REPORT ON THE COPEMED/IMEDEA WORKSHOP ON DOLPHINFISH FISHERY SAMPLING
11-12 July 2000

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Introduction

The developmental objective of the FAO/COPEMED dolphinfish programme part of the COPEMED projecte is the common management of dolphinfish fishery in the Mediterranean. The immediate objectives of the FAO-COPEMED dolphinfish project are:

- To introduce the COPEMED countries Malta and Tunisia to a responsible management of this fishery.
- To acquire data on these poorly studied areas.
- To obtain a global vision of dolphinfish fishery in Mediterranean waters.

The Workshop aim was to design the adequate sampling strategy to fulfill the above objectives, and to adapt the strategy to the characteristics of both target study areas, Malta and Tunisia.

The workshop started on July 11 at the IMEDEA HQ. in Esporles (Mallorca), following the proposed agenda that was discussed and approved. The participants were:

Dr.Enric Massutí, Dir.General Fisheries of the Balearic Islands Government
Dr.Francesc Alemany, FAO-COPEMED
Mr.Mathew Camilleri, D.G.Fisheries Malta
Mme.Amina Besbes, Tunisia
Dr.Leonardo Cannizzaro, IRMA Mazara del Vallo, Italy
Dr.Carles Plá, Girona University, Spain
Dr.Beatriz Morales-Nin, CSIC-IMEDEA, Spain

The first point of the agenda (see Annex 1) was a presentation from the manager point of view of the Mediterranean dolphinfish fisheries by Dr.E.Massutí. In this presentation the data requirement for assessment, the potential problems of overexploitation and the socio-economic fishery aspects were summarised. This introductory talk focused the activities of the day towards the goals of the proposal to FAO-COPEMED.

The rest of the morning was dedicated to the presentations of sampling strategies for biological and fisheries data, as well as for genetic studies (see Annexes 2 and3). The presentations were given in a rather informal way to allow the discussion and participation of all scientists.

The afternoon session was dedicated to the Maltese fishery and to discuss the data sampling and the necessary requirements to accomplish the study goals.

The workshop continued on July 12, following the agenda and dedicated to Tunisia.

Results of the sampling scheme discussion for the study areas

Firstly, the sampling strata were discussed in depth. Two strata were defined for Malta (fig.1) NE and SW off the Islands and three for Tunisia (fig. 2) corresponding to the divisions used in the pelagic fisheries frame survey.

The sampling possibilities were discussed in depth considering the shortage of trained personnel and the short time available before the start of the fishing season on August. Having in mind both limitations, it was accorded that the 2000's fishing season will be a pilot period and a baseline for the 2001 fishing season. Thus, the initially envisaged frame survey for catch and effort has been postponed and during the 2000 fishing season only length frequency distribution and biological sampling will be carried out. Moreover, data on landings will be recorded from official statistics and fleet characteristics will be also described in detail, by boat, from already existing fleet census. During 2001 fishing season, besides the length and biological sampling which will continue, the frame survey for catch and effort will be finally carried out.

More specifically, activities to be carried in both fishing seasons are exposed below.

During 2000 fishing season, **landings** will be recorded by port and using the already existing national fisheries statistic system in both countries. In the 2001 landing will be estimated also from catch and effort frame survey (see Annex 2) and both kind of data will be compared.

Taking into account that most of the necessary data on **fleet characteristics, gear and FADs** is already available (according to the information provided by Maltese and Tunisian representatives), it was agreed that the formulary sheets FS01from Annex 2, will be filled as soon as possible using the registers of port authorities. Lacking information will be completed by means of direct interviews with the fishermen. In the case of Malta this information will be requested to the fishermen when they ask for the yearly fishing license. These data should be obtained for all the fleet and ports.

Regarding **effort estimation**, for the 2000 fishing season the number of boats (and the number of FAD's if available), by port, will be used as a first approach to measure the effort. These data will be taken into account to design catch and effort survey which will be conducted by trained personnel the next year, on field by interview at the fishermen in the ports and/or landing places about the gear and FADs characteristics, and the fishing area using the sheets FS02 from Annex 3. This aims to a more precise estimation of effort, following the methodology indicated in Annex 2.

The sampling ports will be selected according to the available possibilities being at least **two by stratum**. Next year the port selection will be random with probability of selection proportional to the "importance" of the fleet in each port or landing place (see Annex 2).

For the next year a database will be adopted and a software package to calculate the formulas in the annex 2 should be realised.

The **length frequency composition** of the catch will be sampled with weekly frequency, at least at one port by stratum. When possible, the whole catch of the boat will be measured. In the case of large catches, representative subsamples will be taken and analysed. If the catch is divided by commercial categories, a sample must be taken from each category, and the results extrapolated afterwards according to the relative weight of each category respect to the total catch.

