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Status of Fisheries in Gaza Strip: Past Trends and Challenges

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This paper comprehensively portrays fisheries' past trends and current status in the Gaza Strip, relying on the literature review and own data collection. Gaza is a politically contested territory that has not been the subject of a targeted analysis with the view to shaping measures for more effective fisheries management. In order to contribute to this, the article first discusses gaps that may impede effective management and then highlights future challenges. Total seafood production has grown steadily overall in the last 15 years due to the rapid growth of aquaculture alongside an increase in fisheries production (87%) from 1995 to 2020. The fishing fleet of the Gaza Strip increased by 269%, from 647 motorized vessels in 1995 to 1741 vessels in 2020. Gillnets, trammel nets, longlines, purse seine nets, and driftnet were the fishing gear most used by motorized vessels, followed by trawlers. Despite efforts through national legislation to address fishery management problems, weak enforcement, low compliance, and unregulated fishing remain a serious challenge. Fisheries stakeholders, including funders of development aid to Gaza, have to consider the

social and political context of these fisheries when developing suitable management strategies.

Key Words: fisheries, aquaculture, Gaza, fisheries management, subsistence fisheries

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INTRODUCTION

The Food and Agriculture Organization (FAO) of the United Nations works to achieve food security for all, ensuring people have regular access to enough great quality food to live dynamic lives. The fisheries and aquaculture sector contribute considerably to food security and nutrition, particularly in some of the world's most food-limited areas, while at the same time, supporting the income of hundreds of millions of people everywhere in the world. To save these incomes for present and coming generations, constant attention to the sustainable use of natural resources is required (FAO 2020).

Most of the world's fish production comes from developing countries (e.g., tropical fisheries). In many of these countries, management methods are used that do not comply and are not eligible for the formal stock evaluation procedure (Griffin and Mahon 1997). The same fisheries management approaches are often attempted to be used in developing countries, leading to mismanagement of some of the related fisheries (Ruddle and Hickey 2008). For example, the model of a marine protected area (MPA) was seen as traditionally and socially defective and unsuitable in some developing countries (Ruddle and Hickey 2008) and is only gradually being adjusted to promote the sustainable use of natural resources and promote ecosystem services (Hill et al. 2016). An effective co-management with local communities is needed all the more since some of these countries have limited resources for imposing rules and guidelines inside the MPA, which then leads to weak compliance (Samy-Kamal, Sánchez Lizaso, and Forcada 2011). A key factor contributing to their ineffectiveness and the status of 'paper parks' is non-compliance with the rules in place (Mora et al. 2006; Guidetti et al. 2008; Rife et al. 2013; Advani et al. 2015).

Part of the Palestinian Authority, the Gaza Strip (or Gaza), is located at the southeast corner of the Mediterranean Sea, but separated from the other part of the Palestine-West Bank. The area is mostly ignored as a specific subject of study in Mediterranean regional fisheries management, despite occupying 42 km of coast and [181]
contributing to the fishing pressure in the area. In efforts to support the development in Gaza, several international sponsors and partners are working to promote the fisheries and aquaculture sector here. The European Union (EU) and the German Agency for International Cooperation (GIZ) supported the development of blue economy analysis in the Gaza Strip, and the Food and Agriculture Organization (FAO) has a long history in fisheries sector development in Gaza. Recently, FAO started a marine cage aquaculture pilot project with financing from the Italian Development Cooperation. The Japan International Cooperation Agency (JICA) has also supported the aquaculture sector's capacity development via training programs conducted in Indonesia and Egypt. At a regional level, the Gaza Strip and West Bank are involved in scientific and institutional cooperation to support accountable fisheries in the Eastern Mediterranean, supported by FAO, EU, Italian Ministry of Agriculture, Greece Ministries (The World Bank 2020). Sustainable fisheries development and improving the value-chain of fisheries and aquaculture sectors have the potential to increase more job opportunities and economic development activities.

So far, few studies have been published on the state of fisheries and aquaculture in Gaza. To contribute to increasing the socioeconomic benefits of the fisheries sector, while enabling progress on ecological sustainability, this article presents and examines the fisheries and the fisheries sector in Gaza. Previous studies (Abd Rabou 2013; 2019; Abu Amra 2018; Shaheen 2016; Abudaya, Harper, and Ulman 2013; MENA 2001) studied the current status of the marine fisheries and aquaculture sectors in a simplified and concise manner. However, most of them tended to be poor in recent data related to both sectors. The General Fisheries Commission for the Mediterranean (GFCM) is working with the Palestinian Ministry of Agriculture and the FAO office in Palestine to scale up marine fisheries and

aquaculture development to contribute toward the creation of new jobs, the improvement of livelihoods and the recovery from the recent social and economic influences (FAO 2022). The present article provides the first attempt to offer a comprehensive written account
[182] of the Gaza fisheries sector.

The analysis relies on data gathered from the index and non-index published articles, unpublished reports, questionnaires, interviews with the Directorate of Fishery and fishers' staff, and related institutions and organizations. A methodical search was conducted to attain pertinent literature relating to fisheries in Gaza. Some of the data were attained through a predefined search in Google Scholar: (search terms: fisheries in Gaza, Mediterranean fisheries, aquaculture in Gaza, etc.). Results of the study were not limited to texts available only in English or peer-reviewed journals, but was also extended to Arabic reports and un-indexed journals. The data on fisheries landings and fishing effort characteristics found in the collected data spanning from 1995 to 2020 was collated by that held by the General Directorate of Fisheries (DOF) in the Ministry of Agriculture (MOA) (and included published and unpublished reports), the organization responsible for managing Gaza's fisheries, and by FAO statistics. Additionally, interviews and questionnaire surveys with the fishers and related stakeholders and organizations, as well as with related institutions in the Gaza Strip were conducted to amend the statistics.

The general goal of this paper is to outline the status of fisheries in the Gaza Strip, as well as to identify the main gaps related to fisheries management. The paper is made up of three segments: (i) the first reports on the main characteristics of fisheries and aquaculture, including total production trends; trends in landings per species, trends in landing per gears used; catch composition, fishing effort, and socio-economic aspects, where existing knowledge is particularly poorly documented; (ii) the second part provides an overview of the management regulations and analyses their weaknesses in promoting effective management;(iii) based on the findings, key starting points for the management of the Gaza Strip fisheries are discussed in the third segment.

KEY FEATURES AND TRENDS IN THE FISHERIES SECTOR

The Gaza Strip is a narrow part lying along the south-western portion of the Palestinian coastal plains, located between longitudes [34° 20' and 34° 25' east] and latitudes [31° 16' and 31° 45' north], [183]
its area about 365 km². The length is approximately 42 km on the western Mediterranean coast, and the width varies from 6 km to 12 km. The Sinai desert is situated in the south, the Naqab desert in the east, and the Mediterranean Sea in the west (Aish 2013). The population density in the Gaza Strip is measured to be high compared with other areas in the world (5,936 persons/km²), with a population of 2.1 million people and a growth rate of 2.8% at the end of 2021 (PCBS 2019). Gaza is found in an arid to semiarid country; all the rainfall takes place between October and April. Average rainfall ranges between 400 mm/yr in the north and 230 mm/yr in the south (https://water.fanack.com/palestine/climate-and-rainfall/). The fisheries sector in Gaza is divided into two parts, namely the marine fisheries and aquaculture, and they are described as follows:

Marine Fisheries

The fishing zone of the Gaza Strip is locally known as the area along the coast that stretches up to 20 nautical miles (nm) offshore, but due to political instability, not all of these waters are being used for fishing. The fishing area has largely been dictated by the Israeli authority's imposition of rules on Gaza. At its best, the fishing zone in the Gaza Strip fluctuates between three and six nautical miles and rarely exceeds that.

Initially, in 1994, the fishing area was divided into three different maritime activity zones, named K, L, and M; zones K and M are border buffer zones, zone K being situated between Gaza and Israel (20 nm offshore and 1.5 nm wide), and zone M between Gaza and Egypt (20 nm offshore and 1 nm wide), while fishing is restricted within these zones. Zone L extends 20 nm offshore and is open to fishing by fishers from the Gaza Strip according to the 1994–1995 Oslo agreement. However, as Israel has repelled the implementation of this agreement, fishing was further limited to within 12 nm, re-

ducing the total fishing area to about 660 km² (Melon 2011). Israel's administration has been gradually confining Gaza fishers to access the sea, particularly after the second uprising (in 2000). In 2006, the fishing zone was further reduced to 6 nm. Following the Israeli op-
[184] eration (2008–2009), Israel banned Gaza fishers from functioning beyond a distance of 3 nm from shore, in that way preventing them from accessing 85% of the maritime area they are allowed according to the 1994 Gaza-Jericho Agreement (Melon 2011), also leading to conflicts between Gaza fishers and the Israeli Navy (Akram and Rudoren 2012).

