ISSN 0429-9345

FAO FISHERIES TECHNICAL PAPER

398

Manual on sample-based data collection for fisheries assessment

Examples from Viet Nam

DANIDA

Food and Agriculture Organization of the United Nations

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DANIDA

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Rome, 2000

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ISBN 92-5-104526-7

To Thuy, Huong and Ngoc, three hardworking data collectors of Viet Nam.

PREPARATION OF THIS DOCUMENT

The assignment to prepare the present manual was given at the "Regional Workshop on Routine Capture Fishery Data Collection" held 25-28 May 1998 in Bangkok, at the FAO Regional Office for Asia and the Pacific. The Workshop was organized and funded by the FAO/DANIDA Project GCP/INT/575/DEN, "Training in Fish Stock Assessment and Fishery Research Planning". It developed the "Guidelines for the routine collection of capture fishery data" (FAO Fisheries Technical Paper 392), which forms part of a series supporting the "Code of Conduct for Responsible Fishing".

The present manual aims at providing more details on the mechanics of implementing a routine data collection system. The structure of the manual follows that of the Guidelines, but emphasis is placed on providing practical information and detailed examples. The document draws heavily on experience gained in setting up a data collection system in Viet Nam with the assistance of a DANIDA-funded national project "Assessment of the Living Marine Resources in Viet Nam", Phase 1, 1 Mar 1996 – 31 Oct 1997.

The first drafts were prepared shortly after the Workshop. However, in order to bring the manual in line with the Guidelines, a thorough revision was undertaken in 2000 by the author and Paul Medley as editor, using funds of the FAO/Norway FISHCODE Project GCP/INT/648/NOR.

The manual should be considered as one of the major outputs of the FAO/DANIDA Project "Training in Fish Stock Assessment and Fishery Research Planning". It is expected to contribute to better data collection for fisheries management and fish stock assessment and eventually to an improvement of fisheries management.

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Project Manager

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Sparre, P.J.
Manual on sample-based data collection for fisheries assessment. Examples from Viet Nam.
FAO Fisheries Technical Paper. No. 398. Rome, FAO. 2000. 171p.

ABSTRACT

This manual deals with the practical implementation of a routine data collection programme. The data collection programme is developed through a top-down approach, from the identification of the objectives down to the practical recording and management of data obtained from the fishery. The issues are dealt with both through detailed discussion and by using simple examples. The examples are mostly based on situations in tropical fisheries, and in particular, experience has been drawn from developing a data collection programme in Viet Nam. The main questions addressed in the manual are which fisheries data to collect, where and when to collect them.

Only data collected from commercial marine capture fisheries are considered (data from freshwater fisheries, cultured fish and experimental fishery are excluded). The methodologies used are mainly appropriate for a tropical, developing country, with many small (artisanal) vessels and a few large (industrial) vessels.

The methodology is the "sample-based approach" – the manual does not deal with a methodology which assumes complete enumeration. The data collection methodology presented attempts to utilize whatever information can be obtained in practice in a developing country.

Processing and storing of data (fisheries databases) and staff training are partly covered.

CONTENTS

GLOSSARY

ACCESS	The database component of Microsoft Office
ACFM / ICES	Advisory Committee for Fisheries Management / International Council for the Exploration of the Sea.
Activity level	Measure for fishing effort per time unit (say, fishing days per month).
Administrative unit	Division of country, for example, province (or state), districts, communes etc.
Base port	The port that is used as base for fishing trips.
C	Algebraic term for the number of individuals caught (by fishery).
Catch	Fish caught, either measured as "number of individuals" or as "weight of biomass" (yield). Catch = Landings + Discards
Cohort analysis	In this manual used as synonym for "Virtual Population Analysis" (a standard method for fish stock assessment).
Control	The basic component of a form. A control appears on the computer screen, for example, as a "box" for entry of data, or a "button", which starts an operation when clicked on by the mouse.
CPUE	Catch Per Unit of Effort
DANIDA	Danish International Development Agency
Database	A computerised object composed of Tables, Forms and Reports
Discard	The part of the catch that encountered the gear but was not landed.
EEZ	Exclusive Economic Zone
Effort	Measure for fishing activity (say, number of fishing days)
EXCEL	The spreadsheet program of Microsoft Office
F (F_{pa})	Fishing mortality (Fishing mortality of the "Precautionary Approach")
Field	The basic component of a record (a row) in table. A field is the smallest unit in the database.
Fishing mortality	Instantaneous rate of fishing mortality. A measure for the rate of death caused by fishing.
Fishing power	Two fishing vessels are said to have the same "fishing power" if they can catch the same amounts and qualities of fish under similar conditions.
Fishing trip	In the simple case, a fishing vessel leaves the port, steams to the fishing grounds, fishes for a while and steams back to the port where it lands all the catch. This set of events is called a "fishing trip". For more details, see Section 5.
Fixed costs of harvesting	The costs depend on the number of vessels, for example, depreciation of hull, engine and gear, insurance, interest, etc.
Fleet	A group of fairly uniform vessels that have approximately the same size and approximately the same construction. They use the same type of gears and fishing techniques and most often they also share fishing grounds.
Form	The screen displays by which the user interacts with the database (soft form).

Frame survey	Inventory list of fishing units at a specific time, sometimes combined with an indication of their activity levels (for example number of active fishing days per month). A frame survey is usually a complete enumeration as far as the number of units is concerned, whereas the activity data are often are sampled.
GIS	Geographical Information System
Gross Value Added (GVA)	The total income generated by the production: (Private profit) + (Wages + salaries) + (Interest) + (Licence fee) + (Depreciation) + (Taxes and duties minus subsidies)
Home port	The place of registration of a fishing vessel
HP	Horse Power
ICES	International Council for the Exploration of the Sea
Input Tables	The basic database tables containing the observations collected by interviews of skippers, merchants etc., and by recording experimental fishing.
LAN	Local Area (computer) Network
Landings	The part of the catch that is actually brought back to land.
Look-Up-Table	Table with options for filling the fields in the input tables.
Management Unit	A "management unit" is the same as a stock whenever the stock has been identified. When the stock cannot be identified, "Management unit" replaces the concept. A management unit is something for which it is possible to make predictions, under various assumptions on the future fishing regime.
MBAL	Minimum Biological Acceptable Level
Merchant / Buyer	Person who buys the landings for re-sale to next chain in the market. They often have additional relationship to the fishers, for example they may lend them money, pay for medical expenses etc.
MPA	Modal Progression Analysis Method for the analysis of a time series of size frequency data.
MSY	Maximum Sustainable Yield
N	Stock Numbers (Number of survivors)
NAN-SIS	Software for fishery survey data logging and analysis (FAO Computerised Information Series, Fisheries, No. 4), developed for the NORAD-funded Nansen Programme.
Net Value Added	NVA = (Gross value added) - (Depreciation)
Neyman's Criteria	Criteria for optimum allocation of data collection resources
NORAD	Norwegian Agency for Development Co-operation
Opportunity cost	The benefit foregone by using a scarce resource for one purpose instead of its next best alternative.
P	Algebraic term for the price per kg
Population	The set of "data-units" from which data are collected
Private profit	(Ex-vessel value of catch) - (Costs of fishing)
Private profitability (%)	100*(Private profit) / (Investments)

Provisional reference point	When information for determining reference points for a fishery is poor or absent, provisional reference points shall be set. Provisional reference points may be established by analogy to similar and better-known stocks.
Query	A request to the database to perform some operations on the tables (say, merging, filtering and sorting records).
Recruit, Recruitment	A "recruit" is a juvenile fish entering the exploited part of the stock. "Recruitment" is the number of recruits per spawning season.
Reference points (precautionary reference points)	There are two types of precautionary reference points: Conservation or limit reference points and management or target reference points. Limit reference points set boundaries which are intended to constrain harvesting within safe biological limits. Target reference points are intended to meet management objectives.
Stock	A "stock" can be defined as a group of animals from one species, which share a common gene pool. There are many other definitions of the "stock" concept.
Stratification	Division of the population into strata, and allocation of sampling intensity to strata.
SSB	Spawning Stock Biomass, the biomass of adult fish that contribute to spawning.
Variable costs of harvesting	There are two types of variable costs: (1) Costs linearly related to fishing effort, for example fuel and lubrication, repairs and maintenance, ice, crew wages (independent of yield in value), etc. (2) costs, which depend on the ex-vessel value of the landings; for example: crew remuneration and fish auctioning/marketing fees.
Vessel register	Database containing a set of parameters for each vessel, such as a unique registration code, the dimensions of the hull and the engine etc. The vessel register is used for the purposes of taxation, payment of subsidies, issuing license, payment of licence fee, monitoring, control and surveillance, enforcement of fisheries regulations, inspection, etc. The vessel register is also used for processing of catch and activity information.

1 INTRODUCTION

This manual describes how to manage sampling programmes for routine data collection. Routine data are collected in a never-ending programme and are used to monitor fisheries. Although the programme is continuous, it does not mean the programme has a fixed design. It should be able to adapt to changes in technology and activities, as required. Setting up and maintaining a sample-based routine data collection programme is the subject of this manual.

Although related to the Guidelines for the routine collection of capture fishery data (FAO, 1999), this manual contains different information. The Guidelines recommend general methodologies, but do not give instructions on how they might be implemented. There is no universal approach to the implementation of fisheries data collection programmes. This manual gives examples of how parts of the methodology covered by the guidelines might be implemented in practice. The present manual is not comprehensive in the sense that it addresses all topics covered by the guidelines. Rather, it attempts to give representative examples that illustrate the basic principles. Therefore, the specific methodologies can rarely be applied directly, but it should be possible to modify them to match any particular case.

A prerequisite for a successful design of a data collection programme is that the designer understands the objectives of the data collection. It is not always an easy task to link the methodology of data collection to the objectives, as there are usually many objectives. The present manual cannot present the entire theory on the use of fisheries data (fish stock assessment, country sector profiles etc.), but tries to introduce just enough theory to justify the data collection and to define the data requirements.

Design of a data collection programme involves solving a variety of problems through combining the techniques covered in this manual with practical sense, historical knowledge of the fishing sector and understanding of political issues. The present manual is based on a number of assumptions about the structure of the fishery to which the methodology is applied. Without the knowledge about the assumed underlying fisheries structure, it may be difficult for some readers to understand the particular design of the sampling programme introduced here. The author does not consider it possible to construct a "generic data collection methodology" which would apply to any nation or fishery of the world. The author (although usually associated with Denmark and ICES) has primarily used experience from East Asia, in particular from Viet Nam, to write this manual. The author, being a mathematician by education, has experience in fish stock assessment, fisheries management and bio-economics of fisheries, and the methodology suggested is (naturally) influenced by this basis of experience.

During the process of setting up a nation-wide data collection system for the commercial marine capture fisheries of Viet Nam, national collaborators, the author and consultants completed many tasks involving problems of various complexities. The tasks covered a wide range of disciplines. This manual attempts to cover all the major technical tasks faced in Viet Nam, with the main emphasis on the tasks considered problematic or which resulted in lengthy discussions within the group of programme designers. The identification of species and the recording of biological parameters (such as "body length") did not create major problems in Viet Nam, but may require a training programme in other countries. These methods are outside the scope of manual, but may be found in other texts.

The history of marine fisheries is full of incidences of overfishing and stock collapse resulting in closures of fishing industries and bankruptcies. Therefore, it may be argued that the primary objective of fisheries management and planning of fisheries development is to avoid over-investment. Often, investment in the fisheries sector was based on very limited knowledge about the ecosystem, the fish stocks, the fisheries sector and the fisher communities. This lack of knowledge made investors and managers behave optimistically or irresponsibly. In such cases of limited background knowledge, a "Precautionary Approach" should replace the "optimistic" approach. Knowledge and understanding about the real underlying ecosystem, and underlying dynamics of fish stocks are always limited to the system perceived by the researchers and managers.

The precautionary approach, sustainable development, rational exploitation and responsible fishing have been given a central place in international conferences and agreements devoted to the environment of fisheries. Some of the more relevant definitions and statements were given in the "Code of Conduct for Responsible Fisheries", CCRF (FAO, 1995), and in other FAO publications.

International agreements show that a consensus view exists that a "precautionary approach" is required for the management of fisheries. However, there may be controversial interpretations of what the precautionary approach actually is. Paragraph 7.5.1. of the CCRF is devoted to the precautionary approach. It stipulates:

> *States should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment. The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures* (The concept of "reference points" is discussed in Section 2.3).

and in respect to paragraph 12.13 of Article 12, on fisheries research:

> *"States should promote the use of research results as a basis for the setting of management objectives, reference points and performance criteria, as well as for ensuring adequate linkage between applied research and fisheries management.*

A prerequisite for research is data collection. The backbone of data collection for fisheries research is routinely collected data. In its Article 5(c), the UN Agreement on the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks stipulates that the precautionary approach should be applied in accordance with Article 6. One paragraph is of particular relevance in the context of data collection:

> *6.3. In implementing the precautionary approach, states shall:*
>
> *a) Improve decision-making for fishery resource conservation and management by obtaining and sharing the best scientific information available and implementing improved techniques for dealing with risk and uncertainty;*
>
> ....
>
> *d) Develop data collection programmes to assess the impact of fishing on non-target and associated or dependent species and their environment, and adopt plans, which are necessary to ensure the conservation of such species and to protect habitats of special concern.*

The adoption of the precautionary approach has considerable implications for fishery management agencies and the fishing industry. Scientific advice to fisheries managers should allow for uncertainty in both the understanding of the state of the stocks and the effects of future management actions. This implies that when less is known, fishery management agencies should be more cautious. This requires a management approach less influenced by short-term considerations, and more concerned with long-term sustainability.

Socio-economic factors to be considered in establishing objectives for the management of fisheries might, for example, imply the sustainable maximisation of yield, or of employment, either in the fishing industry or in the more general fishing sector. Unfortunately, all desirable objectives cannot usually be met simultaneously, and one of the main roles of fishery management agencies in a precautionary approach would be to derive trade-offs between competing objectives in consultation with interested parties. Fishery management agencies could, for example, pursue economic goals such as high profitability (which implies low exploitation rates and high fishing efficiency) social goals such as high employment (which require higher exploitation rates and/or lower efficiency) or some quantified trade-off between these conflicting objectives. Whichever approach is taken, it will be necessary to quantify objectives and trade-offs it they are to be translated into measurable factors such as levels of fishing mortalities. It can be concluded that international standards consider data collection a prerequisite for responsible management and development of fisheries. It is irresponsible to initiate any major development of fisheries before a solid basis of knowledge has been made available. The more limited the database, the more strictly the "precautionary approach" should be observed.

1.1 SCOPE

Data collection in fisheries is a rather wide field, which may deal with the theory of statistical analysis, design of relational databases, measurements of biological parameters, estimation of biological, technical or economic parameters, analyses of fisheries household survey etc. It is not the intention that the present manual should cover all fields. Other textbooks and manuals in the scientific literature already cover many of these topics in detail. Therefore, topics that are well covered by standard textbooks will be only briefly mentioned here.

The manual is intended to assist in setting up a data collection system mainly from the practical and organisational point of view. This includes the allocation of limited resources (labour and funds) to tasks in the programme, as well as development of the human resources.

The methodology of data collection is dealt with at a level, which does not assume background knowledge in any scientific discipline.

1.1.1 Data Collection Topics Covered

The main questions addressed in the manual are which fisheries data to collect, where and when to collect them.

Only data collected from commercial marine capture fisheries are considered (data from fresh water fisheries, cultured fish and experimental fishery are excluded). The methodologies are most appropriate for a tropical, developing country, with many small (artisanal) vessels and few large (industrial) vessels.

The methodology is the "sample-based approach" – the manual does not deal with a methodology which assumes complete enumeration (such as the systems based on compulsory filling in of logbooks / sale-slips applied in many industrialised and some developing countries). The present data collection methodology attempts to utilise whatever information can be obtained in practice in a developing country, including skippers and buyer's notebooks.

Processing and storing of data (fisheries databases) is partly covered because they are considered tools to control, evaluate and improve the data collection programme. The design of a fisheries database is considered an integral part of the design of a fisheries data collection programme, and the two tasks should not be separated. In order to analyse the collected data (for example, evaluating their quality), some knowledge of databases is required. All staff of a data collection programme should have some knowledge of relational databases, and some staff must be experts. However, a comprehensive introduction to the theory on design of relational databases is outside the scope of the manual. Readers interested in further studies on relational databases are referred to the relevant literature (Chapter 8).

1.1.2 Data Collection Topics Not Covered

The following topics, which might have been included (and which can indeed be found in some manuals of fisheries data collection) are not covered by the present manual. That the topics are not covered does not imply that they are considered to be less important, but they are considered covered adequately elsewhere. These include:

- The practical aspects on how to measure technical parameters. For example, how to identify species, how to measure length, weight, maturity stage, age of individual animals, dimensions of fishing vessels, fishing equipment and fishing gears.
- Economic data such as prices of landings, costs of fishing, investments etc.
- Specialised environmental data. Only data directly related to the fishing operation are included in the programme.
- Data from processing, marketing, distribution, quality control and import/export sectors. Some data from these sources may constitute valuable supplements to the data collected from the harvesting sector, and some brief remarks on the use of data from processing plants are given in Section 5.4.
- Data from experimental fishing or from research vessel surveys. There are already several manuals, including some published by FAO on collection and analysis of data from experimental fisheries and research vessel surveys. Data obtained from experiments or surveys can often be combined with data from a commercial fishery in, for example, fish stock assessment.
- The mathematical theory on sampling. For the theory of statistics (calculation of confidence limits etc.) and sampling techniques, the reader is referred to standard textbooks (see Chapter 8). Only a brief (non-mathematical) introduction of the "Neyman criteria" is given (see Section 4.3.1).

1.2 ORGANISATION OF THE MANUAL

The manual follows the same structure as the FAO (1999) Guidelines for the routine collection of capture fishery data (FAO Fisheries Technical Paper 382; Figure 1.2.1). However, this manual concentrates on practical aspects, rather than the general framework for developing a programme.

Chapter 2 gives a brief discussion of the objectives of data collection in general terms. It also covers who has the responsibility for the fisheries data collection and the database. The allocation of responsibility is a prerequisite for the implementation of a programme and the responsibility is often associated with the use of the data. The idea of management units and reference points as management indicators is also introduced.

Chapter 3 introduces the basic types of data that are collected. It presents some important concepts of fisheries data collection methodology and gives some of the theory behind the use of the data, such as fish stock assessment and bio-economics. The methods used to extract information from the data are relevant to the way the data are collected.

Chapter 4 is concerned with the design of sample-based data collection programmes. It discusses the different types of stratification of the fisheries sector that optimise data collection, as well as stratification required to meet requests from clients. Often the aim of the programme is to obtain as accurate as possible statistics such as total catches from partial coverage. This chapter also explains how samples are raised to these totals.

Chapter 5 presents some data collection methods, mainly through considering what and where data are collected. Suggested data collection forms to be used by enumerators are presented

Chapter 6 gives the basic considerations and design of a fisheries database. In addition, Section 6.7 deals with validation of data, and Section 6.8 with the output from the database (reports). Section 6.9 describes the "Fisheries sector profiles", which contain background information about the fishing sector. This overall description of the sector is the minimum information required by fisheries managers and administrators.

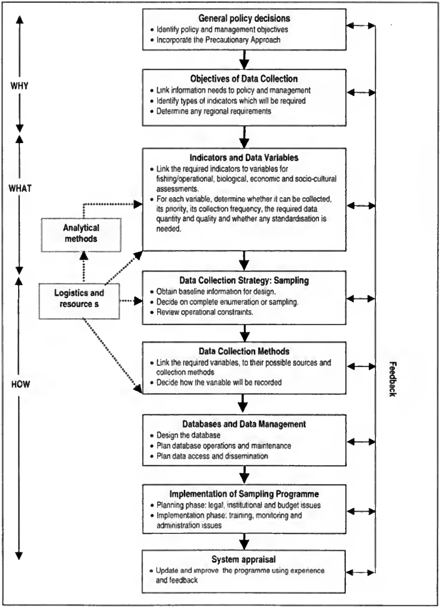


Figure 1.2.1 Setting up a data collection programme follows from identifying data needs through to working out how the data should be collected. In designing the programme, all options should be carefully considered. (From FAO, 1999).

Chapter 7 discusses various aspects of the implementation of sample-based data collection programmes from scratch. Development of human resources is an important element, and this chapter concentrates mainly on this issue. Also, the budget and the documentation of the methodology are discussed.

The concepts are illustrated extensively with examples. Chapter 3.4 introduces a hypothetical, but representative, tropical developing country, which is used to provide an fisheries structure for many of the subsequent examples. Chapter 6.10 presents a minimal fisheries relational database for demonstration of basic principles of fisheries databases. The Fisheries Demonstration DataBase (FDDB) is constructed to illustrate the full-scale fisheries database, "VIETFISHBase" developed by the author and collaborators for the Viet Nam commercial marine fishery and experimental fishery during 1997 – 1998. The FDDB is a combination of various fisheries databases developed by FAO projects.

Finally, Chapter 8 contains a list of literature suggested for further studies.

Although the structure of this manual suggests a linear process from design to implementation, in reality this is only partially true. There are two important aspects, which designers of a data collection programme will need to bear in mind:

- Implementing a data collection programme is an iterative process. So the implementation should be regularly reviewed and modified. Each completed year of the programme should add to the accumulated experience, which is used for planning and implementation in the following year. We shall come back to the iterative process in Section 7.6.
- Often it makes sense to design different parts of the programme concurrently rather than in sequence. For example, the database system should be developed alongside the data collection methods. The form design will often be integrated with design of the database. The database will also be used for checking and validating input, and direct input by fieldworkers may eliminate the need for paper forms at all.

1.3 WHO SHOULD READ THIS MANUAL

The manual is intended for professionals in fisheries research, administration or management. The reader is assumed to be familiar with fisheries. Otherwise, no assumptions are made regarding the reader's background.

The primary target groups are:

- Designers of sampling programmes
- Designers of fisheries databases
- Supervisors of enumerators
- Enumerators

The secondary target groups are:

- Fish stock assessment biologists
- Fisheries bio-economists
- Fisheries managers
- Fisheries administrators
- Students in fisheries science

Individual workers in the primary group will usually also belong to one of the secondary target groups, whereas the secondary group may encompass a much larger group of individuals than the primary group. It has been attempted to introduce each field of expertise so that workers in other fields understand key issues of the data collection programme.

2 OBJECTIVES OF DATA COLLECTION

Collection of fisheries data usually has more than one objective. Fisheries biologists, economists, sociologists, managers, politicians, industrialists, etc. may all require different information. Some basic fisheries data, however, will be of interest to all groups.

The first objective of fisheries data collection is the regular publication of a yearbook or Annual Fisheries Statistics by the government. The publication presents the overall description of the fisheries sector, and it will usually be supplemented by a number of other publications on specialised topics.

An overall description of the sector is the first prerequisite for any rational management of the fishery. The publication should cover biological, technical, demographic, economic and sociological data. In additional to the annual publication, various profiles of the fisheries sector are useful as general information for decision-makers in fisheries management and development. The reports on the fisheries sector must be supplemented by reports on the current stage and the historical development of the resources. Routinely collected data may also be used in research, when supplemented with other data.

2.1 OVERALL OBJECTIVES

Decision-makers in fisheries, at all levels, must posses an overall knowledge of the fisheries sector, including the overall fisheries statistics usually published as the "Yearbook of Fisheries Statistics" or "Annual Fisheries Statistics".

Such annual publications will contain tables with number of fishers, number of fishing vessels and particulars of vessels and fishing gears, fisheries infrastructure, production by species, gear and area in value and weight, import and export, legislation, trends in production and development, etc. Obviously, one objective of data collection is to produce these yearbooks.

However, the yearbook does not always contain the type of detailed information needed for prediction of the effect of management and development decisions. These details comprise landings in weight and value by species (or species group) and by fleet (vessel/gear category, fishing effort), variable costs, fixed costs and earnings of the fishing operations, investments and employment. More detailed data will usually be published in reports from scientists and administrators to the government or to international fisheries bodies. Some results may be published as scientific papers or books.

Eventually, summaries of information will be distributed through the press or the Internet, either through the initiative of data managers or scientists, or through a request from the press itself. The information derived must be distributed or published, and preferably published in different ways to different target groups. If data are not published or made accessible in some form, there is little point in collecting them.

In 1997 FAO published "Fisheries management", No. 4 in the series of "FAO Technical Guidelines for Responsible Fisheries". This publication allocates around 30% of its pages to "Management data and information requirement and use". Many of the data types mentioned are information from processed data, such as the results of fish stock assessment. This type of data does not belong to the type of database dealt with in the present manual, which is constructed to deal with the collection and storage of raw data, not processed data.

The overall objective of data collection cannot be defined in an exact manner, due to the multitude of data needs. There is no single objective, but a suite of objectives, some of which may not go together very well. So the overall objective can be described only in very general terms, such as:

"To create a fisheries management information system"

or

"To meet the requests from the public on information about the fishing sector, with special emphasis on the information needed for a rational decision-making in fisheries management and development".

This may in turn lead to all kinds of specialised (but routinely collected) data for special scientific, inspection, control, enforcement and protection purposes, but the fundamental pillars of the fisheries management information system are the catch and effort data, and vessel registration.

An Example of an Objective: Estimation of Total Landings

It is useful to have an example of an objective of data collection, by which the concepts can be illustrated. A very common and important objective, the estimation of the total landings by value and by weight, is used here to develop an example data collection programme.

Total landings may be all species, all fleets and all seasons combined. However, total combined landings will usually not be considered a sufficiently detailed description of fisheries production, and so landings are divided on several levels.

Landings will usually be divided into:

- Administrative geographical areas (e.g. provinces of a country);
- Landing places;
- Fishing fleets (Vessel category, see definition in Section 3.1.3);
- Commercial landings groups (e.g. species groups, see definition in Section 5.3);
- Fishing seasons;
- Fishing grounds.

For the scientific analysis of fisheries resources, total landings are often required by species (or stock). For fish stock assessment methods such as VPA (Virtual Population Analysis, see Section 3.2.2) the total number of individuals caught by age and/or size group is required. Several methods of resource evaluation, however, use the CPUE (catch per unit of effort, for example kg caught per day) as the basic input, but methods based on absolute values (total catch) are preferable compared to methods based on relative values (CPUE).

2.2 RESPONSIBILITIES

2.2.1 Directorate of Fisheries

The production of an Annual Fisheries Statistics report is naturally the responsibility of a ministry (i.e. the national fisheries management authority). In the following, we shall refer to this government body as the "Directorate of Fisheries".

The Directorate of Fisheries usually assumes the responsibility for registration of fishing vessels, and thereby they will be responsible for maintaining a vessel register. The directorate will usually maintain a number of other databases on production, quality and prices of sea products.

Basic catch and effort data is usually also the responsibility of the Directorate of Fisheries. The basic catch data comprise weight and value of landings by administrative unit (for example province), by fleet (vessel/gear category) and by commercial group of landings (for example, species group and size group).

2.2.2 Fisheries Research Institute

The "Fisheries Research Institute" will often be a part of the ministry responsible for fisheries, although it may also be found under another government department, a section of a university or an independent research institute. In any case, the Fisheries Research Institute must have a close relationship with the Directorate of Fisheries, which may be facilitated if it is a part of the same ministry. The research institute will have the responsibility to collaborate closely with the Directorate of Fisheries on exchange of data, analysis of data and reporting.

The Fisheries Research Institute will often have the obligation to perform resource evaluations and/or bio-economic analyses for the Ministry of Fisheries or for International bodies. The input for scientific analyses is usually a combination of basic catch and effort data combined with other routinely collected scientific data.

The research institute will have the responsibility to present the scientific information in a form, which can be applied by the managers and other decision-makers. It will also have responsibility to combine the scientific data with the basic fishery statistics collected by the Directorate of Fisheries, for the regular publication of reports on the state of the fishery.

2.2.3 Other Agencies

Other types of data from the fisheries sector, which are not specific to fisheries, will be the responsibility of institutions not under the ministry dealing with fisheries. Such data may comprise demographics, infra-structural and institutional data, imports and exports, information on taxation, household data, coast guard (or harbour police) registrations, meteorological data and so on. These agencies, departments, institutes and organisations have the same responsibility as the fisheries directorates and institutes, to deliver information to the public.

Data collected by a government agency should not be considered the property of the agency in question, but should be available to all concerned government agencies, and summaries of data should be available to the public. Similarly, the private industry must have the obligation to deliver basic, accurate information to the government agencies. These obligations must be secured by adequate fisheries legislation.

Some information from individual private entrepreneurs, however, must be treated as confidential. It is important that the industry has a guarantee that confidential information is not passed on to competitors or other parties who have no legal rights of access. This might be achieved by publishing only summary information on the industry, in such a form that the information cannot be traced back to individual entrepreneurs.

2.3 MANAGEMENT UNITS AND REFERENCE POINTS

The concept of "stock" is rather complicated and there is no consensus among scientists on how to define it. A full discussion of the stock concept in the context of fisheries management is given in Begg *et al.* (1999). A living stock could be defined as a group of animals from one species, which share a common gene pool. For the management of fisheries, however, this definition is academic rather than practical. Therefore, we shall try to identify more operational concepts. For management of fisheries, it is the concept of "**management unit**" rather than stock that is useful. A management unit is a resource for which it is possible to make predictions, or, in other words, something for which we can give answers to "What-if questions".

The first problem encountered in a typical tropical country, is that of the definition of stocks. More than 500 species of fish, cephalopods and shrimps may be included in the list of sampled species of commercial interest. Each of the species could consist of a number of "stocks". Thus in practice, a sampling programme is often not able to apply the stock concept rigorously. The programme has to replace the concept of a "stock", with the concept of a "management unit".

According to the agreed international standards, "reference points" are an important concept in implementing a precautionary approach to fishing. Reference points are closely related to the stock concept. Annex II of the UN Agreement on Straddling and Highly Migratory Fish, distinguishes between "target reference points" and "limit reference points" for fish stocks. The relevant paragraphs are:

Two types of precautionary reference points should be used: Conservation or limit reference points and management or target reference points. Limit reference points set boundaries, which are intended to constrain harvesting within safe biological limits within which the stocks can produce maximum sustainable yield. Target reference points are intended to meet management objectives.

Precautionary reference points should be stock-specific to account, inter alia, for the reproductive capacity, the resilience of each stock and the characteristics of fisheries exploiting the stock, as well as other sources of mortality and major sources of uncertainty.

Fishery management strategies shall ensure that the risk of exceeding limit reference points is very low. If a stock falls below a limit reference point or is at risk of falling below such a reference point, conservation and management action should be initiated to facilitate stock recovery. Fishery management strategies shall ensure that target reference points are not exceeded on average.

The fishing mortality rate, which generates maximum sustainable yield, should be regarded as a minimum standard for limit reference points. For stocks, which are not overfished, fishery management strategies shall ensure that fishing mortality does not exceed that which corresponds to maximum sustainable yield, and that the biomass does not fall below a predefined threshold. For overfished stocks, the biomass, which would produce maximum sustainable yield, can serve as a rebuilding target.

Therefore, fishing mortality rates, biomass, or other measures should be regarded as indicators of the status of the stock in relation to predefined reference point **limits**, that should be avoided, or **targets,** that should be aimed at, in order to achieve the management objective. The identification of reference points requires a time series of scientific data, often over many years.

A key concept in some reference points is the Spawning Stock Biomass (SSB), which is defined as the number of individuals multiplied by the fraction of mature individuals for each age group, summed over all age groups. Another important concept is the "recruit", which is a juvenile fish entering the exploited part of the stock.

With a few rare examples, the identification of the relationship between parent stock (SSB, spawning stock biomass) and subsequent recruitment (R) has remained elusive for marine fishes. The only point on the stock-recruitment (S/R) curve known for certain is the origin of the curve. If there are no parents, there will be no offspring, otherwise the curve is rarely estimated with certainty. The precautionary approach dictates that unless it is scientifically demonstrated that there is no relationship between the parent stock and subsequent recruitment, such a relationship should be assumed to exist, even if the data are ambiguous. Figure 2.3.1 shows the characteristic shape of a stock-recruitment curve. The broken straight line through the origin is the "replacement line", which defines the survivorship needed to replace the spawning stock in the future. The slope of the replacement line depends on the fishing mortality. The higher the fishing mortality is, the fewer recruits will survive to become "parents", and replacement line will, thus, be steeper.

There is no single model on the relationship between SSB and recruitment. The observations show large variation around any SSB/R curve, so scientists are not in a position to predict future recruitment with any accuracy. They are only able to tell the probability distribution of the future recruitment, and only then, if a long time series of SSB/R observations is available (Figure 2.3.2).

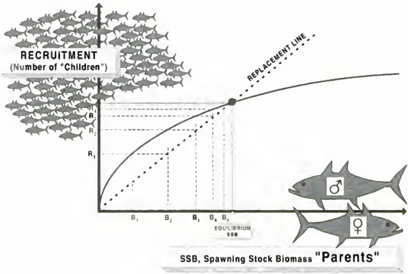


Figure 2.3.1 Illustration of the "Stock Recruitment Relationship", "Replacement line", and "Equilibrium Spawning Stock Biomass". The slope of the replacement line depends on the mortality of the fish. The figure shows how the stock approaches an equilibrium, if the replacement line remains constant (B_1/R_1, B_2/R_2, ... $B_{Equilibrium}/R_{Equilibrium}$).

A **target** reference point is defined by the policy for the fisheries sector. It may aim at, for example, the maximum economic yield. **Precautionary approach** reference points are reference points selected so that the probability of exceeding a limit reference point is very small. Thus, fishing mortality limit reference points should always be larger than the precautionary approach fishing mortality (**F_{PA}**). Notice that, when expressed as fishing mortalities, the reference points must satisfy the condition: **$F_{target} < F_{PA} < F_{limit}$**.

For the tropical fish stocks it is often not possible to apply the methodology of reference points as outlined above, for the simple reason that the information on stock and recruitment, as well as fishing mortalities and other population parameters are not available.

Figure 2.3.2 shows typical information needed for the calculation of reference points, namely a long time series of recruitment estimates. This type of data is usually available for stocks in temperate waters, where the number of species is much less than in tropical waters, and where the definition of stocks is simpler (although still problematic in many cases).

If a data collection programme is to implement international standards for responsible fishing, it has to choose reference points that can be calculated by aid of the data currently available. The basic data collected is first of all catch rates (kg/day by fleet, season, fishing grounds and species group), also called CPUE (Catch Per Unit of Effort). Thus, possible candidates for reference points must be derived from, for example, catch rates.

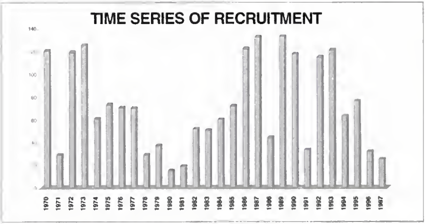


Figure 2.3.2 Time series of recruitment. Information required for the use of international standard reference points.