For the **biological sampling**, a minimum **of 30 dolphinfish by month and by stratum** will be analysed following the agreed procedures. Because there is not trained personnel for this task, at least for the first samplings, the fish heads will be frozen and sent to the IMEDEA for otolith extraction. During the first visit of the experts to Malta and Tunisia local personnel will be trained to carry out this job. Due to the technical complexity of the age reading process for this species, age interpretation tasks will be carried out at the IMEDEA laboratory. However, it is envisaged the possibility of organizing training stages for Maltese and Tunisian technicians, at request of national authorities, in order to prepare them to carry out dolphinfish growth studies in the future.

In both cases, sampling ports (one by stratum) will be chosen by Maltese and Tunisian responsible taking into account logistic factors.

For genetic studies, which will be carried out only once in order to confirm the hypothesis of genetic homogeneity of the Mediterranean dolphinfish populations, a total of 50 dolphinfish will be collected on September in the ports agreed during the workshop. The heart, a piece of liver and another of muscle tissue will be obtained for each fish and frozen to be sent to the Girona University. The sampling protocol will be sent to the Maltese and Tunisian responsibles by Dr.C.Pla.

Conclusions

- It was accorded that an estimation of sampling costs will be obtained for Malta and Tunisia by the fisheries responsibles as soon as possible, and will be submitted to FAO-COPEMED for evaluation. It is urgent to speed up the process because the fishing season starts on August-September.
- The 2000's fishing season will be a pilot period with restrictions in the study, mainly due to shortage in personnel and the short period between the approval of the project and the start of the fishery.
- Previsions should be made to be able to carry out the full study, including the frame survey for effort and landings, in the next fishing season on year 2001.
- For the next year a database will be adopted and a software package to calculate the formulas in the annex 2 should be realised.

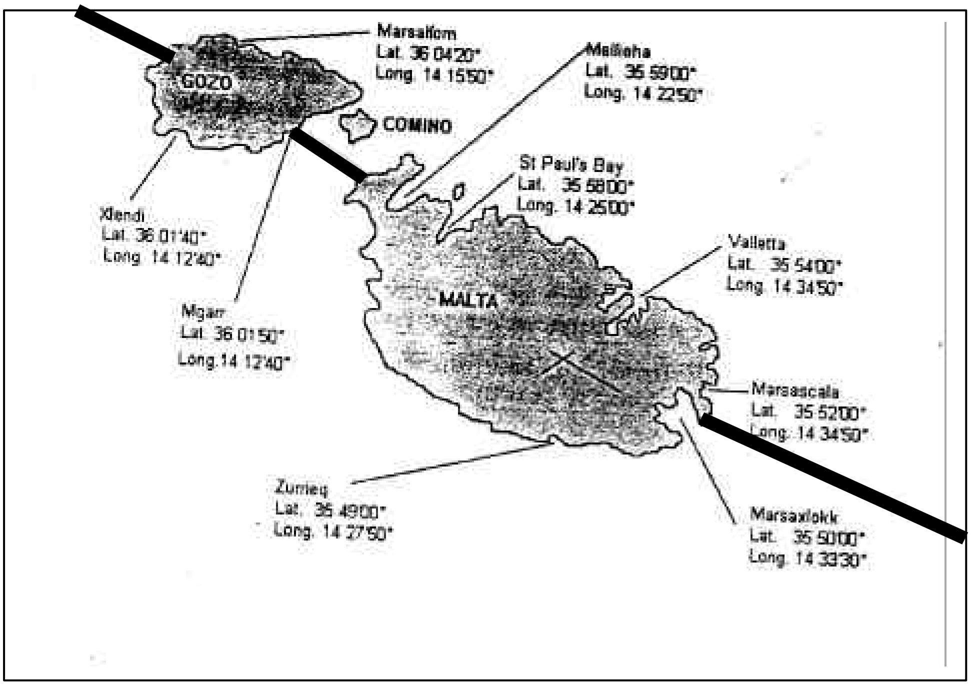

Fig.1.Sampling strata for Maltese islands.