The restrictions lasted until December 2012, and after the intervention of several international organizations, the fishing zone was increased back to 6 nautical miles. This continued until March 2013 when fishing boundary were again returned to 3 nautical miles until May 2013, shifting back to an area of 6 miles until October 2016. In November 2018, the fishing area's capacity returned to 9 nautical miles, with the southernmost point being Wadi Gaza and the northernmost point close to the Israeli border being 6 miles. The permitted fishing zone has now been extended to 9 miles from the northern side close to the Israeli border to the Wadi Gaza side, 12 miles from the wadi Gaza side to the central area, and 15 miles from the central area to the southern side of the Gaza Strip close to the Egyptian border.

Over the past two decades, the Israeli military has gradually increased the restrictions on access to the fishing areas along the Gaza strip coast. Since early 2009, Gaza fishers have been largely prevented from accessing the waters beyond 3, 6 and 9 nm from shore. Thus, Gaza fishers are now prevented from accessing around 50 to 85% of the maritime areas they are entitled to access according to the Oslo agreements. On the other hand, the spatial restriction enforced on Gaza fishers may have served as a de-facto no-take marine reserve, and thus may have the potential to enhance longer term stock status and stock productivity (Abudaya et al. 2013). This fluctuation in the fishing area distance is due to the complex security situation in the Gaza Strip, where the restrictions imposed on the fishing area are constantly changing, and which has a significant im-

pact on the landing process and the fishing fleet operating in the area.

The fisheries sector in Gaza has played a significant role in food security and is a lively source of employment. Presently there are 3,982 registered fishers in the Gaza Strip. This implies about 27,874 [185] people directly rely on fishing for their livelihood. Seeing the total population in the Gaza Strip is approximately 2.1 million people, almost 7% of the population depends on the fisheries sector. Generally, the number of registered fishers has increased from 1,600 in 1995 to 2,305 in 2001; 2,750 in 2007; 3,606 in 2016; and 3,982 in 2020. Most individuals working in the fisheries sector are deprived. According to the DOF in the MOA, about 90% of the fishers live below the poverty line. At present, fishers live with less than (200–250 US$) a month. Per capita income from fishing has decreased from (450–900 US$) before 2007 to less than (200–300 US$) in 2020. In the nineties, owners of large vessels, such as trawlers (locally called Gar) and Purse seine (locally called Shanshula), preferred to work in fishing as it was better than working in other sectors – which is not the case anymore. It was reported that in Gaza, the unemployment rate is beyond 50% while the poverty level has reached 53%, even though the maximum number of people categorized as poor take aid from the government and international organizations. Gaza is gradually becoming very difficult to live in under the worsening socioeconomic circumstances. In 2018, its local economy was constricted by 7%, leading to a 10% decrease in its per capita income (UNCTAD 2019). The study area includes four fish landing sites from the north (1) Gaza city fishing port, (2) the Deir Al-Balah landing site, (3) the Khanyounis landing site, and (4) the Rafah landing site.

Aquaculture

Fish farming operations are considered one of the most important economic activities in the Palestinian territories. A study previously noted that there are about five fish farming projects working in the governorates of the Gaza Strip. Five planted fish species have been cultured, including Oreochromis hybrids (Red Hybrids Tilapia), Oreochromis niloticus (Nile Tilapia), Sparus aurata (Gilt-

head Seabream), Mugil cephalus (Flathead Grey Mullet) and Clarias gariepinus (African Sharp Tooth Catfish) (Shaheen 2016). Fish farming is an essential source of income in light of the limited employment opportunities provided by the Palestinian private sec-
[186] tors. Many investors have twisted to fish farming operations in the coastal area of the Gaza Strip. Aquaculture farms use saline water from the onshore wells as the primary water source and release the wastewater to the sea during the water exchange and harvest, basically without any treatments. At present, two main aquaculture farms are functioning in Gaza, called Al Bahar farm and Fish Fresh farm.

The Al-Bahar farm area is about 16,000 m^2 and was established in 2014 in the Gaza Governorate. The fish farm (31° 29' 22.02' N, 34° 24' 6.8394' E) is located near the beach of Gaza and receives about 13,440 m^3 of marine salty water from beach wells. The farm is semi-intensive, consisting of 30 cylindrical ponds used for overfeeding and hatchery purposes. The ultimate water discharge takes place via manholes direct to the sea. The farm workers examine the ammonia level and salinity in the pipes to ensure that the water is suitable for fish farming and use copper sulphate to combat fish diseases in the ponds. The Fish Fresh farm area is about 32,000 m^2 and was established in 2009 in the Rafah Governorate, which lies in the southern Gaza Strip. The fish farm (31° 20' 37.6074' N, 34° 14' 44.1954' E) is located near the beach of Rafah and receives 28,800 m^3 of marine salty water from beach wells. The farm is semi-intensive, consisting of 25 cylindrical ponds used for overfeeding purposes. The water supply comes through beach wells. Qualified workers measure ammonia, dissolved oxygen, temperature, and salinity levels in the pipes. No sterilization methods are used inside the farm to control fish diseases.

STATUS OF FISHERIES IN GAZA

Total Production Trends

Up to 2005, marine fisheries were the primary sources of national production in Gaza, around 2683tons annually. However, aquaculture production has grown rapidly during the last decade, but is not

TABLE 1 Statistics of Marine Aquacultures Fish Production from 1997 to 2020 in Gaza

Year	(1)	(2)	Year	(1)	(2)	Year	(1)	(2)
1997	3790	–	2005	1813	–	2013	2421	232
1998	3620	–	2006	2323	17	2014	2858	150
1999	3665	–	2007	2702	37	2015	3101	300
2000	2600	–	2008	3243	65	2016	3306	350
2001	1950	–	2009	1855	115	2017	3129	435
2002	1507	–	2010	1724	130	2018	3038	650
2003	1507	–	2011	1403	159	2019	3795	650
2004	2952	–	2012	1938	257	2020	4660	750

NOTES Column headings are as follows: (1) marine production (tons), (2) aquaculture's production (tons). Based on unpublished DOF data.

reflected in the annual national production growth rate. The total national output has increased steadily in the last ten years. Between 1997 and 2008, fish catches have varied from a maximum of 3,790 tons in 1997 to a minimum of 1,507 tons in 2003, depending mainly on the political situation and partly on the quality of the biannual sardine seasons. Although in 2005 and 2008 there was a steady increase from 1,814 to 2,845 tonnes caught, the reduction in Gaza's fishing zone to 3 NM has dropped the fish catch to 1,525 tons in 2009. By 2011, the fish catch decreased further to 1,492 tons, while in 2020, the fish catch increased further to 4,660 tons. Despite its modest fishing industry, Gaza's fisheries sector is a significant source of employment, income, and a supply of high-protein food for the Gazans. The incorporation of fish into the Gazan diet, and the large source of protein it represents, is limited by seawater contamination through untreated sewage, lack of fuel to operate boats, and the ongoing limitation of fishing grounds. According to the statistics of the MOA in 2015 and 2020, the volume of Sparus aurata (Gilthead Sea Bream) production reached 220 tons; in 2016, the production was 350 tons; in 2017 the production was 435; and as the production of Sparus aurata (Gilthead Sea Bream) in 2019 and 2020 reached 650 and 750 tons respectively, the production was recorded at 159 tons in 2011, showing that fish production from aquaculture farms is on the increase (table 1).

Trends in Landings per Species

According to the study conducted by the World Bank, the main landing fisheries species in the Gaza Strip are small pelagic fisheries of Engraulis spp. and Sardina Spp. Other larger landed fisheries
[188] species are Pagellus Erythrinus among demersal fisheries, Protuns Spp. among crustacean, and Loligo Spp., Octopoda, Sepia spp., or Nautiluses among the Cephalopod class. In the Gaza Strip, there is no systematic recording of fish landing amount nor fish stock assessment. A stock assessment of the Sardinella aurita, among the pelagic fisheries, and the Saurida undosquamis, amongst the demersal fisheries, was conducted in 2018 and 2019, respectively, together with a joint effort of the DOF and FAO. The most important types of fish caught in the Mediterranean Sea along the Gaza Strip coast were identified during this study. This was conducted by distributing a questionnaire to the fishers and the owners of the used fishing vessels. Besides this, data were collected from the DOF and reports published online. The findings of these stock assessments demonstrated over-harvesting, with the stock of Sardinella aurita being moderately over-harvested and the stock of Brushtooth lizardfish (Saurida undosquamis) highly overexploited (World Bank, 2020). Table 2 shows the landed fish per species in the Gaza Strip from 2018 to 2020.

