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**Historical series of *Coryphaena hippurus*
landing data (1981-2015) from professional fisheries
using FADs in the Balearic Island, Spain**

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Historical series of *Coryphaena hippurus* landing data (1981-2015) from professional fisheries using FADs in the Balearic Island, Spain.

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Summary

Balearic Island of Majorca has a traditional artisanal fishery using FADs locally called capcers, targeting Dolphinfinch during summer and autumn. This fishery, managed by the regional fisheries administration, was carried out by fleets from different ports around the island during the past century. Presently around 45 artisanal vessels from different ports are landing in Majorca market due to commercial requirements and for a better control of the prices.

Monthly captures from 2002-2015 (average value by kg, total monthly production (kg) and value (€)) were provided by the Balearic Islands regional administration to collaborate in improving the sub-regional assessment of the western and central Mediterranean fisheries and to advance in the management of this stock. The fishery is regulated in several ways: restricted fishing period from July to the end of November and the number of FADs set by boat. Recently two new measures were adopted: first the reduction of the fishing effort from 2001 on (increase from 24 h in 2001 to 48 h of resting during the weekend in 2005) and second, the adoption of individual landing quota of maximum 300 kg by boat and day from 2012 on. These measures were implemented to improve the fishermen revenues and overcome market constraints.

After the introduction of the daily quota an increasing trend is observed in prices of the *Coryphaena* captured by the artisanal fleet using FADs. Maximum annual yields are obtained in September and October. Moreover after the implementation of quotas, landings appear also during the first part of the year corresponding to Dolphinfinch captured as bycatch by the surface longline fleet.

During the Workshop on fisheries and appraisal of dolphinfinch in the MedSudMed and CopeMed II Projects area (Palermo, Italy, July 2011), Grau and Camiñas (2011) presented a document on the state of the fishery of this species in the Balearic Island (Spain). We present here an update with data series comparing the current situation with the one previous to the introduction of technical measures. Landing continuously present annual fluctuations but total revenues increase annually. Prices by kilogram trend increases along the series. Activity of the fleet during 2015 suggests that the fishery, although authorised to 55 artisanal vessels, it is only profitable for half of the fleet that worked more than 21 total days during the fishing season.

Finally we present a long series (1981-2015) combining data from the CopeMed (CORY project) and data from the fisheries administration. The 35 year series shows a continuous increasing trend in landings with fluctuations that could be related with some climatic event.

Background

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A traditional small-scale fishery is carried out in the western part of the Mediterranean along Majorca Island during summer-fall period using local fishing aggregation devices (FADs, locally called "capcers") and targeting the epipelagic species *Coryphaena hippurus* (locally called Llampuga).

Each year FADs are deployed on August 25th and are removed on November 30th. Data series for the period 1981-2015 are presented based on two different sources: the CORY project carried out by CopeMed phase I and data from the official statistics in Majorca. To complete the updating of this fishery, data on the total annual production (€) and on average landing prices (€/kg) related to the artisanal fisheries targeting Dolphinfish by month, were reported by the Fisheries Directorate from the Balearic Islands (Govern of Balears) for the period 2003-2010.

Historical information available from different sources has been used to complete the current picture and understand the fluctuations of this fishery, including information presented during the previous CopeMed-MedSudMed Workshop of 2011 and the CORY project (2000-2003).

The Majorca Island "capcers" fishery

As mentioned in Grau&Camiñas (2011), this fishery is relevant seasonally during summer and autumn in Majorca Island allowing the artisanal fleet rotating target species. Moreover, this species is relatively highly priced (Lleonart et al. 1999). The artisanal fleet using FADs (capcers) target Dolphinfish and additional captures (< 5% total captures) of juvenile pilotfish (*Naucrates ductor*) and greater amberjack (*Seriola dumerlii*) using a traditional gear called "llampuguera" (FAO/COPEMED, 2003; Massutí& Vidal, 1997). Moreover captures of Dolphinfish and Amberjack are also important to the recreational fishery from boats in the Island (Morales Nin et al, 2005). Captures of dolphinfish off Balearic Islands using pelagic surface longline targeting albacore and swordfish are also important (Macias et al, 2012). According to this study surface longlines captures more juveniles than capcers do.