The definition of reference points is difficult in the case where long time series of data are not available. The situation for many tropical countries is that of paragraph 2 in ANNEX II of Straddling and Highly Migratory Fish Stocks (UN, 1995):

> *"When information for determining reference points for a fishery is poor or absent, **provisional reference points** shall be set. Provisional reference points may be established by analogy to similar and better-known stocks. In such situations, the fishery shall be subject to enhanced monitoring so as to enable revision of provisional reference points as improved information becomes available".*

In some cases, only provisional reference points can be applied, which are defined with respect to CPUE data (catch rates). The definition of reference points could include socio-economic aspects. For example, the value of the catch per day of all major vessel types could be collected. This information combined with cost data could estimate the profitability or rates of return on investment. Profitability is one measure for the performance of an individual member of a fishing fleet. This and other measures of performance are of utmost importance when deciding on investment in a fishing vessel. The profitability also reflects the status of the resources. Catch rates and profitability are linked to the stock biomass, and should also signal when the biological reference points are exceeded.

Investments in the entire fisheries sector should be based not only on the profitability of single vessels, but also on the profitability of total fleets. One may, from the profitability, conclude that a certain vessel type is a promising object for investment, but it does not say how many vessels should be invested in. For these decisions total catch, total effort and total number of vessels in each major fleet must be known.

A certain number of vessels correspond to a certain investment, and therefore it should be possible to convert a precautionary approach fishing mortality (F_{PA}) into a "precautionary investment policy". The precautionary approach, which is usually expressed in terms of fishing mortality, can approximately be expressed as a number of vessels. The number of vessels together with the activity level of the vessels, gives the effort, which in turn can be converted into fishing mortality. This allows investment to be used as an indicator to guide decision making in preventing overcapacity, for example.

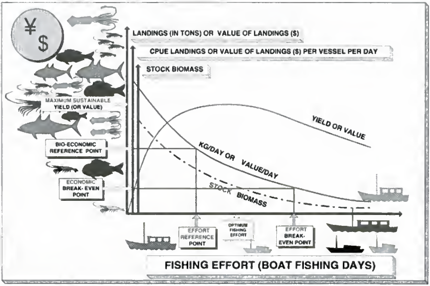


Figure 2.3.3 Illustration of the search for alternative reference points based on bio-economics.

In the tropics, it is not possible to carry out fish stock assessments for all commercially important living stocks. Even if the stock concept is replaced by the management units, there are still too many units to assess all of them. Therefore, the solution is to select a small group of representative species, and carry out a first stock assessment based on data from only one year (i.e. the minimum period covering the seasonal effects).

Figure 2.3.3 illustrates the search for alternative reference points, based on bio-economics. The curve kg/day (or value/day) is the link between biology and economics. The break-even point indicates the level of fishing effort, where the catch per day is so low that the fishers can no longer maintain a subsistence level from fishing (assuming alternative employment is not available). The break-even point may be reached when fisheries are poorly managed. Reaching this point for the major fleets of a nation will cause unemployment and bankruptcies in the fishing industry. "Optimum Fishing Effort" is a better management target, as it represents the long term maximum sustainable yield (or income) to the industry. However, the precautionary approach suggests that the management target of effort should be less than the "Optimum Fishing Effort", as this target level may result in stock collapse, due to the large random (unpredictable) variations of fish stock biomass.

3 INDICATORS AND DATA VARIABLES

3.1 FISHERIES ACTIVITY DATA

This chapter introduces the basic concepts and terminology, which is required to define a fisheries data collection programme. The definitions of concepts are illustrated by examples.

3.1.1 Catch, Landings and Discards

By **"Catch"**, we mean the biomass caught by a gear (a trawl, a hook, a purse seine etc.). A part of the catch is brought on to the deck or into the hold of the vessel and a part may be "slipped", that is released from the gear without being taken onboard the vessel. Of the catch onboard the vessel, a proportion is landed and the rest, if any, is discarded (returned to the sea). It is traditional in fisheries biology to use the word **"Catch"** for the number of individuals and the word **"Yield"** for the weight of the biomass caught. However, in this manual, there is no reason to make a special distinction between numbers and weight, so **"Catch"** can mean either weight or number depending on the context.

"Landings" means the part of the catch that is actually brought on land. In the present context, we shall include the slipped catch into the group **"Discards"**. Thus, by **"Discards"** we mean the part of the catch that encountered the gear, but was not landed.

As for "Catch", "Landings" and "Discards" may refer either to "number of individuals" or "weight", and the reader must judge from the context which interpretation is applicable.

The division of the landings into commercial groups and the recording of the landings will be discussed in Section 5.3. Discards are discussed in Section 3.4.

3.1.2 Fishing Effort and Activity

One of the main targets of fisheries investigations is to link the mortality of fish with fishing effort. That is, for example, to find the link between the number of vessel-days of each fleet and the proportion of the stock that was harvested. The proportion of deaths caused by fishing is indicated by the "instantaneous rate of fishing mortality", usually denoted by "F". The relationship between F and effort is often assumed to be linear, but this may not always be true. To find the relationship between F and effort you must know the historical development in the fishery. That is, it must be known how many effort units each fishing fleet has exerted during some period; for example, the number of fishing days per year by each fishing fleet.

For a bio-economic analysis, effort is the link between the biological and economic models. It is related to production through fishing mortality, as well as to variable and fixed costs. Effort expressed as fishing days or days away from port is the most important variable for the bio-economic assessment of fisheries, as the number of active days is often assumed to be linearly related to the variable costs of fishing.

Fishing effort can be measured in many different ways. The effort measurement may be selected to fit a specific type of vessel and gear. For example, for a trawler you might use the number of trawling hours, for longlines the "number of hooks per line" and for gillnets the "number of gillnets set per night". What can actually be used as measure for fishing effort, of course, depends on which data are available from the fishing operations.

Subsequently, the number of fishing effort units of each fleet must be compared to the number of fish that died due to fishing by that fleet. To estimate the proportion of fish which died due to fishing is a main objective of fish stock assessment (see Section 3.2.2).

Table 3.1.1 lists possible measures of effort by gear categories. The table is divided into five "priorities", where the effort measures, which are most likely to achieve the best relationship between effort and fishing mortality, are the "first priority".

Table 3.1.1 List of effort measures, in order of priority according to the ability of measure to provide a relationship between fishing effort and fishing mortality).

FIRST	PRIORITY	
Fishing Geer	**Effort Measure**	**Definition**
Surrounding nets (purse seines)	Number of sets end Searching time	Number ol times the gear has been set or shot, and whather or not successtully. This measure is eppropriate when school is related to stock abundance or sets are made in a random manner. This represents time on the grounds, less time spent shooting net end retrieving the catch etc. This measure is complicated by the use of aircraft spotting as well as by the dissemination ot information from vessel to vessel. Ideally, it should include tha area searched as well. The measure is appropriate when a set is only mede when a school has been located.
Fishing with FAD (Fish Attracting Device trequently used with purse seine)	Number ot hours or deys since last tishing activity	Number of hours or days (duration) in which FAD (Fishing Attrecting Device) is left in the weter since it was fished lest time.
Beach seines	Number of sets	Number ol times the geer has been set or shot, and the number ot sets in which e cetch was made.
Castnet	Number ot casts	Number ot times the gear has bean cast, and whether or not e catch was made.
Boet seines (Danish seine, etc.)	Number ot hours fished	Number ot hours during which the seine was on the bottom fishing.
Trawls	Number of hours fished	Number ot hours during which the trawl was in the water (midweter trawl), or on the bottom (bottom trawl), end fishing.
Boat dredges	Number of hours tished	Number of hours during which the dredge was on the bottom and tishing.
Gillnets (set or drift)	Number of effort units	Length of nets expressed in 100-metre units multiplied by the number of sets made (= accumulated total length in metres of nets used in e given time period divided by 100).
Gillnets (fixed)	Number of effort units	Length of net expressed in 100-metre units and the number of times the net was cleared.
Litt net	Number ot hours fished	Number ot hours during which the net was in the water, whether or not e catch wes mede.
Traps (uncovered pound nets)	Number of effort units	Number of days fished and the number of units hauled.
Covered pots and fyke nets	Number of effort units	Number of lifts and the number of units (= total number of units fished in a given time period) end estimated soak time.
Longlines (set or drift)	Numbers ol hooks	Number ot hooks set and hauled in e given time period.
Pole-and-line	Number ol days tished	The number of deys tishing (24-hour periods, reckoned from midnight to midnight) including days seerching. Similar to purse seine, in that schools are searched tor and then fished.
Rod-end-reel (recreational)	Number ol line-hours	Number of hours during which the lines were in the water times number of lines used.
Troll	Number of line-days	Totel number ot line days in the given time period.

FIRST	**PRIORITY**	
Fishing Gaar	**Effort Measure**	**Definition**
Jigs, (hend and mechanicel)	Number of line-deys	Totel number of line days in the given time period.
Other small scale net geers	Number of operations	Number of tishing operations, whether or not e catch was mede. These include push net, scoop net, drive-in net etc.
Other smell scele stationary gears	Number of hours tished	Number of hours during which the gears were in the weter for tishing, whether or not e catch was made. Those gears include guiding barriere, beg net, stow net, portable net, etc.
Harpoons / spears	Number of daye fished	The number of days fishing (24-hour periods, reckoned from midnight to midnight) including deys during which seerching took plece without fishing. It more then one speer-fisher operates from a vessef, the numbers of fishers (spears) need to be recorded as welt.
SECOND	**PRIORITY**	
Fishing Gear	**Effort Measure**	**Definition**
Boat saines (Danish seine, etc.)	Number of sets mede	Number of times the geer has been set or shot, whathar or not a catch wes mede.
Trawls	Number of sets made	Number of times the geer has been set or shot (either in mid-water or to the bottom), whether or not a catch was mede
Lift net	Number of hours fished	Number of times the net was set or ehot in the water, whether or not a catch was made
All geers	Number of days tished	The number of days (24-hour period, reckoned trom midnight to midnight) on which any fishing took place. For those fisheries in which searching is e substantiel part of the fishing operetion, days in which seerching but no tishing took place should be included in "days fished".
THIRD	**PRIORITY**	
Fishing Gear	**Effort Measure**	**Definition**
All geers	Number of days on ground	The number of days (24-hour periods, reckoned from midnight to midnight) in which the vessel was on the fishing ground, end includes in eddition to the deys tishing end searching also all the other days while the vessel was on the fishing ground.
FOURTH	**PRIORITY**	
Fishing Gear	**Effort Measure**	**Definition**
All gears	Number of days absent trom port	The number of deys absent from port on eny one trip should include the dey the fishing craft sailed but not the dey ot landing. Where it is known that fishing took place on each day ot the trip the number of "deys ebsent trom port" should include not only the dey of departure, but also the dey ot errival back in port. Where on eny trip a tishing creft visits more than one "fishing area" (ae defined for etetistical purposes) an appropriate fraction ot the total number of days absent trom port should be elloceted to each "fishing erea" in proportion to the number of deys spent in each. The total number ot trip days should be the sum of the number ot deys ellocated to all of tha different "fishing eraas" visited.
FIFTH	**PRIORITY**	
Fishing Gear	**Effort Measure**	**Definition**
All geers	Number of trips made	Any voyege during which fishing took place in only one "fishing eree" is to be counted as one trip. When in e single trip e creft visits more then one "fishing eree" en eppropnete fraction of the trips should be epportioned to each "fishing area" in proportion to the number of days spent fishing in eech. The totel number of trips tor the statistical area as e whole should be the same as the sum of trips to eech "fishing eree".

The concept of "Fleet" will be introduced in Section 3.1.3. Here we shall only note that within a "fleet" of fishing vessels, it is assumed that one day of fishing (or one unit of effort) by any member of the fleet generates the same fishing mortality.

The average number of effort units exerted per time unit per vessel (for example, the number of fishing days per year) is called the "activity level". The activity in general is the "Number of effort units exerted per time unit", where "Effort unit" can be one of the measures suggested in Table 3.1.1. Often it is not possible to make a complete enumeration of all effort units, but it is possible to estimate the activity level from samples.

The sampling of activity observations may be done with trip interviews (see Chapter 5), but it may also be collected through a frame survey (see Section 5.2.2). From the estimate of the average activity level and the number of vessels, the total number of effort units is estimated as the product:

(Total effort per time unit) = (Number of vessels) × (Average activity level)

3.1.3 The Fleet Concept

A **"fleet"** is a group of uniform vessels, which have approximately the same size and the same construction. The vessels should use the same type of gear and fishing techniques and most often, they share fishing grounds.

The fleet definitions may change during the year. A vessel may, for example, do pair trawling for fish during one season and do single trawling for shrimps during another season. Some vessels use a combination of gears during a fishing trip, which may complicate the allocation of vessel to fleets. Sometimes a fleet defined as a "gear combination fleet" can solve the problem.

Fleets may be defined by a combination of gear, engine horsepower (size of vessel), type of construction and fishing grounds. Horsepower, tonnage and length of vessel are usually correlated within a group of vessels of the same basic construction type.

One practical problem is that the sampling programme must adequately cover every fleet. The number of samples from each fleet should have a size, which makes the estimation of the mean catch per unit of effort reasonably accurate. The table below contains an example of categories of fishing vessels according to horsepower class, gear and fishing grounds:

Categories	1	2	3	4	5	6	7
Horse power class	No engine	0-20 HP	21-45 HP	46-75 HP	76-150 HP	> 150 HP	
Gear	Pair Trawl	Trawl	Shrimp trawl	Gillnet	Purse seine	Lift net	Long Line
Fishing ground	"North"	"Central"	"South"				

Although this division does not appear very narrow, it nevertheless results in potentially 6*7*3 = 126 combinations of categories or different fleets. Many of the 126 combinations, however, may be empty. For example, there may not be a lift-net with an engine over 75 HP. The example above suggests a low upper limit on the level of detail, which it is possible to account for in practice.

When the fleets have been defined, we shall in the following assume (as an approximation to reality) that all vessels in a fleet are exactly equal and behave in exactly the same way.

Within the sampling context, the fleet concept is needed for two main objectives:

- To raise catch effort samples to total landings (See Section 4.4). Catch and effort data are combined with activity data and frame survey data (or vessel register) to estimate the total landings by raising sample estimates.
- To assess the competition between fleets (See Section 3.2.3).

There are additional reasons for using the fleet concept. For example, the fleet concept is needed to define suitable measures for CPUE (Catch Per Unit of Effort), which is an important issue in many different types of assessment of fisheries and resources.

The two main objectives may not always lead to the same definition of fleets. However, often the objective of estimating total landings leads to more fleets than necessary for assessing competition between vessels.

The simplest type of "**raising of samples**" is achieved when it is assumed that all fishing vessels within a fleet have the same "fishing power". In its simplest form, raising means that if one vessel is "sampled" and it was observed that the catch was 50 kg/day, then we can "raise" this to the fleet, by multiplication with the number of members of the fleet that were active. In other words, when we "raise" samples we can use the same "raising factor" for all vessels. This is a reasonable approach if all members of a fleet are similar.

Two fishing vessels are said to have the same "**fishing power**" if they can catch the same amounts and types of fish under similar conditions. For example, two trawlers fishing on the same fishing grounds at the same time must catch the same amounts of fish in species, numbers and sizes to have the same fishing power. One may simplify the concepts of fishing power by making it species-specific. Thus if two trawlers, A and B, catch the same amounts of, for example, threadfin breams under similar conditions, then they have the same fishing power relative to threadfin breams. If vessel A catches the double amount of thread-fin breams as vessel B, then vessel A has two times the fishing power of vessel B. This means that one vessel of type A "counts" the same as two vessels of type B.

In practice, this ideal definition can rarely be shown to hold. Instead, if the two trawlers catch the same amount of "demersal fish" during a fishing operation on average, they have the same fishing power, and if one vessel catches X % more on average than the other vessel it has X % more fishing power.

A concept closely linked to fishing power is that of a "**standard vessel**". It is often desirable to express the fishing power relative to some selected vessel type. Usually the most common vessel type is selected as "standard vessel". That may for example be the trawlers of length 15 m with an engine of 60 HP and perhaps some more specific characteristics. Other types of vessels are then expressed in units of standard vessels. If a vessel has 80% of the fishing power of a standard vessel, it counts as a "0.8" standard vessel.

This approach is intuitive, as the purpose is to convert fishing effort into fishing mortality. Two vessels, which remove the same percentage of fish per day from the stock, create the same fishing mortality according to the definition of fishing mortality. If they fish at the same time, then the same percentage will result in the same numbers caught, thus the same fishing power.

Some of the factors that determine fishing power are rather complex. One factor, which is difficult to quantify, is the skill of the skipper. Other factors determining the fishing power are easier to measure, such as engine power, vessel length, year of construction, fitted electronic equipment, mesh size, rigging of the trawl and other physical features of the vessel and gear.

3.2 BIOLOGICAL INFORMATION

Full biological information should cover the composition of the catch, including discards. However, as information about landings usually is easier to obtain than information about the catch, biological information is often based on landings only.

3.2.1 Species Composition of Commercial Groups

Biologists use the fishery data for fish stock assessment. A fish stock is a sub-set of a species, so before stocks (or management units) can be identified, the species must be identified. The landings are often sorted into commercial groups, so the starting point for the sorting into species is usually the commercial group. If a commercial group is only one species, the task should be easy. The enumerator, should however, check that the commercial group is only one single species, as two similar species may be merged in a commercial group. Two similar species will be separated only if the buyers of the landings and their customers appreciate the two species as different products. Other commercial groups, mainly of medium value, contain three to five different, but usually similar, species. For low value products, the number of species in a commercial group may be very large. A commercial group like "Mixed low value small fish" may also contain small specimens of the high value species as well. In any case, the enumerators must take samples from some trips (not necessarily all trips) to record the species composition of the commercial groups.

Most tropical fisheries involve a large number of species. There is no way available manpower and funds will allow for all species to be recorded. The sampling programme must prepare a list of, say, the 400 commercially most important species. Other species found in the species composition samples would then appear as "Other", although recording the number of species (or "recognisable taxonomic units") in a sample may prove useful in future assessments. The number "400 commercial important species" is not universal, and the designer of the sampling programme will have to decide how many species the funding and manpower allows for. The more species are recorded, the more training of enumerators in species identification is needed, and the more time will be spent sorting out species.

Theoretically the species should subsequently be split into stocks, but usually the stock separation in tropical waters has to be based on a set of rather crude assumptions, such as all specimens landed in a set of landing places originate from the same stock. There are sophisticated methods that can be used to separate stocks, but for those the reader is referred to specialised literature.

3.2.2 Fish Stock Assessment, Virtual Population Analysis

Although the methodology of fish stock assessment is outside the scope of this manual, this subsection briefly discusses it, with the main purpose of introducing the type of data needed. It is often easier to understand which data to collect if you also understand how the data are to be used. For further details on fish stock assessment, the reader should consult other manuals and textbooks (see, for example Sparre and Venema 1998 and Lasswen and Medley 2000).

As an example, we shall use the input data needed for Virtual Population Analysis (VPA). The principal input data for VPA is the number of fish caught by size group (length or weight group), which must ultimately be converted into age group. These numbers must be the **total catches of all fleets exploiting the stock in question.**

It is possible to read the age of a fish from the ring structure (reflecting the seasons of the year) in certain hard parts of the body. However, for tropical fish, where differences between seasons are not so great the annual rings are not easy to identify. It is here assumed that no attempt to read ages of fish or squid is made. Instead, we shall use the relationship between body length and age. There is usually a relationship between age and body length for young fish, squid or shrimp.

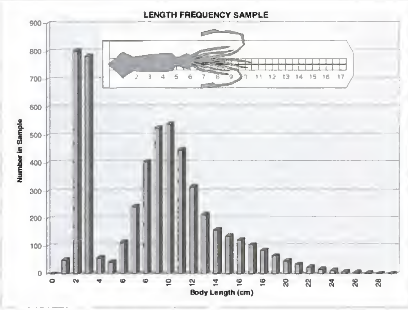


Figure 3.2.1 An example of a length frequency sample.

The method is called "modal progression analysis". Length frequency data (number of fish in the landings in each length-group) can be collected for each month of the year. A length frequency sample is depicted as in Figure 3.2.1, showing a sample of 5390 specimens distributed over 30 length groups of 1 cm. The length frequency samples should be collected during a longer period, preferably not less than a year. One single length frequency sample gives only a "snapshot" of the situation, but to observe changes over time, you must collect length frequency samples must be collected frequently, every month or every quarter of the year.

The reason why the modal progression analysis is possible, is that recruitment to the fish stocks does not occur at the same rate all year round (Figure 3.2.2). The picture shown in Figure 3.2.2 is typical for the seasonality of recruitment of many fish, cephalopod and shrimp stocks. There are usually two spawning seasons during the year. One major spawning followed by a second smaller season.

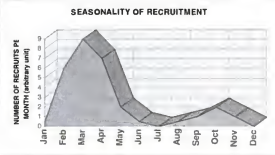


Figure 3.2.2 Seasonality of recruitment (hypothetical example).

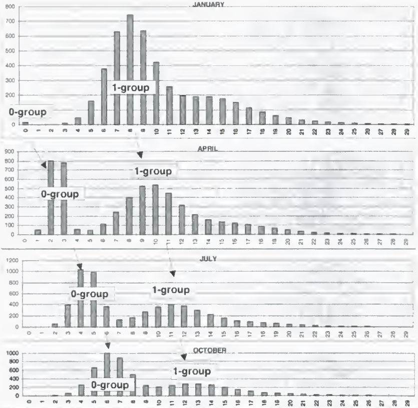


Figure 3.2.3 Simulated input data for Modal Progression Analysis. The figure illustrates the history of a stock during a year from samples taken each quarter.

These peak recruitments can be traced through the size frequencies. To do the "modal progression analysis", we put length frequencies together into a larger graphical picture, and try to find the cohorts by splitting the sample into cohort components (Figure 3.2.3).

There are many theories on the explanation for the observed seasonality of recruitment, which is outside the scope of this manual. We shall point here only that the monsoon and the seasonality of oceanographic features are factors, which influence the conditions for survival of fish in the early stages of life and thus also influence the recruitment to the exploited stock.

Figure 3.2.3 is a hypothetical example constructed to show the principles of modal progression analysis. It is rather easy to separate the 1-group of fish in all samples. In the January sample, it has mean length of about 8 cm and extends from about 4 cm to about 12 cm. In the April sample the 1-group is less in number but they have grown to a mean length of about 10 cm and now with a larger variation between individuals. In April, however, a new cohort, the 0-group, is entering the stock. It has a mean length of about 2.5 cm and it extends from 2 cm to 3 cm. In July, the 0-group has grown to about 4.5 cm length. In this hypothetical example, the youngest cohorts gain approximately 2 cm in the first three months.

Now suppose that the graphs are not just samples, but that they represent the length distribution of the entire catch. In that case, we can estimate the fractions of fish, which survive each quarter of the year. If we count the number of survivors in the two first cohorts, we get (approximately):

	0-group	1-group	Number of Deaths 1-group
JAN	20	3000	400 (13 %)
APR	1700	2600	500 (19 %)
JUL	2800	2100	400 (19 %)
OCT	3400	1700	

The 0-group is increasing in numbers, whereas the 1-group is decreasing in numbers. Taking into account that the fishery starts to catch most fish only after they have reached a certain size this is the expected result. The 0-group is not yet fully recruited to the fishery, whereas the 1-group is fully exposed to fishery.

The decrease in numbers in the 1-group can be used to compute the rate of exploitation (how quickly the fishery removes fish from the fish stock). This assumes the same length distribution in both the catch and stock, so the percentage reduction is the same in each.

If we can do the modal progression analysis, we can also use VPA methods. However, sometimes the modal progression analysis is very difficult. That happens in particular when the length frequency samples are not very big, and in that case we use a more robust method, a method which provides a better fit to the data, but which gives less detailed output. This method is called "**Length-based cohort analysis**". The length-based cohort analysis is based on a number of assumptions about the fish stock dynamics, which make the computations easier.

The "price" we have to pay for an easier method is that the results become less precise. The assumptions we make are never strictly met in reality, they always represent an approximation. In the length-based cohort analysis, we do not try to separate the cohorts, but we sum the length frequencies over the year. The most critical assumption we make in length-based cohort analysis, is that of constant recruitment. Unfortunately, recruitment is usually highly variable, therefore the assumption of constant recruitment is an approximation, which sometimes may be far from reality. However, the average recruitment for a number of years will be less variable, and if several year classes are considered, the assumption may be less critical. The assumption of constant recruitment should be made only when no other alternative is available.

The sum of the length frequencies of Figure 3.2.3 is shown in Figure 3.2.4. The next step in the length-based cohort analysis is to study the slope of the summed length frequencies and to use the results to estimate the number of recruits to the population and the fishing mortality rates for each size group.

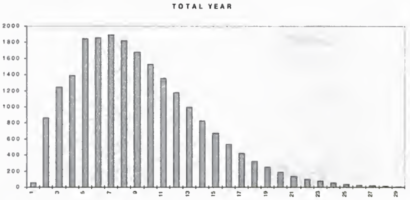


Figure 3.2.4 Input data for length-based cohort analysis (the sum of data of Figure 3.2.3).

3.2.3 Fish Stock Assessment Forecast

VPA and cohort analysis are retrospective, they indicate what happened to a fish stock in the past. The main purpose of a fish stock assessment is to predict what will happen in the future. We may say that the ultimate objective of fish stock assessment is to answer "What-if-questions", like "what will happen to the stock if the fleet size increases by 10%". Where the VPA focused on the "stock", the forecast focuses on the "fleets".

Another important element of fisheries assessment is to analyse the competition and interaction between different fleets. To illustrate the nature of the problem, consider a country with only two different types of fishing vessels, say "fishing fleet 1" and "fishing fleet 2". In 1996 fleet 1 consisted of 100 large industrial vessels and fleet 2 of 2500 artisanal vessels (Figure 3.2.5).

The total value of the landings is $10 million for fleet 1, which is $0.1 million per vessel per year. The figures for the artisanal vessels are $12.5 million for the total and $0.005 million per vessel per year.

We can then ask the question "What happens if the number of industrial vessels are raised from 100 to 500. We could, for example, answer the question by computing (or "by predicting") the landings two years later, that is in year 1998.

In the example given here, the total value of the catch goes down from $10 million to $5 million for the industrial vessels and from $12.5 million to $5 million for the artisanal vessels. A total decline in value from $22.5 million to $10 million.

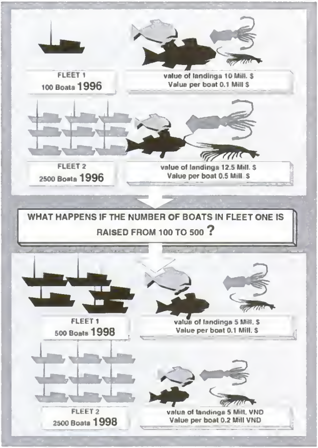


Figure 3.2.5 Illustration of a "what-if" question regarding interaction between artisanal and industrial fleets.

3.2.4 Data Requirements for Fish Stock Assessment

As discussed above, to run the retrospective analysis and the forecast, two principal types of data are needed for each fish stock considered:

1. Total catches by species and by size group for each period (quarter or month) caught by each fleet.
2. Total effort by fleet and by period (for example number of fishing days/month).

The total catch data (by fleet) is derived from two types of basic data:

1. Total weight of catch by species (or species group).
2. Size frequencies for selected species.

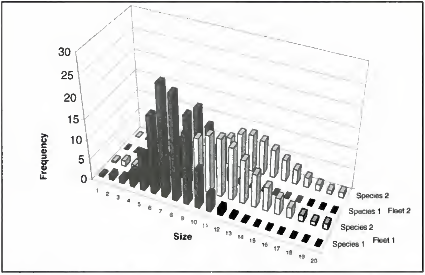


Figure 3.2.6 The principal input data for length-based cohort analysis by fleet. Species 2 grows to a larger size than species 1 and there are some differences between the sizes selected by the two fleets. Effort is also useful for fitting models to the catches. As species 2 is caught by the same fleets as species 1, the corresponding fishing effort is the same for the two species.

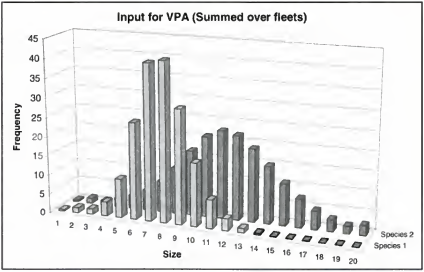


Figure 3.2.7 The principal input data for length-based cohort analysis summed over fleets.

Figure 3.2.6 illustrates the dimensions of the data in a given period. It shows an example with length frequencies for two fleets catching two species. Species 1 gets up to 12 cm long and species 2 gets up to 20 cm long in this hypothetical example. The sampling programme should produce a graph like that of Figure 3.2.6 for each time period of the year, containing all species and all fleets.

As input to the length-based cohort analysis we will use the frequencies (for each species) summed over fleets. Figure 3.2.7 presents the input for two independent cohort analyses, as the cohort analysis is carried out separately for each species.

Usually, it is not a great problem to collect samples of length frequencies. The funds for buying the samples must be available (although the fish can be sold after measurement), or the fishers/buyers may allow measurements without charge. The necessary scientific and technical manpower to collect and analyse the samples must also be available. Furthermore, you must have the co-operation of the fishers and /or buyers to take the samples.

Although it may not always be possible to get certain important types of data, some data should always be obtained for monitoring purposes. If a data collection programme cannot get total catches, the analysis should be based on relative figures. For example, relative figures of length frequencies can be derived from samples. If length frequencies cannot be obtained, other types of data, such as catch (in weight) per day, may still be applied for fisheries assessment.

3.3 BIO-ECONOMIC INFORMATION

Bio-economics is a combination of resource evaluation (i.e. fish stock assessment) and a cost and earnings analysis of the harvesting sector. Ideally, the management and development of fisheries should be based on data and analyses representing all major aspects of the fisheries sector. Thus, biological, economic and sociological information should be collected and processed so the combined output can be used for rational decision making (Figure 3.3.1). Sometimes the processing sector is also included in the analysis of fisheries bio-economics. Here we shall consider only the combination of resource evaluation and an economic analysis of the harvesting sector. The bio-economic methodology is structured by a biological/technical sub-model and by an economic sub-model (Sparre and Willmann 198? And Seijo 1999).

The economic sub-model introduces prices, costs and a range of economic performance criteria. The biological/technical sub-model establishes a physical relationship between fishing effort and fish production (landings). The optimisation of the fishery based on physical quantities (e.g. total catch in tonnes) would result in maximising the sustainable physical yield. As the exertion of fishing effort incurs costs, and as different species and sizes of fish realise different prices in the market, maximum sustainable yield is not, in most instances, a desirable objective of fishery management from an economic point of view.

There should not be two independent data collection programmes, one for the biological data and one for economic data. The biological, technical and economic information are most often collected from the same sources, and are used in combination in analyses. Therefore, the collection of biological/technical data and economic data should be combined in one integrated programme. This approach is cost-effective, and will ensure that the data collected are compatible. Hence, the aim here is not to give a complete list of all possible fisheries economics data, but rather to mention some of the key information, and to discuss how these data can be collected together with the data for resource evaluation.

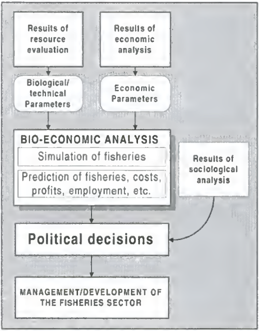


Figure 3.3.1 Illustration of an approach to bio-economic assessment of a fishery.

3.3.1 Fish Prices

Bio-economics operates with two principal types of prices, ex-vessel prices and wholesale prices. Ex-vessel prices are those received by the fisher/vessel-owner at the landing site and those are the only prices considered in this manual.

Different species and sizes of fish generally fetch different prices in the market. In addition, fish of the same species and size may realise different prices because of differences in product qualities, often related to the handling and storage facilities on board of the vessels.

Wholesale prices are those received by the first hand buyer when selling fish to either the domestic or export market. Fish sold for export will earn foreign exchange, which may have additional economic benefit.

Prices are always given by commercial group, and the commercial group is therefore a very important element linking biology to economics. The value of the catch is a useful quantity. When combining catches of different species groups, it may not make sense in a bio-economic context to add together the biomass of species groups, if the price per kilogram differs substantially between species groups. By converting biomass into value, all quantities will be given in the same unit. For example, adding biomass of shrimps, cephalopods and fish often makes little sense, as this sum is rarely part of an explanation for the behaviour of the fishers or the resources.

3.3.2 Costs of Fish Harvesting

There are three different types of harvesting costs, namely

1. Costs depending on the number of fishing effort units;
2. Costs depending on the number of fishing vessels;
3. Costs depending on the value of the landings (i.e. ex-vessel value).

The first category of costs is often assumed to be linearly related to fishing effort. If fishing effort goes up by a factor of two, these costs also go up by a factor of two. This category of costs comprises elements such as fuel and oil, repairs and maintenance, ice, crew wages (independent of yield in value), etc. and is also referred to as "variable costs". For a particular fleet, the total of this cost category is calculated by multiplying the total number of units of effort (e.g. number of fishing days) expended per year with the total costs per unit of effort (e.g. costs per fishing day).

The costs that depend on the number of vessels refer to costs that arise even if a vessel does not go out fishing. They are also referred to as "fixed costs" and comprise elements such as capital depreciation, insurance, interest, mooring fees, refit etc. These costs are usually given on an annual basis. The total costs of this category for a certain fleet would be given by multiplying the number of vessels by the average total fixed costs per vessel per year.

The third category consists of those costs that depend on the ex-vessel value of the landings. They comprise two elements, namely:

1. The crew share, and
2. Fish auctioning/marketing fees.

In fishing, crews are often paid a share of the value of the landings. Although the details of the share system vary from place to place, usually some variable (effort dependent) costs, such as fuel, are deducted from the ex-vessel value prior to sharing the proceeds between the crew and the owner of the fishing vessel. A good share system provides an incentive for the crew to catch more as well as to reduce operation costs. On the other hand, auction fees are determined as a share of the ex-vessel value of the landings without prior deduction of costs.

The total harvest costs of a particular fleet is obtained as the sum over all three cost categories. Clearly, total harvest costs will not increase linearly with fishing effort because some costs depend on the value of the landings produced by that effort, which changes with the intensity of exploiting the fishery resource. The total costs of the entire harvesting sector are given as the sum of the costs of each fleet.

The costs, in particular the costs depending on the effort, are another link between the biological and economic models. The variable costs are linearly related to effort, which in turn is related to fishing mortality and thus the quantities removed from the living resources.

3.3.3 Investments, Foreign Exchange Costs, Taxes and Subsidies

The profit from fishing (value of catch minus costs of fishing) relative to the investment is an important measure of the performance of the fishing sector. The capital investments are mostly the cost of the long term assets, such as hull, engine, gear, electronic equipment, safety equipment etc.

A quantity closely related to investment is the rate of interest to be paid for the loans used to fund the investment. Another important variable is the depreciation rate, for example the percentage depreciated per year for different types of investments.

Data collection of costs will need to reflect the currencies concerned. For a developing country, each of the cost elements and items presented above may entirely or partially be incurred in foreign currency. Fuel, engines, hulls, echosounders, for example, often need to be imported and paid for in foreign exchange. Thus, parts or all depreciation allowances need to be accounted for in foreign exchange. In joint-venture fisheries, crew remuneration may occur in foreign currency because the vessels may be manned by foreign fishers. Also, interest and insurance payments may need to be settled in a foreign currency.

Taxes are payments from private investors/parties to the government. Subsidies are negative taxes, i.e. payments from government to private individuals or companies. Taxes and subsidies apply mainly to fuel and lubricants, repair and maintenance. Taxes will increase the costs of these inputs to the entrepreneur while subsidies will reduce them. In both cases, the real cost to the economy of using these inputs is distorted and needs to be adjusted for determining the optimum management regime.