Trends in Landings per Gears Used in Fishing

The DOF collects landed fish data by (i) trawling gear by trawlers, (ii) purse seining gear by large purse seiners (Shanshulas), (iii) purse seining gear by Hasakas with motors, (iv) longline gear by Hasakas with motors, (v) driftnet gear by Hasakas with motors, and others. There are two main fish catch seasons throughout the year, including the spring season, which starts from mid-March and ends in the middle of June, while the second autumn season begins from the beginning of September and ends in November. The high fishing season is May, and the low fishing season is from November to March. According to our knowledge, there are no observers on vessels; thus, the landed fish and estimated catch fish are not the same. There are slight variations in the recorded data.

TABLE 2 Overall Landed Fish per Species in the Gaza Strip

Species	Group	2018	2019	2020
Engraulis spp. (Anchovies)	Pelagic	562.2	974	945
Sardina spp. (Sardines)	Pelagic	480.2	549	636
Protuns spp. (Swim Crab)	Crustacean	442.4	511	572
Scomber scombrus (Atlantic mackerel)	Pelagic	221.7	266	326
Auxis rochei (Bullet tuna)	Pelagic	137.4	161	187
Loligo spp. (Squid)	Cephalopod	134.2	151	171
Penaeus spp. (Prawn)	Crustacean	129.2	145	156
Etrumeus spp. (Round herring)	Pelagic	91.6	110	140
Siganus spp. (Pinspotted Spinefoot)	Demersal	82.5	102	121
Trachurus spp. (Atlantic horse mackerel)	Pelagic	68.9	86	112
Pagellus erythrinus (Common Pandora)	Demersal	66.9	82	108
Scomberomorus spp. (Spanish mackerel)	Pelagic	64.2	80	98
Sillago sihama (Northern whiting)	Demersal	51.2	64	75
Saurida undosquamis (Brush. lizardfish)	Demersal	46.9	59	72
Other species		459.6	455	941
Total		3039.1	3795	4660

NOTES In tons. Based on unpublished DOF data.

Landed Fish by Trawling Gear (Trawlers). Almost 35-50% of trawler catches are Protuns spp., and about 15% of trawler catches are Penaeus spp. Trawlers also catch squid, Spanish mackerel, common Pandora, Brushtooth lizardfish, and red mullets. The main target is prawns due to their high value. Most of the landed prawns are already packed in boxes in the trawlers. Upon arrival at the fishing port of Gaza city, they are transported to the West Bank and some high-end restaurants in the Gaza Strip. If the checkpoint is not open, landed prawns are kept at cold storage at Al-Tawfeek Cooperative (TC) or traders. Meanwhile, other landed catches, including swim crab, are mostly sold at local markets in the Gaza Strip. Table 3 shows the landed fish by trawlers in the Gaza Strip from 2016 to 2020.

Landed Fish by Large Purse Seining Gear (Shanshulas). The large purse seine gears used by Shanshulas target small pelagic fish. Engraulis spp. and Sardina spp. are the main fish, as well as Trachurus spp. and Etrumeus spp. With Engraulis encrasicolus from spring to autumn and Sardina spp. from autumn to spring, Shanshulas can catch small

TABLE 3 Landed Fish by Trawlers

Species	Group	2016	2017	2018	2019	2020
Protuns spp. (Swim Crab)	Crustacean	271.19	279.38	392.75	400.34	425.40
Penaeus spp. (Prawn)	Crustacean	115.01	100.81	127.41	122.46	146.37
Loligo spp. (Squid)	Cephalopod	46.34	35.13	50.15	46.67	64.16
Scomberomorus spp.	Pelagic	48.02	47.14	47.96	54.03	61.64
Pagellus erythrinus	Demersal	60.21	42.02	46.07	52.01	62.06
Saurida undosquamis	Demersal	9.80	14.06	33.75	34.17	44.93
Mullus spp. (Red mullets)	Demersal	35.42	22.43	26.88	29.64	39.23
Sillago sihama	Pelagic	10.30	7.60	16.51	17.21	32.21
Sphyraena Chrysotaenia	Pelagic	9.61	15.72	14.34	15.94	23.42
Sepia spp. (Cuttlefish)	Cephalopod	21.60	12.90	8.52	10.12	25.21
Other species		100.41	62.14	50.48	66.73	117.88
Total		727.92	639.33	814.82	849.32	1042.51

NOTES In tons. Based on unpublished DOF data.

[190]

TABLE 4 Landed Fish by Large Purse Seining Gear by Shanshulas

Species	Group	2016	2017	2018	2019	2020
Anchovies	Pelagic	821.10	528.25	368.06	488.51	539.77
Sardines	Pelagic	401.41	148.74	177.59	234.96	253.92
Scomber scombrus	Pelagic	131.97	110.36	163.12	216.37	245.62
Etrumeus spp	Pelagic	22.15	27.45	89.29	118.14	126.94
Loligo spp	Cephalopod	36.19	33.12	48.83	64.82	71.41
Auxis rochei	Pelagic	51.16	73.29	39.83	51.77	55.54
Trachurus spp	Pelagic	37.10	35.59	29.29	25.02	32.19
Other species		90.33	182.13	165.89	235.54	262.17
Total		1591.41	1138.93	1081.90	1435.13	1587.56

NOTES In tons. Based on unpublished DOF data.

pelagic fish throughout the year. The fishers raised concerns regarding the decline of fish catches in past years and recognized regional and local issues. As small pelagic fish migrate in the Mediterranean Sea, it requires regional management, but there is insufficient coordination. There was also recognition of the lack of local coordination, as some Shanshulas use small mesh size nets. Table 4 shows the landed fish by large purse seiners in the Gaza Strip from 2016 to 2020.

TABLE 5 Landed Fish by Hasaka with Small Purse Seining

Species	Group	2016	2017	2018	2019	2020
Anchovies	Pelagic	189.04	335.94	194.04	204.41	295.78
Sardines	Pelagic	205.60	122.67	179.74	188.61	281.92
Auxis rochei	Pelagic	76.15	242.11	86.89	176.6	257.2
Siganus spp.	Demersal	60.23	55.09	74.56	62.83	57.87
Scomber scombrus	Pelagic	15.97	10.74	57.87	54.87	67.16
Loligo spp. (Squid)	Cephalopod	16.29	33.51	33.77	35.51	56.17
Sillago sihama	Demersal	0.76	6.61	32.48	23.11	35.12
Trachurus spp.	Pelagic	25.79	43.59	32.08	31.15	39.67
Liza spp. (Mullets)	Pelagic	5.30	6.59	10.54	7.43	11.12
Other species		125.75	252.07	136.95	99.20	184.37
Total		720.87	1108.89	838.91	883.72	1286.38

NOTES In tons. Based on unpublished DOF data.

Landed Fish by Hasaka. Hasakas with motors (small-scale fishing vessels) use different fishing gear, depending on the fishing season. The collected landed fish data were determined by the five types of gear used by Hasakas small purse seining, longlines, driftnet, gillnets, and trammel nets. While some Hasakas use only one type of gear, most Hasakas use multiple types. The target fisheries of small purse seining Hasaka overlap with those of Shanshulas, but the fishing zone is different, because Hasakas fish are closer to the coastal area. Longline fishing by Hasaka targets demersal fish. Their fish catch total is smaller, but higher in value; thus, they target high-end markets, including restaurants in the Gaza Strip. Tables 5, 6, and 7 show the landed fish by Hasaka with small purse seiners, Hasaka with longlines, and Hasaka with drift nets in the Gaza Strip from 2016 to 2020.

Fishing Effort

There are four fish landing areas in the Gaza Strip. These sites are managed by the Ministry of Transport (MOT), collaborating with the Ministry of Agriculture and the Palestinian Coastal Police (PCP). While Gaza city fishing port has solid facilities with the harbour, the other three landing sites have limited facilities with a limited landing extent in the coastal areas. All the landed fish are made up to use

TABLE 6 Landed Fish by Hasaka with Set Longlines

Species	Group	2016	2017	2018	2019	2020
Epinephelus spp.	Demersal	10.20	11.92	8.06	9.23	18.02
Pagellus erythrinus	Demersal	4.64	5.20	7.07	8.07	9.03
Carcharhinus spp.	Chondrichthyes	4.81	11.35	3.32	4.21	12.10
Balistes capriscus	Demersal	1.45	1.58	2.64	1.81	3.24
Rhynchobatus	Chondrichthyes	1.82	2.33	1.72	2.01	4.03
Pagrus spp.	Demersal	2.22	0.95	1.31	1.20	2.30
Dasyatis spp.	Chondrichthyes	0.91	0.93	1.23	1.02	1.91
Argyrosomus regius	Demersal	0.88	0.40	1.21	1.34	2.04
Diplodus spp.	Demersal	1.99	0.73	1.00	0.92	1.45
Auxis rochei	Pelagic	0.82	1.03	0.98	1.06	0.99
Seriola dumerili	Pelagic	2.80	2.32	0.83	1.02	3.07
Other species		1.52	0.74	0.76	5.57	17.95
Total		34.06	39.48	30.12	37.46	76.13

NOTES In tons. Based on unpublished DOF data.

