalouche (1980).

Fisheries resources and products are essential sources of food and employment, therefore their worth to a nation cannot be assessed just by how much it contributes to GDP (gross domestic product). The self-renewability of fishery resources is another factor contributing to their significance. This implies that they have an almost limitless time span if they are properly controlled (FAO, 2003).

The purpose of this research is to provide a comprehensive description of the fishery's status of 13 harbours in the six marine areas of Ain-Temouchent, Oran, Mostaganem, Chlef, Algiers, and Tlemcen in which there is a lack of information. Data from 2010 to 2015 will be included in this assessment.

2. Materials and methods
2.1. Study area description
Fishery and aquaculture resources in Algeria represent considerable economic potential, characterized by a coastline of more than 1280 km and a maritime surface under national jurisdiction offering nearly 9.5 million hectares for fishing.

The Algerian coast is characterized by these two layers of superimposed water, the water modified Atlantic and Mediterranean waters. Indeed, Atlantic water enters the Alboran Sea where its initial characteristics begin to alter, thus giving rise to a modified Atlantic water (Benzohra, 1993). This same author lists this water in the Algerian basin where it is recognised in a surface layer 150 m thick, with a temperature of 15 to 23°C at the surface and 13.5 to 14°C at depth and salinities varying from 36.5 to 38‰. Along the Algerian coast, the modified Atlantic water describes a more or less stable flow before splitting into two branches. In the Algerian basin, the modified Atlantic water would penetrate (Millot, 1987; Millot, 1993 and Benzohra, 1993) in the form of a narrow current vein that gives rise to meanders and coastal eddies associated with upwellings. The latter would favour high biological productivity and therefore increase the trophic capacity of the environment.

2.2. Data collection and procedures
A survey asks is used to deliver informations to management, It is based on the following aspects it was completed and validated from 2010 to 2015. The data was gathered from commercial fisheries landings reported by the fisheries directorates of 13 ports located in 06 maritime sectors in central and western of Algeria. Enquiries allowed us to collect statistical data on fishing, notably on the fleet and the annual production of the groups fished at the level of the fisheries directorates of the Ministry of Fishing and Aquaculture of 13 ports (Marsa Ben M'hedi, Ghazaouet, Honaine, Beni-Saf, Bouzedjar, Oran, Arzew, Sidi Lakhdar, Mostaganem, Ténès, El Djamila, Algiers and Tamentfoust) of six maritime sectors (Tlemcen, Ain Témouchent, Oran, Mostaganem, Chlef and Algiers) respectively **(Fig. 1)**.
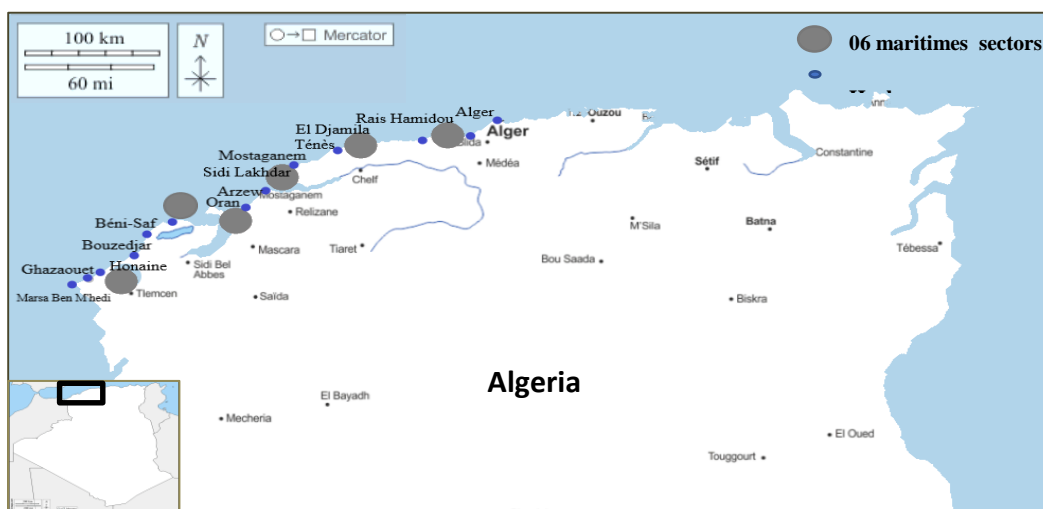
Fig. 1. Study zone in Algerian western coast including the main fishing areas and harbours.