3.4 AN EXAMPLE FROM A TROPICAL FISHERY

Below follows a brief description of the fisheries sector in a "representative tropical country" assumed in the following chapters, which introduces the methodology of data collection. In particular Chapter 5, which introduces a set of data collection forms, is consistent only in the context of this fishery.

The example is constructed to reflect the situation in a tropical country with a large artisanal marine fisheries sector and some industrial or semi-industrial fleets. Logbooks and complete enumeration through the vessel register are only available for the industrial fishers.

Most of the concepts introduced below have already been introduced, so the description given here has the form of a summary. The only new aspect introduced in this chapter is the methodology suggested for estimation of discards (i.e. catch minus landings) from limited information

3.4.1 Data Types Collected

Trip-Interview: Catch and effort data (and other trip-related data) are collected by enumerators on a "per fishing trip" basis, usually at the time of landing (interview), although the actual collection of data also involves biological measurements by the enumerator.

Vessel Registration: Vessels are assumed to be registered in a "Home port", which may or may not be the same as the "Fishing base port", which may or may not be the landing place. The registration details are stored in a "vessel register". The vessel register is intended to be a complete enumeration of all vessels, although gaps and errors may occur.

Landings: Landings (=Catches – discards) may be occur in one or more landing places. For example, shrimps may be landed in place A, whereas fish are landed in place B. Landings may also be transferred to collector vessels or other fishing vessels at sea. The fishing vessels may fish in groups on distant fishing grounds. They may fish in groups for security and fish finding purposes, but also to reduce the cost of landings. One or two vessels may land the catch of all vessels, while the remaining vessels stay at the fishing grounds.

Discards: The fishers do not generally record discards, but they may be able to give some indication of the discard amounts and species composition. For example, a trawler may keep the total catch of the last haul, in which case it is possible to estimate the entire discard, on the assumption the last haul is a representative sample of all hauls made. During the interview the fishers will be requested to give the number of gear operations (say, trawl hauls) with discarding and the number without discarding.

Commercial Groups: Landings are recorded by weight of commercial groups. A "commercial group" may comprise several species, be a single species or a size group within a species. The basic raw data are the weight and the price per kilogram of the commercial group. Examples of commercial groups are: "Mixed small demersal fish", "Mixed threadfin breams", "Middle-sized groupers (usually only one species)", "10-15 peeled shrimp tails per lb.", "Middle-sized dried *Loligo chinensis*". The definition of commercial groups are not under the control of the data managers, they are defined by the demands of the market.

Species Composition: Samples may be taken from commercial groups with more than one species for the estimation of species composition. Sub-samples may furthermore be taken from a species for estimation of, for example, length frequency. In the case of a typical tropical country, the number of species observed may be large. However, only the important species will be recorded, and the non-important species are lumped into "other species".

"Biological Data": These may include several types of data, such as species composition, maturity stages, meristic characters, age distribution, sex distribution, length composition data etc. In the present example, only four types of biological data are assumed to be collected. The data in question are:

- Species composition of commercial groups;
- Length frequency data;
- Body weight by length group for selected species;
- Sex distribution (notably of length frequency data of shrimps).

The number of commercially important species is assumed to be so large that resources are only available to collect biological data for a set of selected "representative" species (see Section 4.3.2.7).

Fishing Activities: Fishing activities, in the form of effort per unit time (e.g. number of fishing days per month) is assumed to be sampled. These data may be collected as a part of the interview, but other authorities than those responsible for the catch and effort data may also collect activity data (e.g. a coast guard under the Ministry for Defence). Recording of fishing activity may or may not be done by complete enumeration.

Migrations of Fishing Vessels: Migration of fishing vessels refers to vessels that do not use the homeport (the port of registration) as the base port of fishing. A port authority or a coast guard may record vessel migrations. Migration data may also be obtained from the interviews together with the catch and effort data. Recording of migration of fishing vessels may or may not be done by complete enumeration.

Costs and Earnings: During the interview, the enumerator also collects costs and earnings data. The data will either (1) be recorded during the weighing of landings by commercial group or (2) be copied from the record-book of the skipper or vessel owner. The enumerator may also collect data already available from the vessel register for the purpose of validation.

Province, District, Village and Site: It is assumed that the country is divided into a number of administrative units ("Province", "District", "Village" and "Site").

Fishing Fleets: The fishing vessels are grouped into "fleets".

"Fish Stocks" and "Management Units": It is not assumed that conventional fish stocks have been identified. Species (and sometimes sex) represents the lowest level of division of the living resources. The definition of stocks in the case of tropical systems is usually rather problematic, and some division of the resources based on fishing grounds is usually the only practical option. Thus, fish (shrimps, cephalopods etc.) caught at one or more pre-defined fishing grounds are assumed to belong to a "stock". This definition of stocks, will not live up to the more strict definitions and therefore is referred to under the broader term "management unit" (Section 2.3).

Spatial Information: When interviewed, fishers will usually be able to identify the fishing grounds. This may, for example, be "East of island X" or other name of the fishing ground. They may sometimes be able to give a more exact position in terms of latitudes and longitudes. Fishing grounds can be defined by statistical rectangles (say, 30 by 30 nautical miles) or finer divisions.

Frame Survey: The frame survey is an inventory list of fishing vessels structured by homeport (port of registration). The frame survey provides the number of vessels in each fleet of each homeport. The frame survey is not required if the vessel register and the data on vessel migration are reliable. However, in the present example, these data are assumed to be questionable, so the frame survey is therefore also used for validation of the vessel register.

3.4.2 Methodology for Estimation of Total Catches

Total landings at one place over some period (e.g. one month) can be estimated by:

$C = TNV \times FV \times AC \times CPUE$

where

C = Catch (landings + discards) from a management unit caught by a specific fleet during a specific period.

TNV = Total number of vessels in the fleet (from the vessel register or the frame survey).

FV = Fraction of the total number of vessels in the fleet exploiting the management unit. Thus, there are FV*TNV vessels exploiting the management unit. FV is estimated from fishing vessel migration data.

AC = Activity level of the fleet, or the average number of effort units exerted per vessel during the period (e.g. average number of fishing days per month).

CPUE = Average catch per unit of effort (e.g. catch in kg per day of a particular species) per vessel for the FV* TNV vessels exploiting the management unit.

CPUE = LPUE + DPUE

LPUE = Average landing per unit of effort

DPUE = Average discards per unit of effort (see next section)

The procedure of estimating total landings will be further elaborated in Section 4.4.

3.4.3 Estimation of Discards from Limited Data

The most accurate, but also most costly, method for estimating discards is to place observers (enumerators) onboard a representative selection of fishing vessels, and then let the observers record the total catch (landings and discards) and let them take samples from the discards. The use of observers may have many more objectives than collecting discard data, and in general, they would be required to monitor the fishing operations. Observers onboard the vessel during the fishing trip is recommended if the budget and personnel allows for this extra activity.

Using an experimental fishery to estimate discards can be recommended as a sound approach to collecting samples of detailed data. To what degree experimental fishing should be used is very dependent on the resources available to the data collection programme. Setting up an experimental fishery, however, is outside the scope of the present manual.

The table illustrates a third simpler and less dependable (amongst several alternatives) method to estimate LPUE and DPUE. The estimates are based on a sub-sample of hauls of a trip where the discards are retained for examination. These samples allow CPUE, including discards, to be estimated.

Table 3.4.1 An example taken from a trawl fishery of a method to estimate LPUE and DPUE. The table assumes that catch can be divided into two groups: high-value species (or size) and low-value species (or size). The high-value species are never discarded, whereas the low-value species are discarded except for the last two trawl hauls. In case the low-value species are always discarded, an alternative approach must be applied, for example, by placing observers onboard the vessel, or by making the fishers collect samples of the discards.

		Description
Average total number of trawl hauls per trip	**10**	***Input***
Average number of "discard-hauls" per trip	**8**	***Input***
Average number of "non-discard-hauls" per trip	2	*= 10 - 8*
Average total landings per trip (kg)	**100**	***Input***
Average landings of high value species per trip	**40**	***Input***
Average landing on low value species per trip	60	*= 100 – 40*
Landings of low value species per non-discard haul	30	*= 60 / 2*
Estimated discards per trip	240	*= (8 * 30)*
Estimated total catch per trip	340	*= 100 +240*
Average number of fishing days per trip	**4**	***Input***
Average CPUE (catch per day)	85	*= 340/4*
Average LPUE (landings per day)	25	*= 100/4*
Average DPUE (discard per day)	60	*= 240/4*

4 DATA COLLECTION STRATEGY: SAMPLING

There is no single prescription for the optimum design of a data collection system, as the underlying conditions for the design varies from place to place. Obviously, the design of a data collection programme for a small island state is different from that of a large country. Also, the nature of the fishing industry, for example, primarily industrial or artisanal fishery, plays an important role in the design. Although it has been attempted to make this chapter general, it concentrates on the case of large country with a dominant artisanal sector, based on experience drawn from Viet Nam.

4.1 SAMPLE-BASED ESTIMATION VERSUS COMPLETE ENUMERATION

The concepts of "**total enumeration**" (sometimes referred to as "**census**") and "**sample-based estimation**", can be explained by a hypothetical example, where a "population" of six vessels is landing at a particular location.

Notice that the word "population" is used for the set of units from which data are collected. Thus, "population" is a general term which may refer to "a set of landing places", "a set of fishing trips", "a set of landings" etc. In the present example, it is assumed that the population consists of six "similar vessels", both with respect to vessel dimensions and fishing techniques. Thus, the average landings are the same for all six vessels.

The landings are in units of "boxes", and the task is to determine the total number of boxes landed on a particular day in a particular landing place.

"Total enumeration" means that all 6 vessels are inspected and all the boxes recorded. Alternatively, all the skippers may have filled in logbooks recording the number of boxes, which subsequently are made available to the data collectors. The result of total enumeration will be a total landing of 19 boxes (see Figure 4.1.1 and Table 4.1.1)

In the sample-based estimation, only a subset of the vessels is inspected (due to limited resources for data collection). In this case, only vessels No. 3 and 4 are inspected and the total number of boxes counted for the two vessels is six boxes.

Table 4.1.1 Illustration of the concepts of " Total enumeration" and "Sample-based estimation"

Vessel No.	Boxes landed	Sampled Boxes
1	3	
2	4	
3	3	3
4	3	3
5	4	
6	2	
Total	19	6
Raising factor = 6 / 2 =		3.0
Sample-based estimate of total 3 × 6 =		18 boxes
Complete enumeration:		19 boxes

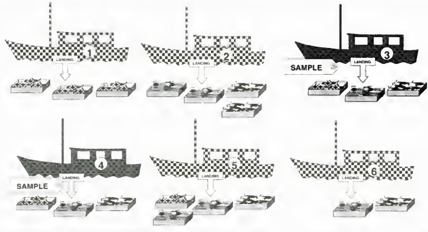


Figure 4.1.1 Illustration of the concepts of "Total enumeration" and "Sample-based estimation". Sampling results in only vessels 3 and 4 being inspected, whereas total enumeration means all vessels are inspected.

The six observed boxes are then "raised" to a total by application of the "raising factor":

Raising factor = (Total number of vessels)/(Number of sampled vessels) = 6/2 = 3.0

The estimated total number of boxes then becomes 3*6 = 18. In this hypothetical case, total enumeration gave the correct number of boxes, whereas the sample approach underestimated the total. In reality, complete enumeration may also give inaccurate results. For example, if some vessels transfer boxes to other vessels at sea so they are not reported, "complete enumeration" would underestimate the total landings. However, unlike sampling, complete enumeration is unlikely to overestimate the catch.

The above example does not account for the duration of the fishing operation of each vessel used to land the boxes. Perhaps vessel 5 landed the double of vessel 6 (see Table 4.1.1) because vessel 5 was fishing for a longer period (see Section 3.1.2).

4.2 GEOGRAPHICAL AND SEASONAL DIVISION OF POPULATIONS

The populations, from which fisheries data are collected, are naturally grouped in several dimensions, such as vessel and landings categories. Some of the divisions can be defined by the designer of the sampling programme. The process of defining divisions and allocation of sampling intensity to divisions of the population is called "stratification". The divisions are called "strata" (see Section 4.3). Other divisions of populations are forced upon the designer of the sampling programme, and that applies to the major divisions in space and time, such as seasons and administrative provinces.

The Government will often request the data to be grouped by the administrative units, primarily by the administrative divisions within a country, for example, by the "provinces" (sometimes called "states"), districts, cities, towns, villages etc.

As living resources, and often fishers, do not keep within provincial or even national borders, the administrative divisions are often in conflict with natural divisions matching the distribution of living resources and fishing fleets. Stocks will disregard administrative borders unless they happen to lie along some natural environmental feature (e.g. a river outflow). In many cases, fishing vessels operate far from the "**home port**" (the place of vessel registration), and therefore use another port as their base for fishing ("**base port**"). However, the administrative units in a country (e.g. province or town) often register fishing vessels, and fishing rights are sometimes linked to the place of registration, which may reduce this problem.

Whereas the administration will naturally group fishing vessels according to their place of registration (home port), the biologist will want to group vessel landings (and thereby also group the vessels) relative to the fishing grounds. Eventually, the biologist will want to group catch data according to which stocks the catch originates from. Stocks are related to fishing grounds, which in turn are more related to landing places and base ports than home ports. The economists and the sociologists, on the other hand, may be less interested in the fish stocks and where the fish were caught, and for many economic, social and technical data, the natural place for data collection is the home port.

A sampling programme with the objective of estimating total catch, has to use the landing places and the base ports as the division of the populations of landings and fishing vessels, and in the following we shall assume that the primary objective is to estimate total landings and discards.

The fishing vessels often change fishing techniques and/or fishing grounds during the year. In the tropics the fishing seasons are usually linked to the monsoon seasons, so it is often convenient to define the start of fishing seasons as different from that of the calendar year. Whether you use already existing geographical and seasonal divisions depends on the objective of the sampling programme. For the estimation of total landings, it will often be preferable not to use the existing divisions:

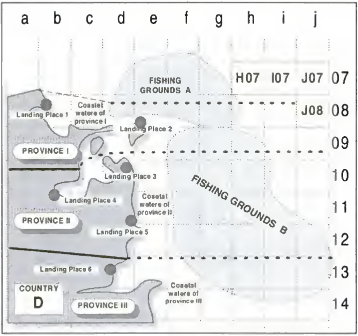
- Rather than using home port, landing places and base ports may be preferable.
- Rather than using provinces, other divisions (such as groups of provinces or sub-divisions of provinces) may be preferable.
- Rather than using months, fishing seasons may be preferable.

However, there are also some advantages to staying with the existing divisions, as many other data will structured according to the administrative divisions (demographic, economic etc.). As a rule of thumb, you should only change the traditional divisions when there is a good reason for it. For example, it may not make any sense to deal with the living resources of a province, where the fish stocks has a larger distribution than the waters of the province in question. Fish stocks may even distribute over the Exclusive Economic Zones (EEZs) of several countries. Landing statistics can be presented both by fishing grounds (often the same as "by stock") and by administrative unit, say "province". To present the statistics by province will usually not be a major problem, as the sampling programme has to structure the data collection according to the landing places anyway.

The coastal waters of a province (or a country) will often be of special interest to politicians, managers and sociologists, as these waters often support traditional (artisanal) fishers and their families. The management instruments for coastal waters may be quite different from those for industrial fisheries. Artisanal fishers are often only able to fish in the coastal waters of their home province, whereas the industrial fishery is much more mobile.

The division of the surface of the earth into degrees of latitude and longitude divides the sea into "rectangles". Fishing grounds are either given as a named area (which can be any area) and/or is defined by a grid reference. The basic spatial concept is the statistical rectangle, defined by latitude and longitude grid. For example, the statistical rectangles could be half degree squares (30' latitude by 30' longitude), that is a total area of 30×30 = 900 square nautical miles (nm^2). Actually, this is correct only for the squares at the equator, as the distance between the lines of longitude gets smaller as they get further from equator.

Figure 4.2.1 summarises the main geographical elements of fisheries data collection by a hypothetical country with its sea areas. The statistical rectangles are usually given names either in a national context or an international context, as illustrated by the four rectangles in the upper right corner of the figure.



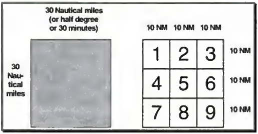


Figure 4.2.1. Illustration of the principal geographical elements of fisheries data collection (hypothetical example). The "Landings places" may also be "Home ports" and/or "Base ports". The grid reference is based on latitude and longitude 30×30 nm squares. These may be further divided into 9 10×10 nm squares (right).

The names of the statistical rectangles, which here are the same as the code, are composed of a letter and a number (Figure 4.2.1). The statistical rectangles may be further subdivided into 9 divisions each of dimension 10×10 nm, with the numbering, 1,2...9, as indicated on the figure. The number "0" indicates the entire 30×30 nm. No real fishing ground fits exactly to the statistical rectangles, but for a number of practical reasons, it is advantageous for the fisheries data collector to adopt the standard system.

The designer of the data collection programme must achieve all the objectives of the sampling programme by covering all the major geographical and seasonal factors. This is not an easy task, as the objectives are often conflicting and funding and manpower are limited. As the optimum solution always involves the particulars of the country in question, it is not possible to give a universal method. Instead, a representative example is given, which it is hoped will lead readers in the right direction as far as their special situation is concerned.

4.3 STRATIFICATION

Resources (manpower and funds) for sampling are almost always limited. Therefore it may not be possible to cover all major landing places in any division (province or group of provinces) of a country. Instead, the landing places are usually categorised, and representatives for each category of landing place selected. Statisticians call this process "stratification".

As an example, consider categories of landing sites defined according to the total landings per year: below 1000 tonnes per year, 1000-2000 tonnes per year etc. To make a first estimate of the total landings of each landing place, we may use a frame survey, and compute the potential catch from the number of vessels in each vessel category. As an alternative, the categories of landing places may also be based on the number of vessels fishing from each place. This will be the only option, if total catches are not known. However, here we assume that some estimate of total landings is available.

The process of defining groups of landing places is the first part of the **stratification**. The stratification is illustrated in Figure 4.3.1. The left-hand side of the figure indicates a coastline with 42 landing places. Four have been categorised as "large landing places", ten as "medium landing places" and 28 as "small landing places". The stratification also involves the selection of landing places to be covered by the sampling programme. The right hand side of Figure 4.3.1 illustrates the sampled population, taken at random from within the groups or **strata**. In this case, it was decided to sample randomly 3 "large", 4 "medium" and 4 "small" landing places.

Estimates of landings from the selected landing places are then raised firstly to the total division of the country by raising factors from the frame survey (or vessel register). If data on total landings are available from the landing places not sampled, we may also use this information in the raising procedure.

4.3.1 Criteria for Strata Selection

Sampling programmes are usually "**stratified**". That means that the "populations" to be sampled are grouped into sub sets or **strata**. This is done simply to reduce sampling costs. Strata and the number of samples they each provide, should be defined according to "Neyman's Criteria" These attempt to optimise the allocation of limited resources (manpower and funds) between the strata. That is, the task is to tell how many samples should be purchased from each stratum, taking into account the cost of obtaining the samples.

As another example, consider the population of a group of fish landed. Let us assume that the task of the sampling programme is to estimate the mean body weight of the fish landed.

Neyman's first criterion is that large samples should be taken from large strata (Figure 4.3.2). We may in this connection think of three parts of the landings, and the largest sample should thus be then from the largest part. If a stratum is large, it represents a larger proportion of the population and its mean value is more representative than that of an inferior stratum. This works in the same way as if there were no stratification.

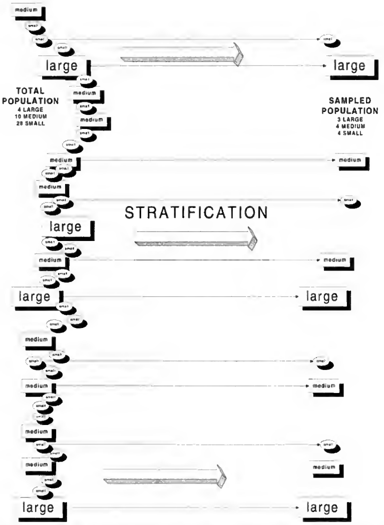


Figure 4.3.1 Illustration of the concepts of "strata" and "stratification" (for further explanation, see text). The left side represents a coast with three categories of landing site to be sampled, large medium and small.

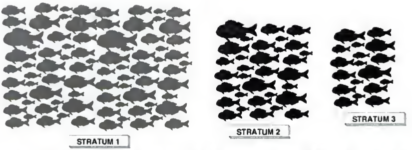


Figure 4.3.2 Neyman's first criterion: large stratum - large sample. The largest sample should be taken from Stratum 1 and the smallest from Stratum 3.

Figure 4.3.3 Neyman's second criterion: large variation - large sample. A larger sample should be taken from Stratum 1 as there is much greater variation in fish sizes. All the fish in Stratum 2 are of the same size, so it would be enough to weigh one single fish, because its weight will equal the mean weight. Stratum 1, on the other hand shows large individual differences, and many individuals must be weighed to achieve a precise estimate of the mean weight.

The second criterion says that more samples should be taken from the stratum containing greater variation (Figure 4.3.3). That the variation within a stratum is large indicates that there is greater uncertainty concerning the mean value for this stratum, and consequently it should become subject to a more examination than the stratum for which there is little uncertainty.

The third Neyman criterion states that large samples should be taken from strata where the sampling is cheap.

The second and third criteria are also used to define strata. Optimum strata minimise variation within them (i.e. maximise variation between strata), and make the most expensive strata as small and as homogeneous as possible. In the fish size example, the most obvious strata are the commercial groups. In other cases, it may not be so simple and some initial random sampling may be required to identify an appropriate stratification.

In defining strata, the definition should be as closely related to the variable of interest as possible. There is no point, for instance, in defining strata based on the first letter of the name of landing places if the sample was to estimate total landings. It would be better to pick the required sample at random from all landing places together. However, there is considerable advantage in stratifying landing sites on fleet composition and nearness to fishing grounds, as these will affect the individual vessel landings at those sites.

In the following example, we consider "the population of landing places" described above. These landing places may be divided according to the total quantity landed per year. Table 4.3.1 shows the number of landing places in the country. Column A gives the definition of landing place category, (or the "strata"), column B gives the number of landing places in each stratum and column C gives the total landings to all places in each stratum. Column D gives the average landings of a landing place. The remaining three columns will be explained below.

Table 4.3.1 "Neyman's allocation" for landing place, based on total catches.

A	B	C	D	E	F	G
					Allocation of samples	
Landing place by size of landings (stratum)	N = Number	Sum of total landings	Average landings	s = Standard Deviation	N*s	% of samples
Less than 1000 t/yr	*378*	*121250*	*321*	*102*	*38459*	*14*
1000 to 2000 t/yr	46	68350	1486	297	13660	5
2000 to 5000 t/yr	66	196436	2976	951	62794	24
5000 to 10000 t/yr	19	138400	7284	2294	43582	16
More than 10000 t/yr	15	249000	16600	7209	108137	41
Total	524	773436			266632	100

Let us say that we have the resources to collect 50 samples. Now the question is how do we allocate these 50 samples to the 5 strata? Neyman's criteria tell us how to solve this problem. But before we can use Neyman's criteria we must compute the "**standard deviations**" for each stratum. The standard deviation is a measure for how much variation there is between the total landings of each landing place within a stratum. If all the landing places have exactly the same total annual landings, the standard deviation would be zero. If they were nearly the same the standard deviation would be small. The larger the variation between total landings the larger the standard deviation becomes. A large standard deviation means that it is difficult to get a true picture about the stratum from a few samples. Calculation of the standard deviation is a simple exercise.

Table 4.3.2 shows three samples (of total catch in a landing place) and illustrates the corresponding standard deviations. Notice that in this example, the standard deviation becomes large when the observations are large (they are approximately proportional to the mean value). This is a feature often observed in fisheries data.

Table 4.3.2 Three examples of standard deviations of ten observations, where the standard deviation is (approximately) proportional to the mean values.

Observation No.	Sample 1	Sample 2	Sample 3
1	5	10	51
2	6	14	72
3	4	9	43
4	5	10	52
5	6	13	66
6	3	7	31
7	4	9	43
8	5	11	56
9	3	6	34
10	4	9	44
Mean value	4.50	10.11	48.63
Standard deviation	1.08	2.35	13.03

Column E in Table 4.3.1 shows the estimated standard deviation of each group of landing places (each stratum). The two first Neyman criteria state that the sample should be large if:

1. The stratum has many members (i.e. values in column B, Table 4.3.1 are large)
2. The stratum has a large standard deviation (i.e. values in column E, Table 4.3.1 are large).

The two criteria are combined by computing the product of "Stratum size" and "Standard deviation" (N*s) (Column F in the table). Eventually the samples are distributed in the same proportions as the "N*s". The percentage of the total possible number of samples to be allocated to each stratum is shown in column G of the table. This is equal to 100 times the **N*s** divided by the sum of the **N*s**.

The results of Table 4.3.1 are depicted in Figure 4.3.4. There are three bars for each stratum. The left most bar indicates the stratum size, the number of landing places. The right most bar indicates the standard deviation of each stratum divided by 100. The middle bar indicates the product of stratum size and standard deviation. Notice that the larger the landings, the larger is the standard deviation. One reason for this is that the difference between any two landing places in the first two strata is limited to 1000 tonnes, whereas for the third stratum the limit is 2000 tonnes, and so on.

The picture observed here is a common result: there are many units in the first stratum, but their standard deviation is small. There are few units in the last stratum, but their standard deviation is large. Although the large landing places are few in number, the standard deviation is so big that most samples are allocated to this stratum (41 %). On the other hand, the small landing places are so many that they cannot be ignored, and according to these criteria, we should allocate 14% of the samples to this stratum.

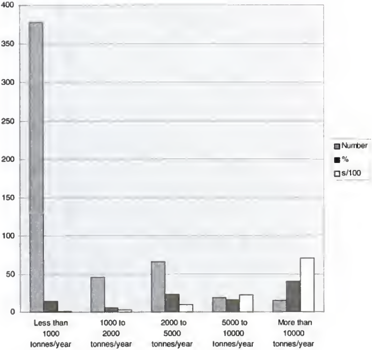


Figure 4.3.4 Illustration of "Neyman's Criteria".

The strata are sometimes forced upon the designer of the data collection programme, and sometimes it is up to the designer to create the strata. Administrative divisions like provinces (or states) of a country is often forced upon the data collection programme, as the government will require the data to be presented by the administrative units. Furthermore, the fisheries institutions involved in the data collection are usually structured by the administrative units. The problem with the administrative units are often that they are not defined to match the distribution of natural resources and the distribution of fishing fleets.

The definitions of fleets, on the other hand is a division where the designer may have a certain freedom to create strata, which match the fisheries. Definitions of fleets are dictated both by the need of the sampling programme, and the needs of the fisheries managers, who are often interested in the performance of the fleets.

4.3.2 Designing Strata

Stratification has two main purposes:

- To optimise the sampling programme.
- To address management and development issues (To be able to answer "what-if-questions", see Section 3.2.3).

The two objectives may be in conflict, but more often, they lead to the same division of the populations.

The solution for the second objective would be to have a very large number of "small" divisions, which could be merged in different ways to meet the request from different "what-if-questions". For example, in one context, you may be interested in the "shrimp trawlers with engines from 25 to 50 HP", in another context you are interested in "deep sea vessels". With a very detailed split-up of the vessels into fleets, you will always be in a position to separate the desired group of vessels.

However, many divisions is in conflict with first objective as all strata must be covered adequately by the sampling programme, and introducing a large number of strata may exhaust the manpower and funding available for data collection.

Stratification in theory is a mathematical exercise along the lines of the Neyman allocation criteria. Stratification in practice is a combination of the theoretical approach and a combination of logistical, political, and administrative factors. The allocation of limited resources of personnel and funding can only be partly solved by the theoretical approach.

Seven types of stratification are considered:

1. Provinces of a country and districts of a province;
2. Landing places;
3. Fleets/gear;
4. Fishing grounds;
5. Commercial groups;
6. Seasons;
7. Fish species.

However, the seven stratification types are not independent. Once stratification on, for example, fleets, is made, it will have implications on the other types of stratification. A purse seine fleet will catch mainly pelagic species, so the stratification on commercial groups, fishing grounds and species will reflect the fact that the catch was made by a purse seine.

One of the most important questions when setting up a sampling programme is "How many samples should be collected?" The more samples collected, the more likely it is that the estimated mean value of the variable is close to the "true value". The "true value" for, say, "the average number of kg landed per day of species X", is the value you would get in case all landings were inspected. Thus, the true value is the result of a complete numeration, without any bias or erroneous reporting.

Figure 4.3.5 shows an example of the confidence limits as a function of the number of samples. The "confidence limits" is here given as the percentage deviation of estimate from true value with a probability of 95%. For example, with 4 samples, there is a 5% chance the mean value will deviate more than 12 % from the true value.

The relative standard deviation 100 × s / (Mean value) is assumed to be 10 % in the example of Figure 4.3.5 where the standard deviation, s, is defined as:

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - Mean)^2}{n}$$

where n = number of samples and $x_i = i^{th}$ observation.

The confidence interval is here computed as: (Mean value) $\pm t_{n-1} * s$, where t_{n-1} is the inverse of the "Student's t-distribution" for $n-1$ degrees of freedom corresponding to the probability 0.05. (For further details, see textbooks on statistical theory and Sparre and Venema 1998).

As can be seen, the confidence limit gets smaller the larger the number of samples, but there are diminishing returns as the sample size gets larger. Thus, little is achieved in terms of increasing confidence after a certain number of samples.

The number of samples which produces a pre-specified confidence interval can thus (in theory) be estimated. As already noted in Chapter 1, this manual does not aim to introduce the mathematical aspects of sampling theory. A reader who wants to go further into these topics is referred to one of the many textbooks on sampling theory (see References in Chapter 8).

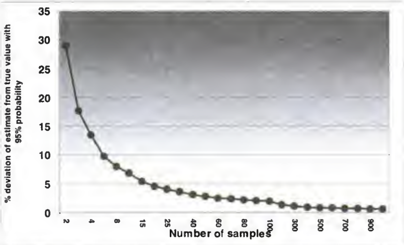


Figure 4.3.5 Hypothetical example of relative 95% confidence limits as a function of number of samples, when relative standard deviation is 10%.

4.3.2.1 Provinces of a Country and Districts of a Province

If the country is divided into administrative units, say provinces, the data collection programme cannot ignore this stratification, although it may not match the distribution of fish stocks and fishing fleets as fish and vessels may cross the province borders.

The resources for data collection may not allow for a complete coverage of all coastal provinces, and in that case, the selected provinces should be representative for the entire coastline. Naturally, following Neyman's criteria, the provinces with the largest production should be given the best cover by the sampling programme, but that is not the only criterion. The leading fisheries provinces may be located at one end of the country, which may deviate in its marine resources and fishery from the other areas of the country. Unless the part of the country with the secondary fishery is very insignificant, it should not be ignored. Logistics, collaboration with local authorities, collaboration with industry, location of fishing companies and processing plants may also make the designers deviate from the Neyman allocation.

The stratification by provinces should be based on the province fisheries profiles (see Section 6.9), and an overall evaluation of the suitability of a province for data collection should be the basis for the allocation of resources. All coastal provinces (or provinces with marine fisheries) must be covered by the sampling programme in one way or another. As a minimum, the vessel registration and/or the frame survey should cover all provinces, to allow for raising of samples to a total (see Section 4.4).

Provinces may be too small to fit to the stocks, the fishing fleets and the limited resources available for data collection. It may therefore be desirable to use groups of provinces rather than the individual provinces as the strata. Provinces are "too small" if the fishing vessels within the group of provinces frequently cross the province borders or even have their main fishery outside the home province (the province of registration).

The grouping of provinces should be chosen so that the migration of fishing vessels is mainly within the groups, and the migration between groups in minimised. Furthermore, the waters of the province groups should not show too much variation in species composition between provinces. The exploited shallow and deep water environments should preferably remain approximately the same within a province stratum. With such a grouping of similar provinces, the samples from vessels within a group can be raised collectively.

Groups of provinces rather than individual provinces may reduce the cost of data collection. Some provinces are considered well represented by other provinces, and only the landing places of representative provinces are covered by the interview sampling programme. If the vessels move between the landing places irrespectively of the provincial borders, vessels from all provinces will be sampled, even if some home-provinces are not sampled.

Table 4.3.3 illustrates the concept of "vessel migration". In this case, it is assumed that the programme has covered all provinces and that all landings during a certain period have been recorded. In this case there are 10 provinces, all of which can be both "home province" (province of registration) and "base province". As can be seen the vessels do not move away from the homeport in a random manner. A vessel from Province 6 is more likely to use Provinces 4 to 8 (group B) than Provinces 1-3 (group A) or Provinces 9-10 (group C). With the grouping of the 10 provinces into three Divisions A, B and C there is still some migration between groups, but the major migration is within the groups.

Table 4.3.3 Number of landings by base port and homeport. (*) Indicates provinces selected to represent group A, B and C respectively (for further explanation, see text).

Division		PROVINCE USED AS BASE FOR FISHING									
of country		A			B					C	
	HOME PROVINCE	Prov.1	Prov.2 (*)	Prov.3	Prov.4	Prov.5 (*)	Prov.6	Prov.7	Prov.8 (*)	Prov.9 (*)	Prov. 10
A	Province 1	92	80	40	8	3	2	3	2	0	1
A	Province 2	76	90	76	7	8	4	2	0	1	0
A	Province 3	30	76	99	16	6	8	3	3	2	1
B	Province 4	8	6	16	46	40	17	20	11	3	2
B	Province 5	3	8	6	37	48	45	14	20	3	1
B	Province 6	1	3	8	17	41	48	45	16	7	4
B	Province 7	2	1	4	20	18	37	47	37	6	8
B	Province 8	1	0	2	10	19	14	40	49	16	7
C	Province 9	2	0	3	2	5	8	6	16	96	83
C	Province 10	1	0	0	0	2	2	7	6	79	92

Table 4.3.4 Migration of vessels. Summary of Table 4.3.3.

Total in %	Division A	Division B	Division C
Division A	**32.5**	3.7	0.3
Division B	3.4	**37.0**	2.8
Division C	0.3	2.6	**17.3**

Table 4.3.4 summarises the migration patterns for the 3 groups of provinces. The table shows the percentage of landings by Division. If the 10 provinces have to be divided into three groups, then the grouping shown in Table 4.3.4 is best. What has been said about provinces of a country applies as well to the districts of a province, except the migration between districts is likely to be more pronounced.

4.3.2.2 Landing Place

Usually, it will not be possible to cover all landing places within a province or a district and representative landing places must be selected for sampling. The Neyman criteria cannot usually be applied directly, but must be combined with a number of features of the landing place:

1. Type of fishery (fleets) of the landing place;
2. Type of landings to the landing place (for example, only fish, only pelagic fish, only cephalopods, all categories of landings, etc.);
3. Number of vessels by fleet (size of stratum);
4. Total landings by commercial group (size of stratum);
5. Seasonality of fishing (when should many samples and when should few samples be taken?);
6. Buyers system (is it easy to access the files of buyers?);
7. Type of landing place (quay, jetty, beach, cold store);
8. Distance from local office of fisheries department and cost of transport;
9. Collaboration with local authority (local fisheries department, coast guard etc.);
10. Collaboration with local fishers and (if applicable) their association;
11. Availability of local enumerator(s);
12. Practical conditions for sampling (problems in getting access to the vessels and the fishers).