The net used is a special surrounding net without a purse-line, which is not very deep and almost rectangular. The design of this net, with a central codend in the form of a spoon and two lateral wings, made it possible to retain the shoal of fish when the two wings are hauled up from the boat at the same time. The Majorca net in average has a 180 m length and a height of 16 m.

Each boat has a mooring area that generally is raffled among all fishermen at the beginning of the season. In Majorca they are placed off 70m depths and can reach the 1200m isobath. The FADs consisted of a float with some palm grounds or bush branches tied on top for location and below to increase their surface. Each vessel uses currently around 30 capcers to concentrate the Dolphinfish. Each fishing vessel encircles a capcer at dusk and moonlight nights, repeating the operation in each own capcer. Often the capcer's rope is used to keep a trap at 13-15 m below the surface to catch other species such as "pámpols" (*Naucrates ductor*) (Massutí and Vidal, 1997).

Fleet and fishing effort

The fishery of "Llampuga" in Majorca Islands is recorded in documents from the XIV century (Massutí and Vidal, 1997) adopting rules for selling of this species in the city of Pollensa. Current fleet is located in different ports around Majorca Island although all landing are disembarked in Majorca city landing market. Active fleet targeting Dolphinfish during XX

century has been 50 vessels (llauts). Since the beginning of the years 2000s the fleet targeting this species fluctuates annually around 45 vessels. The characteristics of the fleet, gear used, FADs structure and the fishery activity were described by Massutí& Vidal (1997) and CopeMed (2003).

During the second half of years 2000s (2007-2010) the prices of this product went down to 3 €/kg. To increase the revenues and profitability of the fishery two management measures were taken with the agreement of the fishermen: the reduction of working hours (fishing effort) and the establishment of quotas (landing limits). As regards to the working time, a weekend rest was gradually increased from 2001. A rest period of 24 consecutive hours (Saturday to 12:00 Sunday) was set on July 2001. Subsequently, on July 2002 the resting time was extended to 30 h. Finally, on July 2005 a resting time of 48 consecutive h during the weekend was established.

The second measure adopted was the introduction of a maximum quota of 300 kg per boat and day. Although the reason to the quota introduction was avoiding the low prices during the maximum captures, we don't know how the quota was calculated, if based on the maximum historical yields or by other reasons. This measure is much more recent, 2012, and since then global revenues of the fishermen and the average price have grown until 2015, the last recorded year. This quota may bias the catches mainly during good fishing years, as 2013 or 2015.

Data sources

Data used for this document come from two different sources: (i) official data provided by the Fisheries Directorate from the Balearic Islands Administration and (ii), research data originally elaborated by the CopeMed CORY Project.

i) Data source for the period 2002-2015 are the sales notes generated at the Palma de Majorca fish market (lonja), the only official place where all the captures of the island are sold. Every note corresponds to a single authorised vessel, so the level of aggregation is species/vessel/day of landing. With the daily statistics the regional Fisheries Directorate from the Balearic Islands administration elaborate monthly official statistics for this seasonal fishery.

ii) Historical landing data (period 1981 until 2001) were obtained from the CopeMed data files corresponding to the CopeMed CORY Project, a research program carried out during the phase one of the project.

The objective of combining the two sources of data was to build a series of landing of Dolphinfish in Majorca Island as long as possible than can give us a better picture of the trend of the fishery.

Trends in monthly capture production

Monthly production in Euros during the period 2002-2015 are presented in Table 1. In Figure landings 1 show a general picture of maximum yield during the months of September-October of the series:

Table 1. Series of official monthly total production (€) of landings of Dolphinfish in Majorca Island (source: Fisheries Directorate from the Balearic Islands, Govern Balear).