2.3. Statistical analysis
Principal component analysis (PCA) was conducted to understand the covariance structure and identify relationships between the variables. The correlation matrix is used to standardise the variables which are not measured on the same scale. Factor analysis is used to understand the correlation between the variables instead as the dimension of the variables are small. The Varimax method is used to produce orthogonal transformations to the reduced factors so as to better identify

the high and low correlations. Pearson's correlation coefficient was used to assess correlation between fishing gear and production rate. All statistical studies were performed using STATISTICA Statsoft 13.

3. Results

The results are obtained from the data archived at the fisheries and resources directorates halieutic resources of the maritime sectors, In this study, we present the evolution of the fleet segments and total production rate of 13 ports over a period of six years from 2010 to 2015.

The figure 2 shows an evolution of the number of vessels (Fishing gear) on the 13 harbours of the Algerian west and central coast between 2010 to 2015. Displays a shift in the amount of gears from one port to another, small craft constitute a significant share of the fleet, which is followed by sardine boat, trawlers, and tuna Seiners.

The statistics relating to the national fleet are based on the number of vessels registered annually and holders of the license to exercise the fishing activity. These statistics reflect above all the economic potential of the fleets, on the one hand, and on the other hand, it represents the fishing effort expressed by the number of vessels and the number of trips at sea.

With regard to large ports, we find that the number of vessels stabilised for all four segments between the period 2011 and 2012, and we also observed a significant increase in the number of fishing vessels at fishing port level and even at fishing shelter level (**Figs. 2 and 3**). Our results are consistent with those of Maouel, 2015, who indicates that during the period 1990 to 2013, the number of vessels of all types tripled from 1548 to 4583 fishing units, an indexed evolution of 296%.

In 2010, the number of vessels decreased by 7.5% compared to 2009 due to the lack of registration of vessels immobilized by the non-repayment of bank credit fees, which explains and confirms the fish crisis according to D.I M (maritime infrastructure department, 2012), the Algerian fishing fleet is characterized by a fairly high rate of immobilization i.e. non-active boat (MPRH, 2014). The causes are multiple and are summarized by the lack of spare parts, lack of qualified mechanics and climatic conditions (Maouel, 2003).

The figure 2 shows that the number of sardine boat in the port of Bouzedjar is higher than the other ports, while trawlers are more numerous in the port of Ghazaouet, Bouzedjar and Algiers. However, the number of small craft is clearly more represented in Ténès.

Regarding the fleet, The Aïn Témouchent fleet with its two harbours (Bouzedjar and Bénisaf) predominates the other maritime sectors, estimating a number of 141 small trades and 87 trawlers 109 seiners and a total of 84 ships at the port of Bouzedjar. In addition, the port of Ténès represents a total of 144 artisanal fishing vessels, while the port of Ghazaouet has the largest number of trawlers, estimated at 74.
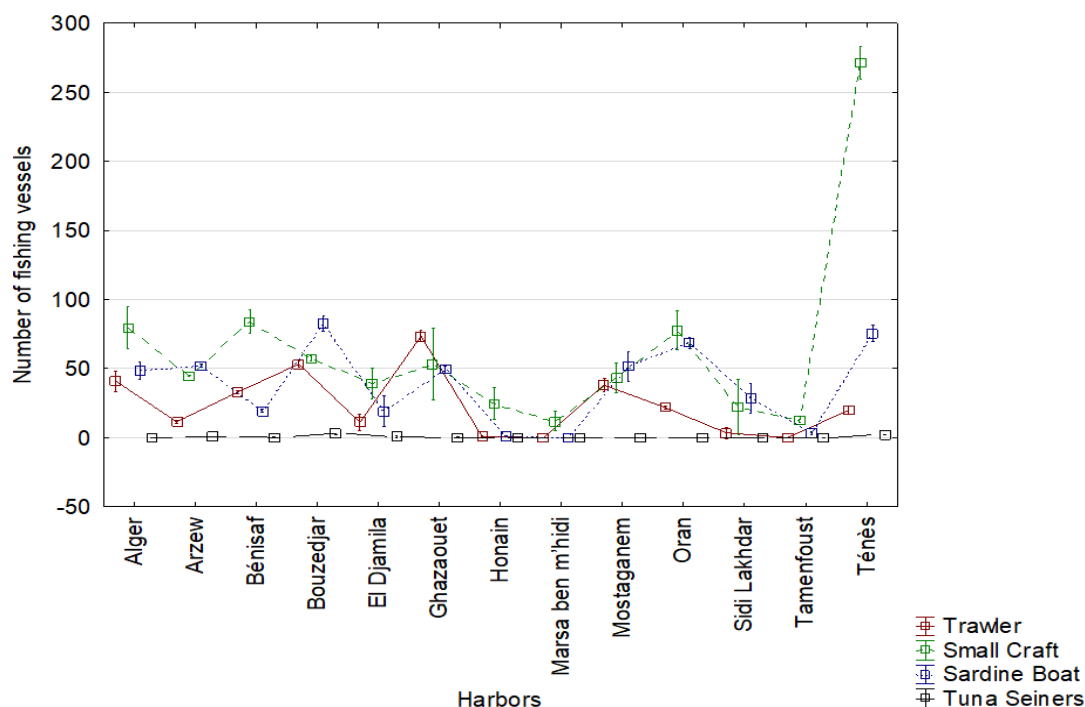
Fig 2 : Evolution of the number of vessels of the 04 segments on the 13 harbours of the Algerian west and central coast between the year 2010 to 2015.