The list is not complete. The final selection of landing places to cover, however, should primarily be made so that the principles of Neyman are adhered to as far as possible.

4.3.2.3 Fleets/Gear

The stratification of fleets is important not only for the data collection, but also for the subsequent use of the database. The fisheries managers and developers will often ask questions related to fleets, but these will be limited by the fleet stratification. Questions asked on categories within strata may not be answerable.

From the point of view of flexibility of the database, it is desirable to have as many fleets as possible, but from the view of funding and manpower, the number should be as small as possible. Thus, the choice of fleet stratification will become a compromise between these two conflicting objectives. The following features of fleets should be considered:

1. Number of vessel in the fleets;
2. Total production by value and weight by the fleet relative to the total fishery;
3. The existing artisanal and industrial vessels of the country;
4. Type of vessel;
5. Horsepower of engine;
6. Dimensions (length, depth, width);
7. Gear(s);
8. Electronic equipment;
9. Primary fishing grounds of the fleet;
10. Home port(s) of fleets;
11. Base port(s) of the fleet;
12. Target species of fleet;
13. Fishing Seasons of fleet;
14. Ownership of vessels;
15. Legal basis (license agreement);
16. Value of vessel;
17. Crew size;
18. Nationality of vessel (national/joint venture);
19. Prospects for further investment in fleet;
20. Requests from decision makers (politicians, managers, developers);
21. Special scientific requests;
22. Practical problems in recognising that a vessel belongs to the fleet.

In practice, the most obvious definition of fleets uses the three features:

a) Horsepower of engine;

b) Gear(s);

c) Type of vessel .

If a vessel register is available and sampling is random, it may be possible to make a "post-stratification" of the fleets. In that case, the sampled vessels can be divided in all the ways the data in the vessel register allows for. That may leave some strata with very few samples. In general, a vessel register facilitates the flexibility for re-definition of fleets.

4.3.2.4 Fishing Grounds

Fishing grounds are to a large degree determined by the fleet stratification. There may, however, be cases where a fleet exploits two or more different fishing grounds, and if the difference is significant, stratification could be made on fishing grounds according to Neyman's criteria.

If catches are also given by position (Latitude, Longitude) or statistical rectangles (see Section 4.2), the flexibility for post-stratification is improved. If recording by statistical rectangles or positions is common, it is advisable to define the fishing grounds by the statistical rectangles (or divisions) they cover.

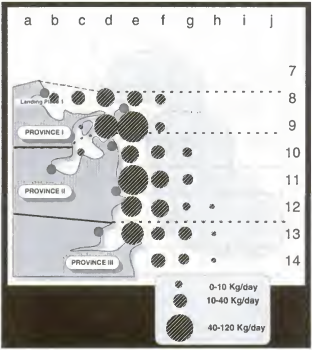


Figure 4.3.6 Abundance of living resources depicted as catch per day by statistical rectangle.

An important feature of a fishing ground is the water depth. Stratification of landings by depth-zone is often adequate, as the distribution of resources is strongly related by water depth. Within a species it is often observed that that the size distribution is dependent on depth, so that the deeper the water, the larger the specimens observed. In addition, the average size of fishing vessels is often related to depth.

The habitat or the bottom type may be important. For example, coral reefs are different from, say, trawling grounds in many respects. Species compositions as well as fishing techniques are specific for coral reefs.

Political issues may also influence the geographical stratification. For example, an EEZ (Exclusive Economic Zone) boundary going across a fishing ground will naturally lead to a geographical stratification, which is not related to the living resources. Nevertheless, this division must be established, unless there is an agreement between countries about equal rights to fish in each other's waters. Often the distance from the coastline is used to define fishing rights, and a stratification of say, 0-10 nm, 11-20 nm, 20-50 nm, 50-200 nm from the coast line may be required to address certain management issues.

Perhaps the most commonly raised question by managers is that of "boxes". Boxes are selected areas where a restriction on fishing is imposed, sometimes by species. Examples are a complete ban on fishing, seasonal ban on fishing, ban on fishing with certain gears, etc. In order to be able to provide advice on where to place such boxes, or the effect of an existing box, the catch by area is required, such as catch by statistical rectangle.

Catch by position or statistical rectangle will allow for the use of GIS (Geographical Information Systems), for example, to produce maps showing the distribution of resources and fishing fleets (Figure 4.3.6).

4.3.2.5 Commercial Groups

The division of landings into commercial groups is in some areas (even regions) standardised, and the commercial groups remain more or less constant from fleet to fleet and from landing place to landing place. The commercial groups will also remain fixed during the year. The commercial groups are in these cases usually fixed by legislation, international agreements and are compulsory. Under these circumstances, the designers of the data collection programme have no options but the prevailing standards. This is usually a great advantage for the sampling programme, as the fishers will be forced to sort the landings in a unique way, which will facilitate the processing of data.

However, this ideal situation usually applies to temperate waters, where the species diversity is small relative to tropical waters. In tropical countries, the commercial groups are often highly variable, and may depend on the fleet, the buyer, the season and the landings place. Often catches are divided into "Small", "Medium" and "Large", but the definition of the three groups depends on the individual fisher who sorts the catch. Therefore, the groups may change during the year. Shrimp grades and some cephalopod grades for export are determined by the world market and therefore standardised.

The commercial groups may not only relate to species and size, but also to the treatment of the landings. High quality (well preserved) fish landed shortly after catching, may fetch a much higher price on the export market than low quality fish sold on the domestic market. Even if they are the same species and size, allocating them to the same commercial group may compromise the bio-economic analysis.

In general, apart from the aspects of limited resources for data collection, the commercial groups should be selected so that they reflect:

1. Commercial importance
2. Ecological importance
3. Selected species for fish stock assessment

The commercial groups selected by designers of the data collection programme are either the commercial groups used by fishers and merchants or they are formed by merging these groups. There is usually no option to choose alternative groups by the time the catch is landed.

All weights by commercial groups should be in units of whole wet body weight. For example, weight of dried squid, should be converted into whole wet weight. The data entered in the database should be the dried weight, together with an indication that this is "dried weight". The conversion is then done by the database system. As a matter of principle, the data entered in the computer should always be the "raw" data, not processed data.

4.3.2.6 Seasons

The stratification of seasons is to a high degree determined by the fleet stratification and vice versa. The fleet definition usually involves accounting for seasonality.

The tropical monsoon will in most countries provide the natural stratification over seasons. Often, two or three seasons during the year will be sufficient to guarantee approximately homogenous fishing within a province. One season is most often that of rough weather. The species composition of catches, the fishing grounds and the gears used may change between seasons. Data will often be structured by month, and in case the coverage by samples is complete for each month (or week), the raising of samples can be made for periods shorter than the fishing seasons.

4.3.2.7 Species (Stock)

Biological data for individual species are usually intended for stock assessment. In practice, "management units" form the basis for sampling (See Sections 2.3 and 3.2).

Traditional stock assessment methods, like cohort analysis and VPA, use length distribution or age distribution of the entire catch from the stock as the primary input (see Section 3.2). Some of the most commonly collected biological (stock specific) data are:

1. Length frequency data;
2. Age frequency data;
3. Length/weight data;
4. Sex distribution;
5. Maturity stage;
6. Condition factor (flesh fat content);
7. Stomach content data;
8. Data for stock identification (e.g. meristic characters);
9. Special measurements of economic interest (swim bladder, shark fins etc.).

In addition to cohort analysis, the traditional stock related analyses are: (a) Estimation of growth parameters (b) Estimation of spawning seasons (c) Maturity ogive (percentage mature as a function of age) (d) Estimation of natural mortality. Combined with spatial data, the above data may also be used for estimation of migration routes, spawning grounds, nursery grounds, distribution by depth zone, etc.

Table 4.3.5 An example of selection of a species for a VPA. The example is from the sampling programme in Viet Nam 1996-7. In this case, the resources available for sampling limited the programme to only 23 sampling units (19 species, and for the 4 shrimp species by sex). Data on some of the species were collected only in certain parts of the country.

	Species group	Number of sampling units
1	Large pelagic fish species	2
2	Small pelagic fish species	3
3	Large demersal fish species	2
4	Small demersal species	3
5	Shrimp species (by sex)	8
6	Cephalopod species	3
7	Other invertebrates (e.g. crabs, lobsters, gastropods and/or bivalves)	2
	Total number of units to sample	**23**

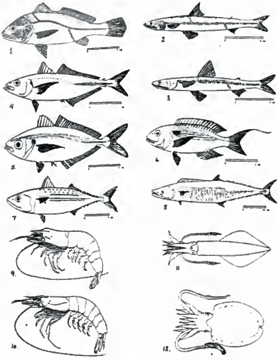


Figure 4.3.7 Example of the selection of species for biological sampling (from Viet Nam, 1996-97).

It is usually not possible to collect data for fish stock assessment from all species of commercial interest in the waters of a tropical country, due to limited personnel and funds. A limited number of species has to be selected as representatives for the entire living resources. The selection of representative species must account for both the ecological and economic importance of the species, that is, large stock size (potential yield) and high price per kg should be the criteria for biological sampling.

The selected species should also be reasonably abundant to secure the availability of continuous samples of reasonable size. It is the author's experience that regular sampling of biological data from more than 20 species was rare in the tropical East Asian countries. In particular, it is costly to buy samples of shrimps even if the samples are resold after the measurement. If possible the data for shrimps should be obtained from processing plants (see Section 5.4).

The sample size needed for modal progression analysis (leading to estimation of growth parameters and cohort analysis, see Section 3.2) is a question often raised. Unfortunately, the author is not aware of an objective method to determine the optimum sample size. The sample size depends on the number of age groups (cohorts) to identify (see Section 3.2.2). The more age groups you try to identify, the larger the sample size needed. For shrimps or squid, for example, with a short life span (one year), there will be only one or two cohorts represented in a sample, and the sample size need not be large, say 200-500 specimens per month. For a long-lived species like grouper (life span of 10 or more years) you may need 2000-5000 specimens per sample. These numbers are based on the experience of the author trying to separate length distributions into cohorts.

The separation into stocks is often very problematic. Even for stocks in non-tropical waters with relatively few species, stock separation is often difficult. Tropical stocks may in theory be separated by the same methods as used in cold waters, such as comparison of meristic characters (for example, size and position of fins and other body parts), number of vertebrae, blood type, parasites, etc. However, these kinds of data collection may well exceed the capacity of the resources of a developing tropical country. Also collection of stomach content data to be used for, for example, the multi-species VPA, where predation mortality is estimated from stomach content of predators, may exceed the sampling capacity. Maturity data, spawning grounds and migration routes, however, are often within the reach of the budget.

4.4 RAISING SAMPLES TO TOTALS

Estimating totals from samples is a basic use of data. The methodology of raising is closely linked to the hierarchy of stratification. The stratification at each level, from the single trip interview to the estimate of total landings of the country, should be designed to make the raising from one level to the next level possible and dependable. There are usually a number of different options available for raising the samples to totals as will be demonstrated by the examples in this section. There is no universal methodology, which will lead to the best estimate in all cases. The elements of methodology given here should be considered examples. These examples should be sufficiently representative to cover most actual cases.

Some raising procedures are based on a rational methodology, where the raising factors can be estimated from observations. This applies to the well-defined strata. However, not all strata are well defined. Usually there is an "Other strata". We may for example have the gear-strata "Trawl", "Gillnet", "Purse seine", "Lines" and "Other Gears".

Very often, this "other group" is not sampled, because it represents a large group of rare gears. Thus, when raising from "Trawl", "Gillnet", "Purse seine", "Lines" to total fishery, we may be in the situation that the raising factor has to be "guessed", that is based on a combination of general knowledge and common sense. Needless to say, the stratification should be designed to minimise the uncertainty from the "Other Strata".

4.4.1 Principles of Raising

The basic principle of raising interview samples is illustrated by Figure 4.4.1.

If interviews containing information about the catch (or landings) per day can be combined with information on total effort and activity, a simple multiplication should provide the estimate of the total catch (or landings). If other effort measures (see Section 3.1.2) are available, they may replace the "fishing days", which may improve the estimation of total landings.

Figure 4.4.2 elaborates on the content of the three boxes in Figure 4.4.1. The samples (the interviews) contain information on the landings and the duration of the fishing trips. In addition, the fishers are requested to tell about their recent level of activity, that is, the number of days they were actively fishing during last month. This allows for the estimation of the monthly catch of one vessel by:

(Catch of vessel / month) = (Catch / fishing day / vessel) × (fishing days / month)

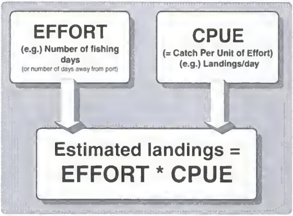


Figure 4.4.1 Raising of catch per unit of effort to total catches.

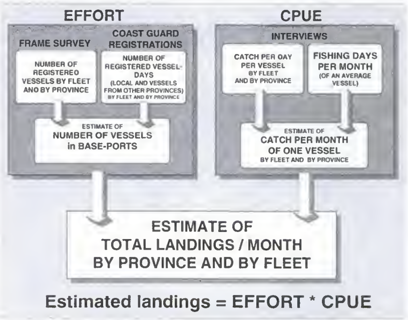


Figure 4.4.2 Further details on the estimation of total landings expanding Figure 4.4.1

If only vessels are considered that are very similar (i.e. vessels belonging to the same fleet) then we can assume that all vessels have approximately the same catch. If we know the number of vessels in the fleet, then the catch of the fleet can be estimated from:

(Catch of fleet in a month) = (Catch of one vessel in a month) × (Number of vessels in fleet)

Note that the "(Catch of one vessel in a month)" means the "average catch" of the sampled vessels.

The "number of vessels" is the number of vessels fishing from the province in question. Here, the "province" is used as an example of a geographical stratum. The "number of vessels" includes the local vessels as well as the vessels from other provinces. If a vessel remains the entire month in the province, then it is counted as one vessel. If it remains in the province a certain fraction of the month then it is counted as that fraction. Often, the number of days registered as fishing from a province should be available from the coast guard, the harbour police or some other local authority. In each fishing port, the appropriate local authority should register the visiting vessels from other provinces, identifying their base port. In the following, we shall refer to the local authority, which records the arrival and departure of non-local vessels, as the "coast guard".

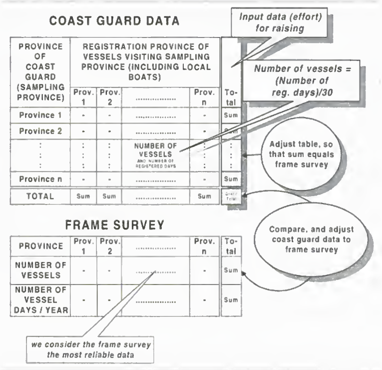


Figure 4.4.3 Estimation of number of (active) vessels from coast guard data and frame survey.

If, however, there is a suspicion that the "coast guard" does not register all vessels, the coast guard registrations should be supplemented by independent data collection. Frame survey data can be used for that purpose. As explained earlier, the frame survey provides a list of the number of vessels registered in each province by fleet. If the frame survey is correct, and the registrations recorded by the "coast guard" are representative for all vessels (also those not registered with the coast guard), then it is possible to use the incomplete "coast guard" data to allocate the fishing fleets to provinces of the country. The principles for this estimation procedure are illustrated in Figure 4.4.3.

The "coast guard" may not regularly record the fishing days, but they should, as a minimum, record the number of days the vessel is registered in the harbour under the jurisdiction of the coast guard station in question. They should record the registration number of the vessel, when it registered and the number of days it plans to register at the port. If a vessel registers for two weeks and then decides to stay another two weeks, there will be two registrations in the file of the coast guard. However, for the calculations, this does not matter, as such a vessel would appear as two half vessels.

The frame survey may also be used to collect information on the annual fishing activity (i.e. the number of days fishing during the year). This information, if available, may be used for estimation of the number of active vessels, rather than just the number of vessels. With these data, it should be possible to improve the estimate of total effort, but the procedure for allocation of effort to provinces (or landing places) remains the same.

4.4.2 Raising to Trip Total

The catch (or landings) information contained in an interview form has three hierarchical levels of samples and sub-samples. Figure 4.4.4 presents a hypothetical example, with three commercial groups and three species represented in each commercial group. The recording on an interview form represents a "fishing trip" (see Chapter 5 for an example of a trip-interview form).

The first level is the recording of the total weight of the landings from a commercial group. **W(t,cg)** is the total weight of commercial group "***cg***" of fishing trip "***t***" (see list of symbols below). Thus the total landings of trip "***t***" is the sum over commercial groups, Σ_{cg} ***W(t,cg)***. From each commercial group, the enumerator may take a subsample to estimate the species composition. The weight of this subsample is denoted ***WS(t,cg)***.

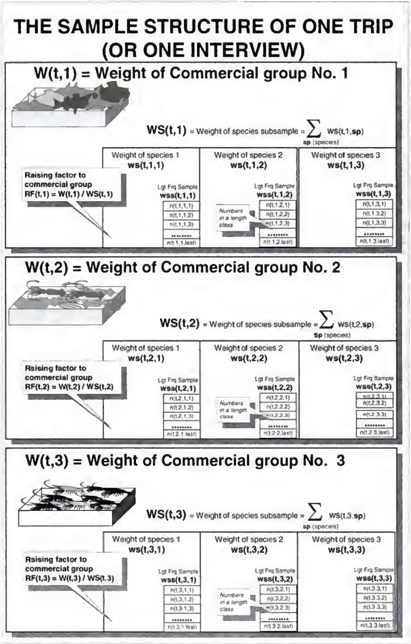


Figure 4.4.4 The sample hierarchy of a trip (or interview) sample.

List of symbols used for the trip data:	
cg	= index of commercial group
sp	= index of species
lc	= index of length class (body length interval)
t	= index of time (date)
W(t,cg)	= weight of commercial group cg landed from trip t
WS(t,cg)	= weight of species composition sample from commercial group cg landed from trip t
ws(t,cg,sp)	= weight of species sp in the sample from commercial group cg landed from trip t
wss(t,cg,sp)	= weight of a subsample of species sp in the sample from commercial group cg landed from trip t
n(t,cg,sp,lc)	= frequency of length group lc of species sp in the sample from commercial group cg landed from trip t
RF(t,cg)	= W(t,cg) / WS(t,cg), Raising Factor for species composition sample
RFL(t,cg,sp)	= W(t,cg) / wss(t,cg,sp), Raising Factor for length frequency sample

The weight of species "*sp*" in the sample is denoted "*ws(t,cg,sp)*", and thus,

$$WS(t,cg) = \Sigma_{cg}\ ws(t,cg,sp).$$

The weight of a species in the sub-sample is raised to the total commercial group by the raising factor

$$RF(t,cg) = W(t,cg)\ /\ WS(t,cg).$$

That is, the estimate for the total weight of species "*sp*" landed in commercial group "*cg*", becomes:

(Total weight of species "*sp*" in commercial group *cg*) = *RF(t,cg)* × *ws(t,cg,sp)*

From the species composition sample, the enumerator may take a sub-subsample, for length frequency. Length frequency samples will be taken only for a limited number of selected species. Here it is assumed (as an example) that the length frequencies are used for VPA (Virtual Population Analysis). In the following, we shall refer to the species selected for length frequency sampling as the "VPA species".

The weight of the length frequency sample from species "*sp*" in commercial group "*cg*", is denoted ***wss(t,cg,sp)***. The number of specimens "*sp*", in length class "*lc*", (or the length frequency) is called ***n(t,cg,sp,lc)***.

This number is raised to the total commercial groups by the raising factor :

$$RFL(t,cg,sp) = W(t,cg)\ /\ wss(t,cg,sp):$$

(Total number of specimens, species "*sp*" in length class "*lc*", in commercial group "*cg*") =

$$RFL(t,cg,sp) \times n(t,cg,sp,lc)$$

4.4.3 Raising to Total of a Province (Geographical Stratum)

The raising of trip records from one fleet to the total province is illustrated by Figure 4.4.5. The "province" is here used as an example of a geographical stratum.

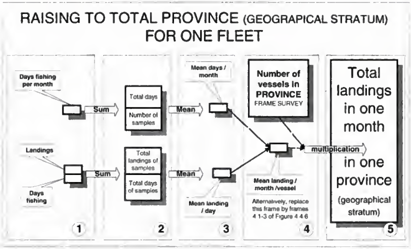


Figure 4.4.5 Raising to total province (geographical stratum) for one fleet.

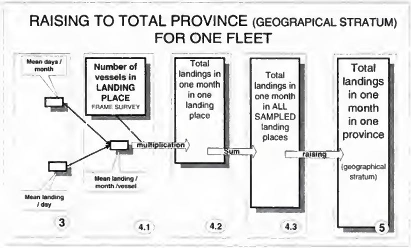


Figure 4.4.6 Additional steps in the raising to total province (geographical stratum). Extension of Figure 4.4.5.

The recording of the fishing activity (number of fishing days last month) and the catch and number of fishing days is summed over all sampled trips (the two leftmost frames in Figure 4.4.5). The third frame indicates the calculation of the mean value of activity level and catch per day. Combining the catch per day and the activity level, provides an estimate for the average catch during the month of one vessel in the fleet in question. Multiplying the catch per month per vessel by the number of vessels gives the estimate of the total catch of the province.

The raising procedure may contain some more steps, as it might be natural first to compute the total catch of a landing place and then sum the landing places within the province. These steps would replace frame 4 of Figure 4.4.5 with three steps (4.1, 4.2, 4.3) as illustrated by Figure 4.4.6.

4.4.4 Raising to Total Country

The raising of samples to the total for the country can follow several structures in the fishing sector. Two alternative structures to follow in the raising procedure are discussed in this section, namely the "province-structured raising" and the "fleet-structured raising". Which alternative to select depends on which structure provides the most homogeneous strata. If the fleets can be defined for the entire country, the fleet-structured raising may be preferable, whereas if the fleets are province specific, the province structure is preferred. Again, the "province" is used as an example of a geographical stratum.

Figure 4.4.7 illustrates raising from one fleet in one province (or a landing place) to the total country landings using the province-structured raising. As mentioned in the foregoing section, the raising may start with the total landings of a landing place (case B) or the total landings of a province (case A). In case of A, we "bypass" the landing place level and start the calculation at the province level. That may be the approach for very small provinces, but most often case B should apply. In case B, the raising is made on the landing place level and then the landing places are summed. It is not possible to give a universal rule for the procedure, as the choice will depend very much on the local conditions.

The raisings described here from the sampled part to the whole population. The raising factors from the sampled fleets to the total set of fleets is expected to be close to 1, as the programme should sample all major fleets. The raising in some cases may have to account for an "other-group", that is, a heterogeneous group which is difficult to sample, and for which only some less quantifiable knowledge is available. This type of "less quantifiable knowledge" could be that it is "rather insignificant" at most 2% of the total, and we may then apply the raising factor 1.015 as the best "guesstimate". The raising arrows in Figure 4.4.8 marked by an asterisk (*) indicates a raising from "all sampled units" to "all sampled units + other units". When not marked, the raising can be made based on quantitative observations, for example the "number of vessels", which would be calculated as:

RAISING FACTOR = (TOTAL NUMBER OF VESSELS)/(NUMBER OF VESSELS IN PROVINCES SAMPLED BY THE PROGRAMME)

Figure 4.4.8 illustrates the "fleet-structured raising". In this case, the raising is made within the fleets until the very last step, where the "other fleets" are accounted for. In the "province-structured raising" the raising to "all fleets" either took place at the province level (Case A in Figure 4.4.8) or at the landing place level (Case B). The "province" is included in the steps to account for provinces not covered by the sampling programme, but differences between fleets in the provinces are ignored.

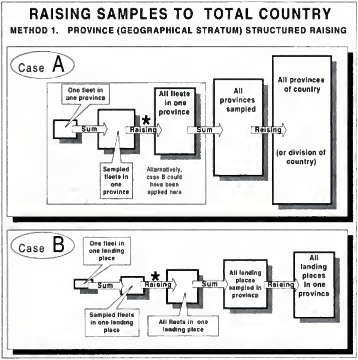


Figure 4.4.7 Raising samples to the country total landings using "province-structured raising". The raising arrows marked by an asterisk (*) indicate a raising from "all sampled units" to "all sampled units + other units".

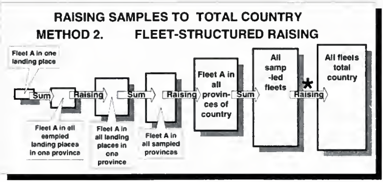


Figure 4.4.8 Raising samples to the total country landings using "fleet-structured raising". The raising arrow marked by an asterisk (*) indicates a raising from "all sampled units" to "all sampled units + other units".

4.4.5 Example to Illustrate the Raising Procedures

Two sets of tables (Tables 4.4.1 and 4.4.2) present a hypothetical example to illustrate the raising procedures in the foregoing sections. Table 4.4.1 (Sub-Tables a to k) illustrates Method 1: "the province-structured raising" and Table 4.4.2 (Sub-Tables a to i) Method 2: ".the "Fleet-structured raising"

The example deals with three species, all of which occur in two commercial groups. This example is perhaps not realistic, but covers most cases that may be met, although they are unlikely to occur all at the same time. The examples are constructed using spreadsheet software.

The first part of Table 4.4.1 (Sub-Tables a-e) refers to the vessels of a single fleet in a single province. As an example, we consider the period of one month. In practice, this period may well be a quarter of the year or half a year or it may be a fishing season.

The table starts by illustrating the raising of an interview sample to total trip, where species composition and length frequency samples have been collected. Sub-Table a illustrates the summation of commercial groups (resulting in Sub-Table c) and the raising of species composition samples to total landings of one trip by commercial group. It also illustrates the raising of length frequencies to total trip.

Sub-Table b contains the activity levels (here exprsssed in number of days fished per month, D) and the "coast guard data", that is, the number of days registered in the base port (DR). As this example deals with the month of January, DR/31 is the fraction of the month the fishing vessel was registered in the base port, and consequently, D*DR/31 is the number of days fishing from the base-port during the month. The activities are also based on samples. Here three samples are taken from fleet A and four samples are taken from fleet B. From the samples, the average number of fishing days/vessel during the month can be estimated. This average number of days combined with the number of vessels by fleet is usually collected by the "Frame survey". The total number of vessels by fleet will be introduced later in the raising process.

Sub-Table c contains the landings by species, because the weight of species is summed over commercial groups. The table illustrates the summation of sampled trips, here exemplified by the sum of two trips.

Sub-Table d contains the sum of sampled trips from Sub-Table c, and Sub-Table e contains the mean catch per day derived from Sub-Table c divided by the total number of days Sub table c represents.

Combining the average landings per day with the number of vessels fishing from the base port during the month (not necessarily the entire month) gives an estimate of the total landings by the fleet during the month. This is illustrated by Sub-Table f, which now contains two fleets A and B, and fleet B has been given the same processing as fleet A. We assume in the present example that only fleets A and B have been sampled. The sum of fleets A and B thus represents the total landings by sampled fleets (Su-table g).

Sub-Table h illustrates the raising from "Sampled fleets" to "All fleets" in province A. This is where "Other fleets" are accounted for. Sub-Table h contains two provinces (A and B) and we assume that these provinces are the only ones sampled. The sum of sampled provinces, illustrated by Sub-Table i, represents all landings (i.e. all fleets) combined, and therefore the following summations and raisings are not fleet-specific. This is the reason for calling the method of Table 4.4.1 the "province-structured raising".

Sub-Table j illustrates the raising from "sampled provinces" to all "Provinces". This raising may be based on observations from earlier years, when these provinces might have been sampled to estimate the relative size of the landings. The raising may be of the same questionable character as the accounting for "other fleets" if little is known about the non-sampled provinces. Other data may be available which can give the relative size of the non-sampled provinces. Such data may be the number of fishers, the total income from fisheries, the income from export of fisheries products, the investments in the fishing sectors of the province, etc. The relative size of the fishery may also be derived from the number of vessels, but then we are in the "fleet-structured raising", which is illustrated by Table 4.4.2.

TABLE 4.4.1 EXAMPLE TO ILLUSTRATE METHOD 1: THE PROVINCE-STRUCTURED RAISING PROCEDURE

Sub-Table A: Data from one Trip, by Commercial Group, Fleet A

ONE FISHING TRIP PROVINCE A MONTH 1 (January)
FLEET A TRIP 1

DIRECT OBSERVATIONS								PROCESSED DATA			
Index of Comm. Group cg	*Weight of Comm. Group W(t,cg) kg*	*Weight of Spec. Comm. Sample WC(cg) kg*	*Index of species* sp	*Weight of species ws(t,cg-,sp)*	*Weight of Length Frq. Sub-sample Wss(t,cg,sp)*	*Index of length class* lc	*Length Frequency (number) n(t,cg,sp,lc)*	*Raising factor to comm. gr. Species sample RF(t,cg) a)*	*Weight of species raised to total comm. gr b)*	*Raising factor to comm. gr. Length frq. sample RFL(t,cg,lc)*	*Length Frq. raised to total comm. group d)*
cg = 1	136	17	*sp = 1*	6	2	*lc = 1*	25	8.00	48	68	1700.0
						lc = 2	20				1360.0
						lc = 3	1				68.0
			sp = 2	7	4	*lc = 1*	15		56	34	510.0
						lc = 2	7				238.0
						lc = 3	0				0.0
			sp = 3	4	1	*lc = 1*	13		32	136	1768.0
						lc = 2	8				1088.0
						lc = 3	2				272.0
			Total	17			Total		136		
cg = 2	483	23	*sp = 1*	8	4.5	*lc = 1*	2	21.00	168	30.2	60.4
						lc = 2	13				392.9
						lc = 3	23				695.1
			sp = 2	9	5.7	*lc = 1*	1		189	23.9	23.9
						lc = 2	8				190.9
						lc = 3	18				429.5
			sp = 3	6	3.8	*lc = 1*	2		126	35.8	71.6
						lc = 2	17				608.4
						lc = 3	23				823.2
			Total	23				Total	483		

a) Raising factor for species composition sample, RF(t,cg) = W(t,cg)/WC(cg)
b) = ws(t,cg,sp)*RF(t,cg)
c) Raising factor for length frequency sample, RFL(t,cg) = W(t,cg)/wss(t,cg,sp)
d) = n(t,cg,sp,lc)*RFL(t,cg)

TABLE 4.4.1 (CONTINUED) EXAMPLE TO ILLUSTRATE METHOD 1: THE PROVINCE-STRUCTURED RAISING PROCEDURE

Sub-Table B: Activity Data and Days Registered in Port, Fleets A and B

ACTIVITY LEVEL		FLEET A	
Sampled Vessel No.	Number of active days during month D(A)	Number of days registered in base port DR(A)	Number of active days in base port D(A)*DR(A)/31
1	16	15	7.74
2	19	31	19.00
3	17	20	10.97
		Average	12.57

ACTIVITY LEVEL		FLEET B	
Sampled Vessel No.	Number of active days during month D(B)	Number of days registered in base port DR(B)	Number of active days in base port D(B)*DR(B)/31
1	18	15	7.74
2	19	31	19.00
3	21	31	21.00
4	17	15	8.23
		Average	13.99

Sub-Table c. Species Composition and Length Frequencies for two Trips (summed over Commercial Groups)

FLEET A TOTAL FOR TRIP 1:

PROVINCE A NUMBER OF DAYS = 7

MONTH 1 (JANUARY)

Species	Total Landings a)	*Length Class*	Total Length Frequency a)
Species 1	216	*lc = 1*	1760.4
sp = 1		*lc = 2*	1752.9
		lc = 3	763.1
Species 2	245	*lc = 1*	533.9
sp = 2		*lc = 2*	428.9
		lc = 3	429.5
Species 3	158	*lc = 1*	1839.6
sp = 3		*lc = 2*	1696.4
		lc = 3	1095.2
Total	619		

FLEET A TOTAL FOR TRIP 2:

PROVINCE A NUMBER OF DAYS = 11

MONTH 1 (JANUARY)

Species	Total Landings a)	*Length Class*	Total Length Freq. a)
Species 1	405	*lc = 1*	1201.0
sp = 1		*lc = 2*	1617.0
		lc = 3	8035.0
Species 2	371	*lc = 1*	709.0
sp = 2		*lc = 2*	1105.0
		lc = 3	1571.0
Species 3	641	*lc = 1*	1742.0
sp = 3		*lc = 2*	1531.0
		lc = 3	978.0
Total	1417		

a) sum over commercial groups

TABLE 4.4.1 (CONTINUED) EXAMPLE TO ILLUSTRATE METHOD 1: THE PROVINCE-STRUCTURED RAISING PROCEDURE.

Sub-Table D Summation over Sampled Trips

FLEET A TOTAL FOR ALL SAMPLED TRIPS
PROVINCE A TOTAL NUMBER OF DAYS =18
MONTH 1 (JANUARY)

Species	Total Landings	*Length Class*	Total Length Frequency
Species 1 *sp = 1*	621	*lc = 1*	2961.4
		lc = 2	3369.9
		lc = 3	8798.1
Species 2 *sp = 2*	616	*lc = 1*	1242.9
		lc = 2	1533.9
		lc = 3	2000.5
Species 3 *sp = 3*	799	*lc = 1*	3581.6
		lc = 2	3227.4
		lc = 3	2073.2
Total	2036		

Sub-Table e Average (per Day) over sampled Trips.

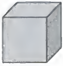
FLEET A **Average / day for all sampled trips**
PROVINCE A **Divide by 18 (total number of days)**
MONTH 1 (JANUARY)

Species	Total Landings	*Length Class*	Total Length Frequency
Species 1 *sp = 1*	34.5	*lc = 1*	164.5
		lc = 2	187.2
		lc = 3	488.8
Species 2 *sp = 2*	34.2	*lc = 1*	69.0
		lc = 2	85.2
		lc = 3	111.1
Species 3 *sp = 3*	44.4	*lc = 1*	199.0
		lc = 2	179.3
		lc = 3	115.2
Total	113.1		

TABLE 4.4.1 (CONTINUED) EXAMPLE TO ILLUSTRATE METHOD 1: THE PROVINCE-STRUCTURED RAISING PROCEDURE.

Sub-Table F Raising to Total Fleet of Province A for two Sampled Fleets

FLEET A **TOTAL OF FLEET A**
PROVINCE A **Number of vessels = 157**
MONTH 1 (JANUARY)
Mean Number of active days/vessel = 12.57



Species	Total Landings Unit 1000 a)	*Length Class*	Total Length Freq. Unit 1000 b)
Species 1 *sp = 1*	68.1	*lc = 1*	324.7
		lc = 2	369.5
		lc = 3	964.6
Species 2 *sp = 2*	67.5	*lc = 1*	136.3
		lc = 2	168.2
		lc = 3	219.3
Species 3 *sp = 3*	87.6	*lc = 1*	392.7
		lc = 2	353.8
		lc = 3	227.3
Total	223.2		

FLEET B **TOTAL OF FLEET B**
PROVINCE A **Number of vessels = 87**
MONTH 1 (JANUARY)
Mean Number of active days/vessel =13.99

Species	Total Landings Unit 1000 a)	*Length Class*	Total Length Freq. Unit 1000 b)
Species 1 *sp = 1*	82.9	*lc = 1*	395.2
		lc = 2	449.8
		lc = 3	1174.2
Species 2 *sp = 2*	133.3	*lc = 1*	268.9
		lc = 2	331.9
		lc = 3	432.8
Species 3 *sp = 3*	172.9	*lc = 1*	774.9
		lc = 2	698.3
		lc = 3	448.6
Total	389.0		

a) (Number of vessels) * (Mean active days/vessel) * (Average landings/day/vessel)/1000 tons
b) (Number of vessels) * (Mean active days/vessel) * (Average number/day/vessel)/1000 specimens

TABLE 4.4.1 (CONTINUED) EXAMPLE TO ILLUSTRATE METHOD 1: THE PROVINCE-STRUCTURED RAISING PROCEDURE

Sub-Table g Summing Sampled Fleets of Province A.