Year	Jan	Feb	Mar	April	May	June	July	Augu	Septem	Octo	Novem	Decem	TOTAL
2002	0	0	0	61	88	280	319	6275	178404	197688	38132	3039	424288
2003	12	0	0	0	0	0	100	21667	255881	197045	50515	5493	530713
2004	0	0	0	0	0	71	87	13306	242190	138987	49638	198	444477
2005	0	0	0	9	0	0	96	10495	188580	144691	61140	3617	408628
2006	0	0	0	0	0	40	177	4550	211388	133532	53720	7511	410918
2007	0	0	0	0	15	2273	4458	4723	158109	112773	52882	443	335675

2008	0	57	0	0	39	149	552	3865	243067	203586	45845	1080	498240
2009	0	0	0	0	0	0	23	17571	205818	193737	52488	35	469672
2010	59	0	0	0	0	329	861	25067	231259	156556	44735	130	458996
2011	33	0	0	0	17	552	18	28663	247918	200033	74849	4879	556962
2012	63	0	0	0	47	1710	762	22883	201776	202734	45857	167	475999
2013	153	355	330	657	839	1888	1663	50742	236423	196206	43048	195	532498
2014	39	230	652	1097	1096	1257	1264	48819	229832	218757	45823	7975	556841
2015	0	275	777	697	4446	3665	1797	68576	404214	243397	21936	9247	759026

This official monthly series confirms that landings occur mainly during summer and autumn periods although other months can be important for the production. As presented in Table 1, landings production before July was practically zero during the period 2002-2012, but from the adoption of the quota (2013 onward) landings appear all along the year, including the period before the opening of the artisanal fishery season. This new situation probably represents a reaction to new demands of product from local retailers to the longliners trying to cover public demand with lower prices (Coryphaena is a bycatch product in surface longline fishery) against the increasing trend in prices (Figure 4) of the Coryphaena from the artisanal fleet using FADs.

Table 2. Official Production (€ and Kg) and prices (€/Kg) of Dolphin fish landed in Majorca Island, 2002-2015.

	€	Kg	€/Kg
2002	424.287,99	107.107,40	3,96133218
2003	530.712,91	176.617,00	3,00488011
2004	444.476,65	152.715,30	2,91049194
2005	408.627,58	97.544,00	4,18916161
2006	410.917,50	86.832,00	4,73232794
2007	335.674,73	57.390,60	5,84894965
2008	498.240,15	93.899,40	5,30610579
2009	469.671,65	114.539,39	4,10052516
2010	458.995,80	152.331,56	3,01313661
2011	556.962,20	135.347,22	4,11506199
2012	475.998,96	72.015,94	6,60963337
2013	532.498,14	148.634,19	3,58260869
2014	556.841,37	77.046,08	7,22738094
2015	759.025,82	119.627,04	6,34493523

Figure 1 presents the yields in kg. In general the trend of the captures is decreasing. Maximum total production (€) corresponds to 2015 (Table 2) with total annual close to 800 M€. Prices in kg varies between a minimum of 2,91 €/kg in 2004 and a maximum of 7,22 in 2014.