The geographical distribution of the total fleet reveals a paradoxical fact, as the western region appears to be the least endowed in terms of fleet, contrary to the central and eastern regions, while the stock of species groups is not distributed in the same way between these three regions. From 2010 to 2015, the fleet underwent a major evolution, as seen in figure 3.
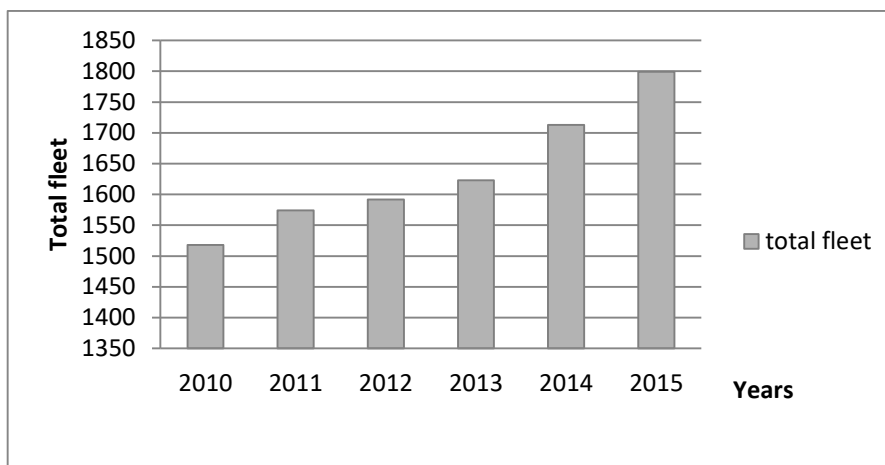
Fig. 3. Evolution of the total fleet from 2010 to 2015 in 13 harbours.