(FLEET A + FLEET B) TOTAL OF SAMPLED FLEETS PROVINCE A MONTH 1 (JANUARY)	Species	Total Landings Unit 1000	*Length Class*	Total Length Freq. Unit 1000
	*Species 1*	141.0	*lc = 1*	719.9
	sp = 1		*lc = 2*	819.2
			lc = 3	2138.8
	Species 2	114.8	*lc = 1*	405.2
	sp = 2		*lc = 2*	500.0
			lc = 3	652.2
	Species 3	186.5	*lc = 1*	1167.6
	sp = 3		*lc = 2*	1052.2
			lc = 3	675.9
	Total	442.3		

Sub-Table h Raising Sampled Fleets (all fleets combined) of Sampled Provinces to Total provinces

PROVINCE A TOTAL OF ALL FLEETS MONTH 1 (JANUARY) Raising factor = (All fleets)/(Sample fleets) =1.1	Species	Total Landings Unit 1000	*Length Class*	Total Length Freq. Unit 1000
	*Species 1*	155.1	*lc = 1*	791.9
	sp = 1		*lc = 2*	901.1
			lc = 3	2352.7
	Species 2	126.3	*lc = 1*	445.7
	sp = 2		*lc = 2*	550.1
			lc = 3	717.4
	Species 3	205.2	*lc = 1*	1284.4
	sp = 3		*lc = 2*	1157.4
			lc = 3	743.4
	Total	486.5		
PROVINCE B TOTAL OF ALL FLEETS MONTH 1 (JANUARY)	Species	Total Landings Unit 1000	*Length Class*	Total Length Freq. Unit 1000
	*Species 1*	170.6	*lc = 1*	871.1
	sp = 1		*lc = 2*	991.3
			lc = 3	2588.0
	Species 2	138.9	*lc = 1*	490.3
	sp = 2		*lc = 2*	605.1
			lc = 3	789.1
	Species 3	225.7	*lc = 1*	1412.8
	sp = 3		*lc = 2*	1273.1
			lc = 3	817.8
	Total	535.2		

a) The raising factor is estimated from various unspecified sources.
(We thus assume that 10 % of the landings are not covered by the sampling programme)

TABLE 4.4.1 (CONTINUED) EXAMPLE TO ILLUSTRATE METHOD 1: THE PROVINCE-STRUCTURED RAISING PROCEDURE

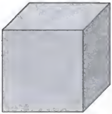
Sub-Table i Summing Sampled Provinces.

ALL PROVINCES SAMPLED (PROVINCES A + B)
MONTH 1 (JANUARY)

Species	Total Landings Unit 1000	*Length Class*	Total Length Freq. Unit 1000
Species 1 *sp = 1*	325.7	*lc = 1*	1663.0
		lc = 2	1892.4
		lc = 3	4940.7
Species 2 *sp = 2*	265.2	*lc = 1*	936.0
		lc = 2	1155.1
		lc = 3	1506.5
Species 3 *sp = 3*	430.8	*lc = 1*	2697.2
		lc = 2	2430.5
		lc = 3	1561.2
Total	1021.7		

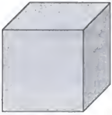
Sub-Table j Raising Sampled Provinces to Total Country.

TOTAL COUNTRY (OR DIVISION OF COUNTRY)
MONTH 1 (JANUARY) Raising factor = 1.13



Species	Total Landings Unit 10000	*Length Class*	Total Length Freq. Unit 10000
Species 1 *sp = 1*	36.8	*lc = 1*	187.9
		lc = 2	213.8
		lc = 3	558.3
Species 2 *sp = 2*	30.0	*lc = 1*	105.8
		lc = 2	130.5
		lc = 3	170.2
Species 3 *sp = 3*	48.7	*lc = 1*	304.8
		lc = 2	274.6
		lc = 3	176.4
Total	115.5		

TOTAL COUNTRY (OR DIVISION OF COUNTRY)
MONTH 2 (FEBRUARY)



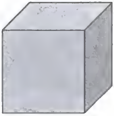
Species	Total Landings Unit 10000	*Length Class*	Total Length Freq. Unit 10000
Species 1 *sp = 1*	24	*lc = 1*	120
		lc = 2	190
		lc = 3	210
Species 2 *sp = 2*	31	*lc = 1*	110
		lc = 2	140
		lc = 3	180
Species 3 *sp = 3*	34	*lc = 1*	205
		lc = 2	199
		lc = 3	117
Total	89		

TABLE 4.4.1 (CONTINUED) EXAMPLE TO ILLUSTRATE METHOD 1: THE PROVINCE-STRUCTURED RAISING PROCEDURE

(TIME SERIES FOR MODAL PROGRESSION ANALYSIS)

Sub_Table K Repeating the Exercise for Each Month

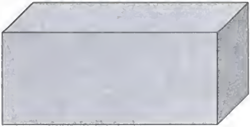
TOTAL COUNTRY (OR DIVISION OF COUNTRY)
MONTH 12 (DECEMBER)



Species	Total Landings Unit 10000	*Length Class*	Total Length Freq. Unit 10000
Species 1	32.2	*lc = 1*	154.6
sp = 1		*lc = 2*	226.0
		lc = 3	446.1
Species 2	26.3	*lc = 1*	79.4
sp = 2		*lc = 2*	135.5
		lc = 3	139.3
Species 3	35.0	*lc = 1*	299.1
sp = 3		*lc = 2*	252.8
		lc = 3	160.5
Total	93.4		

Sub-Table I Summation over Months.
Total Annual Catch of Entire Country (or division of country)

TOTAL COUNTRY (OR DIVISION OF COUNTRY)
INPUT FOR VPA
TOTAL YEAR SUMMATION OVER MONTHS



Species	Total Landings Unit 10000	*Length Class*	Total Length Freq. Unit 10000
Species 1	414.0	*lc = 1*	2055.2
sp = 1		*lc = 2*	2638.8
		lc = 3	6026.2
Species 2	337.5	*lc = 1*	1110.7
sp = 2		*lc = 2*	1596.4
		lc = 3	1857.2
Species 3	501.8	*lc = 1*	3623.6
sp = 3		*lc = 2*	3164.8
		lc = 3	2021.6
Total	1253.4		

TABLE 4.4.2 EXAMPLE TO ILLUSTRATE METHOD 2: THE FLEET-STRUCTURED RAISING PROCEDURE

Sub-Table A: Data from one Trip, by Commercial Group, Fleet A, is the same as for Method 1

Sub-Table B1: Activity Data and Days registered in Port, Fleets A in Provinces A and B

PROVINCE A			
ACTIVITY LEVEL FLEET A			
Sampled Vessel No.	Number of active days during month D(A)	Number of days registered in base port DR(A)	Number of active days in base port D(A)*DR(A)/31
1	16	15	7.74
2	19	31	19.00
3	17	20	10.97
		Average	12.57

PROVINCE B			
ACTIVITY LEVEL FLEET A			
Sampled Vessel No.	Number of active days during month D(B)	Number of days registered in base port DR(B)	Number of active days in base port D(B)*DR(B)/31
1	16	15	7.74
2	19	31	19.00
3	21	31	21.00
4	17	15	8.23
		Average	13.99

ALL OTHER PROVINCES			
ACTIVITY LEVEL FLEET A			
Sampled Vessel No.	Number of active days during month D(B)	Number of days registered in base port DR(B)	Number of active days in base port D(B)*DR(B)/31
1	16	31	16.00
2	13	24	10.06
3	16	20	10.32
4	21	15	10.16
5	17	31	17.00
		Average	12.71

Sub-Table B2: Number of Vessels, Fleets A in Provinces A and B

Province	Number of vessels Fleet A	Number of vessels Fleet B	Number of days Fleet A	Number of days Fleet B
A	157	23	1973.4	287.5
B	87	42	1217.3	525.0
Total sampled provinces	*244*	*65*	*3190.8*	*812.5*
Other Provinces	219.6	32.5	2791.0	406.3
Total	463.6	97.5	5981.8	1218.7
Raising factor			1.875	1.500

Sub-Table c. Species Composition and Length Frequency for two Trips (summed over commercial groups) is the same as for Method 1 (Table 4.4.1).

Sub-Table d. Summation over Sampled Trips is the same as for Method 1 (Table 4.4.1).

TABLE 4.4.2 (CONTINUED) EXAMPLE TO ILLUSTRATE METHOD 2: THE FLEET-STRUCTURED RAISING PROCEDURE

Sub-Table e. Average (per Day) over Sampled Trips is the same as for Method 1 (Table 4.4.1)

Sub-Table F: Raising to Total Fleet A in two Provinces

FLEET A **TOTAL OF FLEET A**
PROVINCE A **Number of vessels = 157**
MONTH 1 (JANUARY)
Mean Number of active days/vessel = 12.57

Species	Total Landings Unit 1000 a)	*Length Class*	Total Length Freq. Unit 10000 b)
Species 1 sp = 1	68.1	*lc = 1*	324.7
		lc = 2	369.5
		lc = 3	964.6
Species 2 sp = 2	67.5	*lc = 1*	136.3
		lc = 2	168.2
		lc = 3	219.3
Species 3 sp = 3	87.6	*lc = 1*	392.7
		lc = 2	353.8
		lc = 3	227.3
Total	223.2		

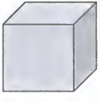
FLEET A **TOTAL OF FLEET A**
PROVINCE B **Number of vessels = 87**
MONTH 1 (January) **Mean Number of active days/vassel = 13.99**

Species	Total Landings Unit 1000 a)	*Length Class*	Total Length Freq. Unit 1000 b)
Species 1 sp = 1	82.9	*lc = 1*	395.2
		lc = 2	449.8
		lc = 3	1174.2
Species 2 sp = 2	133.3	*lc = 1*	268.9
		lc = 2	331.9
		lc = 3	432.8
Species 3 sp = 3	172.9	*lc = 1*	774.9
		lc = 2	698.3
		lc = 3	448.6
Total	389.0		

a) (Number of vessels) * (Mean active days/vessel) * (Average landings/day/vessel)/1000 tons
b) (Number of vessels) * (Mean active days/vessel) * (Average number/day/vessel)/1000 specimens

Sub-Table g. Summing Fleet a over Sampled Provinces

FLEETF A **TOTAL OF SAMPLED PROVINCES**
MONTH 1 (JANUARY) **(PROVINCES A + B)**

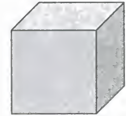


Species	Total Landings Unit 1000	*Length Class*	Total Length Freq. Unit 1000
Species 1 sp = 1	151.0	*lc = 1*	719.9
		lc = 2	819.2
		lc = 3	2138.8
Species 2 sp = 2	200.8	*lc = 1*	405.2
		lc = 2	500.0
		lc = 3	652.2
Species 3 sp = 3	260.5	*lc = 1*	1167.6
		lc = 2	1052.2
		lc = 3	675.9
Total	612.3		

TABLE 4.4.2 (CONTINUED) EXAMPLE TO ILLUSTRATE METHOD 2: THE FLEET-STRUCTURED RAISING PROCEDURE

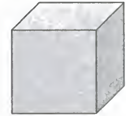
Sub-Table h. Raising Sampled Provinces to Total Country for Fleet A and B

FLEET A TOTAL OF ALL PROVINCES
MONTH 1 (JANUARY) Raising factor = 1.875



Species	Total Lan-dings Unit 1000	Length Class	Total Length Freq. Unit 1000
Species 1 *sp = 1*	283.0	*lc = 1*	1349.7
		lc = 2	1535.8
		lc = 3	4009.7
Species 2 *sp = 2*	376.5	*lc = 1*	759.6
		lc = 2	937.5
		lc = 3	1222.6
Species 3 *sp = 3*	488.3	*lc = 1*	2188.9
		lc = 2	1972.5
		lc = 3	1267.0
Total	1147.8		

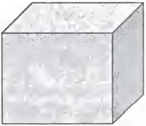
FLEET B TOTAL OF ALL PROVINCES
MONTH 1 (JANUARY) Raising factor = 1.500



Species	Total Lan-dings Unit 1000	Length Class	Total Length Freq. Unit 1000
Species 1 *sp = 1*	331.1	*lc = 1*	1579.1
		lc = 2	1796.9
		lc = 3	4691.3
Species 2 *sp = 2*	440.5	*lc = 1*	888.7
		lc = 2	1096.8
		lc = 3	1430.5
Species 3 *sp = 3*	376.0	*lc = 1*	1685.5
		lc = 2	1518.8
		lc = 3	975.6
Total	1147.6		

Sub-Table i. Summing Sampled Provinces.

TOTAL OF SAMPLED FLEETS
SUMMED OVER ALL FLEETS AND PROVINCES
MONTH 1 (JANUARY)



Species	Total Lan-dings Unit 1000	Length Class	Total Length Freq. Unit 1000
Species 1 *sp = 1*	614.1	*lc = 1*	2928.8
		lc = 2	3332.7
		lc = 3	8701.0
Species 2 *sp = 2*	817.0	*lc = 1*	1648.3
		lc = 2	2034.3
		lc = 3	2653.1
Species 3 *sp = 3*	864.3	*lc = 1*	3874.4
		lc = 2	3491.3
		lc = 3	2242.7
Total	2295.4		

Table J. Raising sampled provinces to total country is the same as for Method 1(Table 4.4.1).
Table K. Repeating the exercise for each month is the same as for Method 1(Table 4.4.1).
Table L. Summation over months. Total annual catch of entire country is the same as for Method 1.

5 DATA COLLECTION METHODS

5.1 THE BASIC RECORD: "THE FISHING TRIP"

A set of data that naturally comes together is called a "record". The individual data in the record are called "fields". For capture fisheries data, the natural data record is a "fishing trip" or perhaps a "fishing operation" for stationary gears.

In the simple case, a fishing vessel leaves the port, steams to the fishing grounds, fishes for a while and then steams back to the port where it lands all the catch. Together these events are called a "**fishing trip**". The duration of the fishing trip is the time between leaving port and returning to port. This is often referred to as "days away from port" as a 24-hours day is often used as unit for time. The "time fished" (days fishing) is the trip duration minus the time spent steaming to and from the fishing grounds. The duration of the trip and time fished are important variables for many different types of analyses.

The important feature about the "fishing trip" is that it should be possible to allocate a catch and a fishing effort to a fishing trip in an unambiguous manner. That demand, however, is not always easy to meet in practice. For many fishing trips, the allocation of catch and effort is straightforward, but there are also many types of trips that are more complex. Some of the most common deviations from the simple standard trip type are as follows.

Pair Trawling: Two vessels operate one trawl. Often only one of the vessels keeps the catch. Sometimes the two vessels have different attributes, and certain measurements are problematic. For example, the two vessels may have engines with different horsepower, but the total horsepower cannot just be calculated as the sum, since the smallest engine may determine the upper limit of trawling speed, etc.

Group Fishing: Includes pair trawling but may be any number of vessels collaborating during the fishing operation. On long distance fishing trips, vessels may stay in groups for security reasons, but they may also share the work between them. While some vessels actually catch the fish, others may scout for resources, or transport the catch to the landing place. Often one particular vessel may act as group-leader, and distribute the tasks among the vessels in the group.

Transshipment: Vessels may not land all their catch themselves, but transfer the catch to other vessels, which may be fishing vessels or collector vessels.

Multiple Landings Places: Vessels may land at more than one landing place. For example, shrimps may be landed in one place, squid in another and fin-fish in a third place.

These deviations from the standard fishing trip complicate data collection structured around the trip. However, the fishing trip is the natural unit in most cases, and although not universal, the trip concept is difficult to replace by anything more useful. It will be an additional task for the enumerators to record non-standard trips, so that catches and effort can be allocated to them.

Thus, "a fishing trip" may be a rather complicated concept. One safe, but costly method for the collection of trip data is to place observers (enumerators) onboard the vessel during a fishing trip. Apart from the observations on group fishing, the observers will also be in a position to record the entire catch and not only the landings, as is the condition for the land-based enumerator (see also Section 3.4.3). The use of observers may have more objectives than collecting discard data and information on group fishing. For example, an observer can monitor the fishing operations in general or even take biological samples. The use of observers is recommended if the budget and manpower allow for this activity.

A second reliable method is to carry out experimental fishing using chartered commercial or research vessels to simulate commercial fishing operations. If the gears used for the experimental fishery are commercial gears and the fishing grounds are the same as those of the commercial fishery, the experimental fishing vessels can be assumed to catch the same as the commercial vessels. Under the conditions of an experimental fishery, any detail of the catch can be recorded, and subsequently compared to the commercial landings.

5.2 FISHING VESSELS

The basic data unit the "fishing trip", is carried out by one or more "fishing vessels" (or in general "fishing unit", in case there is no vessel involved in the fishing operations). Thus there is a "one-to-many relationship" between the vessels and the fishing trips ("for one vessel there are many fishing trips").

The data about the fishing trip is combined with the data about the fishing vessel when the landings data are processed. For example, a set of trips can be grouped according to which fleet the vessels belong to. Knowledge about fishing vessels allows for estimation of the total number of fishing days executed by each fishing fleet. Here, "fishing days" are used as an example of effort measure. Alternatively, one of the measures presented in Table 3.1.1 could be used, and that may actually lead to more accurate estimates of the effort.

The set of data collected from a fishing trip cannot be processed in isolation, but only in combination with a **"Vessel Register"**. If a vessel register is not available, some other set of data, which can partly replace the vessel register, must be made available. An alternative to the vessel register is could be a **"Frame Survey".**

The number of vessels in a fleet must be known in order to estimate the total landings by fleet A during month b:

Total Landings = (Number of fleet A vessels) × (Average catch/day/vessel) x (Activity level)

where Activity level = the average number of fishing days during month b. Alternatively, using one of the effort measures presented in Table 3.1.1 instead of "fishing day"

Total Landings = (Number of fleet A vessels) × (Average catch/effort unit/vessel) × (Activity level)

where Activity level = the average number of units of effort exerted during month b. For more details see Section 4.4.

The assumption behind the above calculations is that all fishing vessels have approximately the same fishing power. Even if all fishing vessels have rather different fishing powers within a fleet, the average estimate may still be unbiased if all vessels have approximately the same activity level.

5.2.1 Vessel Registration

The vessel register is the backbone of fisheries statistics. The creation and maintenance of a vessel register has first priority among the different fisheries data.

The vessel register contains the characteristics of each vessel, such as a unique registration code, the dimensions of the hull and the engine etc. (for further details, see Section 5.8.9). The registration code is usually a combination of letters indicating the homeport of the vessel and a number. Sometimes the vessel registration code indicates the license agreement or the legal basis under which the vessel operates. For example the code, "HP 4711 TS" indicates a vessel from the province of Hai Phong registered as fishing vessel by the provincial authorities ("TS") with the number "4711". (For further suggestions on vessel registration see Flewwelling 1994.)

The vessel register is not only used for the registration and processing of catch/effort/activity data, but also for the purpose of taxation, payment of subsidies, issuing of licences, payment of licence fees, surveillance, enforcement of fisheries regulations, inspection etc. In principle, all fishing vessels should be registered in one way or another. Larger vessels are usually registered, but the smaller vessels are often not registered and therefore not easy to identify.

In the present context, we shall focus on the use of the vessel register for the processing of trip data, of which the catch and effort data are the essential information.

The role of the vessel register in relation to the catch/effort/activity data collected by interviews is illustrated in Figure 5.2.1. Once the enumerator interviews the skipper or buyer, it is enough to record the unique vessel registration code. The database system is then able to retrieve all the details about the vessel in question from the vessel register. The database system will also be able to allocate the vessel to a fleet and to interpret the effort data according to the fleet the vessel belongs to (data processing will be discussed in detail in Chapter 6).

It is of utmost importance that the vessel registration codes are unique, so no two vessels have the same code. The vessel register database should check the integrity of any new registration code relative to all other vessels in the country. This is possible if the vessel registration of a country is centralised (all provinces and states combined).

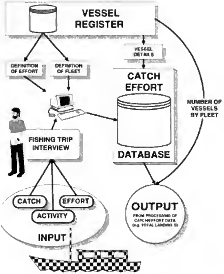


Figure 5.2.1 The role of the vessel register in relation to the catch/effort/activity data collected by interviews.

5.2.2 Frame Survey

The vessel codes in each fleet can easily be extracted from a vessel register at any time. If the vessel register is updated with a short time lag, the number of vessels by fleet can be calculated precisely. If a complete vessel register is not available, an alternative way of counting the number of vessels in each fleet is required.

A "frame survey" is an inventory list of fishing units at a specific time, sometimes combined with an indication of their activity levels (e.g. the number of active fishing days per month). A frame survey is usually a complete enumeration as far as the number of units is concerned, whereas the activity data are often sampled.

The role of the frame survey in relation to the catch/effort/activity data collected by interviews is illustrated by Figure 5.2.2. One of the main purposes of a frame survey is to provide multiplication factors needed for raising procedures. Furthermore, if drastic changes have taken place in the distribution of fleets, for example, the results may be used to modify the allocation of samples.

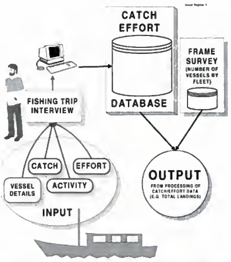


Figure 5.2.2. The role of the frame survey in relation to the catch/effort/activity data collected by interviews.

The frame survey should be updated every fishing season or within some other time unit which forms the basis for raising samples to total landings. A full frame survey can be repeated less often, about every five years.

The local fisheries authorities will usually assist the sampling programme with the counting of vessels in each port. The frame survey will have a definition of fishing fleets, which is usually difficult to change after the completion of the survey. The vessel register, on the other hand, allows for any definition and redefinition of fleets. There is often the need for special definitions of fleets for special purposes. Thus, a well-managed vessel register is much more useful than a frame survey. Frame surveys should be seen as an interim solution until a continuously updated vessel register can be established.

The number of vessels can be linked either to the homeport or to the base port. The base port is a port far enough away from the homeport, that the vessel will return to the base port rather than to the homeport between fishing trips. A vessel may for example move 200 nautical miles away from the homeport, to fish at fishing grounds closer to another harbour. The vessel will then land the catches in this base port or in landing places near to the base port. The vessel may then stay in the base port during a fishing season. Sometimes this migration of fishing vessels is recorded by the coast guard, harbour police or some other local authority.

The relevant relation between numbers of vessels and port is usually the base port, as it is assumed that all vessels of a fleet in a certain area (strata) behave equally in all respects. The fishing grounds and target species are related to the base port rather than the homeport.

Migration of fishing vessels will complicate the estimation procedures only when the migration implies a change of fishing grounds and target species. The coast guard (or the relevant harbour authority) may record the migration, or the migration may be estimated by the sampling programme under the "Directorate of Fisheries".

5.3 COMMERCIAL (SPECIES) GROUPS

When landed, the catch is usually sorted to meet the request from the buyers. The grading of the catch is dictated primarily by commercial requirements.

The price per kg remains the same for all parts of a commercial group. Thus, the value of the landings is calculated as the sum of the weights of each commercial group multiplied by their price.

The commercial grading will also reflect the taxonomic grouping. The catch will nearly always be separated into fish, shrimps, cephalopods and others. The grading will be more elaborate the higher the value is. For high value shrimps ten to fifteen size grades may be used, and usually the shrimps will be sorted by species. Also high value fish and cephalopods will be sorted by species and by size groups, such as "Small", "Medium" and "Large". In certain cases the catch is processed onboard the vessel before being landed (for example dried squid), which will create other types of commercial groups. For low value small fish, often not used for direct human consumption, the corresponding commercial group may contain many species of fish.

The data most easily accessible for the enumerator is the weight by commercial group and the price per kilogram. Sometimes a commercial group is the same as a species, but in general, the enumerator must take a sample to estimate the species composition of a commercial group. If a commercial group is a size class of one species, the total weight of the species must be calculated from the sum of all size classes.

Commercial groups are sometimes standardised within the country or region by the fisheries legislation, and that makes the administration of data by commercial groups easier. However, in other countries commercial groups may change during the year, it may change from landing place to landing place and from fleet to fleet.

5.4 DATA FROM PROCESSING PLANTS

Processing plants may hold data records for monitoring their own commercial activities. These records may also have other uses and be an inexpensive source of information for data collection programmes. The following discussion focuses on shrimp, but exactly the same results apply to any fish that are sorted into size categories.

Most landings of shrimps are exported, but before being exported, they are processed. This usually means that they are graded in species groups (like "Tiger", "White", "Flower" etc.) and within each group, they are graded according to size. Often the product is recorded as the "number of tails per pound" or "number of whole shrimps per kg", but other categories exist. Sometimes the shrimps are exported whole ("Head-on") and then the size categories are different. There are typically 10 to15 different size categories, and these size categories can easily be converted into length-groups, the input needed for the length-based VPA. Thus, shrimp processing plant production records contain excellent scientific data, which can be used as input for fish stock assessment.

A certain number of tails per pound corresponds to a certain tail weight and a tail weight corresponds to a whole-shrimp weight, and a whole-shrimp weight correspond to body length

Tabte 5.4.1 Conversion of production by commercial size categories into number of shrimp

Counts From (lower)	Counts To (upper)	Average weight of tail (g)	Number of boxes /1000	Total weight of boxes*	Number of shrimps /1000	Body lengths (mm) From (lower)	Body lengths (mm) To (upper)
1	15	54.3	8	40	737	40.50	117.09
16	20	24.1	15	75	3109	36.18	39.49
21	25	18.9	16	80	4237	33.15	35.50
26	30	15.5	17	85	5480	30.87	32.65
31	35	13.2	24	120	9117	29.06	30.47
36	40	11.4	33	165	14435	27.58	28.74
41	50	9.5	37	185	19378	25.27	27.31
51	70	7.2	27	135	18800	22.14	25.07
71	110	4.8	12	60	12497	18.55	22.02
111	400	1.7	4	20	11755	11.18	18.48
* One box = 5 kg			Total	965	99546		

(actually we use carapace length). Thus, we relate a commercial size category to a length interval. For example, for a certain species the commercial size category (or "count") "25-30 tails/pound" corresponds to the length interval "30.87-33.15 mm carapace length".

More problematic than size is the species composition. Usually each type of product is composed of several shrimp species, so some additional sampling, corresponding to the species composition in the commercial groups from the fishing vessels has to be done. Furthermore, for shrimp we will often also want to know the sex-composition, because the female shrimps grow to a larger (and more valuable) size than the male shrimps.

Table 5.4.1 shows an example of a conversion from the number of 5 kg boxes produced into the number of shrimps. Knowing the average weight of shrimp tails in a commercial category, one can convert the number of boxes into number of shrimps.

The next step is to split the numbers estimated into species. This split has to be based on samples taken before the shrimps are graded, headed and peeled. Table 5.4.2 shows an example where we assume that there are only two shrimp species represented in the processed quantities. For example, the number of male species B in category 21-25 tails/unit becomes: $4237 \times 0.12 = 508$.

The raising procedure for shrimp processing plants of a province (if there are several in a province) and all provinces in a division of the country follows the same principles as those used for the fishing vessels (Section 4.4).

The data in the last four columns of Table 5.4.2 (Numbers processed) can be used directly as input to the VPA (but only if they represent the total catches of the stock in question accumulated over one year). Each column is analysed separately, so that for each combination of species and sex there would be a separate VPA.

One problem with processing plant data is that it may be difficult to trace the quantities processed back to the fleet that caught the shrimp. However, the fleet distribution estimated from fishing port samples could be used, assuming it is identical to that for the processed catch. In this case, the numbers processed is distributed among fleets in the same proportion

Table 5.4.2 Hypothetical example to illustrate splitting commercial categories to estimate the numbers of shrimp in each species, size and sex category.

Counts (lower limit of length class)	Number of Shrimps /1000	Scientific Sampling of Commercial Groups Species-Sex Proportions				Numbers Processed			
		Sp. A		Sp. B		Sp. A		Sp. B	
		F	M	F	M	F	M	F	M
1	737	1.00	0.00	0.00	0.00	737	0	0	0
16	3109	0.56	0.24	0.14	0.06	1741	746	435	187
21	<u>4237</u>	0.42	0.28	0.18	<u>0.12</u>	1780	1186	763	<u>508</u>
26	5480	0.30	0.30	0.20	0.20	1644	1644	1096	1096
31	9117	0.25	0.25	0.25	0.25	2279	2279	2279	2279
36	14435	0.20	0.20	0.30	0.30	2887	2887	4331	4331
41	19378	0.15	0.15	0.35	0.35	2907	2907	6782	6782
51	18800	0.15	0.15	0.35	0.35	2820	2820	6580	6580
71	12497	0.10	0.10	0.40	0.40	1250	1250	4999	4999
111	11755	0.10	0.10	0.40	0.40	1176	1176	4702	4702

as indicated by the fishing port samples. Where most of the shrimps species, size and sex categories are processed for export, this assumption may be reasonable.

Data from processing plants can be procured at very little cost if the processing plants will give access to their files. As shrimps are a valuable marine resource, it is often wise to give a high priority to collect data from shrimp processing plants. Care should be taken that the data from individual enterprises are treated with confidentiality, so that delivery of production data will not damage the position of the individual company relative to its competitors. As a rule, data on individual enterprises should not be published without their consent.

5.5 DATA FROM OTHER SOURCES

Other types of data from the fisheries sector, which are not specific to fisheries only, are kept in databases outside the area of responsibility of the Directorate of Fisheries. A government statistics department may provide information of interest to fisheries. Detailed data are not likely to be available at this department, but must be obtained from specialised databases. These specialised databases may be located in other ministries, like "Ministry of Planning", "Ministry of the Interior", "Ministry of Agriculture", "Ministry of Defence", "Ministry of the Environment", etc. Data may also be obtained from local databases, maintained by the provinces of the country. Universities, research institutes, research projects or development projects may keep databases of interest to fisheries. Finally, there are international fisheries databases, maintained by international organisations. Part of the information from international databases may be used for validation of the national database (see also Section 6.7). The annual fisheries statistics produced by the Directorate of Fisheries should include international fisheries statistics for comparison with the national statistics. The fisheries data collection programme should regularly check other relevant national and international databases for useful information.

The data from "other sources" are, for example, used to produce "Fisheries Sector Profiles", which in turn can be used for the stratification and validation of the basic fisheries data. This type of data is inhomogeneous, and a complete discussion of their use is considered outside the scope of the present manual. Here, only a short list of important sources is given together with examples of the type of data that might be obtained:

(a) **Demographic data:** human parameters of the fishing communities, e.g. statistics and details of fisher families.

(b) **Infra structure data:** roads, housing, transport, ports, processing plants etc.

(c) **Institutional data:** laws, regulations, inspection and enforcement of fisheries, education, taxation and subsidies, loan providers.

(d) **Market structure:** markets usually consist of merchants who buy the landings and pass them on down a chain ultimately to the consumer. Merchants often have additional relationships with fishers, for example, they may lend money to the fishers. Data includes information on the how landings are purchased, loans given to fishers etc.

(e) **Import / export data:** quantities and qualities of imported/exported marine products.

(f) **Taxation:** authorities may keep audited records on production for tax purposes, which can be used for validation of interview data.

(g) **Household data:** this is the sociological information on the fisher families, such as number of family members, their age, education, occupation, income, houses and installations in houses, ethnic background, religion etc.

(h) **Community data:** this is the sociological information on the structure of the relationships between the fisher families, including the fishing village organisation, merchants, co-operatives, support industries etc.

(i) **Coast guard (or harbour police) registrations:** port authorities may record the migration of fishing vessels, which may be invaluable information for the processing of interview samples.

(j) **Meteorological and geographical data:** these data may be used for definitions of fishing grounds and seasons and to estimate environmental effects that drive the stock dynamics or limit fisheries. They may also be used for validation.

(k) **Co-operatives:** fishers' co-operatives sometimes maintain records (e.g. for accounting) of a higher quality than individual skippers. Individual skippers may not keep long time series of detailed information on catches, fishing grounds, costs and earnings, investment etc., whereas some co-operatives do. Such data are valuable in their own respect and they can supplement or validate data from the interview samples.

(l) **Fisher associations:** fishers' organisations may sometimes keep records on their members and the production of members. In the case where the association manages an auction system, they may keep sales slips, which can be used to supplement and validate the interview samples.

(m) **Banks:** these may provide information on loans and interest rates to the fisheries sector. Banks may also keep databases on the costs and earnings of the vessels.

(n) **Insurance companies:** insurance records may provide information on insurance fees and risks, as well as the assessment of vessels, gear and other equipment.

(o) **Support industries:** other industries include gear and other equipment makers, ice plants, repair shops, chandlers etc. Data may be used to estimate costs of fishing and indirect estimates of effort.

(p) **Fishing companies:** industrialised fishing companies usually keep detailed records on their activities. Industrial vessels may fill in logbooks for each trip (see Section 5.6).

The private industry must be obliged to deliver basic information to government agencies, secured by adequate legislation. Some information from individual private entrepreneurs, however, must be treated as confidential information. Often only summary information on the industry is published, in such a form that the information cannot be traced back to individual entrepreneurs.

5.6 LOG BOOKS / SALES SLIPS FILLED IN BY FISHERS / BUYERS

Figure 5.6.1 shows a set of logbook and sales slip forms. In this example, one form A1 is filled in for each fishing trip and one form A2 for each fishing operation each day. Thus, to each A1 form several A2 forms may be attached. Form B, is filled in by the buyer of the landings, for example, at the auction where landings are sold. Forms A and B contain overlapping information, such as the landings by species, which can be used for data-validation.

It is standard for the fishers and fish buyers in industrialised countries and some developing countries to fill in logbooks and sales slips. Filling in logbooks for all fishing activities allows for complete enumeration of landings and effort. Most tropical developing countries have one or more fishing companies operating industrialised vessels. The industrialised fishing companies will usually request that their skippers fill in a logbook and they will keep records on their production. Such information can be a valuable supplement to the data collected from interview samples.

In some countries, logbooks are compulsory and otherwise, they may be maintained for internal bookkeeping. Logbooks contain the essential fishing trip information, such as start and end date, fishing grounds, gear used, catch and landings etc. Each trip is recorded in the logbook on one or more pages.

The compulsory logbook / sales slip system, is the ideal system from the data collector's point of view, as it allows for complete enumeration. However, logbooks and sales slips do not automatically imply a very high quality of data. Compulsory filling in of logbooks and sales slips usually goes together with strict enforcement of fisheries regulations. The fishers and buyers of landings may not fill in the form correctly to avoid prosecution. Mis-reporting (e.g. reporting one species as if it were another species) is not uncommon in more developed countries. The sample-based interview data collection may therefore provide more unbiased information, because it may be more difficult to misreport landings face to face with the enumerator during the off-loading. However, in general, a logbook system is considered superior to a sample-based system, and establishment of compulsory logbooks is recommended.