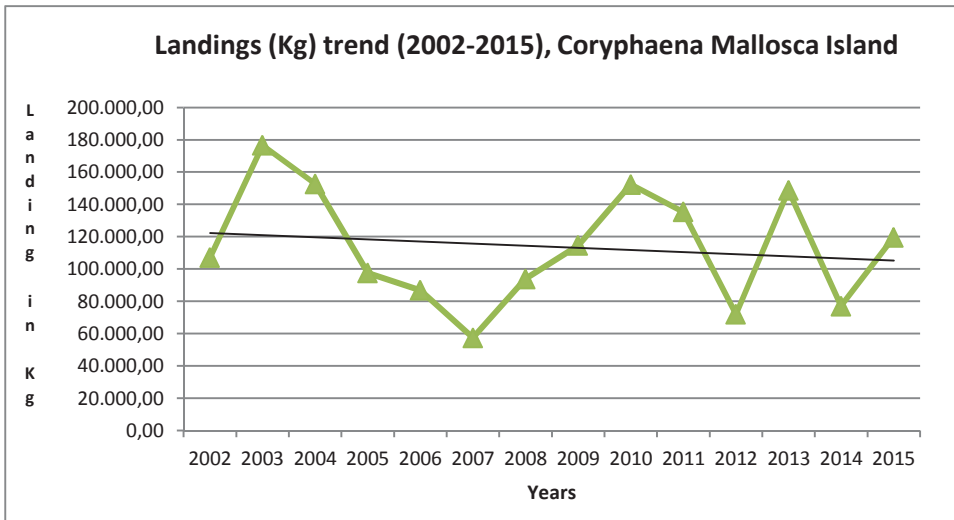


Figure 1. Annual official landing (kg) in Majorca Island during the 2002-20015

During this period, maximum yield corresponded to year 2003 with a total landing production of 176.617 Kg. Minimum value was obtained in 2007 (57.360 Kg). In general annual landings during the period present a decreasing trend, fluctuating around the 100 t/year value.

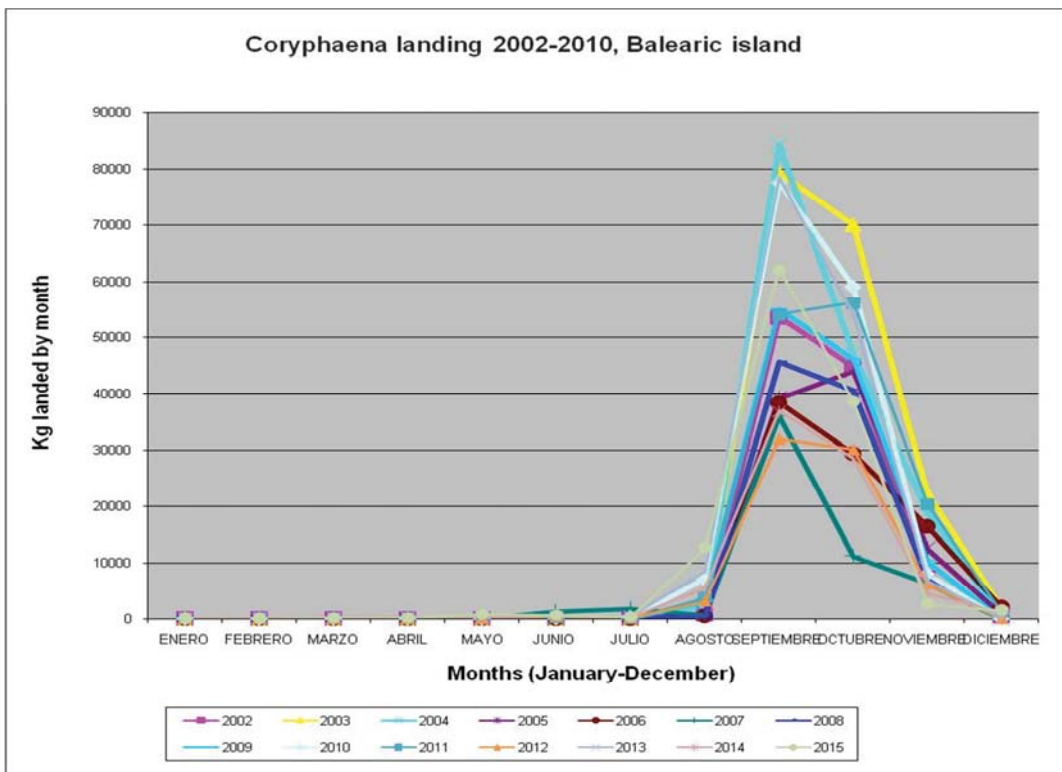


Figure 2: Monthly distribution series of official dolphinfish landing in Majorca Island

