Study to improve the knowledge of the Dolphin-fish fishery in the South-East of Sicily

Project CORY03

FAO - COPEMED

Final Report

Istituto di Ricerche sulle Risorse Marine e l'Ambiente
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8 REFERENCES

1 – SUMMARY

This report illustrates the results of the project "Study to improve the knowledge of the dolphin-fish fishery in the South-East of Sicily" (FAO-COPEMED), whose main objectives were:

- Assessment of Sicilian Dolphin-fish fleet fishing by FADs nearest Maltese Dolphin-fish fishing area;
- Catch-effort analysis;
- Length composition of the catch;
- Age and growth.

The first aim of programme was the estimate of catches and relative fishing effort of Sicilian fleets operating in Dolphin-fish fishery, by Fish Aggregating Device (FADs), in waters near the Maltese dolphin-fish fishing area, also using FADs.

Waters between Malta and Sicily's South-Eastern coast and waters between Malta and the Pelagie Islands was the study area.

The programme started on 20th August 2001 with the Frame Survey (FS). All Sicilian ports whose fleets work by FADs in the study area were identified, and the relative fishing boats were listed.

on basis of information gathered during the fs we have chosen sample ports in a reasoned way. in each sample port, the catch effort surveying (CES) started with interviews at landing (three time per week: Monday; Wednesday; Friday), in the last week of august. in the two ports of the Pelagie Islands (Lampedusa and Linosa) the CES was carried out by census in space and time (catch effort survey, CES).

Moreover, monthly samples of Dolphin-fish have been bought in Porto Palo di Capo Passero and in Linosa to carry out the biological and biometric parameters. In addition, at Linosa catch samples were measured at landing (total length) to study population structure. The 2001 and 2002 fishing seasons started in July so a sample of dolphin-fish was bought in July 2002. An "ad hoc" database has been made for filing of all data of FS, CES and biological and biometric parameters.

In the Pelagie Islands during the 2001 FADs fishing season only 8 boats were active from the Linosa port. At December 31st 2001, 61 sampling days and 60 interviews were carried out in Sicily whilst in the Pelagie Islands were carried out 37 fishing days and totally the 8 fishing boats caught 47,981 Kg in 127 fishing trips.

From the Sicilian ports (Marzamemi, 5 boats, Porto Palo di Capo Passero, 12 boats, Pozzallo, 7 boats, Licata, 7 boats) in the 2001 fishing season 31 boats were active. The total catch in the sample ports was 80,814 Kg. So totally the catch of Italian FADs fleet in the area was 128,795 Kg. The project was extended until September 2002 to collect July samples in the ports that begin fishing before August. So in Porto Palo di Capo Passero in July 2002, 42 specimens of Dolphin-fish were collected. Because these specimens were very small, it was difficult to extract the otholits in order to read daily growth increments.

Totally the project involved 1 Physicist, 4 Fishery Biologists, 3 Technicians, and 3 Field Operators.

2 - PARTICIPANTS

The following tables summarise the complete list of all the people co-operating on the project. Among the participants, we would also like to mention the numerous fishermen who co-operated not only by providing detailed information on their fishing activities, but also by helping to convince the less forthcoming and more diffident fishermen to co-operate too.

Table 2.1: Human resources employed.

Istituto di Ricerche sulle Risorse Marine e l'Ambiente		
NAME	TITLE	EXPERTISE
Dr. Leonardo Cannizzaro	Physicist	Project leader
Dr.ssa Maria Rita Asaro	Fishery Biologist	Biological and Biometric Analysis Biological and Biometric Measurements Age and growth
Dr.ssa Anna Maria Beltrano	Fishery Biologist	Stomach Contents Analysis Biometric Measurements
Dr. Gioacchino Bono	Fishery Biologist	Biological and Biometric Analysis Biological and Biometric Mesurements
Dr. Sergio Vitale	Fishery Biologist	Biological and Biometric Analysis Biological and Biometric Measurements
Dr.ssa Maria Rita Asaro	Fishery Biologist	Biological and Biometric Analysis Biological and Biometric Measurements
Dr.ssa Paola Pizzicori	Fishery Biologist	Responsible for the Pelagie Islands
Mr. Antonino Milazzo	Technician	Catch-Effort Surveys Database management Input data Age and growth
Mr. Salvatore Cusumano	Technician	Database Development
Mrs. Francesca Apollo	Technician	Input data
Mrs. Ivana Giardina	Field Operator	Interviewer
Mr. Corrado Lupo	Field Operator	Interviewer
Mr. Emanuele Scala	Field Operator	Interviewer

3 - OBJECTIVES

The main objectives of the project "Study to improve the knowledge of the dolphin-fish fishery in the South-East of Sicily" were:

- To study the structure of the Sicilian Dolphin-fish fleet fishing by FADs nearest Maltese Dolphin-fish fishing area;
- To study the qualitative and quantitative composition in time and space of the catch;
- Dolphin-fish catch-effort analysis;
- Dolphin-fish length composition of the catch;
- Dolphin-fish age and growth.

The study area was the strip of sea between Malta and Sicily's South-Eastern coast and waters between Malta and the Pelagie Islands.

4 - GENERAL MANAGEMENT AND ORGANISATION OF THE PROJECT

The programme started on 20th August 2001 with the Frame Survey (FS). All Sicilian ports whose fleets work by FADs in the study area were identified, and the relative fishing boats were listed.

At each port or landing place whose fleet works by FADs in the study area, a frame survey was carried out, in the last week of August 2001, to define the target population of boats (TPB) and their characteristics. On the basis of the data and information collected during the frame survey phase, sample ports were selected for performing catch effort surveys and for collecting samples of the catches.

All the sample ports were located away from the headquarters, so local young graduates or students, preferably related or close to the fishing community, were recruited for interviewing the fishermen at landing. These young people were suitably trained by means of theory courses and by means of practice in the field.

In Marzamemi the Dolphin-fish fishing season began on August 14 and thanks to very collaborative fishermen it was possible to find the catch of just one boat from this date. In Porto Palo di Capo Passero the Dolphin-fish fishing season began on 24 July! So the biological samples of July 2001 were losses. But, a Dolphin-fish catch sample was acquired in July 2002. In Linosa the Dolphin-fish fishing season began on August 19.

Table 4.1 shows the number of interview days, the number of interviews and the period of the catch effort surveys, for each sample port in Sicily and in the Pelagie Islands.

Table 4.1: Number of interview days, number of interviews and period of the catch effort surveys.

	Number of Interview Days	**Number of Interviews**	**Period**
Marzamemi	25	20	14/08/01 - 29/10/01
Porto Palo di Capo Passero	36	44	27/08/01 - 23/11/01
Linosa	37	127	19/08/01 - 04/12/01
Total	**98**	**191**	**14/08/01 - 04/12/01**

It was not possible to involve all fishermen in the project! So in Marzamemi only one fisherman collaborated with the project and gave interviews. It is probable that the other fishermen of Marzamemi don't put FADs at sea and agree with Maltese fishermen to use Maltese FADs or buy at sea Dolphin-fish captured by Maltese fleet to commercialise in Sicily with very good profit.

Dolphin-fish catch samples from Porto Palo di Capo Passero and from Linosa were brought to IRMA laboratory for biometrical and biological measurements.

All the original objectives were achieved; in addition, unscheduled objectives were tenaciously pursued and substantially achieved.

The project was extended until September 2002 to collect July samples in the ports that begin fishing before August. So in Porto Palo di Capo Passero in July 2002 42 specimens of Dolphin-fish were collected. Because these specimens were very small, it was difficult to extract the otholits in order to read daily growth increments.

5 - MATERIALS AND METHODS

The research programme started on 20th August. The study area was: the strip of sea between Malta and the Southeastern coast of Sicily; and the strip of sea between Malta and the Pelagie Islands.