Figure 4 shows the harbours those have a wide range of production, the rate production of small pelagics (85%) is followed by demersal (10%), crustaceans and mollusks (2%) and finally large pelagics (1%). Figure 5 demontrates fluctuations from one port to another, reaching the maximum production in 2015. From the figure 6, we notice that the total production during the six years at the harbour level of Ghazaouet is the highest, it is equal to 4 855 7.33 tons per year followed by the harbours of Mostaganem and Bouzedjar which represent almost the same rate of production which exceeds 43 000 tons.
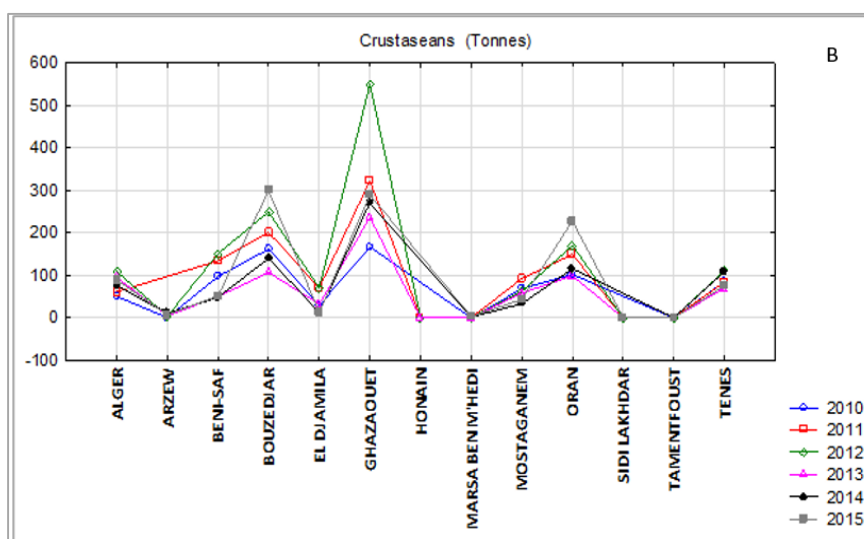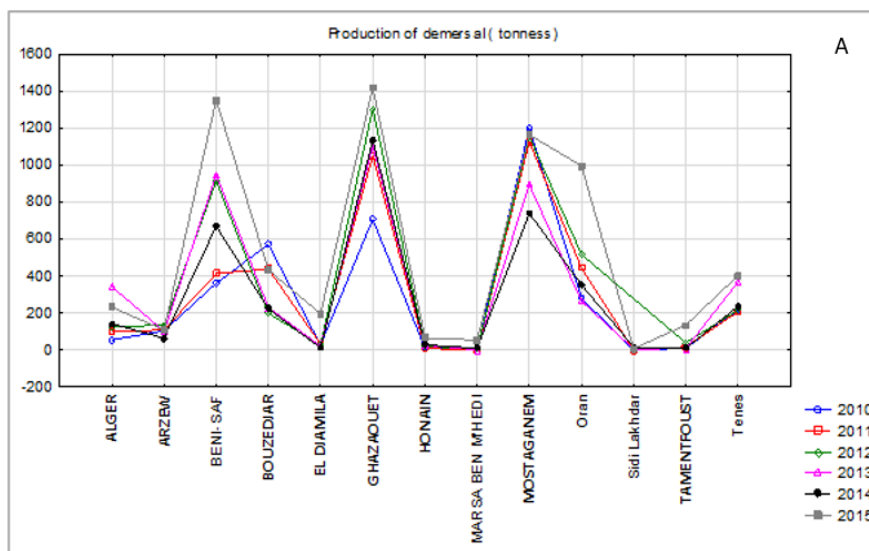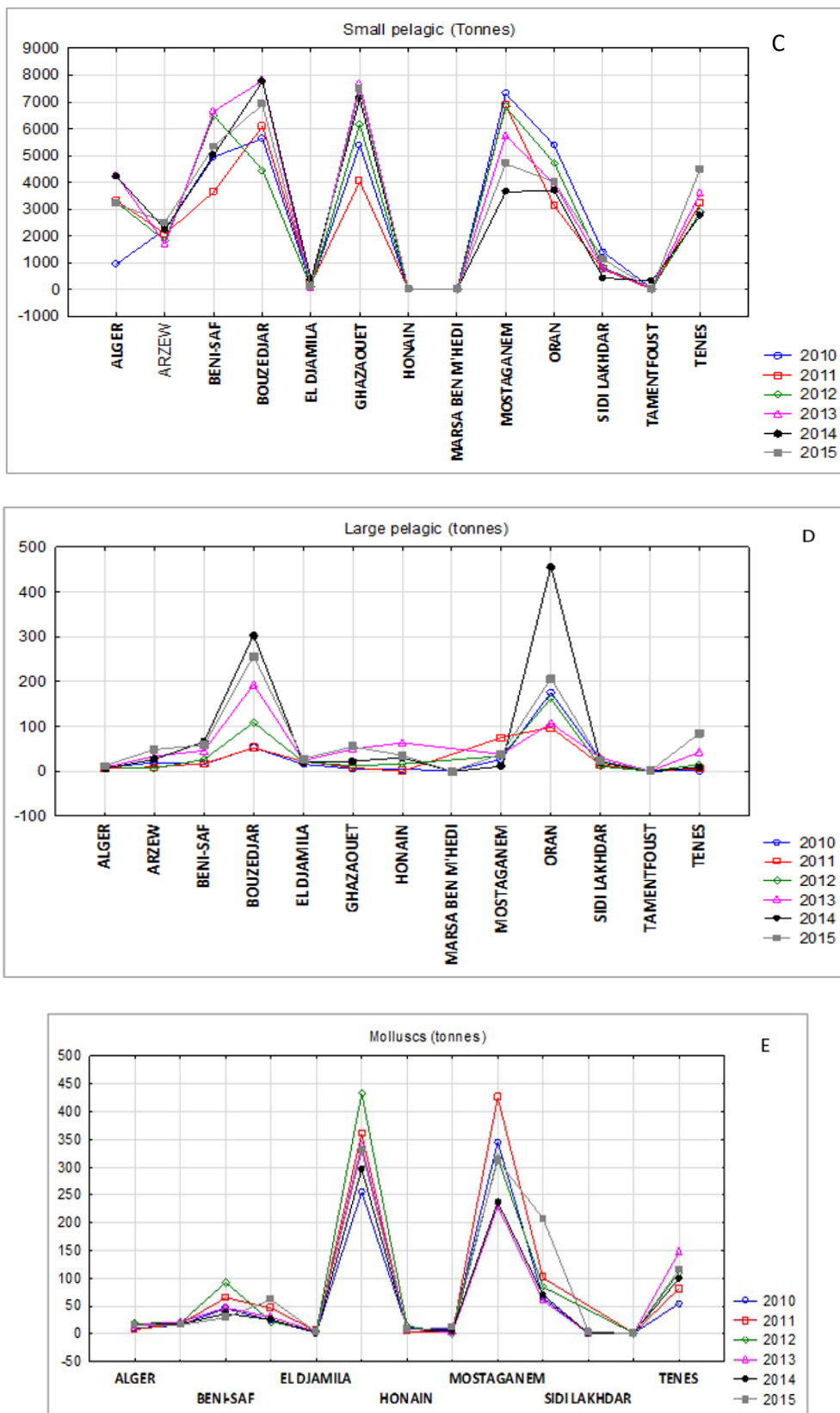
Fig 4 : Production of the main items fished in the 13 harbours of the six maritime sectors
(A : demersals, B : crustaseans, C : small pelagic D : large pelagic, E : , molluscs)
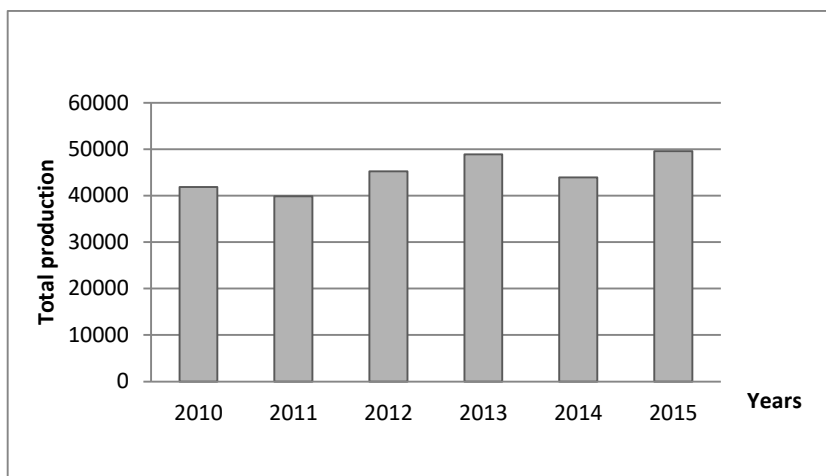
Fig. 5 : Total production of the five fishing groupes (small pelagic, demersals, crustaseans molluscs, large pelagic) during six years.
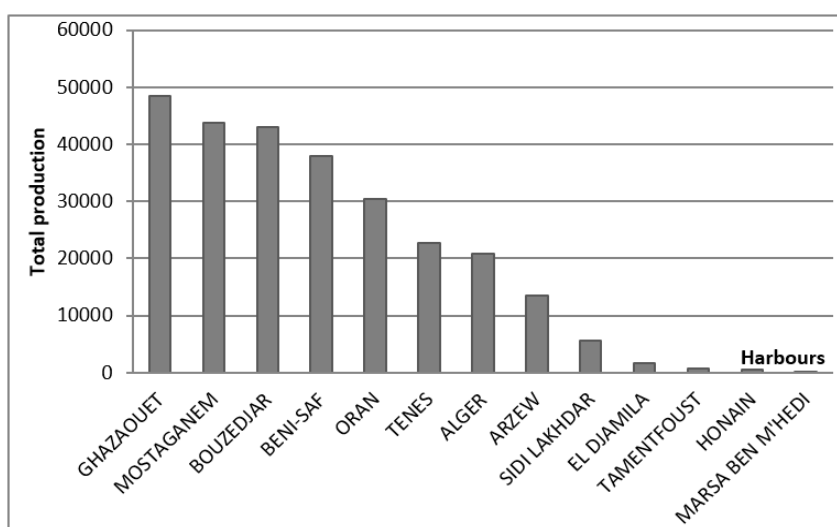