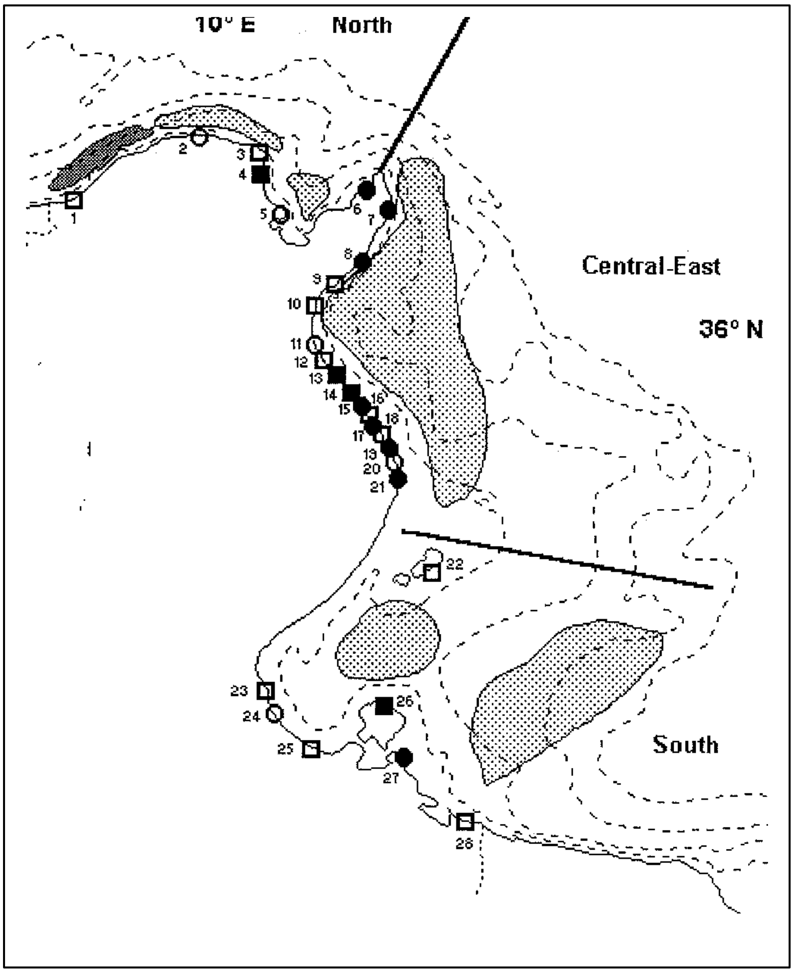

Fig.2. Strata defined for the Tunisian fishery.

Annex 1

Agenda for the dolphinfish fisheries workshop

July 11th

8:45 pick up at the Hotel Isla de Mallorca and transport to the IMEDEA on Esporles.

9:00 -13 morning session. Chairperson B.Morales-Nin
9:00:9.30 **Opening talk** The Mediterranean dolphinfish fishery from the management point of view by Enric Massutí Director Fisheries, Fisheries department Balearic Islands Government
9:30 –10:00 Sampling for fisheries by B.Morales-Nin

10:00-10:30 coffee break

10:30-11:00 Study plan for Maltese and Tunisian FADs Fishery by L.Cannizzaro IRMA-CNR
11:00-11:30 Biological sampling by B.Morales-Nin IMEDEA-CSIC/ICM
11:30-12:00 Sampling for genetical studies by C.Pla U.Girona
12:00-13:00 Open discussion

13-15:00 lunch break

15-17:30 Evening session Chairperson C.Pla
15:00-17:30 Round table: How to sample for effort, landings and length composition for Malta fisheries. All participants.

17:30 transport to the Hotel Isla de Mallorca

July 12th

9:00 pick up at the Hotel Isla de Mallorca and transport to the IMEDEA on Esporles.

9:30-13:00 morning session Chairperson L.Cannizzaro

9:30-13:00 Round table: How to sample for effort, landings and length composition for Tunisia fisheries. All participants.

11:00-11:30 coffee break

13:30-15:00 lunch break

15-17:30 Evening session Chairperson L.Cannizzaro
15:17:30 Round table: discussion of data and revision of concepts. All participants.

17:30 transport to the Hotel Isla de Mallorca or the Airport

Annex 2

Study plan for Maltese and Tunisian Fish Aggregating Devices (FADs) fishery

Leonardo Cannizzaro

Istituto di ricerche sulle Risorse Marine e l'Ambiente

Consiglio Nazionale delle Ricerche

Introduction

The use of floating fish aggregating devices (FADs) to attract fishes has been a diffused activity in the Mediterranean since the antiquity (Morales-Nin *et al*. 1996; 1998). Currently in the Mediterranean FADs are used, mostly for *Coryphaena hippurus* fishing, by artisanal fisheries. Fishing season opens in August, with the FADs setting and laying and closes in January when dolphin-fish are not found under the FADs. Usually the FADs are hand made by a float group and palm branches. They put them along line of several miles perpendicularly to the coast, starting from shallow (15 m) toward deep water (about 1000 m). The fisheries involved are: Sicilian with about 250 boats (about 12 % of the Sicilian small scale fleet), Maltese with about 150 boats, Majorca with about 50 boats (about 45 % of the Balearic small scale fleet) and Tunisian with about 200 boats. Probably also Libyan and Algerian artisanal fishery using FADs but at data any information are available. FADs has been well studied in the Mediterranean EU countries principally in relation to *Coryphaena hippurus* fishery (Morales-Nin *et al*. 1996; 1998). No data exist for the Tunisian fishery and very few data exist about the Maltese fishing effort.

Objectives

The primary objective of the CORY03 project is stock assessment of *Coryphaena hippurus* in the fishing area of Tunisian and Maltese fleet.

The target fleet (TS) is the artisanal fishery devoted to catch dolphin-fish by FADs and purse-seine.