[192]

one of these four fish landing sites. Still, informal landing and transhipment are happening due to the limited capacity and the poor conditions of existing landing areas. Among the total recorded fish catch, 73.3% land at Gaza city port, 7.2% at Deir Al-Balah, 11.3% at Khanyounis, and 8.2% at Rafah (based on unpublished DOF data). There are only two ice plants available that supply ice for fishers. One is at Gaza fishing port, operated by TC, and the other is at Rafah landing site. A fishers' syndicate in Gaza plans to establish an ice plant in the Deir Al-Balah landing site. Currently, there are about 1741 registered vessels in the Gaza Strip distributed in four fishing ports (table 8). Gaza port includes the most significant number of vessels, followed by Deir Al-Balah. There are mainly five types of fishing vessels (i) Trawlers, locally called Gar, (ii) Purse seiners, locally called Shanshula (including large purse seine and small purse seine), (iii) Small Hasaka with motor (including drift nets and longlines net fishing gears vessels), (iv) Felucca, which accompany Shanshula, and (v) Hasaka with oars.

The overall total number of fishing vessels increased from 647 in 1995 to 1741 in 2020. Vessels are made of wood or fibreglass. Originally most of the vessels were made of wood. Still, recently the

TABLE 7 Landed Fish by Hasaka with Driftnet

Species	Group	2016	2017	2018	2019	2020
Sardines	Pelagic	123.18	38.86	122.21	314.50	325.80
Protuns spp.	Crustacea	7.53	9.99	20.40	51.23	67.21
Carcharhinus spp.	Chondrichthyes	3.66	6.32	16.30	30.12	45.23
Sphyraena Chrysotaenia	Pelagic	3.48	3.43	13.94	24.21	30.64
Scomberomorus spp.	Pelagic	19.49	14.10	12.50	19.86	28.63
Saurida undosquamis	Demersal	1.50	4.39	11.46	22.13	22.84
Auxis rochei	Pelagic	4.58	11.37	9.68	19.91	25.12
Pagellus erythrinus	Demersal	21.11	10.80	9.58	16.21	21.13
Sepia spp.	Cephalopod	13.01	12.89	7.44	15.12	19.61
Trachurus spp.	Pelagic	6.26	.51	6.51	11.02	15.09
Mullus spp.	Demersal	0.541	1.83	2.96	5.92	7.08
Rhynchobatus	Chondrichthyes	2.81	1.23	0.96	1.25	2.04
Liza spp.	Pelagic	0.46	0.221	1.76	0.92	1.06
Hirundichthys rondeleti	Pelagic	0.15	30.84	1.55	15.09	16.12
Loligo spp.	Cephalopod	0.601	37	1.48	12.03	21.09
Other species		23.66	9.98	7.66	29.85	18.90
Total		231.47	162.80	247.41	589.37	667.59

NOTES In tons. Based on unpublished DOF data.

TABLE 8 Fishing Vessels by Type and by Landing Areas in the Gaza Strip

Landing area	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gaza port	14	42	59	426	7	299	847
Deir Al-Balah	0	1	28	120	1	231	382
Khan Younis	0	4	21	89	14	156	284
Rafah	0	5	22	96	11	93	228
Total	14	54	130	731	33	779	1741

NOTES Column headings are as follows: (1) trawler (gar), (2) large purse seiner (shanshula), (3) small purse seiner (shanshula), (4) hasaka with motor, (5) felucca, (6) hasaka with oars, (7) total. Based on unpublished DOF data.

fishers started renewing their vessels with fibreglass, because it is lighter in weight, easy to do maintenance, lower in costs, and provides a longer boat life, besides the restrictions imposed by the Israeli occupation on importing and usage of long wood, obliging fishers to turn to fibreglass. The number of operational vessels peaked at 1036 total in 2011 when fishers could get cheap fuel from Egypt

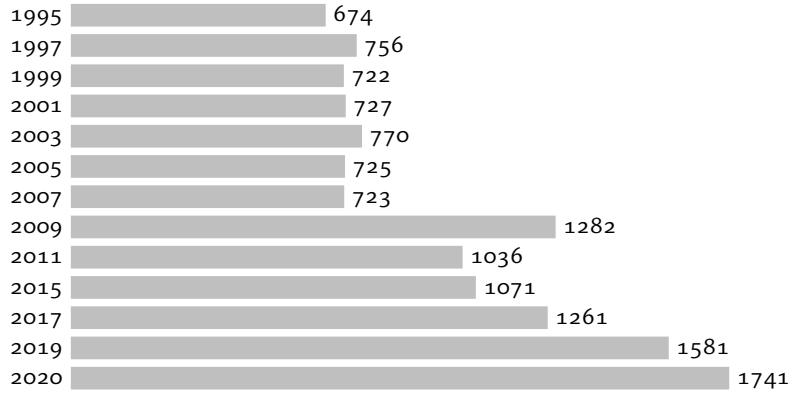

FIGURE 1 Number of Vessels in the Gaza Strip from 1995 to 2020 (based on unpublished DOF data)

around 2010 to 2013. Not all registered vessels are in operation. Figure 1 shows the fluctuating number of vessels in the Gaza Strip from 1995 to 2020. Not all registered vessels are active either, because owners cannot afford to maintain their vessels, and do not renew their licenses or pay license fees, while fishers cannot afford operating costs and may have security concerns. For example, the total number of trawlers and Shanshula vessels in 2012 was 888, but only 218 were operating (25% of the registered vessels were operational) (FAO 2016). In the workshop course during February 2020, conducted by the World Bank in Gaza, the participants discussed the actual operating rate of the registered vessels, concluding that 11 trawlers among 14 are operational, and around 50–70% of registered Shanshulas and Hasakas are operational.

Most vessels in the Gaza Strip are old. The average usage period of each vessel is normally about twice as long as the ideal or typical usage period, as shown in table 9. Most owners of the vessels have different types of risk mitigation measures. Vessel owners say Hasakas are more feasible than trawlers and Shanshulas if the fishing zone is limited only to the coastal area. During the low fishing season, some vessels land on the beaches, and fishers who do not go fishing also benefit from the income if the person belongs to the same family under the vessel's owner. Owners and skippers select

TABLE 9 Summary of Different Types of Vessels in the Gaza Strip

Item	Trawler	Shanshulas	Hasaka with motor	Felucca	Hasaka with oars
Total numbers	14	54	861	33	779
Size	12–24 m	12–24 m	6–12 m	5–6 m	3–4 m
Material	Wood and fiberglass	Wood	Wood	Wood covered by fiberglass	Fiberglass
Engine	400–500 HP	200–400 HP	10–40 HP	Without engine	Without engine
Average no. of crews	11–13	9–11	3–4	1–2	2–3
Gear	Trawling net	Purse seine net	Gillnets, trammel net, and purse seine, hooks	Assistant boat	Gillnet, trammel net, Beach Purse seine
Target fish	Demersal fish, Prawn	Pelagic fish	Pelagic and demersal	Not applicable	Coastal demersal fish
Average usage period	20–25 years	20–25 years	15–20 years	15–20 years	5–10 years
Average days at sea	226 days	177 days	153 days	177 days	250
Average daily wage per crew	50 NIS (15 US$)	40 NIS (12 US$)	20 NIS (6 US$)	Mostly self-employed	12 NIS (3.5 US$)
Effort (days at sea)	228–240 days	180–190 days	155–180 days	Not applicable	260–290

NOTES Based on unpublished DOF data.

the fishers on board. Those who have no other source of income, have economic obligations and a higher number of children usually acquire priority to be on board for fishing. The average daily wage per crew is around 50 NIS (15 US$) for trawlers, 40 NIS (12 US$) for Shanshula, and 20 NIS (6 US$) for Hasaka with motors. Fishers can hardly live on such a low income. Winches and tractors are used for launching, landing, and beaching the vessels. The annual cost of using this old equipment and engines is 2,500 NIS (715 US$) and NIS 900 NIS (57.14 US$) for Shanshula and Hasaka with motors, respectively.