Fig 6. Total production during the six years at the 13 harbours of six maritime sectors.

Two axes were considered to describe between the variables related to the spatial structure, keeping only 84.5% of total information with 64.26 for axis 1 and 20.28% for axis 2. Respectively **(Fig.7)**.
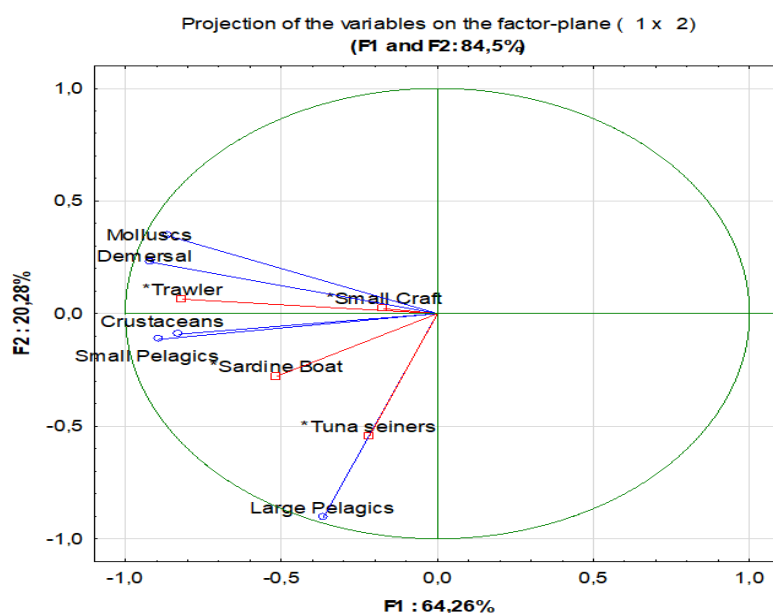

Fig 7. Principal component analysis of vessels and fishing groups

4. Discussion

It is estimated that there are nearly 84100 fishing units operating in the Mediterranean Sea, including 71780 inshore fishing (85.4%), 8500 trawlers (10.1%), 2890 purse seiners (3.4%), 100 tuna boats (0.1%) and 830 others (1%) (CGPM, 2006). Fishing activity in Algeria revolves around three major fishing segments: trawlers, sardine boats and small crafts. At the end of 2009, the national fishing fleet was estimated at 4,532 units, including 494 trawlers, 1,077 sardine boats, 2,935 small-scale boats and 15 tuna seiners, recording an increase of 2% compared to the previous year. However, a growth of 84% was recorded in 2009 compared to 1999. (MPRH., 2010). They land their production in 62 landing points (Hachemane and Bernardon, 2013).

The finding of this study clearly show a development of the fishing activity of the four segments of the fleet, with a continuous increase in the number of vessels in the five major fishing groups of the maritime Sectors of Tlemcen, Aïn Témouchent , Oran, Mostaganem, Chlef, Algiers. On the other hand, we noticed a decrease in the number of fleets from 2011 to 2012, on the harbours of Algiers and Mostaganem, and almost a stalling in the harbours of Ténès, Arzew, and Bouzedjar which could be explained by the strict application of the legislation (MPRH, 2004). According to many authors, In the western Mediterranean, the stock of small pelagics is overexploited, while in the Est of the region it is moderately exploited (Sacchi, 2011 ; Vasilakopoulos et al., 2014 ; Cardinale et al. 2017) which suggest that reducing the size of the fleet (capacity reduction) or attempts at limiting fishing effort have been and will continue to be inefficient in managing Mediterranean fisheries.