5.1 FRAME SURVEY

A Frame Survey (FS) was carrying out to define the target population of boats (TPB), their characteristics and the fishing gear used. This information was collected by consulting the registers in the Port Authority offices and complemented by interviewing boat owners.

5.1.1 Fleet structure

In order to assess the structure of the fleet, the following parameters were collected and recorded on each boat at each port or landing place of the study area: gross tonnage, power (Kw), total length, age of ship, age of engine. All data were collected on standard forms (see enclosure 2, MOD. FS01). For each parameter, total and average values were calculated by port or landing place and by stratum.

5.1.2 Strata and sample ports

The opportunity for stratification and the choice of sample ports were evaluated on the basis of the information coming from the frame survey alone. The strata were selected on the basis of geographical criteria, so two strata being defined. Sample ports per stratum were chosen by purposive criteria (a choice determined by cost considerations).

5.1.3 Fishing gear and FADs

For each boat at the sample ports, information was collected on standard models (see enclosure 2, MOD. FS02) on type of purse seine used, number of FADs and fishing area. Several parameters were identified to define the characteristics of the different purse seine. These include: length, height and mesh size.

5.2 CATCH EFFORT SURVEY

The catch effort survey (CES) was carried out, in Sicily, according to a two-stage sampling method: having selected the sample ports (primary sampling units), on certain fishing days (determined according to cost considerations and on the basis of the time-related variability between catches), information on the catch was obtained (by interviews at landing) for a sample of boats (secondary sampling units) chosen on the basis of a Simple Random Sampling method (SRS method). In the Pelagie Islands the CES was carried out on census basis in time and space; all fishing days all fishermen were interviewed.

In practice, an interviewer had to interview as many fishermen as possible at landings, three days every week (Monday; Wednesday; Friday); he had to arrive to the selected ports before the fishermen returned from sea, to take a census of the fishermen who did not go fishing that day; he used a dedicated form (MOD S01) in which all the target boats (at the selected port) were listed and he made a note of the boats that remained in the harbor (see enclosure 3). He had to wait for the

fishermen to arrive in order to interview them, one at a time, while they unloaded their catch. For this purpose he used another form (MOD CES01; see enclosure 4). When all the boats had returned to the port, he noted on MOD S01 whether each boat, had been interviewed or not. At the end of the day, he noted on MOD S01, for each target boat, whether it had been fishing, and if it had fished whether interviewers had been compiling the MOD CES01 for it or not.

5.2.1 Catch composition at the sample ports

The catch composition per month at each sample port was studied.

5.2.2 Total Catch, effort and CPUE

The total catch per fishing week and/or month and/or season, per port and/or stratum was estimated on the basis of the classical statistical methodology according to the following formulas:

- the average daily catch per vessel would be $C_v = \Sigma_i (C_{\mathbf{d}i}/n_i)$;
- $C_{\mathbf{d}i}$ is the catch of a typical interviewed vessel;
- n_i is the number of interviews on a typical sampling day;
- the average catch per port would be $C_p = C_v * v_a$;
- v_a is the number of active vessels;
- total catch during the week and/or month and/or season per port $C_{tp} = \Sigma (C_p * d_t/d_i)$;
- d_t is the days of fishing per week and/or month and/or season;
- d_i is the days of interviews per week and/or month and/or season
- the variance in total catch per week and/or month and/or season is given by: $Var = d_t^2 * \Sigma (C_{tp} - C_p/d_i)^2 / d_i * (d_i - 1)$;
- total catch per stratum is given by: $C_{str} = C_{tp} * N_{bstr}/N_{bsp}$;
- N_{bstr} is the number of boats in the stratum and N_{bsp} the total number of boats of all sample port of the stratum;
- $Var_{str} = Var * (N_{bstr}/N_{bsp})^2$;

Concerning the fishing effort, the following formula was used:

- $E = N_{fads} * N_{hauls}$;

N_{fads} is the number of FADs put at sea by all the fishing vessels of a port (capacity);
N_{hauls} is the number of hauls made by all the fishing vessels per week and/or month and/or season (activity).
Estimates of effort were obtained using the same procedures used for the catch. The CPUE was calculated as the catch divided by the fishing effort.

5.3 BIOLOGICAL STUDIES

In the sample ports of Porto Palo di Capo Passero and Linosa a sample of Dolphin-fish caught were acquired per month. Fish samples were taken to the laboratory for further analysis. As a rule, all specimens from the sample underwent the following biological procedure and the following parameters were measured in each specimen:

- Lt (total length)
- Ls (standard length)
- Lp (length of snout from start of pelvic fin)
- La (length of snout from start of anal fin)
- Ld (length of snout from start of dorsal fin)
- A.d.v. (height from start of dorsal fin to start of ventral fin)
- Somatic weight
- Sex
- Sexual maturity stage (Holden and Raitt)
- Gutted weight
- Otolith weight

All the parameters measured were collected on special hard copy forms (see enclosure 5) and entered in an *ad hoc* database. All the morphological parameters were measured to the nearest 1 mm. The total weight of each specimen was measured to the nearest 1 g and total gonad weight to the nearest 0.01 g.

5.3.1 Length-frequency analysis

Length-frequency distributions by month and sampling port were constructed.

5.3.2 Age and Growth

Sagittal otoliths were removed from all fish analyzed. They were washed and cleaned in distilled water and kept dry. The otoliths were embedded in Implex resin to form blocks. The blocks were attached to microscopic slides by termoplastic cement and ground longitudinally to the primordia on both sides (Secor et al., 1991). After polishing, daily growth increments were well-distinguished in 80 % of otoliths and counted from nucleus to otolith edge at x400 under transmitted light of a 'Leica' microscope.

Parameters of the von Bertalanffy growth function (VONB) and their standard errors were estimated using the 'Fishparm' statistical package (Saila et al., 1988) separately for each port. Mean total lengths and weights were calculated for each age class for further estimation of growth rates. Absolute increments in TL and weight were calculated according to Ricker (1979) as:

$$AGR = (S_2-S_1)/\Delta T,$$

where S_1 and S_2 are either mean TL or weight values at the beginning and end of time interval (ΔT).

5.3.3 Length-weight relationships

Length-weight relationships ($W = aL^b$) were estimated separately for each sex and sampling port.

5.3.4 Feeding behavior

Diet analysis has been carried out on a sample of 23 specimens caught in Linosa and 67 in Porto Palo, by surrounding net, near the FADs. The sampling was carried out from July to December 2001. For each sample we have pointed out the following parameters: total and standard length (TL and SL) in mm, total weight (TW), eviscerated weight (EW) in g, sex, gonads stage, gonads weight, otoliths drawing. We have pointed out the following parameters too: VL (ventral snout-fin length), AL (anal snout-fin length), DL (dorsal snout-fin length), OH (opercular high).
We have drawn the fish's digestive apparatus (stomach and intestine), which we have fixed in neutralised formalin to 5 % and after we have analysed it wholly, and identified the inside preys.

The analysis of preys found was carried out applying the following indexes: F% (percentage occurrence frequency), N% (percentage number) V% (percentage volume) (numerical method of Hyslop, 1980).

The predatory activity (A) [$A=\sum F\%$] was calculated.

Different aspects of feeding intensity were calculated by using the vacuity index (VC) or repletion index (% of full stomach/total stomach), the degree of fullness (DF), measured according to five point scale (0 empty stomach, 2 traces of food, 3 traces of food with non-dilated walls, 4 traces of food with dilated walls, 5 full with dilated and thin walls)

Moreover, we have calculated:

Feeding index (F.I.) of Lauzanne (1975): $I.A.=F\%*V\%/100$

Main Food Item (MFI) (Zander, 1982): $MFI = \sqrt{[(N\% + F\%)/2] * V\%}$

Index of relative importance (Pinkas et al.,1971): $IRI=N\%+V\%*F\%.$

6 RESULTS

6.1 FRAME SURVEY

On the basis of the FS information the study area was divided in two strata: stratum A (Licata, Pozzallo, Porto Palo di Capo Passero, Marzamemi); stratum B (Pelagie Islands). The following table shows the number of boats for each port and stratum.