As this manual deals mainly with the sample-based approach (not complete enumeration), no further details will be given about logbooks.

FORM A1. TRIP LOGSHEET (LOG BOOK)

Log-sheet Serial No:		Vessel Id.:		IRCS:		Trip No:		Date:	
License No:		Vessel name		Log-sheets attached	From:		to:		

	PORT	DATE	TIME
Departure			
Arrival			

LANDING PLACE	BUYER	DATE	LANDED QUANTITY (KG)

Captain's signature: ______________________ Date: __/__/__

(q)

FORM A2. LOGSHEET (Many A2 forms for each A1 form)

Log-sheet No:		Vessel Id.:		IRCS:		Trip No:		Date:	

FILL IN A NEW PAGE FOR EACH DAY, CHART AREA, GEAR OR MESH SIZE FISHED

Chart area:		Gear type:		Quantity gear:		Gear size:	
Mesh size:		No. of hauls/sets:		Average tow/soak time:			

STATISTICAL AREA	SPECIES	LANDINGS (kg)	DISCARDS (kg)

Captain's signature: ______________________ Date: __/__/__

FORM B. SALES NOTE (SALES SLIP)

Invoice	No.	Purchase date	
Buyer Identification code		Buyer Name:	
Vessel identification code		Vessel name:	
Landings place		Landings date	

SPECIES	CATEGORY	GRADE	QUALITY	WEIGHT	PRICE/KG	VALUE

Figure 5.6.1 Examples of Logbook/Log-sheets and sales slip (logbooks are not included in the methodology suggested in this manual).

5.7 THE SKIPPER / MERCHANT INTERVIEW AT THE LANDING PLACE

As an example of an objective of the data collection programme, we shall use the estimation of total landings by fleet and commercial group. If compulsory log books and sales slips are not available for estimation of total landings, a complete enumeration is usually not possible, and the data collection will have to depend on samples which are subsequently raised to an estimate of the total landings (see Section 4.4).

The most obvious way to collect information about the fishing trip is to interview the crew of the vessel and/or the merchant associated with the vessel at the time of landing. The data in question are catch and effort and fishing trip details. Data on vessel details may also be collected if a dependable vessel register is not available.

The picture on the cover of this manual shows a real-life interview situation from Viet Nam, where landings are in a process of being landed in the island of *Cat Ba*. The photo illustrates the practical conditions for sample-based data collection in a tropical developing country. The landings (in this case mixed demersal fish) are weighed in baskets using a balance scale. Landings of squid in Viet Nam are usually in plastic bags and separated into each size category (small, medium and large). The weight and the price of the basket is recorded by the assistant of a fish buyer. Figure 5.7.1 shows a page from the record-book of the fish buyer purchasing the landings depicted on the cover.

Name of commercial species group	Kg landed	Price per kg	Total value of landings
Small squid	*53*	*5000*	*265000*
Medium squid	*27*	*10000*	*270000*
Large squid	*12*	*23000*	*276000*
Mixed small fish	*250*	*2000*	*500000*
Mixed medium fish	*100*	*2500*	*250000*
..... etc.	....	....	....
		Total	*Sum*

Figure 5.7.1 A page from the record-book of the middleperson buying the landings in the cover picture.

The picture and Figure 5.7.1 give an indication of the accuracy, that can be expected from the samples. The observations achieved in such a situation can be considered reasonably dependable, as the enumerator is in a position to carry out visual inspections of the fish and other record books.

The different types of data to be collected are indicated in Table 5.7.1, which gives a complete set of "trip-data". A complete set of "trip-data" is, however, not common. Most often only a sub-set of the data will be collected. The complete set of trip-data includes data from measurement of samples of fish, squid or shrimps, and it is usually beyond the capacity of enumerators to take measurement samples from all trips sampled.

The vessel may (or may not) land at more than one landing place. That a vessel visits two landing places on one trip may be caused by a number of factors, for example a higher price for squid in one place and a higher price for fish at another.

Table 5.7.1 The principal data types collected during an interview.

Sample information	Date of sampling Enumerator
Vessel information:	Vessel registration Vessel details (dimensions, engine etc.) Gear details
Effort and activity:	Days away from port, days fishing, additional detailed effort data Active fishing days during last month
Spatial information:	Fishing grounds Landing place(s)
Information on total landings:	Weight by commercial group Value, (price/kg) by commercial group
Discard information:	Number of discard operations Percent discarded
Within commercial group samples:	Sample species composition from selected commercial groups Weight (number) by species
Within species, length frequencies samples:	Sample for length frequencies (and other biological measurements) for selected species Number of specimens by length class

The fishers or the buyers will nearly always sort the catch into commercial species and size groups. The species and size groups are determined by the market prices and the appearance (size, quality etc.) of the species in the commercial groups. Specimens of similar appearance are (naturally) in the same group. Individual body sizes will usually also be taken into account.

The data, which can easily be obtained from the skipper's or buyer's accounting book, are the quantities landed by commercial groups and the price per kilo. The landings are usually sold by the basket, box, plastic bag etc. (here named "container") and each container will be weighed. The sum of containers making up the total quantity of a certain commercial group will usually be available to the enumerator.

The next set of details to be sampled is the species composition within a commercial species group (Figure 5.7.2). Sometimes a commercial group (in particular in the case of expensive specimens for export) will comprise only one species, or even only one size group of one species. Expensive species like groupers are usually gathered into small, medium and large grouper categories, and often by species. However, the most common case is that the commercial group comprises two or more species. If the species composition is required, it is necessary to buy or otherwise obtain a sample, and then separate it into species.

The ultimate level of detail collected is that of the length frequency samples and/or other biological data. These samples will be the same as the samples taken for species composition, or sub-samples of the species composition samples.

Sometimes the fishers will be able to give information on the amounts discarded. They may in the case of a trawl fishery be able to tell how many hauls were made from which a certain fraction was discarded. They may also be able to tell the composition (species and size groups) of the discards (also discussed in Section 3.4.3).

While collecting landings data, the enumerator should also collect information on the gear, the effort and the fishing grounds. The most basic effort data you can collect is the number of days away from port. If possible, the number of fishing days will also be recorded. Often this

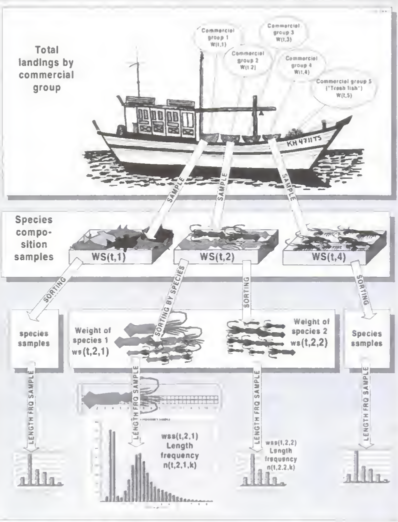


Figure 5.7.2. Data collected from a "trip-interview" (for the interpretation of symbols, see Section 4.4.2).

will be the only effort data available. However, the methodology should be modified if more detailed effort data can be collected (see Section 3.1.2).

Two types of data related to effort are collected:

1. **Effort**: for example, number of fishing days;
2. **Activity level**: Past fishing effort, for example the number of days spent fishing over the previous month. These data may be used as part of a raising factor to estimate the catches of the vessel including days not sampled.

Sometimes more details will be available, in which case there will be both details about the gear (such as mesh size of a trawl), and effort details such as the number of trawl hauls and the duration of a trawl haul.

5.8 DATA COLLECTION FORMS

The eight forms suggested for sample-based catch/effort, vessel registration and bio-economic data collection are based upon the fisheries sector described in Section 3.4. They are presented in Section 5.8.10.

1. Trip interview form;
2. Species composition of Commercial Group form;
3. Length frequency form;
4. Variable costs and earnings per trip and additional trip information;
5. Fishing activity in base port (one vessel category-fleet, for sample-based approach;
6. Frame survey in homeport (port of registration), for sample-based approach;
7. Fixed (annual) costs by vessel;
8. Vessel registration.

The first four forms are associated with the interview of a skipper or buyer at the time of landing. Forms 2 and 3 are used only in the case where the enumerator takes samples for biological data. Form 4 is used only in the case where costs and earnings data are collected. If Forms 2, 3 and/or 4 are filled in, a "Sample number" will link them to Form 1. For each Form 1, there may be several of Form 2, and for each Form 2 there may be several of Form 3. There will be only one Form 4 for each Form 1.

Forms 5 to 8 are mutually independent, as well as independent from Forms 1 to 4. Forms 1 to 4 are based on the fishing trips, where as Forms 5 to 8 are based on fishing vessels.

The forms shown here use only the English language. They should, however, all appear in both English and the language of the location in question. The version in the local language will usually be the form used by the enumerators.

5.8.1 Common Features of All Forms

The first 4 forms make up a hierarchy, where Form 1 will always be present. One cannot have Forms 2 or 4 without Form 1, and one cannot have Form 3 without Form 2. On Forms 1 and 2 there is a field which indicates whether the next form in the hierarchy exists. On Form 1 it reads: "Comm. Gr. Y/N. The field must always be filled in with "Yes" or "No". On Form 2 the similar field to indicate the existence of next form in the hierarchy is named "Length Freq. Sample"

Boxes: The data fields of the forms are structured in groups or "boxes" of data, which are logically related.

Page Number: The forms are designed so that in most cases the enumerator will have to fill in only one page of each type of forms. If, however, one form is not sufficient, two or more forms can be used, and page number should be inserted.

Sample Information Box: This box contains information on who collected the data, who entered the data into the computer, which type of sample the record represents and the validity of the samples. The meaning of "sample-type" and "sample validity" will be discussed for the individual forms.

Enumerator/Encoder: The responsible enumerator and database encoder must fill in their initials on the forms. This information is used for subsequent validation and quality control.

Comments: There may occur various unexpected observations, which do fit into the specific fields, and this information may be entered in the "comment-boxes".

Sample Number: The sample number is to be used by the enumerator/encoder for her/his internal bookkeeping. It is not used for processing of data. Sample numbers are useful when linking several forms used during an interview, in particular when the enumerators and the encoder are not the same person.

Look-Up Tables: Whenever possible, the fields are filled in by selecting an item from a "look-up table" (see Section 0). Only values from the look-up tables will be accepted as input to the database system. The look-up tables will contain a full description of the possible values, as well as a code. The enumerator will however, only enter the code on the form. As an example, Table 5.8.1 contains a possible set of codes and description of the values accepted for body length measurement. The use of look-up tables and well-designed codes will reduce the probability errors and will facilitate the validation of raw data.

Table 5.8.1 Example codes indicating how length was measured. Measurements can be linked to particular species, so the enumerators should be provided with a list indicating the measurement type to be applied for each species.

Code	Length Measurement type
CL	Carapace length
FL	Folk length
ML	Mantle length
SL	Standard length
TL	Total length

5.8.2 Form 1: Trip Interview

Forms 1 to 4 are linked, so Forms 2 to 4 require a Form 1 to be completed.

Sample Information Box:

Sample type: The concept of "sample type" is defined by the local conditions (this also applies to several other fields). Instead of a generic explanation, several fields are described by examples. Examples of sample types are:

1. Not known;
2. Buyer interview from sales-book;
3. Buyer interview when landing;
4. Buyer -Interview without effort data;
5. Skipper's relative interview;
6. Skipper's wife interview;
7. Skipper-Interview from sales-book;
8. Skipper-Interview when landing;

   ... etc.

Sample validity: This indicates limitations in the use of the record for processing. Examples of "sample validity" are:

1. Not known;

2. Not for raising of total catch;
3. Not for raising of total length frequency;
4. Not for estimation of catch;
5. Not for estimation of effort;
6. Only part of landings recorded;
7. Landings from several vessels;
8. Skipper not willing to report;
9. Skipper not well organised;

   ... etc.

Vessel Information Box: This box contains information on vessel, gear and "group fishing". The data in this box can be used for definition of "fleets". The fleets need not be defined in the form of input to the database, but may be defined by aid of the data in the vessel register combined with the data in the vessel information box. Also, spatial information may be used for fleet definition.

Vessel registration number and horsepower: Ideally, the vessel registration number should be sufficient to get all the vessel details. The vessel register should also provide the engine horsepower and other characteristics of the vessel. In this case, it is assumed, however, that the vessel register is not updated continuously, and that it may contain erroneous values. Therefore, the form provides the option for updating and correcting the vessel register. The box "Vessel details" is reserved only for updating and validating the vessel register. While interviewing the skipper, the enumerator can conveniently collect the vessel registration data. The field "More Inf." is checked if, for example, a vessel registration form was corrected.

Gear 1 and gear 2: The form allows for entry of two different gears with one field for "Gear characteristics" (e.g. mesh size). Should more fields be required, the form should be extended accordingly. The fields "More inf." next to the gear characteristics is intended for reference to additional gear-detail forms, which are not included in the present set of forms. A complete set of forms covering all possible details on the major gears is considered outside the scope of the manual.

Group fishing: There are many types of fishery where two or more fishing vessels collaborate, notably pair trawling. For pair trawling, the second vessel should be recorded under "more Information". That means that the enumerator will have to fill in two units of form 1. The field "Group fishing will have to be filled in with the code for "Pair trawling", and the field "Mate Vessel 1 Reg. No." in Form 4, can be used to enter the registration code for the mate vessel. Other types of "group fishing" are more complicated. For example, a group of vessels may fish on distant fishing grounds, with one of them landing the catches of several vessels, while they remain on the fishing grounds. In this case, the enumerator should try to allocate the landings to the vessels that caught them. The fields "Mate vessel x Reg. No." in Form 4 allow for up to 4 vessels in the group. Should there be more than four vessels, Form 4 should be extended with more fields.

Spatial Information Box: This box contains information on where data was collected and where fishing took place.

Sampling location: Site where sample was collected, (usually a landing place).

Fishing grounds: Name of fishing grounds as reported by the fishers. The database should contain a table, which defines the fishing grounds in terms of statistical rectangles (say 30×30 nm) or divisions of statistical rectangles (say, 10×10 nm).

Depth: Average depth at fishing grounds.

Statistical rectangle and division of statistical rectangles: In case the fishers are in a position to indicate the position of the fishing, the enumerator can provide the statistical rectangle. Fishing positions by statistical rectangles allows presentation and analysis of distribution of resources and fisheries using GIS (Geographical Information System).

Landings Information Box: Landings may take place at more than one site. For example, shrimps, fish and cephalopods may be landed at three different places. Therefore the data collected at a specific sample site may not be representative of the entire catch. This box contains information on where different parts of the catch were landed as well as the quantities and commercial groups landed.

Information on Discarding Box: This box is used to record the type and quantity of fish discarded.

Type of discards: The type of discards may be, for example, "All fish", "All Small fish", and "All low value fish". The types actually used depend on the nature of the fishery, for example, the selectivity of the gear in question.

Number of operations with/without discards: Some gear-operations may lead to discarding, whereas others do not. For example, a trawler may keep the entire catch from the last hauls, where all preceding hauls involved discarding. Such information may be used to estimate the total discards (see Section 3.4.3).

Percent discarded: The percent in weight of the total catch that is discarded.

Effort Information Box: Fishing effort can be measured in many different ways, for example, number of days away from port, number of fishing days, number of trawl hauls, number of trawling hours (see Section 3.1.2). As an example, the form offers two effort measurements, but any number of different effort measures could be offered in the form.

Activity information (not trip-related): This information is related to the activity during the last time unit, for example, the last month. Thus, the data are not trip-related. However, the information can conveniently be collected during the interview. The information can be validated if a vessel is sampled more than once during the period. Activity is also recorded independently of the trips in Form 5 (Fishing activity in base port). The information of Form 5 can be evaluated by comparison with the information in the interview form.

Information on commercial groups: This box contains the first level of division of catch data, the data which are usually also recorded by the fishers or buyers. A further division requires sub-samples to be taken by the enumerator for further analysis (Species composition, Form 2 or Length frequency sample, Form 3).

Commercial species group, size and treatment: These three fields form a combined code. The "commercial species group" usually refers to the taxonomic groups, such as "Bull-eyes", "Scads", "Sardines", etc. For high value species, the commercial groups are usually a single species, such as "king fish", "red snapper" etc. For high value species, there may also be a division into size groups, such as "Small", "Medium" and "Large". The "Treatment" field is used to indicate treatments such as "Iced", "Live", "Dried", "Gutted". The actual use of the three fields depends on the particulars of the fisheries and the species caught. The weight and the kg-price are raw data, whereas the "Total value" is computed and is used only for validation of data. If a sample for species identification and/or length frequency is taken, "Spec. Comp." is ticked.

Vessel Details Box: This box is exclusively used for validation and updating of the vessel register. In the case where a dependable and continuously updated vessel register is available, there would be no need for this box. The fields in the box also appear in the vessel registration form, where the description will be given.

5.8.3 Form 2: Species Composition of Commercial Group

The form contains data on the species composition of one commercial group, from the corresponding Form 1.

As there may be several commercial groups recorded in Form 1, there may be several Form 2 sheets related to one Form 1. The first line in Form 2 contains information, which was also in Form 1. This double recording is made in order to assure that the matching of forms is done properly. In particular, the "sample number (Form 1)" is used to assure the linking of the two forms. Also the fields "Commercial species group", "Size", "Treatment", "Sample weight" are copied from the box "Information on commercial groups" in Form 1.

Species name: The "Species name" should be a code selected from a look-up table, which reflects a full taxonomic (scientific) classification of the species.

Sample weight: The total weight of the all specimens identified of the species in question.

Number of specimens: The total number of specimens identified of the species in question.

Length frequency sample:. If a sub-sample is taken of body length measurements, this field is ticked, and a Form 3 associated with the current form is filled in. When a commercial group contains only a single species, Form 2 must still be filled in, if a length frequency sample is taken. Form 3 must always refer to a Form 2.

5.8.4 Form 3: Length Frequency

This form is linked to a species recorded in Form 2, through the information in the first box, and the species name. The sample numbers are used for double security of linking. In practice, the Forms 1, 2 and 3 will be kept together, so it should not normally be necessary to use sample numbers, which are universally unique. The form is designed for data entry as the sample is being measured.

Length unit: e.g. "cm", "mm"

Length measurement type: e.g. "Total length", "Fork length", Carapace length", "Mantle length"

Sample weight: Total weight of all specimens measured.

Female/Male and Both: Separation by sex is used primarily for species with differences of commercial significance, notably shrimps. When the separation of sexes is easy, it may be made even in cases where the economic difference is less important.

Total: Total number of specimens in the length class.

Weight: Total weight of specimens in the length class (used for estimation of average weight, length-weight relationship etc.).

5.8.5 Form 4: Extension of Form 1: Variable Costs & Earnings Per Trip

This form is used partly as an (optional) extension of Form 1 and partly to record costs and earnings data.

Mate Vessel(s) Box: The vessel may be a member of a group of vessels which co-ordinate their activities in one way or the other. Pair trawling, for example, is a very common example of a group of two vessels, which co-ordinate their activities. The box allows for up to four vessels.

Additional Trip Information Box:

Date sailed, Date landed: If these observations are relevant for the calculation of effort or other parameters, this field allows for them to be recorded. In some studies, they may not be relevant observations.

Time sailed, Time landed: As above

Steaming time: As above.

Expected trip duration: This observation can be compared to the actual trip duration and deviations may indicate unfavourable conditions for fishing or accidents.

Ice used: The quantity of ice used during the trip.

Fuel used: The quantity of oil/gasoline used during the trip.

Target species group: The expected main catch composition, species (size group of a species) or species group.

Damage/loss (estimate): For example, estimated value of lost or damaged gear, damage of engine etc.

Trip (Variable) Costs Depending on Effort: Some variable costs depend on the effort exerted, for example the number of fishing days. Other trip related variable costs depend on the weight or value of the landings (see Section 3.3).

Ice: Cost of ice used during the fishing trip.

Fuel and Lubrication: Cost of fuel (oil or gasoline) and lubrication used during the fishing trip.

Water: Cost of water used during the fishing trip.

Food: Cost of food consumed by the crew during the fishing trip.

Bait: Cost of bait used during the fishing trip.

Assistance: Payment for assistance from other vessels, for example, for light attraction or supply.

Trip (Variable) Costs Depending on Value or Weight of Landings: Trip related costs, which are not related to the effort (e.g. fishing days, see Section 3.3)

Auction fee: Fee paid in connection with the sale of the landings

Tax: A tax may be levied for the landings

Subsidy: A subsidy may be granted for the landings.

Consignment fee: A fee may (or may not) have to be paid for each consignment landed.

Sharing of Earnings Box: The crew may either receive a fixed salary, or they may be paid by sharing the value of the landings. Certain costs (fuel, lubrication etc.) will be subtracted from the total value of the landings before the shares are distributed to the crew and the vessel. This box allows for entry of the calculation of the shares for crew and vessel. The skipper will usually get a higher share than the other crewmembers.

Total value of landings:

Subtraction 1,2,3: Deductions from the value of landings.

Divisible earnings: The amount to be shared by crew and vessel.

Vessel share: The percentage of the divisible earnings given to the vessel-owner.

Captain's share: The percentage of the divisible earnings given to the skipper. If the skipper is also the owner she/he will also get the vessels share, but it should be recorded separately in the field above.

Crew share: The percentage of the divisible earnings given to the total number of crew except for the skipper.

Captain's wage: The wage of the skipper if he gets a fixed salary, or a salary on top of the share of the divisible earnings. The wage is the wage for the number of days the trip lasted and the number of days in the waiting period until next trip.

Crew wage: As above.

Transfer at Sea, Offload/On-Load Box: It may happen that a vessel does not land all or part of its catch. For example, of a group of 10 vessels operating on distant fishing grounds, only two will go to the landing place with the combined catch of all vessels, while the remaining 8 vessels continue fishing. Catches may also be transferred to "collector vessels", that is, vessels which do not fish but only collect the catches of other vessels. The vessel may transfer or receive catches from other vessels.

Off-load vessel registration number: Registration number of the vessel to which the vessel of the interview transferred catch.

On-load vessel registration number: Registration number of the vessel, which transferred catch to the vessel of the interview.

Off-load commercial group, weight, value: Specification of the commercial group(s), weight and value of the transferred catch.

On-load: Commercial group, weight, value: As above.

Information on Sale by Commercial Groups Box: This box extends the box "Information on commercial groups" in Form 1, as it allows for a further split of the catch by merchant. In case landings of the box in Form 1 all went to a single buyer, it may not be necessary to fill in this box.

Commercial species group, size, treatment, weight, price/kg: Information similar to box "Information on commercial groups" in Form 1.

Buyer: The name of the buyer (merchant, processing plant, exporter etc.)

Skippers Performance Box: This is to evaluate the skipper's ability to provide information and his experience as fisher.

Skipper's experience: Number of year the skipper has been active skipper.

Is a logbook used? (Yes or No)

Type of logbook: The logbook may be an official (compulsory) logbook or the skipper may record the fishing activity for internal bookkeeping and for recording of experience.

Type of other recording: Skippers may keep notes on landings, prices costs and other recordings, which is not of the standard of a logbook, but may still be useful information.

Vessel Details Box: This box is used for validation/update of the vessel register (optional). The fields are explained in Form 8, the vessel registration form. Some additional vessel details may be collected if it is considered necessary for validation of the vessel register.

5.8.6 Form 5: Fishing Activity In Base Port

This form is for recording the number of fishing operations per time unit (e.g. number of fishing days per month in each fishing season of the year). The data are collected for individual vessels in the base-port of fishing. The concept of "fishing operation" may be more specific than the "fishing days". For example, as fishing operation may be a "gillnet set", a "long-line set" etc. Note that the form is used for several vessels, which should all belong to the same vessel/gear category.

The form suggested here might be too general for real fisheries. A generic form, which can be used for recording of activity for any fishery, would be too complex. The activity form most likely has to be modified to meet the specific requests from the fishery in question.

Sample Information Box: This box is similar to the box for Form 1

Time Period Box.

From (date) to (date): The period during which the activity was recorded, e.g. the number of fishing days from 1st until 31st of May.

Number of days: This information is to check the two dates above.

Fleet Information Box.

Vessel type: The "vessel type" refers to the size of the vessel (say, length or horsepower) and the type of construction.

Gear: May be one gear or a combination of gears.

Fleet (optional): The "fleet" can be used if the vessel type and the gear are insufficient to define the fleet. The fleet concept may, in addition to vessel type and gear, include features like fishing techniques, fishing grounds, target species etc.

Basic Activity Data Box.

Vessel registration number, Province of registration, Homeport, Name of skipper: Basic information about the vessel.

Number of days away from port: Number of days at sea (whether fishing or not fishing) during the time period in question (= steaming days + shelter days + fishing days)

Number of fishing days:Number of active fishing days during the period in question (=days away from port - steaming days - shelter days)

Number of days at shelter: Number of "idle days", with no fishing or steaming during the period in question. These days may apply to periods of bad weather.

Number of days steaming: Number of days used to go to and from the fishing grounds during the period in question.

Number of trips: Number of fishing trips during the period in question.

Port registration: Start date, End date: When the base-port is not the homeport, fishers may register with the local authority in the base-port, for example the coast guard or the harbour police. This information may be used to estimate the migration of fishing vessels.

Additional Information (Optional) Box: This box is used to record activity data more detailed than the number of days in the basic activity data box.

Start time, End time: Hours starting fishing and ending fishing during an average 24 hour circle.

Number of gears:. This may, for example, be the number of gillnets used, the number of long-lines, etc. It may also be used to give the dimensions of the gear (length of gillnet, number of hooks, etc.)

Number of operations: The average number of gear operations, for example, the number of trawl hauls during a 24-hour period.

Target species: The expected most important species (species group) in terms of value.

Fishing grounds and landing place: This information may be used for calculation of steaming time and/or definition of fleets.

Duration of fishing operation: For trawls, this may be the average duration of a haul; for traps, it may be the soak time.

5.8.7 Form 6: Frame Survey

This form is used primarily when neither a reliable vessels register nor a good coverage by interview forms is available. The main information is the number of vessels by fleet. A frame survey should be a complete enumeration for the geographical area covered. It is not a sample.

Sample Information Box: This box is similar to the sample box for Form 1, except for the three fields: "Direct observation", "Data source" and "Contact person". The frame survey data refer to vessel categories (fleets), not to individual vessels. The frame survey is an inventory list for a "sampling site" (a port, village, district etc.), combined with some characteristics of the vessel category. The frame survey is made for the home port (the place of vessel registration).

Direct observation: (Yes or No). Direct observation means that the enumerator(s) of the sampling programme collected the frame survey data.

Data source: If the enumerators did not obtain the frame survey information by direct observation, this field is used to indicate the data source (local fisheries administration, co-operative, fishing company, etc.)

Contact person: The contact person for the data source.

Spatial Information Box

Province (or State), District, Village and Site: The geographical area covered by the frame survey. If the frame survey covers the entire province, the District, Village and Site field will not be filled in. A site is a part of a village, which is a part of a district, which is a part of a province.

Time Period Covered Box

Period sampled: Start date, End date: The period when the actual data collection took place (may be a single day).

Extrapolation period: Start date, End date: The period for which the frame survey data are assumed to be representative. The "period sampled" is a subset of the "extrapolation period".

Number of Vessels by Category Box: The essential data is the number of vessels in the vessel category (primary data). The other information may be used for the definition of fleets (secondary data). The primary data is used for raising samples of landings to total landings for the geographical area of the frame survey.

Primary data: Vessel type: The vessel type may relate to type of construction, material of construction, size of vessel (vessel length, horse power of engine).

Primary data: Gear type: The gear may be one gear or a combination of gears. Additional information may be adequate to characterise the gear, for example mesh size or length of gear, in which case the form should be extended to cover the additional gear parameters (the leftmost "other" field may be used for that purpose).

Primary data: Number of vessels: This should be the total number of active vessels in the vessel category during the "extrapolation time period". An active vessel must fish at least one day during that period.

Secondary data: Fishing grounds: The primary fishing grounds of the vessel category during the "extrapolation time period".

Secondary data: Average trip duration: The average duration (days or hours) of the trip for the vessel category during the "extrapolation time period".

Secondary data: Target species group: The primary target species (species group) of the vessel category during the "extrapolation time period".

Secondary data: Fishing ground type: This may be sandy or muddy trawling grounds, the surface waters, coral reefs etc.

Secondary data: Number of fishers: Average crew size per vessel for the vessel category in question.

Secondary data: Fleet (Optional): The concept of fleet may be predefined, or it may be post-defined according to a processing of the frame survey data. In the case the fleets are predefined, the fleet may be recorded in this field.

5.8.8 Form 7: Fixed (Annual) Costs By Vessel

The fixed costs are the cost of maintaining the vessel independently of the level of fishing activity (see Section 3.3). The form refers to an individual vessel.

Sample Information Box: This box is similar to the sample box of Form 1.

Vessel/Enterprise Information Box:

Vessel registration number, Homeport, Owner, Skipper: These are the same vessel details as in Form 1

Enterprise: Name of fishing company, co-operative etc. if applicable.

Contact person: The person who may be contacted for further information or verification of data.

Loan Box: This box contains the information on the financing of the purchase of vessel and equipment. The design of the box is very dependent on the local conditions and traditions. The box given here is to be considered one amongst many possible designs.

Credit scheme: Name of provider of loan, e.g. bank, person giving loan (merchant), etc., or name of specific fisheries credit scheme (if applicable).

Total annual payment: The annual instalment and interest.

Rate of interest: The percentage paid annually in interest.

Payment by share of landings: (Yes or No). Whether the owner of the vessel pays the loan in the form of a share of the landings. This sometimes applies to loans given by merchants. In some fisheries, this type of loan may not apply, so the following fields would not appear on the form.

Share of landings: The share of the landings paid as instalments and interest.

Variable costs paid by creditor: (Yes or No) The creditor may provide variable costs (fuel) and gear as a part of the agreement with the fisher.

Costs 1 paid by creditor, Costs 2 paid by creditor: Type of variable cost (for example, fuel) or additional investment (for example, new gear) provided by creditor.

Annual Costs and Subsidies Box: These are costs or subsidies to be paid or received on an annual basis, irrespectively of fishing activities.

Tax: The annual tax or levy to be paid for the vessel.

Subsidy: Fixed annual subsidy, levied irrespectively of fishing activity (for example, subsidy on fuel not included).

Type of subsidy: Cash payment, equipment, gear, services, assistance etc.

Licence fee: The annual fee for fishing licence to be paid for the vessel.

Harbour fee: The annual fee for harbour facilities to be paid for the vessel.

Investments/Depreciation Box: The investment is characterised by the value of the investment, the longevity of the investment, expressed as the % investment depreciation per year. If the investment is expected to last for, say, ten years, the depreciation is 10% per year. The part of the investment to be paid in foreign currency may be indicated.

Engines: The total value of the engines when purchased.

Gear: The total value of the gear(s) when purchased.

Hull: The total value of the hull, hold, cabins etc. when purchased.

Electronics: The total value of the electronic equipment (Radio, navigation equipment, fish-finder, etc.) when purchased.

Freezers: The total value of the freezing installations when purchased.

Annual Costs of Land-Based Support (per Vessel) Box: Operating the vessel usually requires additional support costs. These costs must be obtained by vessel. These costs may relate to the family of the fisher, temporarily hired support staff, or the management and support staff of a company. As the costs may be shared by a group of vessels, some of the costs of land-based activities often have to be estimated.

Salaries: Salaries paid per vessel per year of land-based management and support staff.

Overheads: Overheads paid per vessel per year of land-based support staff.

Investments: Annual investments in land-based facilities per vessel per year (estimate).

Operations costs: Operation costs paid per vessel per year for land-based activities (Storage of equipment, storage of landings, transport etc.).

Insurence Box

Insurance of vessel or crew? (Yes or No). Yes, if any type of insurance related to the fishing activity is provided. Insurance not directly releted to the fishery should not be mentioned (insurence thet should not be included in fixed costs of fishing).

Insurance of vessel per year: Annuel premium for insurance of the vessel and its equipment.

Insurance of personnel per year: Annual premium for insurance of crewmembers.

5.8.9 Form 8: Vessel Registration

The vessel registration form belongs to another category of documents compared to Forms 1-7. There are several edministrative and legal purposes for the registration of vessels, which shall not be discussed in the present context. However, the vessel register cen elso be considered e pert of the fisheries statistics, end ectuelly, it is the "backbone" of many functioning fisheries statistics systems. The basic data collection unit is a "fishing trip" executed by one or e group of vessels, the identification end deteils of which are stored in the "vessel register".

Registration Box

Owners name, Owners address: Full name and address of the primery owner (edditional owners listed in "Owners box")

Name of contact-person: The person to be contacted for information.

Chartered vessel (Y/N)?

Home port: Port of registration.

Main fishing grounds: The intended main fishing grounds (possibly linked to the fishing licence).

Association: Membership of fishers association, if applicable.

Credit scheme: Financing body (moneylender) of the vessel.

Vessel registration number: The unique vessel registration code. No two vessels should have the same vessel registration code. The code should be composed of letters and numbers, where the letters may indicate the homeport or home province of the vessei. If the province structure of e country is changing frequently, the use of province codes in the vessel registration code mey be unfortunete.

Radio call sign: Radio call code used to uniquely identify a vessel.

Name of vessel: The name of vessel painted on the vessel.

Additional vessel registration number (1): In addition to the vessel registretion number assigned by the Directorate of Fisheries, other netional or internationel authorities may register the vessel with a different code for different reasons than the Directorate of Fisheries.

Telephone number, Mobile telephone number: Telephone number of vessel.

Legal basis: The legal basis of the registration.

Type of registration: Fishing vessel (full time/part time), collector vessel, supply-vessel, etc.

Authority of registration: The euthority, which issued the registretion document.

Remarks by "Directorate of fisheries" (Registration Authority): Any information relevant for the vessel registration, which is not covered by the above fields.

Vessel Information Box

Type of vessel: The "vessel type" concept may account for the main gear (trawler, purse seine, etc), and it may account for construction type, the hold type (with ice, with freezer) and other features of the vessel. The "vessel type" will depend on the local situation.

Construction material: Wood, steel, glass fibre, cement etc.

Year vessel built: The year the vessel was delivered from the shipyard.

First year of fishing: The year the vessel started to fish and land the catch.

Ship yard (and number): Name of shipyard, and the number of the construction assigned by the shipyard.

Engine Information Box

First engine, second engine, auxiliary engine: Information on all engines

Year of construction:

Manufacturer: Name of manufacturer.

Year of renovation: Year or last major engine renovation.

Max horsepower: The maximum number of horsepower the engine possibly can exert.

Nominal horsepower: The horsepower exerted with the actual setting of the engine.

Insurance Box

Insurance amount, last insurance assessment (year): The total amount insured (hull, engine, equipment and gears).

Crew Box

Crew number: The average number of crew on an average fishing trip.

Owners Box

Owner (1-7): The primary owner and owners in addition to the primary owner.

Name and address and registration no. of owner: The owner-registration may for example be related to the tax-authority.

Share % - Percent owned of vessel's value: The fraction of the total vessel-value of the additional owners.

Technical Information Box

Registered length for regulation purposes (m), Maximum length (m), Overall length (m), Breath (m), Depth (m), Gross tonnage, Net tonnage: Dimensions of the vessel.

Information on Change of Ownership of Vessel Box

Preceding vessel registration number, Preceding vessels name: The former vessel registration code/number and name of vessel as given in the registration box.

Date of change of ownership: The date the change of ownership was registered in the owner's register.