The results of stock assessment, using different data sets and methodologies, indicate excessive fishing mortality applied to the majority (80–90% of assessed stocks) of Mediterranean fish stocks (Colloca et al., 2013; Froese et al., 2016; STECF, 2017 and 2019). The Mediterranean fisheries management model should move to limit the fishing mortality of juvenile fish (improve selectivity and/or protect nursey areas), set up an efficient monitoring, control and enforcement program. The socio-economic effects of stronger management are anticipated to be negative in the short term (Froese et al, 2016).

The total production of 13 harbours in western and central Algeria during the 10-year period represents a very high rate of 85% of small pelagics. Our results agree with data from the FAO (2004) In (Kherraz, 2015) where the world production of pelagic species also constitutes the largest part of the world's marine catches, (small pelagics: herring, sardines, anchovies, etc.) representing 22.5 million tonnes of the total catches because small pelagics are of great socio-economic importance in the world.

The largest pelagics: tunas, pelamides, marlins account for 17.7 million tonnes of total catches. Demersal fish: (flounder, halibut and sole, cod, hake, haddock and fish) representing total catches of 12.3 million tons. Miscellaneous coastal fish remained stable at 6.1 million tons, while crustaceans: crabs, lobsters, shrimps, krill and miscellaneous crustaceans stood at 5.8 million tons. Molluscs: squid, octopus, etc., rose slightly to 6.8 million tons. From the biological richness point of view, the continental margin of Algeria conceals significant halieutic resources, in particular, its pelagic resources estimated at 191 468 tons during the acoustic campaign carried out by the oceanographic vessel "THALASSA" in October 1982. (ISTPM, 1982), and 187 000 tons are estimated during the acoustic campaign carried out in February 2003, carried out by the Spanish oceanographic vessel Vizconde de eza (MPRH., 2004). It can be seen that the wilaya of Ain-Temouchent with its two harbours Bouzedjar and Béni-Saf have the highest total landings in the other sector. But the port of Ghazaouet has the highest total landing compared to other ports. This could be explained by the great use of pelagic trawling by trawlers operating in this sector and the richness of the area in nutritious foods caused by the entry of water currents from the Atlantic to the Mediterranean.

The gears that target sardines or small pelagics in general are primarily the seine net and the rope trawl. This trawl was introduced in Ghazaouet in the early 1990s. According to the CNRDPA survey in August, 2012, 80% of the trawl fleet at this port have had a rope net for the past seven years, moreover its use varies with the season, especially during the period of biological rest. (Hachmene and Bernardon, 2013).

The information collected showed that landings of demersal species and molluscs from Bouzedjar, Ghazaouet and Mostaganem occupy first place, as they represent a fairly large catch. Similarly, the landing rates are highest in the sectors of Aïn-Témouchent and Tlemcen. The existence of bentho-pelagic (demersal) and benthic species in the environmental sectors can be explained by the presence of an ideal geomorphology for bottom species, by the presence of marine subterranean canyons (Canals et al., 2006), but above all by the contribution of organic matter by rivers, the entry of water from the Atlantic to the Mediterranean. According to our results we notice that the landing of the sector of western Algeria is more important compared to the sector of the center. it could be explained by the decrease in production and productivity moving away from the Strait of Gibraltar towards the east and indicating a trophic impoverishment of the Mediterranean which represents a biodiversity of only 0.8% of surface area and less than 0.25% of the volume of the oceans. In the world, contains about 7% of the world's known marine fauna and 18% of the world's marine flora, 28% of which are endemic.

Furthermore 10,000 to 12,000 marine species have been recorded in the Mediterranean and have been the subject of a valid scientific description, where there are 694 described species of marine vertebrates. This guide includes information on 530 species of fish (3 agnathans, 86 cartilaginous fish and 441 bony fish, 5 turtles, 21 marine mammals and 340 invertebrates including (62 crustaceans, 104 bivalve molluscs, 94 gastropods, 53 cephalopods and 27 belonging to d other groups) (FAO, 2002 in Benghali, 2015).

Most of the Algerian fish production comes from the West region (40.93%), followed by the Center with 33.76% and finally the East with 19.5%. This is because of the nature of the continental shelf which narrows from west to east and the entry of water masses from the Atlantic to the Mediterranean (Ounnaci, 2003).