Table 6.1.1: Port, number of boats and strata.

Port	Number of boats	Strata
Licata	7	A
Pozzallo	7	A
Porto Palo di Capo Passero	12	A
Marzamemi	5	A
Total stratum A	**31**	**A**
Lampedusa (Pelagie)	0	B
Linosa (Pelagie)	8	B
Total stratum B	**8**	**B**

In stratum A (Sicily) the FADs fleet totally count 31 boats based in 4 ports. While there are 8 boats in the Pelagie Islands based at Linosa port.

6.1.1 Fleets structure

Tables 6.1.1.1a - e shows the structural characteristics of the FADs fleets by port, stratum and total. Except than in Porto Palo di Capo Passero the average GRT is less than 10 tons. The average power of the engines ranges from 35 Kw (Linosa feet) to 164 Kw (Porto Palo di Capo Passero fleet). The most part of the fleet is constituted of very small boats. The average age of the boats ranges from 24 to 29 years. Also the average age of engine is very high. So fishing activity cost is very cheap and the revenues are very high!

Table 6.1.1.1a: Number of boats, GRT, Average GRT, Standard Deviation on Average GRT, Minimum and Maximum GRT.

Name of Port	Number of boats	Gross Tonnage	Average Gross Tonnage	SD on Average Gross Tonnage	Minimum Gross Tonnage	Maximum Gross Tonnage
Licata	7	36.6	5.6	1.6	3.0	8.3
Pozzallo	7	37.8	5.4	2.7	2.6	10.0
P. Palo Capo Passero	12	183.8	15.3	10.1	4.1	32.2
Marzamemi	5	49.7	9.9	6.2	3.4	19.7
Total stratum A	**31**	**307.9**	**9.9**	**8.1**	**2.6**	**32.2**
Linosa	8	40.0	5.0	4.3	2.6	15.3
Total stratum B	**8**	**40.0**	**5.0**	**4.3**	**2.6**	**15.3**
Total	**39**	**347.9**	**8.9**	**7.3**	**2.6**	**32.2**

Table 6.1.1.2a: Number of boats, Power, Average Power, Standard Deviation on Average Power, Minimum and Maximum Power.

Name of Port	Number of boats	Power kw	Average Power	SD on Average Power	Minimum Power	Maximum Power
Licata	7	1087.8	155.4	32.7	88.2	176.0
Pozzallo	7	310.9	44.4	19.2	16.2	80.9
P. Palo Capo Passero	12	1969.1	164.1	87.4	79.4	330.8
Marzamemi	5	546.8	109.4	67.2	18.4	205.8
Total stratum A	**31**	**3914.6**	**126.3**	**77.9**	**16.2**	**330.8**
Linosa	8	279.8	35.0	30.2	13.0	104
Total stratum B	**8**	**278.8**	**35.0**	**30.2**	**13.0**	**104**
Total	**39**	**4194.4**	**107.5**	**79.7**	**12.9**	**330.8**

Table 6.1.1.3a: Number of boats, Average length, Standard Deviation on Average length, Minimum and Maximum length.

Name of Port	Number of boats	Average Length m	SD on Average Length	Minimum Length	Maximum Length
Licata	7	9.8	1.2	8.1	11.5
Pozzallo	7	9.6	1.7	6.8	12.3
P. Palo Capo Passero	12	13.4	3.5	7.8	19.4
Marzamemi	5	12.1	3.0	8.5	16.1
Total stratum A	**31**	**11.5**	**3.1**	**6.8**	**19.4**
Linosa	8	8.8	2.6	6.9	15.0
Total stratum B	**8**	**8.8**	**2.6**	**6.9**	**15.0**
Total	**39**	**11.0**	**3.2**	**6.8**	**19.4**

Table 6.1.1.4a: Number of boats, Average age of boats, Standard Deviation on Average age of boats, Minimum and Maximum age of boats.

Name of Port	Number of boats	Average age of boats years	SD on Average Age of boats	Minimum age of boats	Maximum age of boats
Licata	7	27.0	17.6	8.0	48.0
Pozzallo	7	24.0	9.0	12.0	34.0
P. Palo Capo Passero	12	24.3	8.8	14.0	39.0
Marzamemi	5	29.2	9.1	17.0	38.0
Total stratum A	**31**	**25.6**	**11.0**	**8.0**	**48.0**
Linosa	8	29.1	7.2	18.0	36.0
Total stratum B	**8**	**29.1**	**7.2**	**18.0**	**36.0**
Total	**39**	**26.4**	**10.4**	**8.0**	**48.0**

Table 6.1.1.5a: Number of boats, Average age of engine, Standard Deviation on Average age of engine, Minimum and Maximum age of engine.

Name of Port	Number of boats	Average age of engine	SD on Average Age of engine	Minimum age of engine	Maximum age of engine
Licata	7	16.4	6.1	10.0	26.0
Pozzallo	7	14.4	3.3	11.0	21.0
P. Palo Capo Passero	12	19.8	8.9	11.0	36.0
Marzamemi	5	21.4	5.4	18.0	31.0
Total stratum A	**31**	**18.1**	**7.0**	**10.0**	**36.0**
Linosa	8	15.9	7.4	7.0	32.0
Total stratum B	**8**	**15.9**	**7.4**	**7.0**	**32.0**
Total	**39**	**17.6**	**7.2**	**7.0**	**36.0**

6.1.2 Strata and sample ports

In stratum A, sample ports were Porto Palo di Capo Passero and Marzamemi. This choice was made because fishing-boats of Marzamemi often unload the catch in Porto Palo di Capo Passero.

In the Pelagie Islands the CES was carried out by census both in space and time. So, all fishing-boats were interviewed for all fishing days in Linosa.

In stratum A the fishing season started in the last week of July! So, large quantities of very young Dolphin-fish with an average weight equal to about 100-150 g were caught.

In the stratum B the fishing season started, by tradition, in the second half of August, with the FADs laying, whereas the real fishery started in the last week of August.

The catch-effort survey started on 24th August in stratum A and in stratum B. Catches of stratum B, that were carried out before 24th August, will be estimated on basis of information gathered after this date.

6.1.3 Fishing gear and FADs

The FADs fishery of stratum A using a typical purse-seine with rings. The features of the equipment used by all the boats are as follows:

- Local name of net: Lampugara;
- Length: 180 m;
- Height: 45 m;
- Number of floats: 1 every 0.14 m;
- Number of sinkers: 900;
- Weight of sinkers: 90 Kg;
- Net material: nylon.

See figure 6.1.3.1.

The FADs fishery of Linosa using the same typical purse-seine as stratum A but without rings, in order to speed up recovery to the advantage of the number of hauls made in one leg. As mentioned, eight boats with tonnage ranging from 1 to 3 tonnes engage in this type of fishing, and all are equipped with a hydraulic winch for recovering the net.

In Sicilian ports (stratum A), the FADs used are constructed with a given number of empty plastic bottles tied together to form a single float, which is tied in turn to two or three palm branches. In some cases the float is polystyrene cork placed inside a jute sack like Maltese FADs.

The FADs used by Linosa fleet (stratum B) are very similar to the Maltese. They are of polystyrene cork placed inside a jute sack to which two or three palm branches are tied.