In some cases, injuries happen among the fishers due to the in-

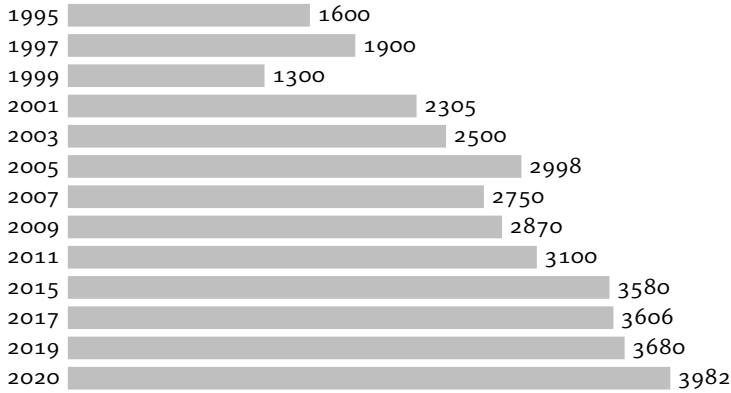

FIGURE 2 Number of Fishers in the Gaza Strip from 1995 to 2020 (based on unpublished DOF data)

[196]

adequacy of the equipment, and the vessels are likewise damaged during landings. Conventionally, trawlers and Shanshula do not fish near the coastline because the bottom of the vessels would be damaged in order to give some fishing space for small vessels like Hasakas. When there are restrictions in the fishing area, all different vessels fish in the same area near the coastal extents, which sometimes causes arguments among the fishers and the responsible organizations. Smaller mesh nets, sometimes 5mm in size, tend to be used when fishing near the coast occurs.

Several characteristics, including the restricted continental shelf, artisanal gears and vessels, lack of electronic equipment (e.g., GPS, fish finder), and lack of freezing facilities, result in fishing activities restricted to 3–6 and sometimes 6–9 nautical miles from the coast. Most fishing gears use small mesh sizes and hooks because small-sized fish and juveniles exist in the landings. The fishing techniques are mostly based on passive gears such as gillnets, trammel nets, longlines, purse seine nets, drift nets, trawler nets, and beach seines. Fishing operations, with the exception of longlines, are mostly carried out at depths of up to 50 m. It stands to reason to have knowledge about the number of fishers and how it has varied over the years due to fishing restrictions (see figure 2). After the Second Intifada, the number of fishers in the Gaza Strip declined for a few

years to reach a plateau from 2004 until 2012. After 2013, and the expansion of the fishing zone, fishers started slowly coming back to the sea and the profession. This can also be explained by the change in the composition of the sea vessel fleet. The new fleet was composed of smaller and non-motorized boats; therefore, more hands-on-deck were needed for the same amount of fish yield. In addition, the 2006 fishers spike in the Gaza city might be explained as either a logistical error or a different way of classifying where each fisherman belonged. [197]

One discrepancy that appears through this piece of information is that it goes against every other source on the matter. Multiple accounts in the bibliography state that the number of fishers has progressively dwindled over the years, a notion that local sources in the area have also cultivated, whether by NGOS and organizations, or fishers themselves. Yet according to the information by the Palestinian Central Bureau of Statistics (PCBS 2019), besides the decline of 2010, the number of fishers either remained stable or increased steadily from 2004 until 2020.

Domestic and marine cage aquaculture fish farming is growing and seems to be one of the most auspicious sectors in the Gaza Strip. In 2010, Gilthead seabream (Sparus aurata) and European seabass (Dicentrarchus labrax) were introduced. Lately, the marine cage aquaculture of Seabream has commenced as a pilot project. Domestic Tilapia fish farming has the longest history in the Gaza Strip, and still, many small farmers raise Tilapia in small ponds and irrigation systems. In 1997, the DOF constructed a small-scale Tilapia hatchery and produced Tilapia fingerings for sale. In 2005, the Palestinian Agriculture Development Association (PARC), with DOF, were advanced through a training session on Tilapia hatcheries in Egypt and formed a new freshwater Tilapia hatchery in the Gaza Strip. DOF provided fingerlings to about 20 irrigation ponds, which afford organic fertilizer for irrigation purposes.

FAO also supported the formation of about 13 intensive fish farming facilities and 300 irrigation-based fish farms. Many small farmers continue raising Tilapia in small ponds and irrigation systems, and it is easy to get Tilapia fingerlings in the Gaza Strip. Eu-

ropean seabass and Grey mullet farming did not develop as much as Tilapia, and the production of these fisheries is minimal (The World Bank 2020). Seabream and Seabass species were introduced to the market in 2010, and Gilthead seabream production is continuing.
[198] A number of private businesses started to raise Sparus aurata and Dicentrarchus labrax in 2010, but most of them had to close their business in 2013 when the future looked gloomy, and also could not finance fuel for backup generators use. Presently, two farms are operational: Al-Bahar in Gaza city and Fish Fresh in Rafah city produce about 300 and 450 tons of Gilthead seabream fingerlings.

The cost of Gilthead seabream fingerling production is about 33 NIS per kg (10 US$). Imported Gilthead seabream fingerling used to cost around 2.4 NIS (0.72 US$) per gram, but now it is available for about 1 NIS (0.30 US$) per gram, because of the current hatcheries in the Gaza Strip. Presently, around 1.5 million Gilthead seabream fingerlings are produced in a year. Gilthead seabream production has been increasing. Currently, about 60% of the production is exported to the West Bank. Following the success of domestic fish farming, FAO introduced an inventive project of marine cage farming intending to support the resilience and livelihoods of the fisheries sector. The project established a pilot cage farm delivering marine aquaculture technologies and capacity development to fishers and the Gaza Fisheries Syndicate to operate the marine cage farm as a social business and promote access and links to markets.

The pilot marine cage farm, which started in the middle of 2020, is located approximately 3.5 nautical miles off the southern border of the Deir Al-Balah governorate. The establishment of this marine aquaculture zone is expected to encourage the future growth of the marine aquaculture sector in the Gaza Strip (FAO 2018). Many studies were conducted before introducing the project, including possible diseases and weather conditions (FAO 2018). Tension Leg Cage (TLC) is considered the most suitable system and will be mounted throughout the project. The project also supports capacity development and generates several skilled jobs required for management and operations. The fingerlings of seabream will be available from the local market. The farm location is acknowledged in coordina-

tion with the Gaza Port Authority, DOF, and MOA and shared with other experienced fishers to diminish the risk. The project will also enable accessibility to trade Gilthead seabream in the West Bank and external markets. There are no fish feed industries in the Gaza Strip. Owners of aquaculture businesses keep large feeder records for the crisis, which costs them a lot of money and space. Whereas most feed for inland aquaculture and marine cage culture is imported, some farmers started developing alternatives for imported fish feed, including the Azolla plant. This aquatic fern grows on the water surface. Azolla plant fish feed is a cost-effective, environmentally friendly, and economical feed. The Gaza Strip is well-known for citrus fruits and other crops, and there are fruit and vegetable wastes that can be used for fish feed. A study suggested that an orange peel can improve the nutrient absorptive ability of the intestine in Nile tilapia (Salem, Heba, and Abdel-Ghany 2018). In addition, another study concludes that potato peel feed is very nutritive and helps in the qualitative and quantitative growth of fish. That orange peel feed showed brighter body scales (Sanyogita and Satyanarayan 2016). However, using citrus and vegetable peel, and other plant residues is recommended to be tested as alternative fish feed in the Gaza Strip.

Socioeconomic Aspects of Fisheries and Aquaculture

The fishers in the Gaza Strip are present mostly in inaccessible live-in areas where there are no modern communication systems, having a very low developmental and socio-economic impact in the community. There is no denying that fishers and the fishing community as a whole are the poorest and most disadvantaged groups in the Gaza Strip. They have no other income-generating activities except fishing, which cannot be carried out throughout the year while in idle periods, they lack alternative employment opportunities. Their socio-economic development is negligible. For the overall planning, development, and implementation in the fisheries sector, it is necessary to have sound knowledge about the livelihood patterns of the related people.

The study showed that a majority (95%) were married, while the

unmarried fishers represented only 5% of active fishers. In the fisheries community area, there are a total of 3,982 fishers, the members in the fishermen families approximability 21,021, of which 9,029 are adults (44%) and 4,720 are children (23%), and 2,257 are old (11%),
[200] and 4,515 were women (22%).

The fishing area is an important characteristic, especially for commercial fishing as the habitats of the fish in the sea are not found everywhere. Therefore, it is important to choose a fishing area that is more commercially viable for fishing.