In order to accomplish the primary objectives, the following steps have been identified:

a) Study the structure of the Tunisian and Maltese target fleet;
b) Study the activity in time and space of the Tunisian and Maltese target fleet;
c) Study the qualitative and quantitative composition in time and space of the catch of the Tunisian and Maltese target fleet;
d) Esimate total Tunisian and Maltese catch and the relative fishing effort;
e) Try to assess the stocks of the dolphin-fish using catch equations and/or VPA based on pseudo-coorte analysis.

Tunisia Frame Survey

Data relative to the structure of target fleet are of two types: 1) data regarding the boat’s structure; 2) data regarding the equipment used when fishing by FADs and purse seine, the fishing areas and the total number of FADs dropped in the sea.

In the last week of July and in the first week of August a census of all ports or landing places will be performed. A list of all boats operating in each port or landing place will be carring out by consulting the fishing fleet master books from port authorities or beach delegation offices. For each boat the form FS01 (see enclosure 1), regarding the boat’s structure, will be compiled.

The second and third weeks of August all fishermen will be interviewed, using the FS02 form (see enclosure 2), regarding the number of FADs that they wont put on the sea, the gear structure, the fishing area and the fishing activity in the period January to August.

For each boat operating with FADs it is necessary to complete the pair of FS forms as fully as possible. In addition, a sheet with the interviewer's eventual notes and observations must be attached to the pair of forms; this serves above all for evaluating the reliability of the interviewes.

It is necessary that each boat has a pair of the FS forms because each fisherman uses different fishing equipment and techniques and arranges the FADs according to different criteria.

The set of all boats for which a pair of FS forms exist constitutes the target population and it is from these and only these boats that all necessary information is acquired for reaching the planned objectives.

Malta Frame Survey

The Maltese frame survey will be conduct with the same criteria of the Tunisian. Probably in the offices of port authorities will be available more informations than in Tunisia. In any case the pair of forms FS will be filled for each boats. The strata and the sample ports will be selected with the same criteria of the Tunisian.

Strata and sample ports

The opportuneness of stratification and the choice of the sample ports will be evaluated, the first time, only on the basis of the information coming from all of the FS forms. Next time (next fishing season) it is possible using the the frame survey information and the catch-effort survey data to allocated strata and sample ports.

Often each sampling unit of a population can be divided into a certain number of smaller units; in these case a sample of "large" units should be chosen and then a sample of "small" units extracted from them. In this way subsampling is carried out, i.e. each unit is not monitored completely but is itself sampled. This type of sampling has been defined by Mahalanobis as two-stage sampling and can naturally be generalised. Several types of sampling can obviously be combined at the various stages (according to needs): simple random, stratified, systematic etc. The original units are generally referred to as first-stage units or primary sampling units, while the units which compose them are second-stage units or secondary units, and so on. The first is to select a sample of primary units and the second is to select a sample of secondary units from each chosen primary unit (and so on). The units, according to their size, are mainly selected in two ways:

- equal sizes: equal probability of becoming part of the sample is assigned to each of them (**s**imple **r**andom **s**ampling or SRS);
- unequal sizes: different probabilities of becoming part of the sample are assigned to each of them (**p**robability is **p**roportional to unit **s**ize or PPS sampling).

The researcher who is working with equal size population units or having no information on its structure, even if he or she knows the units are different in size, has to refer to SRS. Whilst, if there is clear information on the structure of the study population, it is important the researcher to associate each unit a different weight as an indicator of the importance of this unit in the population. So he or she has to refer to different probability of extraction referring to different units. There are different ways of associating weight to units but, for the study in question, the case wherein weight (and thus probability) is proportional to unit size, or PPS sampling, is important.

Units can also be selected with or without replacement. The efficiency of the without replacement design will almost always exceed that of the with replacement one, since this design does not have the same units more than once. As regards PPS sampling, we prefer using the with replacement design because of the smaller approximation of the variance of the estimators.

In without replacement sampling, the variance estimators contain terms, known as correction factors, required for eliminating the distortion due to changes in the composition of the population linked to the type of sampling (note: once you have extracted a unit, you do not insert the unit again). For large populations these factors may be omitted or, rather, the two types of sampling, in practical terms, coincide. In table 1 a parallelism between statistical methodology terms and the case in question terms are indicated.

Classic name	Name of the case in question
Study area	Whole coast
Stratum	Section of coast
First-stage unit	Ports
Second-stage unit	Boats

Table 1: Statistical terms and the case in question terms.

In this work plan, sampling always refers to two-stage sampling with characteristics: i) first-stage units initially stratified and later sampled according to PPS sampling method with replacement; ii) second-stage units sampled according to the SRS method without replacement.

The strata (minimum two) will be selected on the basis of geographical criteria.

The samples ports or landing places (minimum two for each stratum) will be selected by PPS with replacement technique.