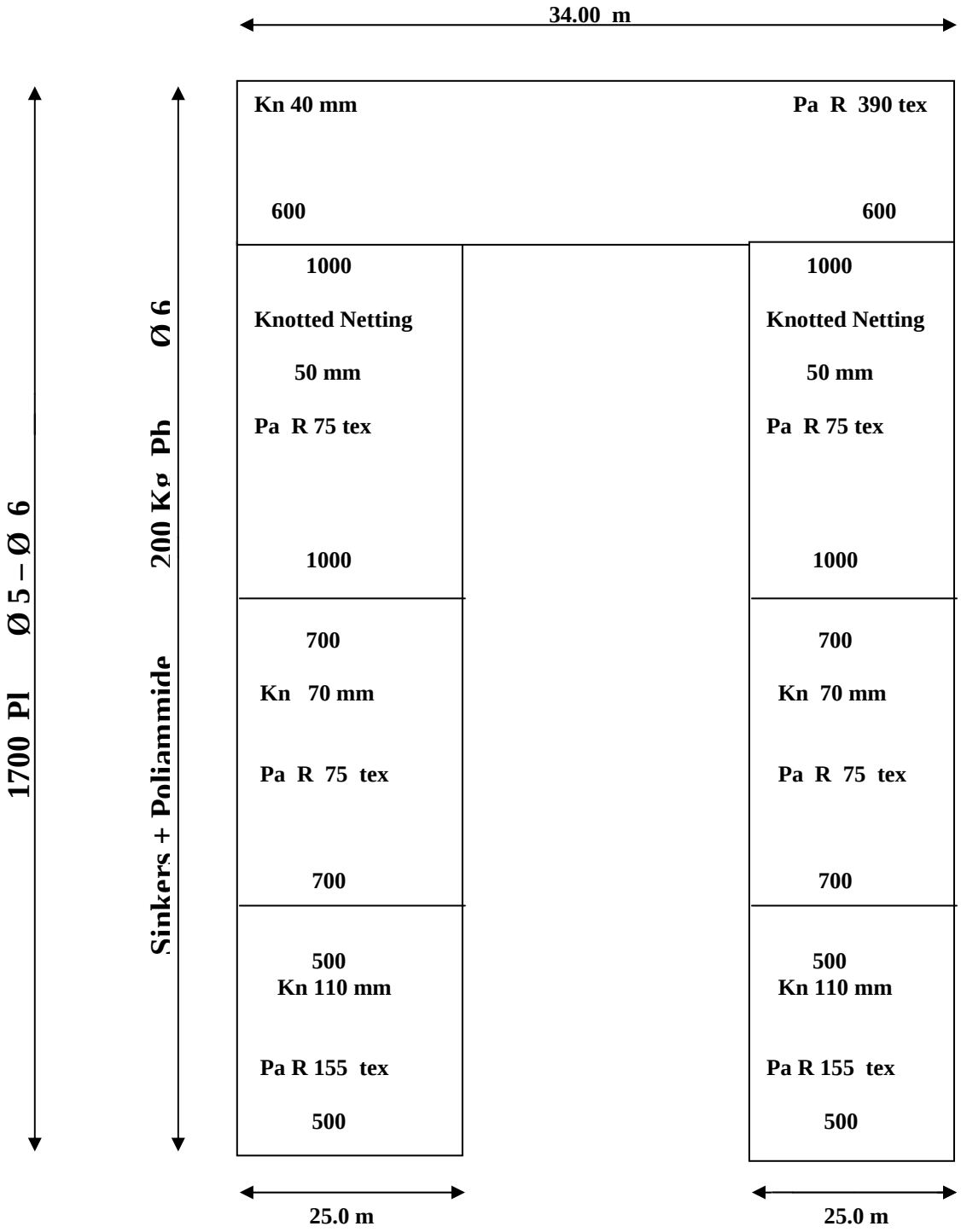


Figure 6.1.3.1: Schema of the purse-seine named lampugara.

6.2 CATCH EFFORT SURVEY

The catch-effort survey started on 24th August in stratum A and in stratum B. Unluckily in stratum A the fishing season started in the last week of July! So, it was not possible to have good information on quantities caught before August 24 except that large quantities of very young Dolphin-fish with an average weight of about 100-150 g were caught.

In the stratum B the fishing season started, by tradition, in the second half of August, with the FADs laying, whereas the real fishery started in the last week of August. In any case catches of stratum B, that were carried out before 24th August, will be estimated on basis of good information gathered after this date.

6.2.1 Catch composition

Table 6.2.1.1 show the species landing by the FADs fleet at Porto Palo di Capo Passero or at Linosa during the 2001 FADs fishing season.

Table 6.2.1.1: Species caught in the Fads fishing area of Porto Palo di Capo Passero or Linosa during the 2001 fishing season

Coryphaena hippurus	Main Target Specie
Seriola dumerili	Target Specie
Naucrates ductor	Target Specie
Tunnus spp.	Target Specie
Polyprion americanus	by-catch specie
Balistes carolinensis	by-catch specie
Schedophilus ovalis	by-catch specie
Tetrapturus belone	Target Specie but very rare

6.2.2 Total Catch, Effort and cpue

Table 6.2.2.1 to 3 shows total catch, effort and cpue for each sample port by week, month and fishing season.

In Linosa the best catches were carried out in September and October. In these months the cpue was very high.

In Porto Palo di Capo Passero the cpue increased month by month like in Linosa but reached the maximum in November. The average somatic weight was: 208 g, 722 g, 993 g, 1027 g respectively in August, September, November and December (it was not possible to find biological samples in October but the interviewer ~~have~~ estimated (by eye!) the average somatic weight as 750 g to one Kg).

In Marzamemi the fishing season finished in October the cpue ranging from 14 to 84 the maximum cpue was reached in October.

Total catch in the stratum A was 80,814 Kg with 2 % of relative error; the effort was 1808 with 2 % of relative error. So the cpue was 45.

Table 6.2.2.4 to 6 shows total catch of the by-catch species per month. In some cases, due to the very high price, *Seriola dumerili* was considered target species. When fishermen caught Amberjack the by-catch of Pilot-fish increased because the Amberjack stay together with Pilot-fish. Usually the oldest fishermen do not catch all of the Pilot-fish because they think a FAD without any fish is unattractive to Dolphin-fish. But when the price of Amberjack was very high (15 € per Kg or more) they wanted to catch all the Amberjack and so caught the Pilot-fish as well. When the target specie is Dolphin-fish the by-catch of Pilot-fish and Amberjack is very low or null.

Table 6.2.2.1: Total catch, fishing effort and cpue of 2001 fishing season.

Port: Linosa					
Month	Week	N° of boats	Catch Kg	Effort	CPUE
August	13 – 19	1	76	1	70
	20 – 26	2	3628	28	131
	27 – 02	7	6546	66	98
	Total	**7**	**10250**	**92**	**111**
September	03 – 09	6	6417	20	325
	10 – 16	6	6967	42	167
	17 – 23	4	1500	4	420
	24 – 30	5	4998	18	279
	Total	**6**	**19882**	**83**	**240**
October	01 – 07	7	9048	24	371
	08 – 14	6	2469	16	150
	15 – 21	5	594	11	43
	22 – 28	1	150	1	104
	Total	**7**	**12261**	**53**	**231**
November	29 – 04	1	60	2	26
	05 – 11	5	640	11	58
	12 – 18	-	-	-	-
	19 – 25	4	2445	12	205
	26 – 02	4	2157	10	224
	Total	**5**	**5302**	**35**	**152**
December	03 – 09	2	286	5	52
	10 – 16	-	-	-	-
	17 – 23	-	-	-	-
	24 – 30	-	-	-	-
	Total	**2**	**286**	**5**	**52**
Total season		**7**	**47981**	**268**	**179**

Table 6.2.2.2: Total catch, fishing effort and CPUE of 2001 fishing season

Port: Porto Palo di Capo Passero						
Month	N° of boats	Catch Kg	ER%	Effort	Er%	CPUE
August*	12	203	22	17	36	12
September	12	10560	2	334	2	32
October	12	15472	5	238	2	65
November	4	2094	27	15	34	138
Total	**12**	**28329**	**-**	**604**	**-**	**47**

* Catch and Effort relative only at last 5 days of August. The fishing season began last week of July!