The monthly distribution of landings values (Figure 2) shows the annual maximum production in September or October depending on the year and less important production in August and November. The annual series (Table 1) show that some landing occurs in Majorca during the period of the year before the FADs season corresponding to landings from the surface longline fleet targeting other species (mainly swordfish) around Balearic Island that bycatch some Dolphinfish.

The historical series of annual landings (in tonnes) elaborated from the two sources mentioned, the CopeMed CORY project (years 1981-2001) and the official data provided by the Fisheries Directorate from the Balearic Islands (years 2002-2015) are summarised in Table 3:

Table 3. Annual historical landings series. Majorca Island, *Coryphaena* fishery. (Data from CORY Project and Balearic Islands fishing administration)

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	
Production (T)	8	78	31	53	74	44	31	84	97	98	78	42	54	106	128	52	45	
Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Production (T)	55	55	44	199	107	177	153	98	87	57	94	115	152	135	72	149	77	120

The distribution of landings (in tons) in Majorca Island (Table 3) presents several fluctuations in production, as observed also in Figure 3. This figure shows a general increasing trend in landing in Majorca Island. The maximum yield of the total series corresponds to 2001 reaching 199 tons, after several years of low captures. Minimum values of the series correspond to the first 20 years.

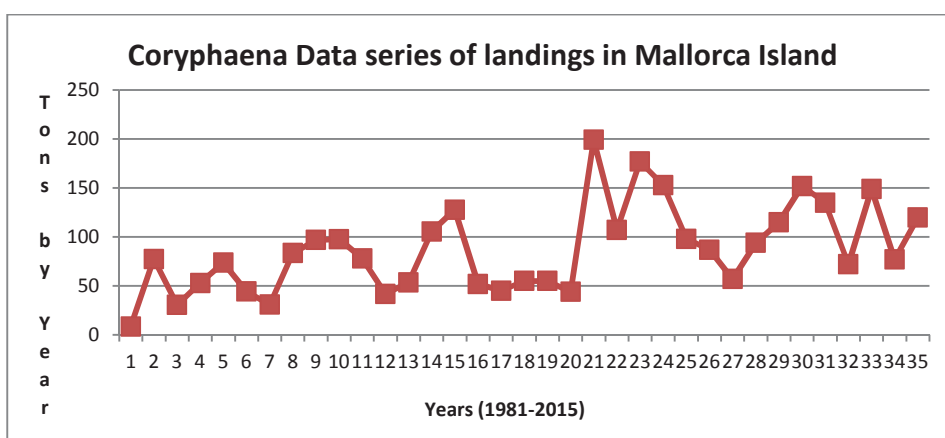


Figure 3: Historical data series (1981-2015) of *Coryphaena* landings (tons) in Majorca Island with the data combined (prepared by authors).

After the fishermen's agreement to establish a daily quota by vessel from 2012 (year 32 in Figure 3) fluctuations in landing move above and below the 100 tons/year line, probably as an effect of the quota established not reflecting the real abundance.

Evolution of prices

As showed in Table 2 and Figure 4, annual prices at landing increased during the period 2002-2015. Also after the quota was adopted (2012) a drop in prices appears in 2013 followed by a high increase in 2014 and a lesser price in 2015, showing that quota has not stabilized the prices.