The technique considered for choosing the ports to be sampled is a probabilistic technique so that the probability that each unit of the population becomes part of the sample is known. A different probability of being extracted (p_{hi}) is associated to each port; this probability is commonly referred to as depending on its own size. The size is such that it can be determined according to one of the three criteria:

- or at the number of FADs in all fishing area of each ports or landing places;
- or at the number of FADs in all fishing area of each ports or landing places multiplied for the number of boats in the same ports or landing places;

This technique is preferable when it is considered that each port has different importance for the purposes of the analysis and when the necessary information on how to discriminate the ports is available (the number of boats and the number of FADs in each ports or landing places are known by the frame survey). A with replacement extraction technique is preferred because of the smaller approximation of the estimators. In addiction it is possible select in each stratum, with purposive selection, one more sample port.

Catch-effort survey

The catch-effort survey will be conduct by interviwes at landing using two kind of standard forms: the form S1 (see enclosure 3) and the form S2 (see enclosure 4).

For each sample port or landing place will be compiled a S1 form. In the S1 form will be listed all fishing boats, of the target population, relevated in the port or landing place during the frame survey. It is absolutely necessary that the interviwers arrive in the sample port or landing place before the boats come back from the fishing trip. The interviewers will recorded, on S1 form, the fishing boats, of the target population, that don't work and, where possible, the motivation.

When fishermen come back from the fishing the interviewers will ask all information listed in the S2 form and will loking the catch.

Maltese and Tunisian Catch-effort survey

An S1 form is compiled for each sample port, with the port's boats pre-printed on it; for each sample day, the number of active boats, the number of inactive boats, the total number of landings made and the total number of interviews held are recorded. The number of S2 forms for each sample day in each port is deduced from this form. Each S2 form constitutes a landing interview. Particular attention is given to compiling the NOTE section as it is necessary to give a global evaluation of reliability, as well as indicating: whether the form was compiled at landing; if the interviewer had the possibility of seeing and counting the boxes of fish; where the interview was held (if not at the landing place); if it was not possible to interview the fisherman, who supplied the information and, according to the interviewer's experience, their level of reliability. It should also be born in mind that S2 forms that do not indicate the start and end times of the catch, or the name of the boat, or the number of boxes of fish caught, are completely useless. It is absolutely necessary to be certain of the duration of the catch and the number of boxes of dolphin-fish caught; it is better to have one interview less than have uncertainties on these data.

Database

During the projects CORY1 and CORY2 was carring out the , version of the database DBCORY. This database appear inadeguate for this new project. It is necessary a new version of , DBCORY or make a new "ad hoc" database by Access language or some other powerfully language.

Maltese and Tunisian Total catch estimation

The tables 2, 3 and 4 shows the meaning of the most common used statistics and quantity.

Population		Sample	
symbol	**meaning**	**symbol**	**meaning**
H	number of Strata	**H**	number of Strata
$\mathbf{M_h}$	number of Ports	$\mathbf{m_h}$	number of Ports
$\mathbf{N_{thi}}$	number of Boat in operation in the *i*th Port, the *t*th day	$\mathbf{n_{thi}}$	number of Boat in operation in the *i*th Port the *t*th day
T	number of working days during the fishing season	**r**	number of interview days, among the working days
h=1,2, ..., H	Strata	**h=1,2, ..., H**	Strata
$\mathbf{i=1, 2, ..., M_h}$	Ports	$\mathbf{i=1, 2, ..., m_h}$	Ports
$\mathbf{j=1, 2, ., N_{thij}}$	Boats	$\mathbf{j=1, 2, ..., n_{thij}}$	Boats
t=1, 2, ..., T	working days	**t=1, 2, ..., r**	interviewing days

Table 2.

Symbol or formula	Meaning
$n_{th} = \sum_{i=1}^{m_h} n_{thi}$	Total number of Boat in operation in the sample ports of the *h*th stratum the *t*th day
$N_{th} = \sum_{i=1}^{M_h} N_{thi}$	Total number of Boat in the *h*th stratum the *t*th day
$M = \sum_{h=1}^{H} M_h$	Total number of strata
$w_h = M_h / M$	Weight of *h*th stratum
v_{hi}	Number of boats in the *i*th port of the *h*th stratum
V_h	Number of boats in the *h*th stratum
a_{hi}	Number of FADs put in the fishing area of the *i*th port of the *h*th stratum
A_h	Number of FADs put in the fishing areas of the *h*th stratum
$p_{hi} = v_{hi} / V_h$ or $p_{hi} = a_{hi} / A_h$ or $p_{hi} = v_{hi}a_{hi} / V_hA_h$	Probability that in the *h*th stratum the *i*th port is extracted or weight of *i*th port of the *h*th stratum or
x_{thij}	*j*th boat catch of the *i*th port, of the *h*th strata, on the *t*th interview day
$x_{thi.} = \sum_{j=1}^{n_{thi}} x_{thij}$	Sample catch in the *i*th port, of the *h*th strata, on the *t*th interview day
$x_{th..} = \sum_{i=1}^{m_h} x_{thi}$	Sample catch in the *h*th strata, on the *t*th interview day
$x_{t...} = \sum_{h=1}^{H} x_{th}$	Sample catch on the *t*th interview day
$\bar{x}_{thi}$	Average catch estimate per boat in the *i*th port, of the *h*th stratum, on the *t*th interview day
$\bar{x}_{th}$	Average catch estimate per boat in the *h*th stratum (average catch for secondary unit in the *h*th stratum), on the *t*th interview day
$\bar{x}_{t}$	Average catch estimate per boat on the *t*th interview day
$\hat{x}_{thi}$	Estimate of the total catch in the *i*th port, of the *h*th stratum, on the *t*th interview day
$\hat{x}_{th}$	Estimate of the total catch in the *h*th stratum, on the *t*th interview day
	Estimate of the total catch on the *t*th interview day

$\hat{x}_t$	

Table 3.