Date of new registration: The day the change of registration number and name of vessel was registered in the vessel register.

Information on Termination Box

Reason of termination of fishing: The reason may be scrapping of vessel due to old age, decommission, capsize, sale of vessel for non-fishing purpose, etc.

Decommission amount: In case decommission is applied, the amount paid to the owner of the vessel.

Date of termination:

Navigation Speed (Optional) Box.

Navigation speed (knots): The steaming speed (Nautical miles/hour)

Hold (Optional) Box

Hold capacity m^3: The volume of the hold for storage of landings using ice for preservation (excluding the freezing capacity).

Freezing capacity m^3: The volume of the hold for storage of landings using freezing for preservation.

Gear Information (Optional) Box

Gear type 1-4: List of gears in order of importance.

Fishing Grounds Information (Optional) Box

Fishing grounds 1-4: The major fishing grounds or area specified in licence.

Electronic Equipment (Optional) Box

Navigation: Compass, radio navigation, satellite navigation, GPS, etc.

Fish finder: Echo sounder, sonar

Communication: Type of radio, and type of communication, range of equipment.

5.8.10 Forms 1 to 8

Below follow the eight forms as described in the text above:

Form 1

Page [ ] of [ ] page(s)

TRIP-INTERVIEW for catch & effort (1)

(For sample-based approach)

Sample information :

Date (DD-MM-YY)		Province	
Sample Number		Enumerator	
Sample type		Encoder	
Validity of Sample		Sample site	

Comment :

Vessel information :

Vessel Reg. No	
Horse power	
Gear 1	
Gear 2	
Group Fishing	

Gear Characteristics

More inf.

Spatial information :

Sampling location	
Fishing grounds	
Depth (m)	
Statistical Rectangle	
Division of Stat. Rect.	

Landings information :

	Weight of Total Landing (kg)
Landings this sampling site	
	Weight
1st partial landing elsewhere	
2nd partial landing elsewhere	
3rd partial landing elsewhere	

Total landings accounted for (Y/N) [ ]

Name of landing place	Commercial group(s)

Information on discarding

Discard type	Number of operations with/without: Discard	Non-Disc.	Percent discarded (of total Weight)
			%

Effort information

	Effort Type	Effort Value
Effort 1		
Effort 2		

Activity information (not trip-related)

Days in port last month [ ] Days fishing last month [ ] Days of shelter at sea last month [ ]

Information on commercial groups

	Commercial species group	Size	Treat-ment	Weight (kg)	Price/Kg	Total value	Spec. Comp.
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
12							
12							
12							
12							
12							

More commercial groups (continued on new page) [ ]

Vessel details

Used for validation/update of vessel register (Optional)

Owner	
Ownership type	
Registration port	
Fleet	
Length	
Tonnage	
Number of Crew	

Is there Cost/Trip information (form 4)? [ ]

Comment

Form 2

Page | | of | | page(s)

SPECIES COMPOSITION OF COMMERCIAL GROUP

2

Date (DD-MM-YY)		Province		Sample Number (Form 1)		Enumerator	

Commercial species group	Size	Treat-ment	Sample Weight (kg)

	Species name	Sample Weight (kg)	Number of specimens	Length frequency sample	sample number
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

More species (continued on next table)

Comment

...

Form 3

Page | | of | | page(s)

LENGTH FREQUENCY

3

Date (DD-MM-YY)		Province		Sample Number of form 1		Enumerator	
				Sample Number of form 2			

Species name	Length unit	Length measurement type	sample weight	Female	Male	Both

		Total	Weight (kg)
0		17	,
1			,
2			,
3			,
4			,
5			,
6			,
7			,
8			,
9			,
0			,
1			,
2			,
3			,
4			,
5			,
6			,
7			,
8			,
9			,

More length groups (continued on new page)

Comment

Form 4

Page | | of | | page(s)

VARIABLE COSTS & EARNINGS / TRIP
ADDITIONAL TRIP INFORMATION

4

Date (DD-MM-YY)		Province		Sample Number (form 1)		Enume-rator		Vessel Reg. No	

Mate vessel(s)

Mate Vessel 1 Reg. No		Mate Vessel 2 Reg. No		Mate Vessel 3 Reg. No		Mate Vessel 4 Reg. No	

Additional trip information

Date Sailed		Date Landed		Time Sailed		Time Landed		Steam time	
Expected trip duration	days	Ice used		Fuel used		Fuel type		Target species (group)	
Damage/loss (Estimate)									

Trip (variable) costs depending on effort

Ice	
Fuel	
Lubrication	
Water	
Food	
Bait	
Assistance	

Sharing of earnings

Total Value of landings		Vessels share	%	
Subtraction 1		Captains share	%	
Subtraction 2		Crew share	%	
Subtraction 3		Captains wage		
Divisible earning		Crew wage		

Transfer at sea (Y/N)

Offload:

Offload Vessel Reg. No.		Weight Offload	Value Offload
Comm. Group 1		Kg	
Comm. Group 2		Kg	
Comm. Group 3		Kg	
Comm. Group 4		Kg	
Comm. Group 5		Kg	

Onload:

Onload Vessel Reg. No.		Weight Offload	Value Offload
Comm. Group 1		Kg	
Comm. Group 2		Kg	
Comm. Group 3		Kg	
Comm. Group 4		Kg	
Comm. Group 5		Kg	

More information on transfer (new page) ?

Repair / maintenance cost

Engines	
Fishing Gear	
Deck equipment	
Electronics	
Processing/ Freezing	

Trip (variable) costs depending on value or weight of landings

Auction fee	
Tax	
Subsidy	
Consignment fee	

Information on sale by commercial groups

	Commercial species group	Size	Treat-ment	Weight (kg)	Price/Kg	Buyer
1						
2						
3						
3						
5						
6						
6						
8						
9						
10						
11						

More information on sale by commercial groups (continued on new page) ?

Skippers performance

Skippers experience	yr
Is logbook used ?	
Type of logbook	
Type of other recording	

Vessel details

Used for validation/update of vessel register (Optional)

Year vessel built			yr
Vessel construction type			
Hold capacity			
Engine	yr	make	HP
Main			
Second			
Auxiliary			

Comment

Form 5

Page		of		page(s)

FISHING ACTIVITY IN BASE PORT

(One Vessel Category - Fleet)

For sample-based approach

5

Sample Information :

Date (DD-MM-YY)		Province	
Sample Number		Enumerator	
Sample type		Encoder	
Validity of Sample		Sample site	

Comment :

Time period

From (date)	
To (date)	
Number of days	

Fleet information

Vessel type	
Gear	
Fleet (optional)	

Basic activity data

Vessel Registration No.	Vessel homeport			One or more Trips					Port Registration		Additional infor.
	Province of registration	Home-port	Name of skipper	Number of days steaming	Number of days away from port	Number of fishing days	Number of days in shelter	Number of trips	Start date	End date	

Additional information (Optional)

Vessel Registration No.	Start time (hour)	End time (hour)	Number of gears	Num-ber of operations/day	Target species	Fishing grounds	Landing place	Duration of operation

Comment

Form 6

Page		of		page(s)

FRAME SURVEY IN HOMEPORT (6)
(port of registration)
for sample-based approach

Sample Information

Date (DD-MM-YY)		Province	
Sample Number		Enumerator	
Sample type		Encoder	
Validity of Sample		Direct observation	
Sample site			

Data source	
Contact person	

Comment :

Spatial Information :

Province	
District	
Village	
Site	

Time period covered

Period sampled

Period	
Start date	
End date	

Extrapolation period

Period	
Start date	
End date	

Number of vessels by category

Primary data			Secondary data						
Vessel type	Gear type	Number of vessels	Fishing grounds	Average trip duration	Target species (sp. group)	Group fishing type	Number of fishers	Fleet (Optional)	Other

Comment :

More frame survey data (continued on new page) ☐

...

Form 7

Page		of		page(s)

FIXED (ANNUAL) COSTS BY VESSEL (7)

Sample Information :

Date (DD-MM-YY)		Province	
Sample Number		Enumerator	
Sample type		Encoder	
Validity of Sample			
Sample site			

Comment :

Vessel/enterprise information

Vessel Reg. No	
Home port	
Owner	
Skipper	
Enterprise	
Contact person	

Loans

Credit scheme	Total Annual payment	Rate of interest
		%
		%
		%
		%

Payment by share of landings	☐
Share of landings	

Variable costs paid by creditor	☐
Costs 1 paid by creditor	
Costs 2 paid by creditor	

Comments

Annual Costs and subsidies

Tax	
Subsidy	
Type of subsidy	
License fee	
Harbour fee	
Other fee	

Annual Costs of landbased support (per vessel)

Salaries	
Overheads	
Investments	
Operations costs	

Investments/depreciation

	Value	Depreciation	% in foreign currency
Engines		%/yr	%
Gear		%/yr	%
Deck equipment		%/yr	%
Hull		%/yr	%
Electronics		%/yr	%
Freezers		%/yr	%
Other		%/yr	%

Insurance

Insurance of vessel or crew ?	☐
Insurance vessel/year	
Insurance persons/year	

Comment :

Form 8

VESSEL REGISTRATION (8)

Registration

Owners Name	
Owners Address	
Name of contact-person	
Address of contact-person	
Ownership type	
Chartered vessel	☐
Home port	
Main fishing grounds	
Association	
Credit scheme	

Vessel Registration Number	
Radio signal	
Name of vessel	
Additional Registration No. (1)	
Additional Registration No. (2)	

Telephone No.	
Mobile Telephone No.	

Legal basis	
Type of registration	
Authority of registration	

Remarks by "Directorate of Fisheries" (Registration Authority)

Date: Signature:

Vessel information

Type of vessel	
Construction material	
Year vessel built	
First Year of Fishing	
Ship yard (and number)	

Technical information

Registered length for regulation purposes (m)	
Maximum length (m)	
Overall length (m)	
Breath (m)	
Depth (m)	
Gross tonnage	
Net tonnage	
V	
Y	
X	
Z	

Gear information (optional)

Gear type 1	
Gear type 2	
Gear type 3	
Gear type 4	

Engine information

	First engine	Second engine	Auxiliary engine
Year of Construction			
Number of engine			
Make			
Year of renovation			
Max Horse Power			
Nominal Horse Power			

Information on change of ownership of vessel

Preceding vessel registration No.	
Preceding vessel name	
Date of change of ownership	
Date of new registration	

Information on termination

Reason of termination of fishing	
Decommission amount	
Date of termination	

Fishing grounds information (optional)

Fishing grounds 1	
Fishing grounds 2	
Fishing grounds 3	
Fishing grounds 4	

Insurance

Insurance amount	
Last insurance assessment (year)	

Crew

Crew number	

Owners

Owner	Name and address Owner Reg. No.	Share (%)
1		
2		
3		
4		
5		
6		
7		

Navigation speed (optional)

Speed	Knots

Hold (optional)

Hold capacity	m^3
Freezing capacity	m^3

Electronic equipment (optional)

Navigation	
Fish finder	
Communication	

Comment:

6 DATABASES AND DATA MANAGEMENT

This section introduces the concept of a relational database, illustrated by a hypothetical fisheries example.

A database is used to store the "raw data". That means that pre-processing of data should not occur. For example, the interview data to be entered in the database are exactly the same values as those written in the interview forms by the enumerator. All processing of data should be executed by the database system. If processed data are entered, the tracing of errors – validation of data – becomes difficult if not impossible. In addition, re-analysis of pre-processed data may be impossible.

It is important to develop the database simultaneously with the development of the data collection programme, as the database acts as a check on the consistency of the data collection programme. The database will show if the programme actually produces the expected output. The database will also help in the search for the best stratification.

A "database" consists of **"Tables"**, **"Forms"** and **"Reports"**. These three main components are linked by aid of **"Relations"** and **"Queries"**. Below follows a very brief introduction to these basic concepts. For a more comprehensive introduction, the reader is referred to textbooks on databases (e.g. Arte 1988 and Date 1995).

6.1 TABLES, RELATIONS AND QUERIES

The "tables" are the containers of the data, the "forms" are the tools used to interact with the database and the "Reports" are the output produced by the database. A table has "rows" (records) and "columns" (fields). As an example, a part of the list of province names is shown, which has 2 columns.

Name	**Letter**
Quang Ninh	QN
Hai Phong	HP
Thai Binh	TB
Nam Ha	NH
....	....
....	....
....	....
Kien Giang	KG

The number of "Records" equals the number of coastal provinces of Viet Nam. A row is called a "record", and each of them contains 2 "fields".

You may also consider the fields as the columns. The fields of the records in "Province Name Table" are:

"Name" = The name of the province

"Letter" = The code letters for the province.

Tables A and B below contain some basic fisheries landing statistics, which might originate from the trip-interview forms.

The fields in the records are given "names" and the fields of these two tables are:

TABLE A: TRIP DETAILS AND TOTAL LANDINGS: NAME OF FIELD	Field type
Vessel Registration Code	*Key, text*
Date of sampling	*Key, date*
Name of Landing Place	*Key, text*
Type of Landing Place	Text
Name of Gear	Text
Total landings in Kg	Number

TABLE B: LANDINGS BY COMMERCIAL SPECIES GROUP NAME OF FIELD	Field type
Vessel Registration Code	*Key, text*
Date of sampling	*Key, date*
Name of Landing Place	*Key, text*
Commercial Species Group	*Key, text*
Weight of commercial species group	Number

TABLE A: FISHING TRIP DETAILS AND TOTAL LANDINGS

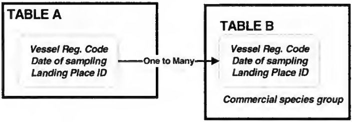
Vessel Registration Code (Key)	*Date of sampling (Key)*	*Name of landing place (Key)*	Type of landing place (text)	Name of gear (text)	Total landings in Kg (number)
QN4711	*11-3-1997*	*Hong Gai*	Jetty	Bottom Trawl	132
NA9990	*15-3-1997*	*Hong Gai*	Jetty	Bottom Trawl	423
NA9990	*20-3-1997*	*Cua Lo*	Beach	Bottom Trawl	197
KH2345	*17-3-1997*	*Xom Bong*	Quay	Tuna Long Line	530
KH1900	*17-3-1997*	*Xom Bong*	Quay	Tuna Long Line	401
MH1234	*24-3-1997*	*Cua Lo*	Beach	Gillnet	514

TABLE B: LANDINGS BY COMMERCIAL SPECIES GROUP

Vessel Registration Code (Key)	*Date of sampling (Key)*	*Name of Landing Place (Key)*	*Commercial Species Group (Key)*	Weight of Landings (number)
QN4711	*11-3-1997*	*Hong Gai*	*Small fish*	75
QN4711	*11-3-1997*	*Hong Gai*	*Large fish*	32
QN4711	*11-3-1997*	*Hong Gai*	*Small shrimps*	10
QN4711	*11-3-1997*	*Hong Gai*	*Large shrimps*	15
NA9990	*15-3-1997*	*Hong Gai*	*Small fish*	223
NA9990	*15-3-1997*	*Hong Gai*	*Large fish*	200
NA9990	*20-3-1997*	*Cua Lo*	*Small fish*	97
NA9990	*20-3-1997*	*Cua Lo*	*Large fish*	75
NA9990	*20-3-1997*	*Cua Lo*	*Small shrimps*	13
NA9990	*20-3-1997*	*Cua Lo*	*Large shrimps*	12
KH2345	*17-3-1997*	*Xom Bong*	*Small fish*	230
KH2345	*17-3-1997*	*Xom Bong*	*Large fish*	300

The fields are of different data types. We shall come back later to this topic, but here we shall only note that some fields are **"key-fields"** and other are "non-key-fields". Bold Italics indicate the key fields. The combination values of a set of keys (i.e. three key fields in Table A and four key fields in Table B) is unique. That means that no two records in the database can have the same combination of (***Vessel Registration Code, Date of Sampling, Name of Landing Place)***.

This example also illustrates the concept of **"Relations"** and **"Queries"**. Here the relation between the two tables is that for each combination of (***Vessel Registration Code, Date of sampling, Name of Landing Place)*** in Table A, there are zero, 1 or more records in Table B with the same first three keys, namely one for each observation of the fourth key, ***Commercial Species Group.***



A "query" is (for example) to join the two tables together into one big table containing all the data from a trip in one row (see below). The query in this case matches the records, which have the first same value of the three first keys. Furthermore, it groups the records so that rows with identical first three keys are together. This is just one example of what a "query" can do. When designing a data collection programme, it is important that the database designers are involved, to secure compatibility of database and interview forms.

Vessel Registration Code (Key)	***Date of sampling (Key)***	***Name of landing place (Key)***	Type of landing place (Text)	Name of Gear (Text)	Total landings in Kg (Number)	***Commercial Species Group (Key)***	Weight of Landings (Number
QN4711	***11-3-1997***	***Hong Gai***	Jetty	Bottom Trawl	132	***Small fish***	75
QN4711	***11-3-1997***	***Hong Gai***	Jetty	Bottom Trawl	132	***Large fish***	32
QN4711	***11-3-1997***	***Hong Gai***	Jetty	Bottom Trawl	132	***Small shrimps***	10
QN4711	***11-3-1997***	***Hong Gai***	Jetty	Bottom Trawl	132	***Large shrimps***	15
NA9990	***15-3-1997***	***Hong Gai***	Jetty	Bottom Trawl	423	***Small fish***	223
NA9990	***15-3-1997***	***Hong Gai***	Jetty	Bottom Trawl	423	***Large fish***	200
NA9990	***20-3-1997***	***Cua Lo***	Beach	Bottom Trawl	197	***Small fish***	97
NA9990	***20-3-1997***	***Cua Lo***	Beach	Bottom Trawl	197	***Large fish***	75
NA9990	***20-3-1997***	***Cua Lo***	Beach	Bottom Trawl	197	***Small shrimps***	13
NA9990	***20-3-1997***	***Cua Lo***	Beach	Bottom Trawl	197	***Large shrimps***	12
KH2345	***17-3-1997***	***Xom Bong***	Quay	Tuna Long Line	530	***Small fish***	230
KH2345	***17-3-1997***	***Xom Bong***	Quay	Tuna Long Line	530	***Large fish***	300
KH1900	***17-3-1997***	***Xom Bong***	Quay	Tuna Long Line	401	No data	No data
MH1234	***24-3-1997***	***Cua Lo***	Beach	Gillnet	514	No data	No data

6.2 FORMS OF DATABASE

The **"forms"** are the tools for all communication with the fisheries database. The "soft-forms" are the screen pictures through which you communicate with the database.

It is important that the forms are designed so that the data entry is "friendly" to the encoder. The paper interview forms should not be too different from the "soft form". The encoders with their accumulated experience should contribute to the design of the database forms. Forms could also be developed for "palm-top" computers for direct field entry.

The forms are composed of "controls" and "text-boxes". The "controls" are the tools used for communication with the computer and the "text-boxes" are used for giving information to the user. Controls may be the "scroll-bars" and the "toolbars". When you click on a control, it is in "focus". Only when a control is in focus you can use it.

This section, as an example, shows a small collection of forms from the "VIETFISHBase". The commercial software behind VIETFISHBase is MS ACCESS, the database of Microsoft Office. Note that this particular choice of commercial software does not imply any recommendation on its suitability for fisheries databases from the side of the author or FAO. Many other databases could be used1.

The first form you see when starting the system is the "logon form" (Fig. 6.2.1), where you tell who you are, and then the system checks your status as user (i.e. the privileges you have as a user). For example, only a restricted number of operators will possess the right to change the program or to change the "look-up-tables". The password is a secret code, only known by the user and the administrators. After the log-in form, you enter the main menu of the database (which is not shown). There are several items in the main menu of VIETFISHBase, which will not be discussed here. In this example, we shall use only one item from the main menu, namely the interviews main form, which is used for entry of data from hard forms or editing existing data. As an example of a well-designed data entry form, the "interview form" of VIETFISHBase is shown (Fig. 6.2.2).

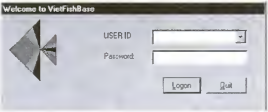


Figure 6.2.1 Log-on form

The controls for data entry are either "boxes" where you can enter data from the keyboard, or they are "list-boxes" where you can select the data from a "look-up-table".

The "interview form" is shown in Figure 6.2.2 as it appears on the computer screen. The interview form and its sub-forms are designed to handle all the data from a "fishing trip". Only part of the elements of the interview form will be explained, as the purpose here is not to give a complete introduction to VIETFISHBase, but to use it as example of form design.

1 MS Access is only suitable for relatively small databases. You should review the software available with expert help and choose one suitable for the data collection programme envisaged.

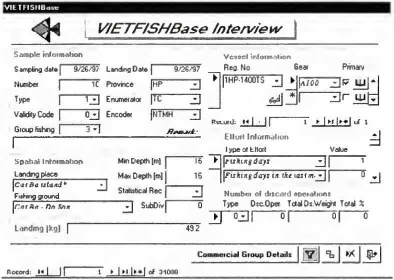


Figure 6.2.2 The interview form of VIETFISHBase.

In the design of this interview form, it has been attempted to include as much as possible in one screen, without making the form too complex. Furthermore, it has been attempted to make the data entry as safe as possible, by using look-up tables to fill in the fields, whenever possible.

The interview form is the first form in a hierarchy of forms, and to enter the complete set of interview data, the forms in the following levels of the hierarchy must be activated.

The interview form is composed of one main form, "Sample information" and five sub-forms:

1. Vessel information (which fishing vessel and which fishing gear);
2. Spatial information (where did fishing take place, and where did landing take place);
3. Effort information (what was the fishing effort, e.g. days away from port);
4. Number of discard operations (what was discarded);
5. Landings (what was the total weight of the landings).

The five sub-forms cannot be filled in before the sample information form is filled in. It is possible to omit the sub-forms, although at least one of the sub-forms, the Vessel information sub-form, must be filled in to make the record meaningful.

It may not be straightforward to find a specific interview in a set of interviews. (There were 34088 interviews in the database when this material was selected for illustration.)

The database has a special facility to search for a specific interview, or to "filter" the interviews, leaving only a sub-set of interviews, which satisfy certain conditions, for example, only interviews from Hai Phong province. You activate the search facility by the "binocular-control", depicted on the left.

The "Copy" record is useful, because many of the data a particular encoder enters are the same for subsets of records. For example, the name of the landing place remains the same, for all interviews from that landing place. The "copy record" allows the encoder to change the data that differs between records, rather than type the record in again each time.

The delete control deletes the interview record.

Sample information form: This form does not contain any direct information on the fishery or the landings, only information on when, where and by whom the data sample was collected.

The encoder will not enter the name of the province from the keyboard, but selects it from a look-up table. The names of the enumerator and the encoder are also selected from look-up tables. Thus, only encoders and enumerators in the look-up table can be entered in these fields. This check of encoders is necessary for the security of the database.

Vessel information sub-form: This form is used to identify the vessel(s), which performed the fishing trip, and the gear(s) it used. The first information to enter is the registration number of the fishing vessel, therefore this form may also be used for control and updating of the central vessel register. It also alklow for entry of data on the gear.

Spatial information sub-form: This contains the name of the landing place and the location of the fishing ground, either by name or in the form of a "statistical rectangle" (rectangles of 30X30 = 900 square nautical miles) or subdivision of a statistical rectangle (9 divisions of each 100 square nautical miles). All statistical rectangles have a code. Also the depths (max and min) at the fishing grounds can be entered.

The landing place is selected from a look-up table, which also contains information on the position of the landing place (the division of a statistical rectangle), so that this combined with the fishing ground can be used to compute the distance between the two. The fishing grounds are also selected from a look-up table. All fishing ground names in this look-up table are defined by another table, which contains information on which statistical rectangles (or divisions) correspond to a fishing ground.

Effort information sub-form: The effort measurement may be of several types, but the most common one is the number of days away from port. In addition, the level of fishing activity (the effort per month), here measured as the number of days actively fishing during the last month, is entered in this sub-form. The interviews should preferably contain both the fishing days and the fishing activity during the last month.

Number of discard operations sub-form: "Discards" are catches not landed but returned to the sea because of limited hold capacity or low value of the catch. The discard information is given by the type of discard (all fish discarded, only low value discarded, etc.) and the number of discard operations "Dsc.Oper", (say trawl hauls) and the estimated % of total weight "Dsc Weight", which is discarded.

The **Interview form** is the first in a hierarchy of three forms to record the landings, at various levels of details. Clicking the mouse on the button **"Commercial group Details"** brings you the pop-up sub-sub-form for entry of information about the commercial groups.

6.3 THE USE OF CODES

Codes are abbreviations for names, which makes it easier to identify the correct item in a long list. Codes also make it easier to search in a database for groups of data. A well-designed code system will facilitate the administration of large sets of data.

There is no general agreement on a universal codes system for fisheries data. One good reason is that many code systems are based on the local language, and match a special feature of the fisheries sector of the country in question. However, even international codes for data exchange are not yet standardised, although several attempts have been made to introduce international standards.

6.3.1 The Use of Unique Keys

Codes should be "keys", that is, every value of a code must be unique. Once you use a code, there can be only one way to interpret it. For example, a vessel registration code should refer to only one vessel. A computerised relational database system will ensure that no two values of a "key" are the same. If, for example, you try to enter an already existing vessel registration code, the system will give an error message. Species codes are probably the most complex types of codes in a fisheries database.

The "keys" are used to establish consistent relations between the tables in a database. Some keys of a database are just unique numbers, where the actual value is arbitrary (e.g. a serial number given to an interview record). Other keys, like the species codes, are given names, which should make it possible to extract sub-sets of data. This section deals with the type of keys that have been assigned values indicating a meaning.

All the keys should have the same length, measured in number of characters, to facilitate the extraction of data.

6.3.2 Codes for International Exchange of Data

A code system used for international exchange of data needs to meet standards different from those of a national code system. In the following, some suggestions are discussed for international exchange codes for species identification, but the author is not in a position to recommend any particular code.

Scientific Species Name: The scientific name is of variable length, which is not suitable for a code. Taxonomy is a fluid science and scientific names may change significantly, which would complicate future data exchanges. Furthermore some species have more than one scientific name (synonyms) and this can cause confusion.

Common Species Name: The majority of fish have a common name, but this name varies depending on the language spoken and/or the country. The same name can often be used for many species as for commercial group categories, and its meaning may vary from place to place. Rare species may not have a common name. Common names are not suitable for exchange of data.

FAO Species Codes: FAO has developed the International Standard Statistical Classification of Aquatic Animals and Plants (ISSCAAP). This has two components:

A three-letter code based on the common name, which is used at an administrative level to report catches of commercial fish. It is not widely used within the scientific community.

A 10-character numeric, fixed field, hierarchical code.

The alpha code does not enable any taxonomic data to be encoded.

RUBIN (RoUtine for Biological INformation): The Nordic Code Centre (a division of the Swedish Museum of Natural History) created two systems. Firstly, there is the Rubin Code, which is based on the first four letters of the genus plus a space plus the first three letters of the species (e.g. "Gadus morhua" gives "GADU MOR"). These eight characters are followed by a further two characters which are used for computer storage and handling.

The Nordic Code Centre also produced a 12 digit numeric system - the Rubin Number. This system consists of a proceeding digit to separate biological and non-biological parameters, followed by a 10 digit code to identify the species, followed by a final digit to signal the version number.

CLOFNAM: The most comprehensive texts on fish identification in the NE Atlantic are 'Checklist Of the Fishes of the Northeastern Atlantic and of the Mediterranean' (CLOFNAM) and `Fishes of the Northeastern Atlantic and the Mediterranean` (FNAM), both published by UNESCO.

In 1965 a panel of experts was convened and asked to produce an extensive generic listing of fish in European waters. This listing was first published in 1973 as the CLOFNAM code. As a logical follow up it was decided to publish descriptions of the fauna with keys, diagnoses and illustrations and FNAM was published in 1984. Practically every species liable to be encountered in this area is described in FNAM and given a code first determined in CLOFNAM. This code is hierarchical because it is based on the taxonomic position of the species and is alpha/numeric in structure. For example, the codes for three species are:

Lampetra fluviatilis	1.2.1
Callionymus fasciatus	163a.1.3
Sciadonus cryptophthalmus	174.2.1

The disadvantages are: the codes have variable length, alpha/numeric codes are not easy to sort and they are only revised about every 10 years. Some species have two codes whilst a debate is held over their exact taxonomic position. An additional complication is that this code is limited to fish species an that it does not include invertebrates.

NODC-CODE (National Oceanographic Data Center Taxonomic Code): The NODC code system, is probably the most recognised species code system. It is used by ICES and its member countries. The system was originally developed for North America. The start was "A Taxonomic Code for the Biota of Chesapeake Bay" published in 1972 at the Virginia Institute of Marine Science (VIMS). The VIMS codes contained a maximum of 10 digits with each two digits representing a different level of the systematic hierarchy. During 1974 and 1975 the University of Alaska developed a taxonomic code in order to manage biological data for the Alaskan Outer Continental Shelf Environmental Assessment Program (OCSEAP). These codes, known as the "Alaska Species Codes" were based on the VIMS numeric concept, but used a completely different numerical sequence.

Following the publication of the Alaska Species Codes, the National Oceanographic Data Center produced a taxonomic code into which virtually any existing taxon could be placed. The first version of the NODC Taxonomic Code was issued in 1977.

The NODC Taxonomic Code contains a maximum of 12 digits and each code number is partitioned into a series of 2 digit couplets. Each couplet represents one or more levels of the taxonomic hierarchy (Table 6.3.1).

Table 6.3.1 Example NODC code representing taxonomic hierarchy.

NODC Code	Number of digits	Level of the taxonomic hierarchy
93	2	Subkingdom, Phylum, Subphylum, Class, Superorder, Order
9301	4	Superclass, Class, Subclass, Superorder, Order, Suborder, Infraorder, Section, Superfamily
930101	6	Class, Order, Suborder, Family, Subfamily
93010101	8	Genus
9301010101	10	Species
930101010101	12	Subspecies

The NODC code has been expanded to accommodate more taxa, which gave problems especially when a taxon was re-classified. The subsequent re-coding was time consuming and complicated the data management. Relational database management systems now allow for efficient searches and retrievals to be conducted without the need for taxonomic information in the codes. For these reasons, the NODC Taxonomic Codes released in June 1996 (version 8.0) will be the last release of a system based on a hierarchical system. The NODC will continue to publish and maintain this system for the foreseeable future, but no additions or modifications will be made to version 8.0. The NODC Taxonomic Code is the most widely used of all the various coding systems developed during the last two decades. Although the National Oceanographic Data Center is not developing the NODC code further, they are still developing and maintaining a system of encoding data (Table 6.3.2). In 1996 NODC introduced the "Taxonomic Serial Number" (TSN). This system comprises of a non-intelligent' code (i.e. the code will not be hierarchical based) whereby taxa are assigned a unique serial number. This serial number remains with the taxon even though the taxon itself may go in or out of synonymy or be entirely reclassified.

Table 6.3.2 Examples of exchange species codes

Scientific Name	NODC Code	TNS Code	CLOFNAM Code
Acipenser	8729010100	161065	28.1
Acipenser gueldenstaedti	8729010108	161073	28.1.2
Anguilla	8741010100	161126	71.1
Anguilla anguilla	8741010102	161128	71.1.1
Beryx	8810050100	166154	112.1
Melanogrammus	8791031300	164743	101.6
Melanogrammus aeglefinus	8791031301	164744	101.6.1
Paraconger	8741120500	161368	82.4
Paraconger macrops	8741120503	161371	82.4.1
Saurida	8762020300	162407	51.2
Saurida undosquamis	8762020308	162417	51.2.1
Scomber	8850030300	172411	156.1
Scomber japonicus	8850030301	172412	156.1.2
Scomber scombrus	8850030302	172414	156.1.1
Cephalaspidea	5110000000	76047	NA, Only fish
Cephalopoda	5700000000	82326	NA, Only fish
Penaeus	6177010100	203624	NA, Only fish

There are codes for many different types of data. Here we shall only mention one more code system, namely the codes for fishing gears. FAO has developed a code system for fishing gears as shown in Table 6.3.3. This system is internationally accepted as the standard for exchange of data.

It should be noted that conversion from one type of code to another type of code, usually is not a big problem for modern database software. Hence, the development of a local code system will not create problems as long as the codes can be readily converted to international exchange standards

Table 6.3.3 Examples of exchange codes for fishing gears. International classification of types of fishing gear (ISSCFG) FAO-1980.

	Category of gear	abbre-viation	Code ISSCFG		Category of gear	abbre-viation	Code ISSCFG
1	**SURROUNDING NETS**		01.0.1	**38**	**FALLING GEAR**		06.0.0
2	*With purse lines (purse seines)*	PS	01.1.0	39	*Cast nets*	FCN	06.1.0
3	*One vessel operated purse seines*	PS1	01.1.1	40	*Falling gear (not specified)*	FG	06.9.0
4	*Two vessels operated purse seines*	PS2	01.1.2	**41**	**GILLNETS AND ENTANGLING NETS**		07.0.0
5	*without purse lines (lampara)*	LA	01.2.0	42	*Set gillnets (anchored)*	GNS	07.1.0
6	**SEINES**		02.0.0	43	*Drift nets*	GND	07.2.0
7	*Beach seines*	SB	02.1.0	44	*Encircling gillnets*	GNC	07.3.0
8	*Boat or vessel seines*	SV	02.2.0	45	*Fixed gillnets (on stakes)*	GNF	07.4.0
9	*Danish seines*	SDN	02.2.1	46	*Trammel nets*	GTR	07.5.0
10	*Scottish seines*	SSC	02.2.2	47	*Combined gillnets-trammel nets*	GTN	07.6.0
11	*Pair seines*	SPR	02.2.3	48	*Gillnets and entangling nets (not specified)*	GEN	07.9.0
12	*Seine nets (not specified)*	SX	02.9.0	49	*Gillnets (not specified)*	GN	07.9.1
13	**TRAWLS**		03.0.0	**50**	**TRAPS**		08.0.0
14	*Bottom trawls*		03.1.0	51	*Stationary uncovered pound nets*	FPN	08.1.0
15	*Beam trawls*	TBB	03.1.1	52	*Pots*	FPO	08.2.0
16	*Otter trawls 1)*	OTB	03.1.2	53	*Fyke nets*	FYK	08.3.0
17	*Pair trawls*	PTB	03.1.3	54	*Stow nets (swing nets)*	FSN	08.4.0
18	*Nephrops trawls*	TBN	03.1.4	55	*Barriers, fences, weirs, etc.*	FWR	08.5.0
19	*Shrimp trawls*	TBS	03.1.5	56	*Aerial traps*	FAR	08.6.0
20	*Bottom trawls (not specified)*	TB	03.1.9	57	*Traps (not specified)*	FIX	08.9.0
21	*Midwater trawls*		03.2.0	**58**	**HOOKS AND LINES**		09.0.0
22	*Otter trawls*	OTM	03.2.1	59	*Handlines and pole-lines (hand operated) 2)*	LHP	09.1.0
23	*Pair trawls*	PTM	03.2.2	60	*Handlines and pole-lines (mechanised)*	LHM	09.2.0
24	*Shrimp trawls*	TMS	03.2.3	61	*Set longlines*	LLS	09.3.0
25	*Midwater trawls (not specified)*	TM	03.2.9	62	*Drifting longlines*	LLD	09.4.0.
26	*Otter twin trawls*	TT	03.3.0	63	*Longlines (not specified)*	LL	09.5.0
27	*Otter trawls (not specified)*	OT	03.4.9	64	*Trolling lines*	LTL	09.6.0
28	*Pair trawls (not specified)*	PT	03.5.9	65	*Hooks and lines (not specified) 3)*	LX	09.9.0
29	*Other trawls (not specified)*	TX	03.9.0	**66**	**GRAPPLING AND WOUNDING**		10.0.0
30	**DREDGES**		04.0.0	67	*Harpoons*	HAR	10.1.0
31	*Boat dredges*	DRB	04.1.0	**68**	**HARVESTING MACHINES**		11.0.0
32	*Hand dredges*	DRH	04.2.0	69	*Pumps*	HMP	11.1.0
33	**LIFT NETS**		05.0.0	70	*Mechanised dredges*	HMD	11.2.0
34	*Portable lift nets*	LNP	05.1.0	71	*Harvesting machines (not specified)*	HMX	11.9.0
35	*Boat-operated lift nets*	LNB	05.2.0	**72**	**MISCELLANEOUS GEAR 4)**	MIS	20.0.0
36	*Shore-operated stationary lift nets*	LNS	05.3.0	**73**	**RECREATIONAL FISHING GEAR**	RG	25.0.0
37	*Lift nets (not specified)*	LN	05.9.0	**74**	**GEAR NOT KNOWN OR NOT SPECIFIED**	NK	99.0.0

1) Fisheries egencles may indicate side and stem bottom and side and stem midwater trawls, as OTB-1 and OTB-2 and OTM-1 and OTM-2, respectively. 2) Including jigging lines. 3) Code LDV for dory-operated line gears will be maintained for historical data purposes. 4) This item includes: Hand and landing nets, drive-in nets, gathering by hand with simple hand implements with or without diving equipment, poisons and explosives, trained animals, electric fishing.