Most of the fishers in the fisheries community area in the Gaza Strip are used to going from 3 to 12 miles from the seashore for fishing. The duration of the fishing trip depends on the availability of fish and catch. Depending on various factors, duration is usually from 6 to 12 hours for most vessels and about 24 hours for the trawlers segment during the day and night. Different kinds of fishing gear are used in the fisheries community of the Gaza Strip. Most fishing gears use small mesh sizes and hooks, with the significance that small-sized fish and juveniles exist on the landing sides. The fishing methods are mostly based on passive gears such as gillnets, trammel nets, longlines, purse seine nets, drift nets, trawler nets, and beach seines. These are traditional fishing nets widely used in the coastal area of Gaza. Usually, large, medium, and small-sized boats are used. There are 11 trawlers for deep-sea fishing. Most of the vessels are operated by using motors. Capacity utilization of days at sea is about 75%. The fleet-average length over all is 18 m to 24 m, 18 m (trawlers and large purse seiners), 6 to 9 meters for small purse seiners and small-scale vessels with motor, and 3 to 4 meters for small-scale vessels without an engine using passive gear. The motor power of the vessels range from 20 to 450 horsepower (HP) mostly. Some fishers have their vessels; some share the vessel and others work as labourers on vessels. There are about 54 kinds of species usually caught in Gaza Strip marine waters. Most fishers reported Sardina spp. catch is dominant, and others are Loligo spp., Engraulis Spp., Etrumeus spp., Mullus barbatus, Trachurus spp., Sphyraena spp., Dasyatis spp., Sillago sihama, Auxis rochei, Liza spp., Thunnus thynnus, Pagellus erythrinus, Argyroso-

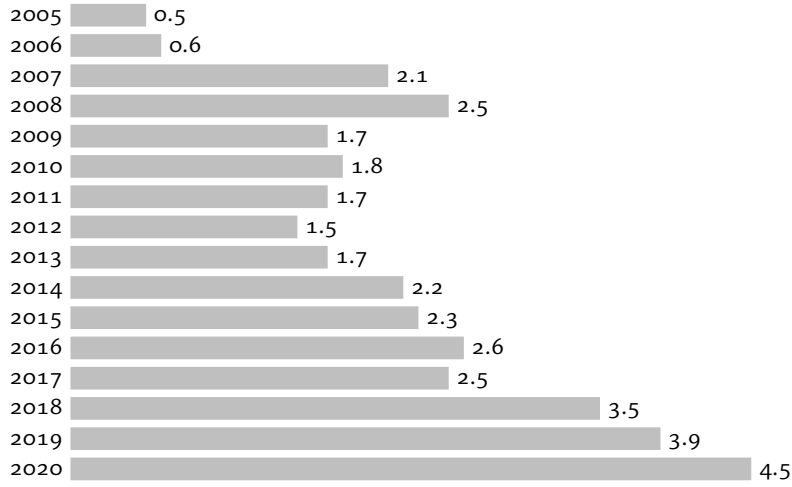

FIGURE 3 Per capita fish consumption in West Bank and Gaza from 2005 to 2020 (kg/year; based on FAO 2020 and unpublished DOF data)

mus regius, Alectis alexandrinus, Sepia sp., Balistes capriscus, Red mullets, Poops boops, Dentex gibbosus, Trachinotus ovatus, Anchovies, Saurida undosquamis, Protuns sp., Sphyraena Chrysotaenia, Scomberomorus, Hirundichthys rondeleti, Epinephelus spp., etc. For the average fishing trip, vessels in the Gaza Strip caught 32 kg of fish per day in each catch. 65% of the fishers sell their captured fish wholesale to retailers in the markets, and 35% sell their fish directly to consumers. The interviews found that the fishers' highest income per month (14 working days) from selling fish is 320 USD, and the lowest is 61 USD.

Moreover, every year, many people are becoming involved in fishing as a seasonal or part-time occupation. As a result, fishing pressure is continuously increasing in the sea. 4% of fishers' monthly income is about 320 USD, 14% of fishers' monthly income is 220 USD, 15% is 10 USD, 30% 80 USD, and 37% of fishers' income is about 65 USD.

The fish species in the Gaza Strip are clustered into two classes: 'high-value fish' and 'public fish,' according to the determination of DOF for trade purposes. High-value fish are those with a unit cost of over 6 USD per kilogram, and public fish cost less than 6 USD

per kilogram. Public fish, such as sardines and anchovies, are normally consumed in Gaza. Resident consumption of fish has been low, but has demonstrated a sound increase. A FAO study indicated that average fish consumption in the Gaza Strip is 3.5 kilograms per
[202] person per year. This is very low compared to neighbouring countries, where average consumption is around 15 kg per person per year (FAO 2020). Figure 3 shows the growth of understood fish consumption per capita in the West Bank and Gaza Strip (separate data for the Gaza Strip did not exist). It is observed that much of the fish consumption compared to the West Bank is recorded in the Gaza Strip. The increase in fish demand has been supported by expanding fish imports. As understood from figure 3, the amount of food fish consumed in the West Bank and Gaza has increased noticeably, but much of it is characterized by fish imports. In agreement with the FAO booklet, annual fish consumption in the Gaza Strip is presently about 20,000 tons. Customary fishing produces 26% of locally consumed fish, with in-land aquaculture producing 3%. The shortage is supported by fish imports from abroad, which account for over 66% of locally consumed fish. Fish exports from the Gaza Strip have increased recently, mostly due to increased aquaculture fish export. There was no trade from 2008 to 2013. Since the truce in 2014, Gaza started again exporting fish, but merely to the West Bank. The amount of aquaculture fish production has increased, and its export is also growing.

High-value fish include seabream, seabass, and octopus. There is no limit in exporting high-value fish, and exporters prefer to handle high-value fish. Meanwhile, public fish are limited for export, because they are considered to have high demand in the local market. Public fish include sardines and anchovies. Fish from the Gaza Strip is exported to the West Bank only on Sundays and Wednesdays. The volume of export by each exporter is limited to 1.5 tons per week, resulting in a total of 24 tons a month for all four permitted exporters. Four leading exporters trade fish with the West Bank. They have to take pre-authorization permission from DOF to export fish. Exporting fish from the Gaza Strip is more profitable than selling locally, creating 30% added value to the revenues. Traders mentioned

a shortage in essential infrastructures for export, such as storage and collection centres, decent transportation, cold storage facilities on the border, distribution packing centres, and other export trade support. They experienced high costs due to the border and road closures. These high business costs (favouring mainly Israel) make [203] Palestinian agricultural output uncompetitive in the export markets despite a strong internal and external demand. However, according to the traders, trading with the West Bank is feasible and promising for future interventions by investors conditioned with facilities from the Israeli side. They also certify that inland fish farming could hold promise on the grounds of flexible exportation and lower production costs.

The Current Status of Fisheries Management

The question of how best to manage littoral resource for artisanal fisheries has been examined on a large scale in the Mediterranean basin, including the topics of closed areas, co-management and options. There are many strategies that can be used to address threats to the marine environment, and fisheries in particular. These strategies may be cross-cutting and may relate to structural as well as non-structural measures. It may also contain actions that have already been previously defined by different organisations. Accordingly, a set of potential strategies related to fisheries were presented in a study made by (Abudaya, Harper, and Ulman 2013).

The General Directorate of Fisheries in the Ministry of Agriculture is the chief authority responsible for fisheries management and collecting associated fisheries statistics. The DOF played an important role in fisheries management up to 2007, by issuing licenses to fishers, administering the construction of ships, collecting and analysing data, solving arguments between fishers, enforcing laws and regulations, ensuring the health and safety of fishers, inspection of the quality of fish before arriving at the auction market, capacity-building in health and safety and on the technical subjects of fishing. Since 2007, though, the DOF's role has weakened because of the crucial political situation and financial difficulties.

The main challenge of the fisheries sector in the Gaza Strip is the

extremely limited fishing zone, especially to the three n.m. This restriction has been imposed by the Israeli military on fishers regarding access to the fishing areas along the Gaza Strip coast where the fishers are always trying to protect themselves from being shot and
[204] arrested by the Israeli military. However, such a limitation has substantially reduced both the quantity and quality of fishing catches. Thus, nearly 90% of fishers are now considered either poor (with a monthly income of between 100 and 150 US$) or very poor (earning less than 100 US$ per month), which constitutes a sharp increase from 2009 when almost 50% of fishers fell into these categories. Although this restriction, imposed by the Israeli military, is justified 'for security reasons,' which is uncertain, it seriously affects the fisheries' economic viability and long-term sustainable exploitation, which profoundly impacts the fisheries' livelihoods and food security. The fishers know very well the restrictions imposed on fishing activities in the Gaza Sea are their main obstacle for meeting the challenge for the survival and progress of the fisheries sector. Applying the fishing terms of the Oslo Accord to the 20-n.m. limit would remove this obstacle and open up opportunities for Gazans from which they are presently destitute. Fishing beyond the 12 n.m. would improve the sector and bring considerable economic nutritional benefits, as well as employment and many other advantages to the sector.