Table 6.2.2.3: Total catch, fishing effort and CPUE of 2001 fishing season

Port: Marzamemi						
Month	N° of boats	Catch Kg	ER%	Effort	Er%	CPUE
August**	5	5707	3	322	2	18
September	5	3214	45	232	27	14
October	1	3794	36	45	12	84
November	0	0	-	0	-	-
Total	**5**	**12715**	**-**	**599**	**-**	**21**

* Catch and Effort relative only at last 17 days of August. The fishing season began last week of July!

Table 6.2.2.4: Total catch of by-catch species per month of 2001 fishing season

Port: Linosa			
Month	N° of boats	*Naucrates ductor* (kg)	*Seriola dumerili* (kg)
August	7	721	21
September	6	2826	186
October	7	1516	136
November	5	417	4
December	2	88	2
Total	**7**	**5568**	**349**

Table 6.2.2.5: Total catch of by-catch species per month of 2001 fishing season

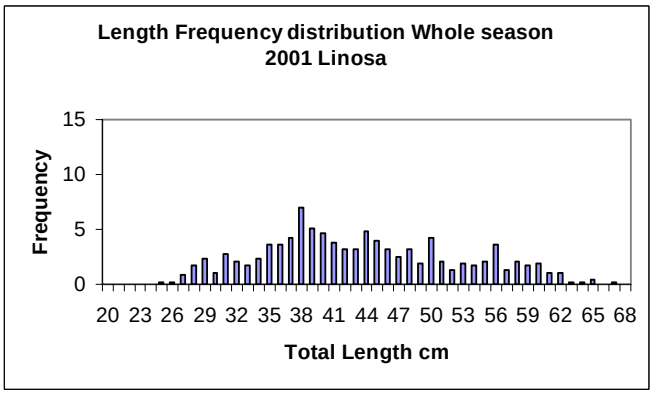
Port: Porto Palo di Capo Passero				
Month	N° of boats	*Naucrates ductor*	*Seriola dumerili*	*Tunnus* spp.
August	12	-	-	-
September	12	1658	415	-
October	12	3673	369	2943
November	4	28	186	67
Total	**12**	**5359**	**970**	**3010**

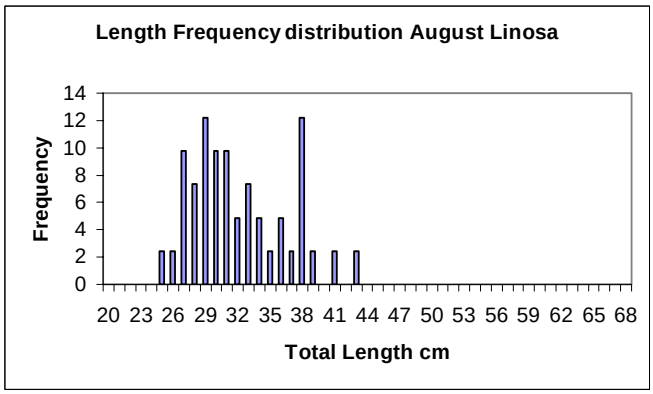
Table 6.2.2.6: Total catch of by-catch species per month of 2001 fishing season

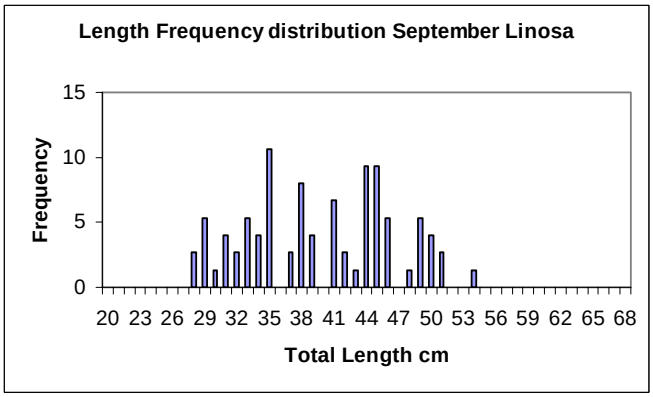
Port: Marzamemi			
Month	N° of boats	*Naucrates ductor* (kg)	*Seriola dumerili* (kg)
August	5	12203	304
September	5	6160	803
October	1	969	-
November	0	-	-
Total	**5**	**19333**	**1107**