Similar to data on fisheries resources in Algeria, the annual potential is estimated between 160 000 and 300 000 tons per year, but this remains far from being achieved knowing that production has been difficult to exceed the threshold of 100,000 tons/year since 2007. Conforming to the 2018 edition of The State of Mediterranean and Black Sea Fisheries, there are currently about 86,500 fishing vessels in the region. Their number has decreased by about 6,000 (or six percent) in the last two years, due to measures taken by several countries to adapt their fleet capacity to the available resources. However, the actual size of the fleet is likely to be larger: in some countries there is little data on this issue,
During the period 2014-2016, reviewed in the 2018 edition of The State of Mediterranean and Black Sea Fisheries, the average annual volume of landings in the Mediterranean and Black Sea combined was 1 220 000 tons, slightly higher than the volume of landings recorded in 2013, but lower than the annual average for the period from 2000 to 2013 (1 473 429 tons).
The newest statistics indicate that overall landings in the Mediterranean and Black Sea have climbed by 2 to 3 percent, despite the fleet not growing since 2016. Just over half of the overall catch comes from pelagic trawlers and purse seiners that fish for anchovies and sardines. In 2018, 1 175 700 tons of fish were taken in the Mediterranean and Black Seas combined. Three nations collectively make up than 50% of this total volume, with Turkey coming in second with 273 977 tons (23.3%). Italy contributed 178 723 tons (15.2%), and Algeria recently replaced Tunisia as the third-largest provider by volume with 103 008 tons (8.8%). (Bertrand et al., 2020)
The main producing countries remain Turkey, Italy, Tunisia, Algeria (8%), Spain and Croatia. In these countries, fishing is an important sector and fishery resources are accessible. In general, the volume of national landings has remained stable since 2013 (Pauly., 2017), these results are in the same way with our study.

Since the Ministry of Fisheries and Fishery Resources' main objective is to meet the needs of the population while maintaining the aspect of the sustainability of our resources, fishing production has increased significantly over the past ten years. However, this sector has faced challenges due to the decline in production levels, which only manages to ensure 5.10 kg/inhab./year in 2006 given the interest of fshery products in human nutrition (Bertrand et al., 2020).
As a results of the principal component analysis (PCA) reveal that crustaceans and small pelagics are well correlated, with a r Pearson value of 0.66, whereas mollusks and demersals are highly correlated (r of Pearson = 0.85). They are caught by the same equipment, which explains this (Trawler). However, it was shown that there was no evidence of a correlation between large pelagic species and other species (r of Pearson 0.38). They get ensnared by another device (Tuna seiners).
A good correlation was found between demersal (Pearson's r =0.70), small pelagic (Pearson's r =0.84), molluscan (Pearson's r =0.64) and crustacean (Pearson's r =0.75) with the trawler, which shows that in Algeria, these fish are caught by this gear. According to the PCA results, small pelagics are also correlated with the sardine boat (Pearson's r =0.63). However, the large pelagics are correlated with the tuna boat (Pearson's r =0.52). The latter are fished by this gear.

5. Conclusion
In conclusion, the findings of this study, based on field surveys, personal commercial fishing statistics, and data from the Directorate of Fisheries and Halieutic Resources, provide valuable insights into the fishing fleet and landings in major Algerian harbors. The analysis indicates a stabilization of the fishing fleet in most harbors, with the exception of Algiers and Mostaganem, where there have been discontinuous trends and even a decrease in the four vessel segments between 2011 and 2012. Additionally, the study observes an evolution in fishing harbors and shelters.

Among the fourteen ports studied, there is a significant dominance of small pelagic species in terms of landings, followed by demersal species and crustaceans, which hold a higher economic value but are caught in lesser quantities. The statistical analysis reveals a strong correlation between crustaceans and small pelagics, likely due to their shared capture method (trawler), while mollusks and demersals also exhibit a high correlation. However, there is no evidence of a correlation between large pelagic species and other species, as they are caught using a different device (tuna seiners). These findings have important implications for the assessment and management of fisheries resources. Local, national, and international strategies for fishing in the Mediterranean should consider the results of this study. Recommendations stemming from this work include conducting economic and social evaluations of coastal and marine water consumption at the national and Mediterranean levels and investigating the usage and management of marine species that are at risk due to fishing activities. By implementing these recommendations, sustainable fisheries practices can be promoted, ensuring the long-term viability of Algerian fisheries and contributing to the broader conservation efforts in the Mediterranean region.

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