The Gaza Strip faces a decline in employment opportunities imposed by the occupation, leading to high poverty rates and a lack of employment opportunities. It becomes impossible to build an economy in conditions that lack the most basic development necessities. Other conditions have to be met. The fisheries authorities and public institutions should make long-term arrangements to strengthen and upgrade the capacity of the fishers and fish farmers in the Gaza Strip, and the related fishing support activities to improve the management and the governance of the sector. The level of experience in the modern methods of running fisheries also needs to be raised while the sector's needs should be better understood. The restriction on importing the various requirements for the sector should be lifted without burden. The number and type of fishing equipment

required to maintain the existing vessels and gears, and onshore services to develop new fishing methods, should be provided. Until the pledged entirely devoted fisheries harbour is lastly established, the current fisheries infrastructure facilities in the small Gaza harbour, the fish market (the Hisba) and the fishing and marketing support [205] services, will remain in poor condition, and what is available needs to be improved and expanded.

Under the present conditions, Gaza needs and often receives aid and assistance from several international and regional donors and NGOS in various fields, including the fisheries sector. For example, Palestine takes part in the FAO executed EastMed project, GFCM, and others, and receives support from donor agencies such as the EU, USAID, and others. However, it is recommended that this support be continued without interruption and expanded to the fisheries sector to become self-sufficient and support itself. The areas of assistance most needed include (1) training of fishers and fish farmers on new and more productive techniques, (2) data collection and analyses, (3) stock assessment, (4) value-added production, (5) promises for export, (6) hygienic systems in fish preservation and processing, (7) marketing techniques, (8) value-chain analysis, (9) introduction of new species and other issues that support a sustainable fishery in the Gaza Strip.

The Fisheries Organizing Law of 2005 was qualified and approved by the cabinet of the Palestinian National Authority. The law is for (i) promoting the general plan for protecting fisheries and the long-term conservation, sustainability, development, processing, and utilization of fishery resources; (ii) the organization and management of fishing and aquaculture; (iii) programs to protect the marine environment, reduce pollution of fishing waters, work to address the adverse environmental effects of fisheries resulting from humanitarian activities, avoid excess fishing capacity, and maintain the exploitation of fish stocks from an economic point of view in coordination with the competent authorities; (iv) the development of investment in fisheries; (v) scientific research in the field of fisheries and aquaculture; (vi) the setting of standards of conduct for all those involved in fisheries and aquaculture and the development and ra-

tionalization of fishing methods and method, and (vii) enhancing the contribution of fisheries and aquaculture to food security.

The Palestinian law of environment No.7 was established in 1999, which is a framework for protecting the environment, public health,
[206] and biodiversity in Palestine, including marine areas. The law includes a narrative that the Environment Quality Authority (EQA), in coordination with specialized agencies, shall set standards for seawater quality, and set rules and regulations to prevent marine environment pollution that comes as a result of wastewater discharges and solid waste dumping. It is well known that different ministries and departments were working in the fisheries sector in the Gaza Strip along with agencies, which had significant roles, until 2007, but a lot has changed since then. Until 2007, the Palestinian National Authority (PNA) obliged all boats and ships to have telecommunications equipment tools to enable fisheries and maritime police to communicate and track them. The Ministry of Agriculture used to conduct more training for fishers and the Ministry of Transport used to update vessel data in terms of efficiency, effectiveness, licensing, and registration. The vessels were previously licensed based on specific lengths and standards, but currently, new licenses are frozen. There was a protected area where fishing was prohibited during the mating and spring periods and prevented fishing within 3 miles of shore. Still, unfortunately, fishers at present are not implementing these laws due to the political and economic situation and, above all, the delimited Israeli siege on the Gaza Strip.

DISCUSSION

It is clear that Gaza has a smaller production capacity in terms of both fisheries and aquaculture. Trends show that fisheries production has fluctuated in recent years, while aquaculture has gained considerable importance, because of the increasing human population's high demand for aquatic food products. Therefore, the aquaculture industry is a promising sector for the economy in Gaza, while wild fisheries have more challenges to overcome. The geographical location of Gaza presents a major advantage in supporting biodiversity in marine and brackish water resources. Fisheries in Gaza are

still an underdeveloped activity, and they remain a poorly managed sector compared to other large neighbouring eastern Mediterranean countries (e.g., Egypt, Turkey, and Greece). The reported increase in landings in the late eighties and nineties is possibly attributable to the improvements in fishing technology, a large area of the fishing [207] zone, and increasing effort rather than a clear retrieval. There was a similar worldwide increase in fish landings (including the Mediterranean) during the eighties. However, landings have decreased or remained constant in later years despite technological advances due to the depletion of traditional fishing grounds (Pauly et al. 2002) and minimizing the fishing zone.

International Organizations such as FAO started to support fish farms financially in the late nineties (FAO 2010). Therefore, aquaculture production increased 472% in the years between 2011 and 2020. As a result, fish consumption in Gaza rose to 4.5 kg per capita per year, which is a small amount when compared to the average European consumption (22 kg) and less than the global (15.3 kg) and African (10.4 kilograms) averages (FAO 2013; 2020). It has averaged around 2.5 kilograms over the past decade. Marine and aquaculture fisheries are the main source (about 30%) of wild production, and the remainder is imported from abroad. The aforementioned decline was mainly due to the decrease in marine fishery landings. In turn, fishing efforts gradually increased during the same period. This would inevitably lower the CPUE (catch per unit effort) as more vessels compete for fewer resources. One of the main difficulties in Gaza marine fisheries (Mediterranean Sea) is that they depend very much on seasonal supplies of small pelagic fish species. These species show great fluctuations on a global scale, because they are more vulnerable to environmental factors (Fréon et al. 2005). However, the current fishing regulations are unenforced, and illegal fishing techniques, including destructive fishing, are affecting marine resources (Ashworth and Ormond 2005; Samy-Kamal, Sánches, and Forcada 2011). Thus, some (MPAS) are now functioning as 'paper parks' (Mora et al. 2006; Guidetti et al. 2008; Rife et al. 2013; Advani et al. 2015). However, there are currently no marine protected areas in the territorial waters of the Gaza Strip. In turn, Mediterranean

fisheries are suffering from unjustified trawl fleet overcapacity.

Moreover, all the landing sites are facing the same challenges: pollution, habitat loss, a significant reduction in area, the spread of aquatic weeds, declining fish yield and quality, overfishing, illegal
[208] fishing practices like harvesting of fish fry. These are actually part of the whole challenges facing the marine environment and fishery resources of the Gaza Strip (MENA 2001; Abd Rabou et al. 2007). There is low awareness among fishers of environmental issues, and the need for regulation measures is of utmost priority (Mehanna 2008). Most of these assessments have recommended a reduction in fishing mortality of 40% via the adoption of appropriate management measures. Such recommendations include the improvement of trawl selectivity by increasing mesh sizes, identifying and protecting nursery and spawning areas, the minimum distance of trawling from the coast, and closed areas and seasons (FAO 2014).

Compared to other neighboring countries such as Egypt and Lebanon, fisheries management in Gaza faces challenges from the problematic nature of the accompanying socio-ecological systems. The fisheries are defined as labour-intensive, multi-species, and multi-gear; they are extensively distributed along the coast and related to high levels of community need. It is durable to control fishers' behaviour or impose and implement regulations in such a situation. The demand for fishery resources has been steadily increasing due to the rise in population and increased unemployment rate. This has led to increased pressure on stocks and the use of damaging and illegal gear and practices. Most of the damaging methods are prohibited by law, but continue to be used due to lack of investigation, enforcement, public awareness, and increased poverty. Despite the existence of national legislation for the potential ability to address fishery management issues, these laws have not been implemented to the completest level (FAO 2014). To our knowledge, more licenses have been issued to fishers and new vessels to practice fishing in marine waters of the Gaza Strip, and the mesh-size regulations were set at lower limits than experts and scientists recommended (based on unpublished DOF data).

Additionally, these laws and regulations are somewhat old and

seem not to consider the current changes in international policy or regional fisheries arrangements. The laws vary with the General Fisheries Commission for the Mediterranean regulations, despite Gaza not yet being a member, but Palestine is an observer in FAO. Consequently, the wild fisheries of Gaza are under-regulated with [209] no rational management plans. This has had positive results on the amount of national production and distorted multi-species production into farmed single-species production.