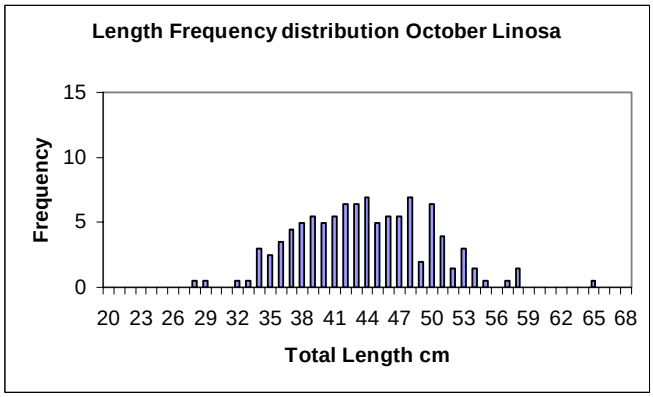
6.3 BIOLOGICAL STUDIES

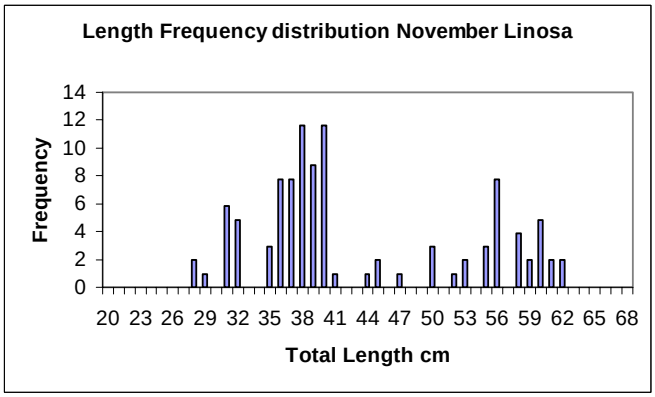
6.3.1 Length-frequency analysis

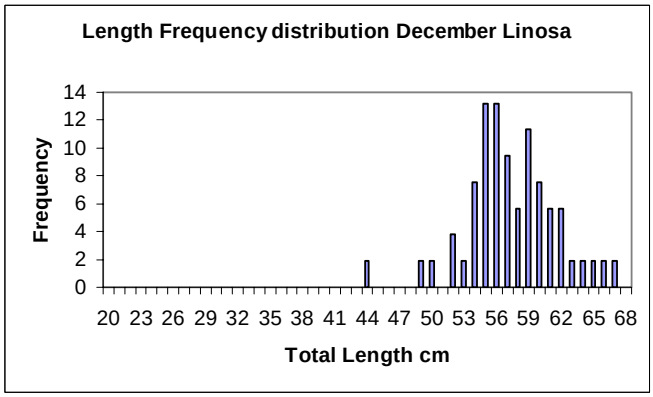


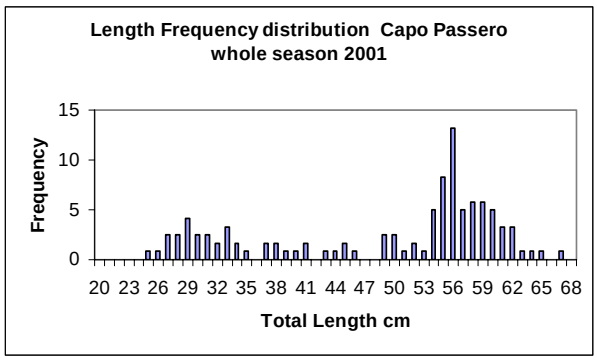


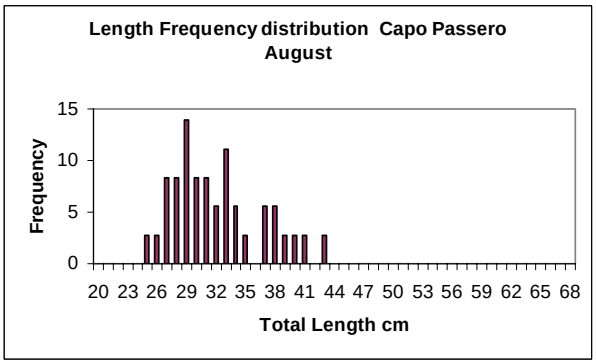









Length Frequency distribution Capo Passero whole season 2001
Frequency
0
5
10
15
20 23 26 29 32 35 38 41 44 47 50 53 56 59 62 65 68
Total Length cm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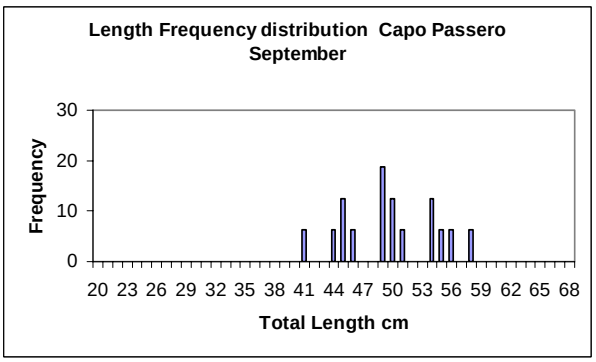
Total Length cm


Length Frequency distribution Capo Passero September
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10
20
30
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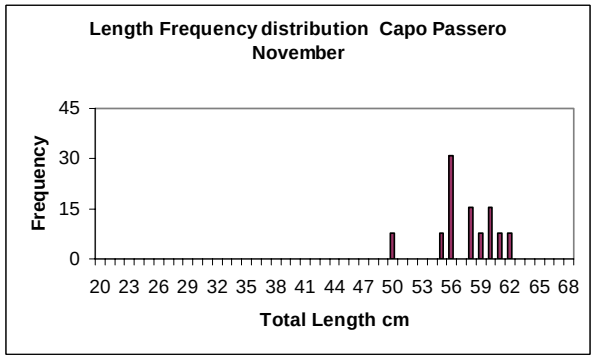
Total Length cm


Length Frequency distribution Capo Passero November
Frequency
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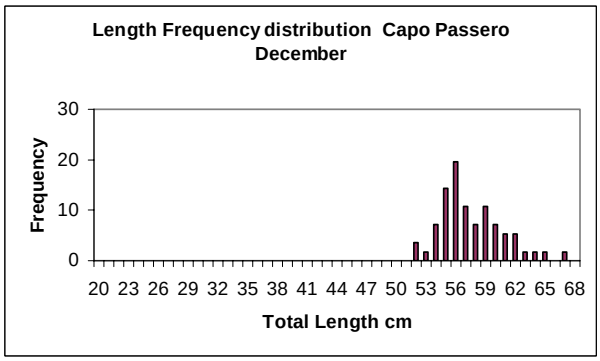
15
30
45
20 23 26 29 32 35 38 41 44 47 50 53 56 59 62 65 68
Total Length cm


Length Frequency distribution Capo Passero December
Frequency
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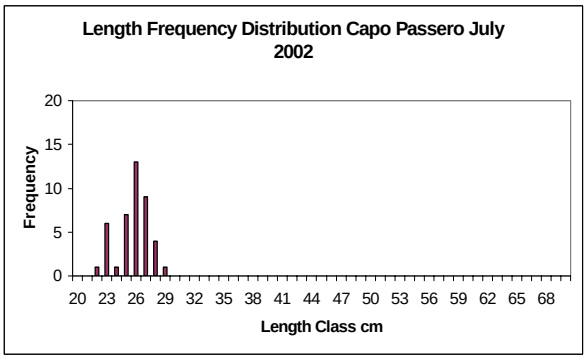
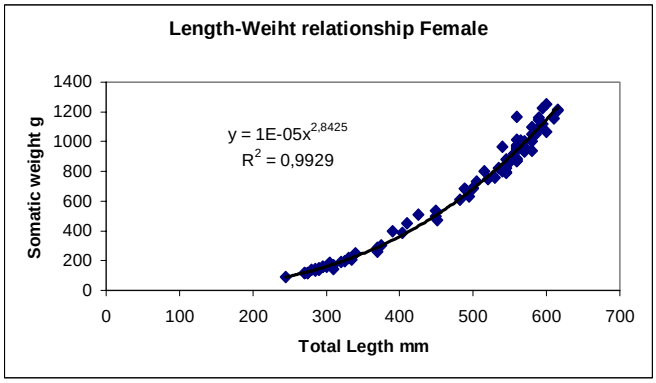
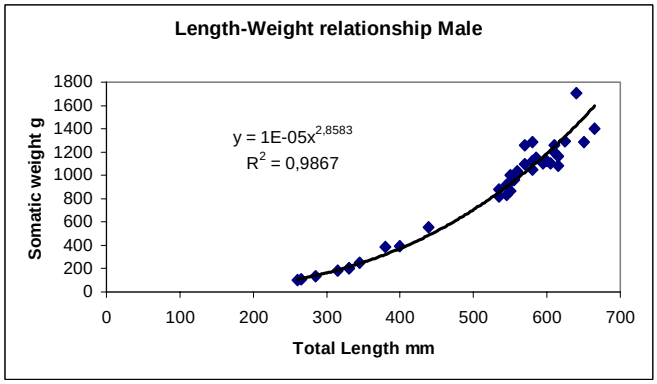
10
20
30
20 23 26 29 32 35 38 41 44 47 50 53 56 59 62 65 68
Total Length cm

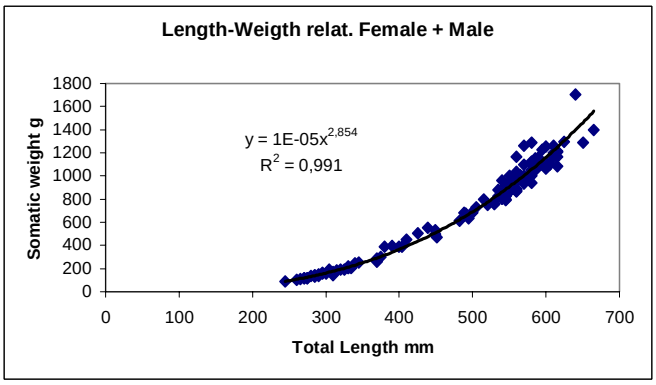

Length Frequency Distribution Capo Passero July 2002
Frequency
0
5
10
15
20
20 23 26 29 32 35 38 41 44 47 50 53 56 59 62 65 68
Length Class cm