Any term with the ^ symbol above (generally said statistic), is to be intended as a sampling estimate of a population parameter (the same term without the hat).

Symbol or formula	Meaning
$\bar{x}_{thi} = \sum_{j=1}^{n_{thi}} x_{thij} / n_{thi}$	Estimate of the average catch per boat in the *i*th port of the *h*th stratum, for the *t*th interview day
$\bar{x}_{th} = \sum_{i=1}^{m_h} \left[\sum_{j=1}^{n_{thi}} x_{thij}/n_{thi} \right] \hat{p}_{thi}$	Estimate of the average catch per boat in the *h*th stratum, for the *t*th interview day
$\bar{x}_t = \sum_{h=1}^{H} \left[\sum_{i=1}^{m_h} \left(\sum_{j=1}^{n_{thi}} x_{thij}/n_{thi} \right) \hat{p}_{thi} \right] w_h$	Estimate of the average catch per boat in the whole area for the *t*th interview day
$\hat{x}_{thi} = (N_{hi} / n_{thi}) \sum_{j=1}^{n_{hi}} x_{thij},$	Estimate of the total catch in the *i*th port of the *h*th stratum, for the *t*th interview day
$\hat{x}_{th} = (1 / m_h) \sum_{i=1}^{m_h} (1 / p_{hi}) \left[(N_{thi} / n_{thi}) \sum_{j=1}^{n_{thi}} x_{thij} \right]$	Estimate of the total catch in the *h*th stratum, for the *t*th interview day
$\hat{x}_t = \sum_{h=1}^{H} (1/ m_h) \sum_{i=1}^{m_h} (1/ p_{hi}) \left[(N_{thi} / n_{thi}) \sum_{j=1}^{n_{thi}} x_{thij} \right]$	Estimate of the total catch for the *t*th interview day
$s^2_{thi} = \sum_{j=1}^{n_{thi}} (x_{thij} - \bar{x}_{thi})^2/(n_{thi}-1)$	Estimate of the variance of the catch **within the *i*th port** of the *h*th stratum, for the *t*th interview day
$std_{thi} = s_{thi}$	Estimate of the standard deviation of the catch **within the *i*th port** of the *h*th stratum, for the *t*th interview day
$CV_{thi} = s_{thi}/\bar{x}_{thi}$	Estimate of the coefficient of variation of the catch **within the *i*th port** of the *h*th stratum, for the *t*th interview day
$s^2_{2th} = \sum_{i=1}^{m_h} s^2_{thi} \hat{p}_{thi}$	Estimate of the variance of the catch **within the ports** of the *h*th stratum, for the *t*th interview day
$std_{2th} = s_{2th}$	Estimate of the standard deviation of the catch **within the ports** of the *h*th stratum, for the *t*th interview day
$s^2_{1th} = \sum_{i=1}^{m_h} \hat{p}_{thi} \ (\bar{x}_{thi} - \bar{x}_{th})^2$	Estimate of the variance of the catch **between the ports** of the *h*th stratum, for the *t*th interview day
$std_{1th} = s_{1th}$	Estimate of the standard deviation of

	the catch **between the ports** of the *h*th stratum, for the *t*th interview day

Table 4.

Variance, standard deviation and relative error of average and total estimators

ESTIMATOR: $\bar{x}_{thi}$

$var[\bar{x}_{thi}] = s^2_{thi}/n_{thi}$,
$std[\bar{x}_{thi}] = (var[\bar{x}_{thi}])^{1/2}$,
$rel\text{-}error[\bar{x}_{thi}] = std[\bar{x}_{thi}]/\bar{x}_{thi}$,

ESTIMATOR: $\bar{x}_{th}$

$var[\bar{x}_{th}] = (1/\sum_{i=1}^{m_h} N_{thi})[\sum_{i=1}^{m_h} N_{thi}(\bar{x}_{thi} - \bar{x}_{th})^2 + \sum_{i=1}^{m_h} (N_{thi} - n_{thi}) s^2_{thi}/n_{thi}]$,
$std[\bar{x}_{th}] = (var[\bar{x}_{th}])^{1/2}$,
$rel\text{-}error[\bar{x}_{th}] = std[\bar{x}_{th}]/\bar{x}_{th}$,