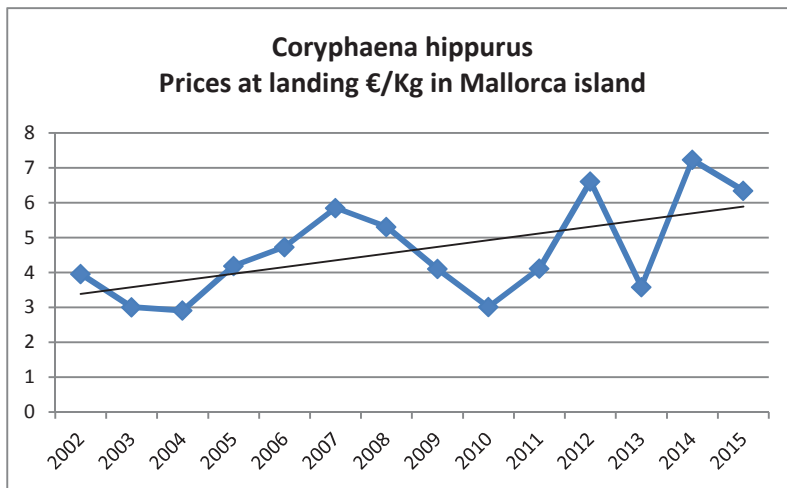


Figure 4. Evolution of prices at landing (€/Kg) by year in Majorca landing.

Annual landing in relation to the establishment of the quota in 2012

Landing statistics presented correspond to the global fishery in Majorca Island. One question that rose during the meeting of the WG (Malta, 16- 18 March 2016) was what has been the real effects of the establishment of a quota in 2012 on the behavior of the fishermen and on the total daily capture by each individual vessel.

In order to understand the quota effects on landings, available data corresponding to the 2015 season were provided by the fisheries administration from Balearic Islands, corresponding to individual artisanal vessel landing in Majorca during the *Coryphaena* season.

A total 55 artisanal vessel landed during the season period producing 116,79 tons of *Coryphaena*. Differences with total production in 2015 (Table 2 and 3) correspond to surface longline landings). We classified the data from artisanal vessel according the activity (days at sea) of the fleet in 6 strata (Table 4): less than 10 days at sea during the *Coryphaena* season; from 10-20 days; from 20-30 days; from 30-40 days; from 40-50 days and over 50 days/season.

Table 4. Summary of activity and CPUE (landing/day in Kg) of Majorca artisanal fleet targeting *Coryphaena* in 2015

Day's classes	N° vessels	Days (average)	Total days	Capture/1000	CPUE
<10	18	3,11	56	1,44	25,66
10-20	9	16	144	12,37	85,92
20-30	11	23,64	260	21,50	82,71
30-40	9	35,44	319	34,52	108,20
40-50	6	46,33	278	33,13	119,18
>50	2	57	114	13,83	121,33
Total	55	8,7	1171	116,79	99,74

Most of the artisanal vessels (18) were fishing less than 10 days for *Coryphaena* with an average of 3, 11 days and a CPUE of 25, 66 kg/day. This landing value is far from the 300kg quota. A second group of vessels (11) were fishing between 20 and 30 days with 23, 64 days in average and a CPUE of 82, 71 kg/day. Only two vessels were working more than 50 days/season obtaining a CPUE of 121,33 kg/day. This value is close to the CPUE obtained by the group of vessels that worked an average of 46,33 days.