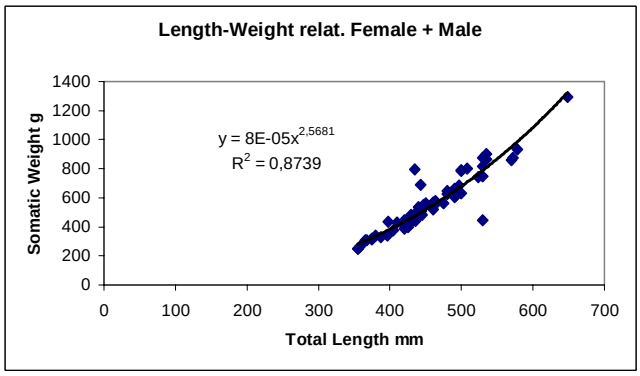
6.3.2 Length-weight relationship

Sample Port	Sex	Sample size	a	b	R^2
Porto Palo Capo Passero	Female	85	1E-05	2,8425	0,99
	Male	36	1E-05	2,8583	0,99
	Female + Male	121	1E-05	2,8540	0,99
Linosa	Female	-	-	-	-
	Male	-	-	-	-
	Female + Male	64	8E-05	2,5681	0,87

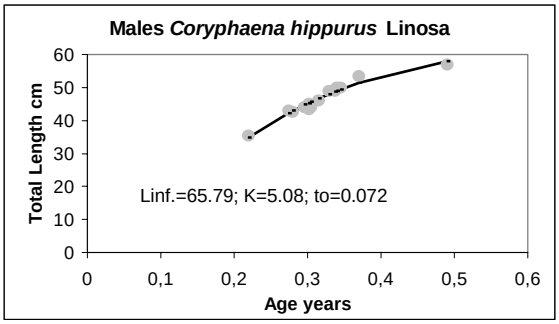


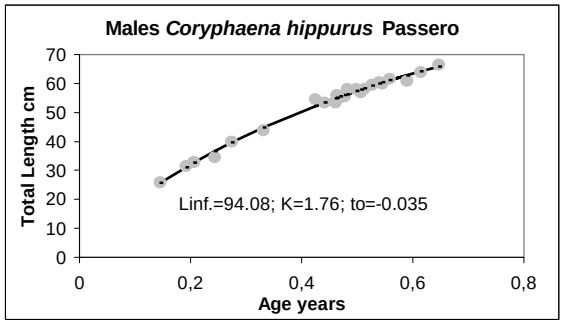


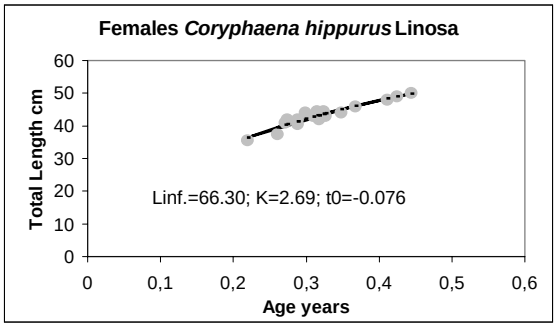


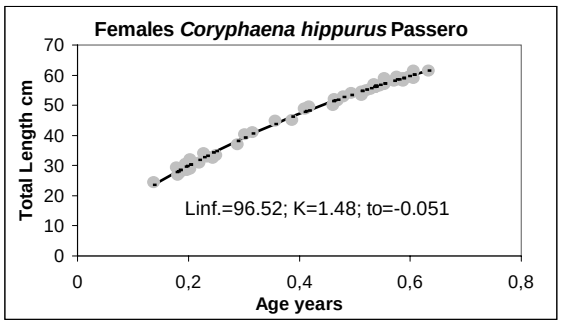


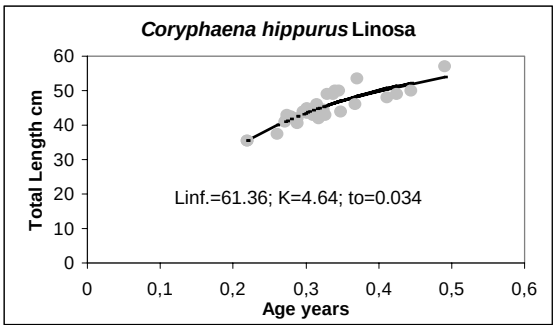
6.3.3 Age and Growth

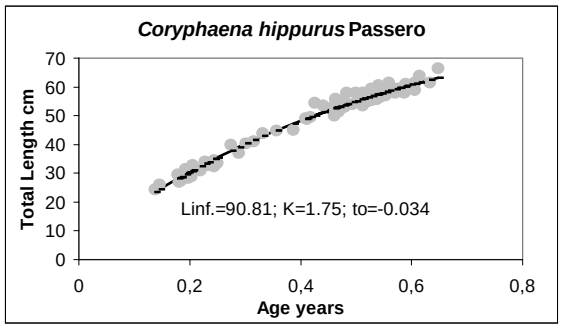












6.3.4 FEEDING BEHAVIOUR OF *CORYPHAENA HIPPURUS*

The stomach contents analysis of *Coryphaena hippurus* on Linosa revealed that fishes were the preferred prey with the frequency of occurrence equal to 79%; moreover the fishes show high values of percentage number (N%=56) and volume (V%=93), as table 1 indicates. Most of the fish found were clupeids.

The second preferred prey are decapods with 47% of frequency of occurrence, values of N% equal to 20% and V% equal to 10%.

Other preys such as fish larvas, Euphausiids, Hyperiids and Tunicates result secondary preys.

The vacuity coefficient has resulted about 17%. The mean total length of examined specimens is equal to 445 mm, ranging from 355 to 500 mm. The specimens with empty stomachs showed a mean total length equal to 443 mm.

The feeding index (F.I.), which indicates the alimentary preferences considering both frequency and biomass, points out the fishes as priority category (FI=73%).

Also the Main Feeding Index (Fig. 1), shows that the fishes were the most important prey category for dolphin-fish with 79%.

The IRI index confirms the importance of this prey.

The predatory activity (A) were resulted 200.

Table 6.3.4.1: The composition of whole alimentary tract contents of *Coryphaena hippurus* in Linosa area.

Food component	F%	N%	V%	FI	MFI	IRI
Decapods	47,4	20,1	10,0	4,75	18,4	19,18
Fishes	78,9	56,2	93,3	73,67	79,4	56,53
Fish larvas	26,3	13,9	3,5	0,92	8,4	10,82
Hyperiids	10,5	1,0	0,3	0,04	1,4	2,94
Euphausiids	26,3	8,2	1,9	0,51	5,8	9,03
Tunicates	5,3	0,5	0,3	0,02	0,9	1,50
Posidoniae	5,3	-	-	-	-	-
Parasites	52,0	89,0	-	-	-	-

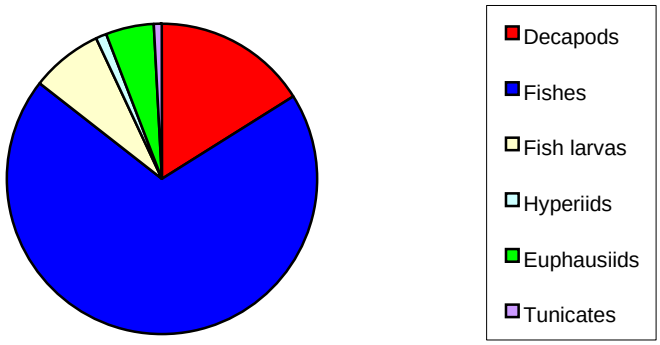


Figure 6.3.4.1: Diet composition of *C. hippurus* by food index MFI in Linosa area.

In Porto Palo area the diet analysis revealed that fishes were the most important prey with the frequency of occurrence equal to 320%; they show the high value percentage number equal to 63 % and volume equal to 95 %. The Main Food Item index (Fig.2) and the Importance Relative Index (IRI) show higher values for this prey (135 and 97% respectively). Also the Feeding index (F.I.) indicates fishes as main category.