Although fisheries in Gaza look to be poorly studied (Shaheen 2016; Abu Amra 2018), much information is still needed to address management gaps. The management of fisheries requires detailed data on the fleets and misused resources. Such information should indicate the status of each fishery, their dynamics, characteristics, as well as of time and spatial distribution of each fleet (e.g., Forcada et al. 2010; Samy-Kamal, Forcada, and Sánchez Lizaso 2014). It should also include confirmation supporting estimates of maximum sustainable yield and documentation of the standing stock's best size and age composition. To retrieve this information, it is indispensable that scientists, in turn, be provided with data on harvests, numbers of fishers, gear types, vessels, effort, and fishing location.

In Gaza, fisheries statistics collected from the landing sites are not comprehensive enough to provide a complete picture of the resources and fleets. Furthermore, knowledge of the ecology of marine fish communities is sparse, and quantitative ecological studies and research on invasive species (Abd Rabou 2019) are needed. For instance, there are no data on the impact of the aquaculture farms on the nearby marine environment or the yield of adjacent fisheries. In such intensive coastal aquaculture areas as Gaza, fish farms may act as small MPAS. For this reason, the ecological interactions with the surrounding fishing grounds and influences on the fish stocks should be considered (Dempster et al. 2002). The future of fisheries management in Gaza also lies in improving the current management strategies and measures. It is important to evaluate the effectiveness of management measures (e.g., Samy-Kamal, Forcada, and Sánchez Lizaso 2015a; 2015b; 2015c) to understand if they can achieve their main objectives.

Fish is one of the most important food sources of human beings and is of great importance at local and global level. The fisheries sector is a form of agricultural production in the Gaza Strip and is always targeted by the Israeli occupation forces. This has a negative
[210] impact on the rate of fish production from marine catches. Fish is one of the most important food sources for humans, because they contain protein and essential nutrients. The Food and Agriculture Organization (FAO) has recommended that the annual lowest individual consumes 13 kg of fish. In the Gaza Strip, by sea catches, only 1.75 kg per capita is available annually; imported fish supply the rest. The per capita share was 4.1 kg in 2016 due to the increase in the area of the fishing zone in Gaza.

An overview of the fishing history showed that the period (1967–1978) was the golden age of the fishing profession in the Gaza Strip. This is due to the area where the fishers were allowed to do fishing, up to 180 km from the shore of the Gaza Sea to Lake Bardawil in the south, near the city of El Arish; sometimes fishers arrived in the Egyptian Port Said. As a result, the amount of fish caught in that period reached 60 tonnes per day, but the situation did not continue in this way. The Israeli occupation authorities started to impose obstacles on the fishers, and they set the allowed fishing distance of 82 km, which reduced the amount of fish caught. After the Oslo agreement was signed between Israel and the PLO in 1993–1994, this distance was reduced to 20 nautical miles. The occupation authorities did not commit to allowing fishers to use this fishing zone, which was reduced to 12 nautical miles. Therefore, the amount of caught fish decreased (WAFA 2020). After the Israeli war on the Gaza Strip, from December 2008 until January 2009, Israel narrowed the allowable distance to three nautical miles, which negatively affected the fishing sector in the Gaza Strip. This prevented many vessels from operating; Shanshulas catches ceased working in sardine fishing, which accounted from 40 to 70% of total fish production (WAFA 2020). This closure lasted until December 11, 2012, and after the intervention of a number of international organizations, the fishing area was increased to 6 nautical miles. This continued until 23 March 2013; the fishing boundary returned to 3 nautical miles

until 21 May 2013, once again rebounding to an area of 6 miles until (October 2016), and finally to this day returned to an area of: 15 miles in the south of Gaza, 12 miles in the middle of Gaza, 9 miles from Gaza seaport to Wadi Gaza and 6 miles in the northern of Gaza near the borders of Gaza (based on unpublished DOF data). [211]

In the context of widespread unemployment and food insecurity, the fishing sector continues to be an important source of employment. Fish, especially sardines, is a significant source of protein, micronutrients, and omega-3 fatty acids for people in Gaza and contributes to nutritional variety. In 2017, it was estimated that 40% of households in Gaza were severely or moderately food insecure, while unemployment rates reached 43.6%. According to the Directorate General of Fisheries in the Ministry of Agriculture, 3,700 registered fishers in Gaza depend on this sector for their livelihoods. Gaza fishers are estimated to support another 18,250 people (based on an average household size of 5–7 in Gaza). It is also estimated that a large number of people depend on fishing-related industries, including vessels and fishing gear maintenance and fish retailing. According to the Ministry of Agriculture, only 2,000 registered people fish daily, while approximately 1,700 in the sector work sporadically, about once a month. Fishing quantities and revenues vary widely over the years, while the designation of fishing grounds affects fish landing quantities and revenues. Revenues also vary depending on the type and quantity of fish available in the specified area. Restricting fishing in a small area near the coast leads to overfishing and has a negative impact on fish breeding areas. According to the Directorate General of Fisheries, the effects of the restrictions on the fishing zone and its limitation to three nautical miles in 2006 and 2007 were not seen until 2009, when the fish breeding areas of the 3-nautical-mile zone were heavily depleted (OCHA 2018).

The income of fishers from fishing does not cover their operating costs. The Gaza Strip still suffers from a shortage of fish due to the occupation authorities imposing fishing restrictions, which sometimes prevents fishers from practising the profession of fishing at sea. This has encouraged the people to establish fish farms to meet their needs from fish. A number of traders have turned to

fish farming projects, 'fishponds,' to compensate for the shortage of fish stocks. Despite the importance of these projects to the fisheries sector, they are almost limited due to their high cost and current political and economic conditions (OCHA 2018).

[212] The marine ecosystem of the Gaza Strip has been degraded. Construction along the coastline has blocked sand transport and has caused an erosive effect on the coast downstream. Large vessels are damaging the seabed, hence affecting the habitats and niches of marine life. The discharge of partially treated sewage into the seawater from different wastewater treatment plants is a serious challenge affecting the marine environment. This discharge may pose serious health hazards, destroy marine habitats, and causes severe threats to the population of marine biota such as fish, zooplankton, phytoplankton, and macro-algae. The dumping of solid wastes in the coastal and marine environments by locals and fishers has affected the marine ecosystem. Fishers have collected solid waste in their fishing nets, which can pose direct threats to marine species and their habitats (MENA 2001; Abd Rabou 2007; 2013).

CONCLUSION

The challenges of fisheries in the Gaza Strip are closely related to the current complex security and political situation. The fisheries in Gaza are a reflection of the devastating impact of Israeli policies on the citizens of Gaza. Access to resources that would provide them with food for subsistence is significantly impeded. Poverty, lack of training, and lack of sanctions contribute to a continued poor management of the resource; but poor management of the resource is also the only option available to people trying to survive.

The fisheries and aquaculture sector in the Gaza Strip has many challenges of institutional structure, movement constraints, having old infrastructures and vessels. Despite these various challenges, there is also potential to expand, create more jobs, and generate more revenue. There is potential for capacity development in the fisheries and aquaculture sector in the Gaza Strip. People are desperate to attain new knowledge and techniques. They suffer from a lack of exchange of experiences with the outside world, which affects the

quality of research, data, fishing skills, health and safety procedures, and ports and ship management. Different stakeholders exist in the fisheries and aquaculture sector, and it is useful to clarify more details of available capacity and capacity development needs. Sustainable fisheries development and improving the value-chain of fisheries and aquaculture sectors have the potential to increase more job opportunities and economic development activities. It is required to have comprehensive coastal and environmental management of the fisheries sector in the Gaza Strip. [213]

The challenge for Gaza fisheries managers is not only to provide proper strategies to develop the current situation in Gaza, but also to monitor the success of management plans and implementation of the guidelines. Most of the measures and guidelines related to fisheries are outdated and often not followed, making the situation difficult to control. Furthermore, little data exist on environmental issues' social and economic aspects. In general, there is a lack of communication among the leading groups of stakeholders in adaptive management: managers, fishers, experts, and scientists. Experts, policymakers, scientists, and fisheries managers need to consider these fisheries' various scopes and nature, counting the framework in which they work. They must then try to evolve management policies proper to the framework of these fisheries.

Moreover, integrating the fishing sector into management decisions and actions is very important (Jentoft 1989). This helps understand the community's priorities and behaviour in order to adopt appropriate management tools to their needs (Gelcich, Godoy, and Castilla 2009; Pita et al. 2011). Improving enforcement is necessary, and this implies the need for greater effectiveness of fisheries perambulations, which may enhance community education regarding environmental and fisheries concerns.

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