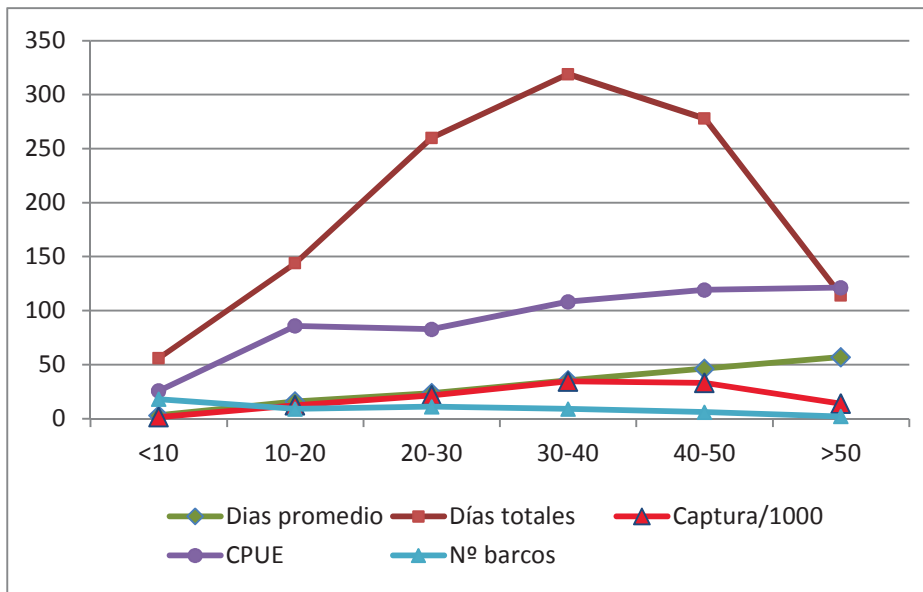


Figure 5. Activity of the Balearic Island artisanal fleet targeting *Coryphaena* in 2015.

From the distribution of the values in Table 4 and Figure 5, we observe that the maximum fishing effort corresponds to a group of vessels fishing between 30-40 days/season, followed by vessels working 40-50 days and vessels working 20-30 days. Nevertheless if we observe the CPUE (kg landed by vessel and day), maximum values (121,33 kg/day) correspond to the 2 vessel working the maximum average time (57 fishing days/season), that correspond to an average monthly activity of around 14 days/month during the effective fishing period (August, September, October and November). CPUEs corresponding to the groups of vessels working 30-40; 40-50 and > 50 days are similar, meaning that with less fishing effort the artisanal vessels of these three groups could obtaining similar yields in terms of CPUE.

The absolute maximum yield of the fleet in landing (kg) and total value of landing corresponded to a single vessel that was working 62 days in 2015 catching 7.568 Kg of *Coryphaena*. Applying the average annual prices at landing (Table 2) in 2015 (6,35€/kg) yield in value for this vessel was 48.020,37€ from the *Coryphaena* landing in Majorca port. Minimum yield corresponded to a vessel fishing only 1 day with no captures of *Coryphaena*.

Artisanal fleet activity targeting *Coryphaena* in 2015

The artisanal vessels are not all equally involved in targeting the species during the *Coryphaena* season in Majorca Island. There is not easy to understand why after obtaining an annual license for this fishery some vessels are not as interested as others in obtaining important yields and are not active during the whole season. According to the available data 69,09% of the fleet worked less than 30 days (Table 5) and the rest, the 30,91% of the vessels were fishing more than 30 days.

Apparently there are different reason for the fleet/fishermen behavior and fishing strategy, including distant to the single landing port (in Majorca city) from the fishing areas, different CPUEs around the island (according the administration vessel with lines and capcers in the eastern part of the island have higher yields than those in the south and eastern part of Majorca Island), variations in the prices along the season, etc. that could reduce the interest in fishing of some vessel that are not interested along the season. The 49,09% of the vessels working in 2015 were active less than 20 days (Table 5) while only half of the fleet (28 vessels) were fishing more than 20 days with a maximum of 57 days.

Table 5. Activity of artisanal fleet targeting *Coryphaena* in 2015, Majorca Island.

Day's classes	N° vessels	% Vessels	Acumulated
<10	18	32,73	32,73
10-20	9	16,36	49,09
20-30	11	20,00	69,09
30-40	9	16,36	85,45
40-50	6	10,91	96,36
>50	2	3,64	100,00
Total	55	100,00	

Figure 6 shows the distribution of the fishing time of the fleet groups in “day’s classes” as in Table 5.