Crustaceans, especially decapods, found with a high frequency of occurrence (40 %) and numerical abundance (11,7 %), were the most important prey after fishes as the table 2 shows.
Other preys that constitute the diet of *C. hippurus* in this area were fish larvas, Euphausiids, Hyperiids and Tunicates that result accessory preys.

Particularly, the identified teleost preys were fishes belonging to the families: Clupeidae, Sgombridae, Dactylopteridae, Exocoetidae (tab.3). The main fish species were *Engraulis encrasicolus* present in the greatest number (27 %), occurrence (126 %) and volume (45 %), followed by *Sardinella aurita*, *Sardina pilchardus* and species of genus *Scomber*. Also the Main Food Item index and the Index of Relative Importance show a high value for these preys. The vacuity coefficient has resulted about 16 %. The predatory activity (A) were resulted equal to 447. The mean total length of examined specimens is equal to 349 mm, ranging from 220 to 625 mm.

A sample of 42 specimens, caught in July, with mean age equal to 73 days (mean total length = 253 mm), shows a degree of fullness equal to 4,5, whereas the greater specimens of mean age of about 159 days (mean total length = 508), caught from August to December shows a degree of fullness of about 2. Moreover the repletion index results 60% and 98% for greater and smaller specimens respectively.

A higher number of examined specimens showed the presence of many parasites in both areas.

Table 6.3.4.2: The composition of whole alimentary tract contents of *Coryphaena hippurus* in Porto Palo area.

Food component	F%	N%	V%	FI	MFI	IRI
Decapods	40,0	11,8	2,0	0,80	7,2	1,1
Fishes	320,0	63,2	95,9	306,9	135,6	97,7
Fish larvas	26,7	8,8	0,5	0,1	3,0	0,5
Hyperiids	20,0	7,8	0,8	0,2	3,3	0,3
Euphausiids	26,7	7,8	0,6	0,2	3,3	0,4
Tunicates	6,7	0,5	0,2	0,01	0,8	0,0
Parasites	93,3	82,8				

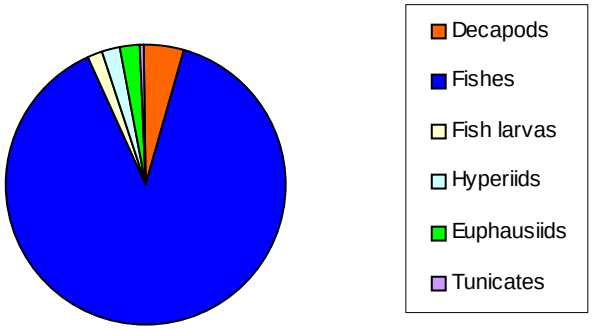


Figure 2 - Diet composition of *C. hippurus* by food index MFI in Porto Palo area.

Table 6.3.4.3: Prey items found in *Coryphaena hippurus* stomach contents from Porto Palo area. Were indicated: percentage frequency of occurrence (%F), percentage number (%N), percentage volume (%V) and index of relative importance (%IRI) of prey categories.

Prey category	F%	N%	V%	MFI	IRI f	IRI v	IRI fnv
Crustaceans							
Decapods	40,00	11,76	1,99	7,17	3,98	1,09	8,31
Hyperiids	20,00	7,84	0,80	3,35	1,25	0,24	4,43
Euphausiids	26,67	7,84	0,61	3,25	1,63	0,22	5,43
Fishes							
CLUPEIDAE							
Engraulis encrasicolus	126,67	27,45	45,53	59,23	66,95	74,51	30,87
Sardinella aurita	53,33	9,31	17,71	23,56	10,44	11,78	12,43
Sardina pilchardus	33,33	3,43	11,20	14,35	3,53	4,37	7,42
SCOMBRIDAE							
Scomber sp	33,33	4,41	11,63	14,82	3,87	4,66	7,64
DACTYLOPTERIDAE							
Dactylopterus volitans	6,67	0,49	0,54	1,38	0,05	0,04	1,19
EXOCOETIDAE							
Danichthys rondeletii	20,00	1,47	4,32	6,81	0,84	0,98	3,99
Cypselurus heterurus	13,33	0,98	2,38	4,12	0,32	0,36	2,58
Unidentified fishes	40,00	15,69	2,60	8,50	5,30	1,54	9,01
Fish larvas	26,67	8,82	0,49	2,95	1,80	0,18	5,56
Tunicates	6,67	0,49	0,20	0,85	0,03	0,02	1,14
Parasites	93,33	82,84	0,55				

The feeding behaviour of *Coryphaena hippurus* is mainly piscivorous in both areas (Linosa and Porto Palo), in fact teleost fishes are important both in terms of frequency and abundance and biomass.

The stomach contents analysis, with complex indexes such as FI, MFI, IRI, confirmed the importance of fishes for dolphin-fish. Particularly juveniles and adults of clupeids, scombrids, exocoetids were found.

Following in importance are the pelagic crustaceans as to frequency of occurrence, percentage number and volume.

Other planktonic preys such as euphausiids, hyperiid amphipods and Tunicates, result of secondary importance in its diet.

Results revealed same percentage of empty stomachs between specimens caught in Porto Palo and Linosa areas.

But in Porto Palo a higher repletion index value for smaller than greater specimens could indicate necessity of smaller one of major quantity of food, so of energy, but it's possible too that smaller and larger fish feed at different times of the day. Moreover the smallest feed mainly on fishes, whereas the largest feed on a wide variety of preys.

Moreover the predatory activity is lower in Linosa than in Porto Palo. This may be attributable to different periods of catch (hours of the day) or to different environmental trophic availability, or different sizes/age of specimens in two areas.

7 CONCLUSIONS AND FINAL RECOMMENDATIONS

The 2001 fishing season started in some ports of Sicily (Porto Palo di Capo Passero, Marzamemi) in great advance compared with previous years. The advanced beginning seems due to the great demand of the market; the price of Dolphin-fish, paid to fishermen at the end of July and August, was equal to 10 Euro! This event brought some unforeseen difficulties, for the FS and the CES started in the second half of August.

Another great problem was that a fishing ban was carried out in September, October and November for purely political reasons. So, the fishing season of Dolphin-fish proved particularly penalised; for in October and November, when by tradition most catches are recorded, fishing days were very few due to both the fishing ban and to adverse marine-weather conditions.

Dolphin fish is always the target species but another two species are considered targets according to the period of the trend in the catches of dolphin fish and the market. When the catch/price product of Dolphin-fish is considered good by fishermen, it is this species which is caught on an exclusive basis. Generally in the last weeks in August and the first in September the price/catch product is considered advantageous also for amberjack so that both species are considered targets and, since the amberjack mixes in order to form a single shoal with pilot fish, the latter species becomes a by-catch. By the first half of October the amberjack leaves the FADs. Finally when the dolphin fish starts to become scarce because the imminent winter causes the temperature of the water to drop below the threshold preferred by this species (around 18°C) and the amberjack has abandoned the FADs some time before, it is the pilot fish which becomes target species until the sea weather conditions destroy the FADs completely. The other species, which make up the by-catch are caught rarely and by accident.

Dolphin fish tend to gather under the FADs and can easily be fished thanks to a special technique. The action consists of approaching the FADs while dragging a hand line equipped with two hooks with a feather as bait. According to how fast the fish are biting and their number, the fishermen, thanks to their experience, are able to estimate the amount of fish under the FADs. In the case of a large number of dolphin fish, the hand lines and the fish caught are dragged not too far from the FADs. This operation has an assembling and approaching effect on the other dolphin fish, creating the conditions for fast entrapment of the fish, away from any obstacles, using a special purse seine net (Bono *et al.,* 1997). So it is possible to fish for Dolphin-fish in a very selective manner!

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