ESTIMATOR: $\bar{x}_t$

$var[\bar{x}_t] = \sum_{h=1}^{H} w^2_h\{var[\bar{x}_{th}]\}$,
$std[\bar{x}_t] = (var[\bar{x}_t])^{1/2}$,
$rel\text{-}error[\bar{x}_t] = std[\bar{x}_t]/\bar{x}_t$,

ESTIMATOR: $\hat{X}_{thi}$

$var[\hat{X}_{thi}] = N^2_{thi} s^2_{thi}/n_{thi}$,
$std[\hat{X}_{thi}] = (var[\hat{X}_{thi}])^{1/2}$,
$rel\text{-}error[\hat{X}_{thi}] = std[\hat{X}_{thi}]/\hat{X}_{thi}$,

ESTIMATOR: $\hat{X}_{th}$

$var[\hat{X}_{th}] = (1/m_h)\sum_{i=1}^{m_h} p_{hi}[(\hat{X}_{thi}/p_{hi}) - \hat{X}_{th}]^2 + (1/m_h)(1-f_{2th})\sum_{i=1}^{m_h} N^2_{thi}(s^2_{thi}/n_{thi})/p_{hi}$,

or $var[\hat{X}_{th}] = [(1/m_h(m_h-1)]\sum_{i=1}^{m_h}(\hat{X}_{thi}/p_{hi} - \hat{X}_{th})^2$ if we assume that the contribution by the variation within the primary units (the ports) is negligible.

$std[\hat{X}_{th}] = (var[\hat{X}_{th}])^{1/2}$,
$rel\text{-}error[\hat{X}_{th}] = std[\hat{X}_{th}]/\hat{X}_{th}$,

ESTIMATOR: $\hat{X}_t$

$var[\hat{X}_t] = \sum_{h=1}^{H} w^2_h\{var[\hat{X}_{th}]\}$,
$std[\hat{X}_t] = (var[\hat{X}_t])^{1/2}$,
$rel\text{-}error[\hat{X}_t] = std[\hat{X}_t]/\hat{X}_t$.

Concerning the fishing effort, I propose to use the following formula:

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

N_{fads} is the number of FADs put to sea by all the fishing vessels of a port;
N_{hauls} is the number of hauls made by all the fishing vessels per week and/or month and/or season.

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CORY03 **MOD. FS01**

PORT OR LANDING PLACE:____________________ DATE: _ _ / _ _ / _ _

1	NAME OF BOAT	
2	REGISTERED NUMBER	
3	GRT GROSS TONNAGE	
4	TSN NET TONNAGE	
5	LFT m OVERALL LENGTH	
6	HP / AXIS / KWATT	
7	OTHER USED GEARS IN THE YEAR	

10	USED GEAR	
11	LENGTH m	
12	HEIGHT m	
13	DEPTH m	
14	NUMBER OF MESHES	
15	OPENING OF MESH	
16	FLOATS	
17	BUOYANCY	
18	NUMBER OF LEADS	
19	WEIGHT OF LEADS	
20	NETTING MATERIAL	
21	RTEX	

CORY03 **MOD. FS02**

PORT OR LANDING PLACE:____________________ DATE: _ _ / _ _ / _ _

22	TOTAL NUMBER OF FADS PLACED IN THE SEA	
23	POSITION (**LAT E LON**) OF FAD NEAR THE PORT	
24	POSITION (**LAT E LON**) OF FAD FURTHER FROM PORT	
25	COURSE BETWEEN THE FIRST AND LAST FAD	
26	DISTANCE BETWEEN FADS	
27*	POSITION (**LAT E LON**) BETWEEN THE FIRST FAD AND A INTERMEDIATE	
28*	COURSE BETWEEN THE FIRST AND AN INTERMEDIATE FAD*	
29*	POSITION (**LAT E LON**) BETWEEN AN INTERMEDIATE AND LAST FAD	
30*	COURSE BETWEEN AN INTERMEDIATE AND LAST FAD	
31	LOCAL NAME OF THE AREA IN WHICH FADS ARE PLACED	

EVENTUAL SCHEMATIC DRAWING OF WHOLE OF FADS

* **PARAMETERS MARKED BY ASTERISK MUST BE SURVEYED ONLY IF FADs ARE NOT ALL ALONG ONE COURSE.**

CORY03 MOD.
S01

CATCH AND EFFORT SURVEY

ARTISANAL FISHERY

PORT OR LANDING PLACE:____________________ YEAR ________

BOAT NAME	Reg. n°	DD/MM	DD/MM	DD/MM	DD/MM
		/	/	/	/

NUMBER OF ACTIVE BOATS					
NUMBER OF INACTIVE BOATS					
NUMBER OF LANDINGS					
NUMBER OF INTERVIWES					

NOTES:____

CORY03 **MOD. C01**

SURVEY CATCH AND EFFORT *Coryphaena hippurus*
INTERVIEW AT LANDING

PORT OR LANDING PLACE:____________________ **YEAR** ________

BEGINNING TACK _ _/ _ _ / _ _ _ _/_ _ FORM N°: _ _ _ _

D D MM YY HH MM

END TACK _ _/ _ _/ _ _ _ _/_ _

D D MM Y Y HH MM

BOAT: REGISTERED NUMBER:

N° HAULS :

N° VISITED FADs: REA:

SPECIES	N° Boxes	N° Specimens per box	Weight box Kg	Medium Size gr.	Total Kg
Coryphaena hippurus					
Naucrates ductor					

Seriola dumerili					
Balistes carolinensis					
Polyprion americanum					
Caranx crysos					
Coryphaena equiselis					

NOTE:

Annex 3
Dolphinfish fishery evaluation and sampling

B.Morales-Nin
CISIC/UIB-IMEDEA

The study of the fishery requires a detailed description of the fishery characteristics including the following aspects:

1. Fishing operations: **how the fishermen fish**. This means describing the period of fishing, seasonality and turnover, together with other fishing activities: how the fishing areas are attributed, port organisation, times of the day that they fish, fishing on drifting objects, by-catch, etc.
2. Commercialisation of the catch: **fish market**. Fish wharfs, fish sales, fishermen's organisation, commercialisation channels.
3. Characteristics of the fleet: **type and number of boats**. The age of the boats, size, engine power, winches, boat material (plastic, wood) and other boat descriptors should be recorded per port. Also the number of men/boat should be recorded.
4. Characteristics of the gear:
   a. **description of the type of net used**. Material used and size, type of net, fishing operation.
   b. **Description of the FADs.** Material used and shape, number of FADs/boat, position of the FADs (location), FAD grouping, FAD replacement throughout the fishing season.

Besides this simple fishery description which is necessary in order to find out the characteristics of the exploitation pattern, we need other related information that should be collected and **stratified in space (ports) and time (weeks)** during the fishing season. Since the species has a fast growth and the fishing period is short, it is very important to keep the weekly sampling throughout the whole period without missing any week.
The objective of these data is to have the basic information to evaluate the state of the stock. Due to the dolphinfish life history, the fishery acts upon young-of-the-year. Thus, the evaluation should be carried out using a VPA modified to use the week as time unit. The data necessary to carry out this analysis are the following:

1. **Effort**. To measure effort in a FAD fishery is rather difficult, because the FADs are aggregating fish and acting upon the population throughout their mooring period. Probably the best measure of effort would be the number of visits to the FADs (both the positive, resulting in fish detection, and the negative together). However, due to the difficulty in finding this out, the number of FADs plus the number of fishing hours may be used. To collect these data, logbooks should be distributed to the fishermen. The number of logbooks per port should be extrapolated to the port boat number in order to calculate the port effort measure.*
2. **Catch**. The catch is composed of the landings of the target species and the by-catch. In this fishery there aren't any discards because all fish are commercialised. The port landings should be evaluated using data from the port authorities or data gathered by observers. The landings per unit of time (week) and stratum should be recorded.
3. **Size composition of the landings**. Samplers either on board or in the port, should sample for length composition of the catch using the sampling scheme on time and space. The total catch of a boat, or a random sub-sample, should be weighed and measured. The samples should be extrapolated to the total catch of the stratum using the weight of the sampled catch and of the total stratum catch. These samples will enter in the VPA and they should be a very close representation of the actual length frequency of the catch.

4. **Age composition of the catch**. Biological samples should be collected to obtain the otoliths for posterior age determination in days. It is very important that the otoliths (and ages) are available for all the lengths present in the landings, so a regular sampling strategy of all the lengths should be carried out. The smallest and the biggest individuals are very important because they provide the extreme points in the age-length key and, since they are the rarest specimens, you should particularly look out for them.
5. **Length-weight parameters**. The length-weight relationship should be calculated from the biological samples. Use the same sampling strategy as for otoliths (do not forget the extremes, the smallest and the largest individuals).

***Some reflections on the effort measurements**. There are three main parameters of effort: (i) time, (ii) number of fishing units and (iii) number of fishing actions. **Time** should be measured in days or hours (always maintaining the week as the basic time-unit, i.e. number of days with fishing activity during a week), **fishing units** are number of FADs or boats, and **fishing actions**, visits to FADs or landings. A good measure of true fishing effort (that is, an index of the fishing mortality) should involve the three parameters, so good measures of all of them are necessary. In my opinion the best effort measure is the number of visits to check the presence of fish (fishing action) during a week (time) times the number of FADs. Since it can be difficult to count the number of unsuccessful visits, the number of landings (successful visits) could constitute an underestimated approximation of the real effort or other different approaches. Either way, it is most important to try to obtain the following information, both per port and on a weekly basis (these are useful considerations in order to properly design the logbooks to be distributed among the fishermen):

Fishing units: Number of boats with activity in that fishery

Fishing units**: Number of FADs per boat**

Time: Number of days (or hours) with the boat at sea with the dolphinfish as target

Fishing actions: Number of visits to the FADs (and number of FADs visited when only some are visited) by boat

Fishing actions**: Number of landings by boat**