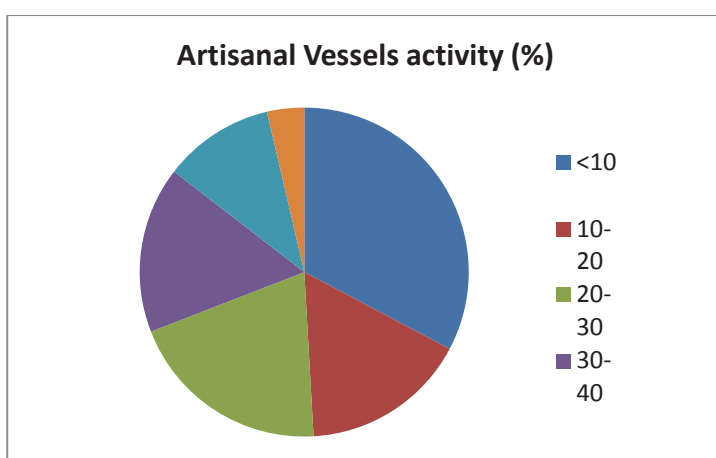


Figure 6. Category of vessels (% of the total fishing days) during 2015 targeting *Coryphaena* grouped according the number of days of activity in Majorca Island.

Discussion

Artisanal fisheries targeting Dolphinfish in Majorca Island are authorized during a restricted period of the year including summer and autumn months. A long series of 35 years of landings in Majorca Island from 1981 has been build using data recovered from the CopeMed files (CORY Project) and complemented with others provided by the Balearic Islands fisheries administrations and corresponding to the period 2002-2015. This series shows important annual fluctuations but the general trend of the landings increase from the starting year onward.

Since 2012 the fleet and local retailers have introduced technical measures to reduce the fishing effort and captures of Dolphinfish. The purpose of these measures is not only the conservation of the resource butto improve the income of fishermen and retailers, reducing the supply of this product and improving the quality. A quota by boat and day of 300 kg maximum was agreed although landings after the quota introduction were not reduced when comparing tothe series.

Despite no reduction in landings, nevertheless an important increase of the total production (in €) from the introduction of the quota is observed. Annual production reaches about 800 thousand € in 2015 and the average annual price was 6-7 €/kg during the two last years. As noted, both the average price and, especially, total annual income take an upward trend, due to the changes introduced by the sector itself in terms of quotas and weekly rest period.

Until 2013 *Coryphaena* landings from artisanal fishery corresponded to summer and autumn months; from that year Dolphinfish landing in Majorca market appear all year long. From January to July catches correspond to surface longlines and from July until end of November to artisanal fleet using FADs. This situation probably shows an increase of the Dolphinfish product demand locally during the closing seasons to the artisanal fleet favoring the landing of this species bycaught by the surface longliner fleet targeting swordfish around Balearic Islands.

The analysis of the longer data series obtained in Majorca (1981-2015) shows different periods of production and a tendency to increase landings. During the first 10-year landing was less than a hundred tons with an extraordinary peak in 2001 that has not been repeated any more

The analysis of the fleet activity in 2015 from individual vessel information provided by the Balearic Islands Fishing Administration shows that no vessel was able to work the whole fishing season period (seasonal number of available days is around 80 days) and none of them captured amounts close to the established quota. Artisanal vessel targeting *Coryphaena* do not carry out this activity equally during the authorized season, they can vary from few days of activity to a maximum of 57 days. Landing/days showed amounts far from the established quota of 300 kg/day. In this situation quota appears more as a target limit than a precautionary limit in terms of capture or economic yield.

By other side the 50% of the authorized fleet targeting *Coryphaena* in 2015 used only less than 20 days of the authorized period. This situation can be interpreted as consequence of low yields in relation to the cost of the activity or low prices at landing that don't compensate the investment, although bad weather conditions are an important factor limiting the fishing activity during the season. In our opinion weather conditions and low economic yields should be the main cause of the reduced activity of the 50% of the fleet, although this hypothesis needs confirmation.

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