6.3.3 Codes for National Fisheries Data Collection

The national code system suggested below is based on the author's experience in setting up a data collection programme and database for Viet Nam's marine capture fisheries. The code system was decided upon by the data managers of this particular data collection programme, therefore it would not necessarily be appropriate anywhere else. Nevertheless, the system presented here serves to illustrate the issues surrounding the development of a code system.

The code system should always be bilingual, (unless English is the first language of the country in question). In the presentations, first priority should be given to the national language. It is however, important for the exchange of data that translations into English exist. The example of a code system given below, had all descriptions of codes both in English and Vietnamese language, but the codes were based on English (for species, the scientific names in Latin). In the original versions of the codes given below, the description of all codes was given both in Vietnamese and English.

The codes are alphanumeric strings. The general structure of code often used is **"MSX(N)"**, where

M = Major group,

S = Subdivision of major group,

X = Indication of specific features.

N = Indication of further details, if required

Each part of the code may consist of one or more characters.

Code for Fishing (or "Home") Ports: The code for fishing port, landing place (or "home port") has seven characters and the general structure: "PDX", where

P = Province, D = District (abbreviation), X = Town or village (abbreviation)

Code for Fishing Vessels (Vessel Register):

The Official Vessel Registration code reads "PNZ", where

P = province code, or home port code, N = Numerical, Z = Authority of registration (optional)

Some vessels however, may not be officially registered with the code above. This applies in particular to smaller vessels. It may therefore be necessary to introduce an extended vessel registration system, so those vessels that have been sampled but do not have a registration code, can be entered in the database.

Code for Fishing Grounds and Landing Places (Spatial Information)

For the definition of a "statistical rectangle", see Section 4.2.

The format of the code for a statistical rectangle is

XNN (or XNN0) where X = A,B,.... (from west to east) and N = 1,2,... (from north to south)

The format of the code for a subdivision of a statistical rectangle is

XNNs where s indicates the subdivision, s = 1,2,...,9.

One important objective of using statistical rectangles is to convert geographical data from the fisheries database into maps using GIS (Geographical Information System).

Table 6.3.4 Example fishing ground codes. Overall structure of the code for fishing grounds is: XxNNNN, where Xx = Type of area, NNNN = "Indication of name". For certain types of fishing grounds (e.g. waters bordering islands, reefs, banks, see example) the code is numerical: IxNNN, x = 1,2,3,4,5,6,7,8 where the number indicates the compass directions.

X	Description	NNNN	Description
A	Archipelago (fishing grounds around several islands)	NNNN	Abbreviation of name
Ax	*x = 1,2,3,4,5,6,7,8 defined as for islands (see example below)*		
B	Bank	NNNN	Abbreviation of name
Bx	*x = 1,2,3,4,5,6,7,8 defined as for islands (see example below)*		
C	Coral reef	NNNN	Abbreviation of name
Cx	*x = 1,2,3,4,5,6,7,8 defined as for islands (see example below)*		
D	Depth strata	dddd	Mean depth of depth strata
F	Other Fishing grounds	NNNN	Abbreviation of name
Fx	*x = 1,2,3,4,5,6,7,8 defined as for islands (see example below)*		
I	Island *(fishing grounds around an Island)*	NNN	Abbreviation of name
Ix	*x = 1,2,3,4,5,6,7,8 to indicate the compass (see example below)*		
L	"Large area", (or sub-area) but something smaller than "Main area"	NNNN	Abbreviation for name
M	Main area, the largest unit areas considered	NNNN	Abbreviation for name
O	Off a land-location	NNNN	Abbreviation for name
Ox	*x = 1,2,3,4,5,6,7,8 defined as for islands (see example below)*		
P	Provincial Waters of two or more provinces combined.	PPP (P or "#")	"PPP" = "abbreviation of combined provinces" *If last character is "#" it means that the province does not exist to day.*
PW	Provincial Waters of **one** province	PP (P or "#")	"PPP" = "Province abbreviation", *If last character is "#" it means that the province does not exist to day.*
T	Between two locations	NNnn	"NN" abbreviation of name of first location, "nn" abbreviation of name of second location
Z	Special values (e.g. "Not known")	NNNN	Abbreviation of meaning of special value

Ix	Compass direction
I1	North of Island
I2	N-E of Island
I3	East of Island
I4	S-East of Island
I5	South of Island
I6	S-W of Island
I7	West of Island
I8	N-W of Island

6.3.4 Example of a Code for Species: "NAN-SIS Species Code"

The NODC code system for species was considered in Viet Nam, but was not found "user-friendly". The numerical codes based only on taxonomic groupings had many shortcomings for the recording of a commercial fishery, which only to a certain degree respects the rules of taxonomy. As this is a national code system, the data managers were not so concerned about the compatibility with an international standard.

The code for species that was adopted is a seven character mnemonic code developed by the Nansen Programme (Strømme, 1992) for worldwide use in trawl and acoustic surveys. The species code consists of three sub-fields. The first two sub-fields, comprising three and two letters respectively (1-5), indicate the higher taxonomic categories to which a species belongs while the last two fields (6,7), usually numbers, define the species.

1	2	3	4	5	6	7
Higher taxonomic category			Lower taxonomic category		Species	

In the case of bony fishes, the first three letters usually coincide with the first letters of the family name to which the species belongs, the next two letters refer to the genus and the numbers to the species:

1	2	3	4	5	6	7
Family of bony fishes			Genus of bony fishes		Bony fish Species	

Example: **CARCH01** = *Chloroscombrus chrysurus*

CARANGIDAE	CHLOROSCOMBRUS	**01** = CHRYSURUS
Family	Genus	Species

For other taxonomic groups (i.e. sharks, rays, shrimps, lobsters, crabs, stomatopods, squids and cuttlefish, bivalves and gastropods) the system is slightly different. The first three letters indicate the "taxonomic group". The next two letters indicate the family, followed by one number (or letter) for the genus and the last number (or letter) indicates the species:

SHA	RAY	SHR	LOB	CRA	STO	SQU	BIV	GAS.
Sharks	rays	Shrimps	Lobsters	Crabs	Stoma-topods	Squids Cuttlefish	Bivalves	Gastr opods

Example: **SHRPE69** = *Penaeus brasiliensis*

SHRIMP	PENAEIDAE	6 = *Penaeus*	9 = *brasiliensis*
Higher taxon	Family	Genus	Species

In addition, there are some special codes, such as codes not conforming to the taxonomic grouping. There are also codes for animal groups closely linked to (or included in) the taxonomic system. The NAN-SIS codes were originally used for bony fish species, but the designers of NAN-SIS plan to develop the code so that non-bony fish get the same treatment, which would improve the system.

CODE	"Scientific Name"
NOSAMPL	N O S A M P L E
NOCAT00	N O C A T C H
UNIDE00	UNIDENTIFIED FISH
FISJU00	JUVENILE FISHES
FISLA00	FISH LARVAE
FISNC00	FISH, SMALL NOT COMMON
MISCE00	MISCELLANEOUS FISH

Code	"Scientific Name"	English Name
BIVAA00	B I V A L V E S	BIVALVES
CRUKR00	KRILL	KRILL
CRUAA00	C R U S T A C E A N S	CRUSTACEANS
CRAAA00	C R A B S	CRABS
ECHEC00	ECHINOMETRIDAE	SEA URCHINS
ECHSH00	STICHOPODUDAE	SEA CUCUMBERS
ECHST00	STRONGLYOCENTRIDAE	SEA URCHINS
ECHAA00	E C H I N O D E R M ATA	ECHINODERMATA
GASAA00	G A S T R O P O D S	GASTROPODS
ISOAA00	ISOPODS	ISOPODS
JELLY00	J E L L Y F I S H	JELLYFISH
KRILL00	KRILL	KRILL
LOBAA00	L O B S T E R S	LOBSTERS
MOLLU00	MOLLUSCS	MOLLUSCS
RAYRA00	RAJIDAE	SKATES
RAYAA00	R A Y S	BATOID FISHES, RAYS
SALAA00	SALPS	SALPS
SEAUR00	SEA URCHINS	SEA URCHINS
SHRAA00	S H R I M P S	SHRIMPS
SHAAA00	S H A R K S	SHARKS, CHIMAERAS
SNAKE00	SNAKES	SNAKE
SQUSQ00	SMALL SQUID UNIDENTIFIED	SMALL SQUIDS UNIDENTIFIED
SQUAA00	C E P H AL OPODA	CEPHALOPODS
STARF00	S T A RFISH	STARFISH
TURAA00	T U R T LES	TURTLES

6.3.5 Code for Gears

The FAO-codes for gears (Table 6.3.3) were not used, as the codes suggested below were found easier to handle, in particular for retrieval of data from the database. Furthermore, the FAO code did not cover all the types of gears used in Viet Nam.

The gear code is a four characters alphanumeric code, **XSNN**, where

X = Major group of fishing gears

S = Subdivision of major group of fishing gears

NN = Indications of specific gears (or gear groups)

The first character X is alphabetic and indicates the main group of fishing gears, exemplified by the list below (from AMLRV, 1998).

	Code (X)	Name of gear group
1	**A**	Trawl gears
2	**B**	Entangling nets/Gillnets
3	**C**	Push nets
4	**D**	Surrounding nets / purse seine
5	**E**	Lines
6	**F**	Lift nets

	Code (X)	Name of gear group
7	**G**	Cast nets
8	**H**	Traps
9	**I**	Diving gears
10	**J**	Dredge gears
11	**K**	Combination of multi-gears
12	**Z**	Special codes (see following table)

The second character, S, is numerical and indicates the subdivisions of the main groups of fishing gears: The last two numerical characters are used to indicate specific gears, as illustrated by gillnets in the tables below:

XSNN	Name of gear group	XSNN	Name of gear group
B210	Drift net	B232	Bottom stationary gillnet
B211	Surface drift net	B240	Encircling gillnet
B212	Mid-water drift net	B250	Off shore gillnet
B220	Gillnet for swimming crab	B251	Tuna-mackerel gillnet
B230	Bottom gillnet	B252	Flying fish gillnet
B231	Bottom drift gillnet		

6.3.6 Code for Fishing Fleets

The code for fishing fleets, naturally, is linked to the gear code, as the fleets are defined (amongst other features) by the gear they use. The code has 6 characters: **XSNNxx**

X = Major group of fleets (defined by the gear(s)). Alphabetical

S = Major sub-group of fleets (defined by the gear(s) and target species).

NN = Indication of further fleet characteristics to further divide the major sub-groups

xx = Engine horsepower group

Currently, X, can take the values listed in the table below, (which are equivalent to the code for fishing gear):

Fleet Code X	Name of fleet	Gear (s)
A	Trawler	Trawl
B	Entangling / Gillnetters	Entangling net
C	Push netter	Push net
D	Surrounding netter / purse seine	Surrounding net
E	Hook and line fleet	Line
F	Lift netter	Lift net
G	Cast netter	Cast net
H	Trap fleet	Trap
I	Diving vessels	Diving
J	Dredge fleet	Dredge
K	Combination of gears fleet	Combination of gears
Z	Special codes (see table below)	

The characters "SNN" are used for sub-divisions of the main fleets.

Finally, the code is shown for the division of a fleet into horsepower classes, where x = a,b,c,d,e. The example below shows the division of trawlers into four horsepower classes (a,b,c and d). Notice that "e" indicates the combination of all classes.

Fleet Code XSNNxx	Name of Fleet (English)	Gear (s)
A000a0	Trawler <= 45 HP	Trawl
A000b0	Trawler 46-74 HP	Trawl
A000c0	Trawler 75-140 HP	Trawl
A000d0	Trawler >140 HP	Trawl
A000e0	Trawler > 0 HP	Trawl

6.3.7 Code for Commercial Groups (Species/Size/Treatment-Quality)

Commercial groups are the species groupings made by the fishers and the buyers. The commercial groupings are considered so different from the taxonomic groupings behind the NAN-SIS codes, that it was decided to develop a special code for the commercial groups. Commercial groups are not only determined by the species, but also by the size, quality and the treatment of the catch.

Thus, we shall consider three aspects of commercial grouping: (1) Commercial species groups, (2) Commercial size group and (3) Treatment & quality groups. The commercial species groups vary from province to province and from fleet to fleet within a province. Therefore, commercial species groups are defined for each combination of province and fleet.

The commercial group code is a combination of three codes of which the first two codes are similar to those explained earlier.

Province code: PPP

Fleet code: XNNNxx

where X = Main group of gear, NNN = sub-group or gear, xx = horsepower class

Species / Size Group / Treatment-quality code: XXXNNSTT

where

Species group sub-code: XXX = Major group, that is:

either Taxonomic group, (e.g. a family, suborder, or order)

or Commercial group (e.g. "trash fish" or "pink prawn").

NN = Indication of species or species group, if required, otherwise "_"

Commercial size group sub-code: S = Size group

(e.g. small, medium and large or Category I, II and III)

Treatment-quality sub-code

TT = Treatment (e.g. fresh, iced, salted, dried and "for export")

Thus the total 17 character alphanumeric code reads:

Province			Fleet						Species/Treatment-Quality/Size Group							
			Gear				HP		Major Group			Species		Size	Treatment	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
P	P	P	X	N	N	N	X	x	X	X	X	N	N	S	T	T

Whenever a character is not used, it is replaced by underscore "_". Zero or "0" usually means "all". The lists are not complete and most likely will be modified.

It should be kept in mind that no attempt to make a scientific biological (taxonomic) classification has been made with the codes for commercial groups. The code is selected to reflect the market situation for sea products in Viet Nam and the export market. Thus, when the sellers and buyers, for example, combine genus, family and even orders in commercial groups, no attempt is made to represent this in the codes for commercial groups. The sole purpose is to reflect the commercial groups as the market mechanisms have created them. Example codes are given in Tables 6.3.5 – 6.3.8.

Table 6.3.5 Example of major commercial (species) groups. The groups are those of fishers and fishmongers, not those of biologists. However, they are useful for economists, as they reflect the prices and the marketing options. The codes indicated with bold, are used in the example given below.

XXX	Major Group	XXX	Major Group
BIV	Bivalves	RSK	Rays and skates
CRA	Crabs	SCT	Scads and trevalies
CUT	**Cuttlefish**	SHA	Sharks
FDE	Demersal fish	SHD	"Tom dat"
FIM	Mixed fish	**SHR**	**Mixed shrimps**
FPE	Pelagic fish	SHP	Pink shrimp
GRP	**Groupers**	**SHR**	**Shrimps**
KIN	King fish (*Scromberomorous commerson*)	SHT	Tiger shrimp (*Penaeus monodon*)
LOB	**Lobster**	SHW	White shrimp
MAC	**Mackerels**	SNG	Snakes
MIC	Mixed cephalopods	SNL	Snails
MIF	Mixed fish	**SQU**	**Squid**
MIS	Mixed shrimps	TRS	Trash fish
OCT	**Octopus**	**TUN**	**Tuna**

Table 6.3.6 The two character "NN" (indication of "species" or "species group") again does not primarily deal with the scientific species concept, but with the marketing, as is illustrated by the examples given.

Commercial Species Group Code	Species (or Species group)	Name of Commercial Species Group
FIMLD	LD	Mixed big fish group
SHRPK	PK	Pink prawn
LOBSL	SL	Slipper lobster
FISTR	TR	Trash fish
SHRWH	WH	White prawn

Table 6.3.7 Example size class codes. The size classes may be the *ad hoc* sorting usually practised into two groups "Small" and "Large" or the groups "Small", "Medium" and "Large". In this case, we use the letters "S","M" and "L". If more size groups are needed, for example in the case of commercial groups for shrimps (counts or number per weight unit) numerical characters or special signs are used.

S	Description of commercial "Size group"
0	All size groups
L	Large size
M	Medium size
N	Not Known
S	Small size
1	Size class 1 (if more than 3 size classes are used)
2	Size class 2 (if more than 3 size classes are used)
.... etc	Size class 3,...,9, (if more than 3 size classes are used)

Table 6.3.8 Example codes for treatment of the catch ("TT"). This is most likely not the final version of this table, but rather the very first suggestion.

TT	*Description of "Treatment-Quality"*	TT	*Description of "Treatment-Quality"*
00	Fresh, not iced (no treatment)	HE	Headed
DR	Dried	IC	Iced
DP	Dried and packed	DP	Dried and Packed
DE	Dried and packed for export	LI	Live
EX	For export	NK	Not known
FR	Frozen	HP	Headed & Peeled
FE	Frozen for export	QI	Fresh high quality, Iced
FP	Frozen and Packed	SA	Salted
PE	Frozen and packed for export.	TF	Salting Trash fish for sauce

6.4 USE OF LOOK-UP TABLES

When entering a value in a data form (the "hard form" used for trip-interview or the form used on the computer screen for entry of data), misspellings and other mistakes may easily occur. A well-designed code system can minimise the risk of errors. Many data fields are of a type where only a limited number of options for the value are available. Whenever this is the case, a "look-up-table" should be prepared for the enumerator or the encoder, and the enumerator should be instructed only to use the options in the look-up table (see example in Figure 6.4.1).

The tables shown in Section 6.3 are examples of look-up-tables.

A look-up table should always be in the local language. The international language (English) may or may not be shown. The enumerators and encoders will master the local language, but may not benefit from the English name. Table 6.4.1 shows an extract from the look-up table for species of VIETFISHBase. The complete table contains 1007 species, genus, and families or species groups. The enumerators, should all be given a copy of this table, and when filling in the forms they should give both the code and the local name. Giving both allows for validation of data by the time they are entered in the computer.

The look-up tables are created to facilitate the data entry and to prevent mistakes. A look-up table is shown on the forms by a button with the sign. The example below shows the look-up-table for the provinces of Viet Nam.

"Code" *"Name of province"*

Province

Clicking with the mouse on the triangle makes a list appear below, from which you can select an item, by "clicking with the mouse" on it:
Clicking on "Ben Tre" makes the list disappear, and enters the selection in the two empty fields left of the triangle:

Province BT | Ben Tre

Province

HC	Ho Chi Minh City
TG	Tien Giang
BT	Ben Tre
TV	Tra Vinh
C	Can Tho
MH	Minh Hai
KG	Kien Giang

If trying to write something in the two fields you will discover that they are locked. You cannot write in them.
Your only choice is to select from the list of province names. This approach prevents misspellings of province names, so whatever you enter, it is a province in Viet Nam.

Sometimes, you may also select from the look-up-table, by entering the key (that is the unique identifier) for the item. This applies when the look-up-table is very long. An example is the list of species names, where the unique key is the species code of the NAN-SIS system.

	"Species code"	*"Scientific name"*	*"Local name (Vietnamese)"*	*"English name"*
Species	CLUIL02	Ilisha elonga	De (be)	Elongated ilisha

In this case you enter the species code " CLUIL02" in the field left of the triangle, instead of selecting from the list (For a description of the species codes, see Section 6.3.4).

Figure 6.4.1 Look-up tables for data entry from computer screen.

Table 6.4.1 Extract from the species look-up table from VIETFISHBase.

	Code	Scientific Species Name	Scientific Genus Name	Scientific Family name	Viet Namese Name [2]	English Name
1	ACRAC00	*Acropoma sp.*	Acropoma	ACROPOMATIDAE		Glowbelly
2	ACRAC01	*Acropoma japonica*	Acropoma	ACROPOMATIDAE		Glowbelly
3	ACRSY02	*Synagrops japonicus*	Synagrops	SYNGNATHIDAE		Japanese splitfin
4	ALBAL01	*Albula vulpes*	Albula	ALBULIDAE		Bonefish
5	AMMAA00	AMMODYTIDAE	Not defined	AMMODYTIDAE		Sandlances
6	AMMBL01	*Bleekeria anguillaris*	Bleekeria	AMMODYTIDAE		Sandlances
7	ANRAN04	*Antennarius striatus*	Antennarius	ANTHENNARIIDAE		Straited frogfin
8	ANRAN05	*Antennarius hispidus*	Antennarius	ANTHENNARIIDAE		Shaggy angler
...	....	....	....	....		....
999	URAUR00	*Uranoscopus sp.*	Uranoscopus	URANOSCOPIDAE		Stargazer
1000	URAUR06	*Uranoscopus oligilepis*	Uranoscopus	URANOSCOPIDAE		Stargazer
1001	URAUR07	*Uranoscopus japonicus*	Uranoscopus	URANOSCOPIDAE		Japanese stargazer
1002	URAUR08	*Uranoscopus bicinctus*	Uranoscopus	URANOSCOPIDAE		Marbled stargazer
1003	VELVE02	*Velifer hipselopterus*	Velifer	VELIFERIDAE		Sailfin velifer
1004	XIPXI01	*Xiphias gladius*	Xiphias	XIPHIIDAE		Swordfish
1005	ZEIAA00	ZEIDAE	Not defined	ZEIDAE		Dories
1006	ZEIZE00	*Zeus sp.*	Zeus	ZEIDAE		Dory
1007	ZEIZE01	*Zeus faber*	Zeus	ZEIDAE		John dory

6.5 REPORTS FROM THE DATA BASE

A database system includes a number of pre-prepared reports, which can be automatically produced. The reports are the output from the sampling programme. In this section, we shall deal only with one type of report, namely the reports specifying the quantitative content of the database, that is the number of records of each type, who collected the data where and when (the administrative reports). The database reports for wider distribution, the primary output from the database will be dealt with in Section 6.8.

The administrative reports are mainly for the internal evaluation of the sampling programme. They are used to modify the sampling programme in order to make the best use of the limited resources available. Furthermore, the administrative reports can be used to compute the average costs of samples for the different fleets at different locations, when combined with the accounting records of the sampling programme. One could include the costs of sampling in the catch effort database, but the costs of sampling should be kept distinct from the fisheries statistics.

When an interview form is filled in, it will contain information on who (the enumerator) filled in the form and who entered the data into the computer. This information is needed for the subsequent validation (and, if applicable, correction) of data.

The database will thus be able to produce tables, which summarises the activities of all enumerators and encoders. The database contains a look-up table with all the particulars of the entire staff of the sampling programme. A person becomes an authorised staff member of the data collection programme, by being included in the table of staff members. Only authorised persons can enter data in the database.

Apart from reports on the staff activities, the administrative reports comprises summaries of data collection activities, such as:

2 The Vietnamese names have been omitted because of the differences in fonts

1. Number of interviews by fleet, month, province (or landing place).
2. Number of frame survey samples by province (or homeport) by month and fleet.
3. Number of vessel registrations by province (or homeport) by months and fleet.
4. Number of species composition samples by commercial group, fleet, month, province (or landing place).
5. Number of biological samples (e.g. length frequency samples).

To make the full use of these samples for the improvement of stratification, the administrative reports should also indicate the weight and value of landings represented by the samples.

6.6 SQL (STRUCTURED QUERY LANGUAGE)

The user who wants to apply the data for non-standard (e.g. research) purposes is not satisfied with the pre-prepared reports. She/he will need the data structured a specific way, to allow for some specific processing. It is the experience of the author that in practice the database system never contains all the reports you need. It is more or less impossible to predict every request for a report from every user. The skill to extract of data from the database is the primary skill you need to make full use of the database. Although this skill is often considered restricted to "computer experts" it is recommended that also other users acquire the basic skill to extract data.

In order to do this, the database user must master the SQL language. This is the tool by which you can extract data from a database, and by which you can do the first processing of the data, such as summation, grouping, calculating averages, etc. The part of SQL dealt with here, deals only with the creation of "Queries" (SQL contains a lot more than the query).

This section is by no means an attempt to teach the universal database language, SQL. The interested reader is referred to one of the many textbooks on SQL (e.g. Stephens *et al.* 1997). This section is to inform the reader with no or little background in database theory about the existence of SQL, and to give brief some idea of what the SQL is.

A query in SQL is most often constructed the following way (SQL-words are in capitals):

SELECT

(The columns you want in the table)

FROM

Where the data should come from, (from one or several Tables)

WHERE

(The subset of data, say, only data from 1 Oct 1996 to 30 Sep 1997)

You may furthermore add: "**GROUP BY**" in case you want to sum or average over a group, say, a fleet.

One good reason for knowing some SQL is that it puts the user in a position to define exactly which data she/he wants. Should the knowledge of SQL and the database not be sufficient to complete the job, the user will be competent to complete the job with a little help from a "computer expert".

We illustrate the SQL by a simple (hypothetical) fisheries database with only three tables. One table is an input data table "Landings" and there are two look-up tables "L_Species" and "L_Vessel_Register" (see Table 6.6.1).

Table 6.6.1. Tables of hypothetical data for demonstrating a fisheries database.

Table: Landings

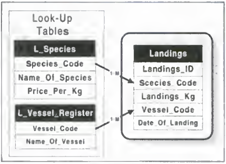
Landings_ ID	Species_ Code	Landings_ Kg	Vessel_ Code	Date_Of_ Landing
1	SAR	2	HP17	11-Jan-98
2	TPR	3	HP17	11-Jan-98
3	SCR	1	HP17	12-Jen-98
4	LOB	4	HP17	12-Jen-98
5	GRP	3	QN19	12-Jen-98
6	SAR	6	QN19	13-Jan-98
7	KMC	11	HP83	13-Jan-98
8	TPR	2	HP83	15-Jan-98
9	TBR	2	QN01	15-Jan-98
10	SQU	3	QN01	15-Jan-98
11	LOB	5	QN01	16-Jan-98
12	CUF	1	QN01	16-Jan-98
13	GCL	7	HP17	16-Jan-98
14	CRP	15	HP17	17-Jan-98
15	LOB	5	HP17	17-Jan-98
16	LOB	8	HP83	17-Jen-98
17	LOB	2	HP83	17-Jan-98
18	WSH	4	HP83	19-Jan-98
19	CUF	2	QN01	18-Jan-98
20	MAC	6	QN01	18-Jan-98
21	SAR	8	HP17	19-Jan-98
22	WSH	5	HP17	19-Jen-98
23	TRV	10	HP83	19-Jan-98
28	TPR	5	HP83	19-Jan-98
29	CUF	11	QN01	20-Jan-98
30	TBR	8	QN01	20-Jan-98
31	TRV	12	QN01	20-Jen-98
32	SCR	4	HP83	20-Jen-98
33	SCR	10	HP17	20-Jan-98

Table: L_Species

Species_ Code	Name_of_Species	Price_ Per_Kg
CUF	Cuttlefish	4
GCL	Giant Clam	15
GRP	Grouper	21
KMC	King Mackerel	17
LOB	Lobster	40
RSN	Red Snapper	10
SAR	Sardine	8
SCR	Swimming Crab	23
SNL	Snail	12
SQU	Squid	14
TBR	Threadfinned bream	5
TPR	Tiger Prawn	32
TRV	Trevelly	3
TUN	Yellowfin Tuna	11
WSH	White Shrimp	23

Table: L_Vessel_Register

Vessel _Code	Name_of_Vessel
HP17	Viet Nam Star
HP83	Bien Dong
QN01	Halong 408B
QN19	Bac Bo explorer



The table "Landings" contains the total landings ("Landings_Kg") by species and by vessel ("Species_Code" and "Vessel_Code", respectively) and the date landed ("Date_Of_Landing"). The look-up table "L-Species" converts the 15 species codes of this example, into 15 species names ("Name_Of_Species") and it contains the price per kg, which is thus assumed to remain constant. Eventually, there is the vessel register, "L_Vessel_Register", which in this hypothetical example contains only 4 vessels.

The Landings-table has a key field, "Landings_ID", which is a unique number for each record. This unique number is used to secure the integrity of data, For example, landings_ID 16 and 17 are both with LOB (Lobster) landed by vessel HP83 on the 17th January 1998. The reason could be that two different merchants bought lobsters from HP83 on the 17th January.

The "Landings_ID" values are arbitrary numbers created by the database system. Had the "Landings_ID" not been there, there would have been two records with the same keys ("Species_Code", "Vessel_Code" and "Date_of_Landing") and a relational database would not accept it.

Table 6.6.2.a. Queries of hypothetical demonstration fisheries database (presented in SQL language and resulting table).

Query 1: (SQL)

```
SELECT

Landings.Species_Code,
Landings.Landings_Kg,
Landings.Date_Of_Landing
FROM
Landings;
```

Query 2: (SQL)

```
SELECT
Landings.Species_Code,
Landings.Landings_Kg,
Landings.Date_Of_Landing
FROM Landings
WHERE
Landings.Species_Code = 'LOB';
```

Query 3: (SQL)

```
SELECT
Landings.Species_Code,
Landings.Landings_Kg,
Landings.Date_Of_Landing
FROM
Landings
WHERE
Landings.Species_Code IN

('LOB','TPR','SCR','WSH')
AND
Landings.Date_Of_Landing >
#1/12/98#;
```

Query 1

Species_Code	Landings_Kg	Date_Of_Landing
SAR	2	11-Jan-98
TPR	3	11-Jan-98
SCR	1	12-Jan-98
LOB	4	12-Jan-98
GRP	3	12-Jan-98
SAR	6	13-Jan-98
KMC	11	13-Jan-98
TPR	2	15-Jan-98
TBR	2	15-Jan-98
SQU	3	15-Jan-98
LOB	5	16-Jan-98
CUF	1	16-Jan-98
GCL	7	16-Jan-98
SCR	15	17-Jan-98
LOB	5	17-Jan-98
LOB	8	17-Jan-98
LOB	2	17-Jan-98
WSH	4	19-Jan-98
CUF	2	18-Jan-98
KMC	6	18-Jan-98
SAR	8	19-Jan-98
WSH	5	19-Jan-98
TRV	10	19-Jan-98
TPR	5	19-Jan-98
CUF	11	20-Jan-98
TBR	8	20-Jan-98
TRV	12	20-Jan-98
SCR	4	20-Jan-98
SCR	10	20-Jan-98

Query 2:

Species_Code	Landings_Kg	Date_Of_Landing
LOB	4	12-Jan-98
LOB	5	16-Jan-98
LOB	5	17-Jan-98
LOB	8	17-Jan-98
LOB	2	17-Jan-98

Query 3

Species_Code	Landings_Kg	Date_Of Landing
TPR	2	15-Jan-98
LOB	5	16-Jan-98
SCR	15	17-Jan-98
LOB	5	17-Jan-98
LOB	8	17-Jan-98
LOB	2	17-Jan-98
WSH	4	19-Jan-98
WSH	5	19-Jan-98
TPR	5	19-Jan-98
SCR	4	20-Jan-98
SCR	10	20-Jan-98

Table 6.6.2.a. (continued) Queries of hypothetical demonstration fisheries database (presented in SQL language and resulting table).

Query 4: (SQL)

```
SELECT
Landings.Species_Code,
L_Species.Name_of_Species,
Landings.Landings_Kg,
Landings.Date_Of_Landing
FROM
L_Species
INNER JOIN Landings
WHERE
Landings.Species_Code IN
('LOB','TPR','SCR','WSH')
AND Landings.Date_Of_Landing
> #1/12/98#;
```

Query 4

Species_Code	Name_of_Species	Landings Kg	Date Landing
SCR	Swimming Crab	15	17-Jan-98
SCR	Swimming Crab	4	20-Jan-98
SCR	Swimming Crab	10	20-Jan-98
LOB	Lobster	5	16-Jan-98
LOB	Lobster	5	17-Jan-98
LOB	Lobster	8	17-Jan-98
LOB	Lobster	2	17-Jan-98
WSH	White Shrimp	4	19-Jan-98
WSH	White Shrimp	5	19-Jan-98
TPR	Tiger Prawn	2	15-Jan-98
TPR	Tiger Prawn	5	19-Jan-98

Note that "IN" (Queries 3 and 4) is used to express the condition that a field value belongs to a pre-specified set of values. Note further the character "#" is used to signal that numerical characters refer to a date.

Query 5 (see Table 6.6.2.b) extends and modifies Query 4. It illustrates the calculations and the "AS"-command. The species code has been removed, and the price per kg has been added. The query also makes a calculation, namely the value of the landings "Landings.Landings_Kg*L_Species.Price_Per_Kg AS Value". The "AS" command is used to give a new name to a variable. Note the expression "INNER JOIN .... ON ...." in Query 5, which links the records with the same species code in two tables.

Query 6 (see Table 6.6.2.b) extends Query 5. It joins Query 5 with the vessel register and adds the columns with the vessel codes.

Query 7 (see Table 6.6.2.c) simplifies Query 6, to facilitate the introduction of the concepts in Query 8.

Query 8 (see Table 6.6.2.c) extends Query 7. It illustrates the "GROUP BY"-command and the "SUM"-function. It groups the records by vessel, and computes the sum for each vessel.

Query 9 (see Table 6.6.2.c) extracts data from another query (Query 8), not from the tables. It computes the sum of all vessels. This works because each query creates its own table.

This example of SQL represents only a small fraction of the SQL commands and functions. The commands presented here are not given a comprehensive explanation. It is hoped, however, that the reader has been given the impression that SQL is a very powerful tool for data manipulation. To be able to utilise a relational database fully, an advanced user must master SQL.

Table 6.6.2.b. Queries of hypothetical demonstration fisheries database (presented in SQL language and resulting table). Continued.

Query 5: (SQL)

```
SELECT
L_Species.Name_of_Species,
Landings.Landings_Kg,
Landings.Date_Of_Landing,
L_Species.Price_Per_Kg,
Landings.Landings_Kg*L_Species.Price_Per_Kg
AS [Value]
FROM  L_Species
INNER JOIN Landings
ON Landings.Species_Code =
L_Species.Species_Code
WHERE  Landings.Species_Code  IN
('LOB','TPR','SCR','WSH')
AND Landings.Date_Of_Landing > #1/12/98#;
```

Query 5

Name_of_ Species	Landings_ Kg	Date_Of_ Landing	Price_ Per_Kg	Value
Swimming Crab	15	17-Jan-98	23	345
Swimming Crab	4	20-Jan-98	23	92
Swimming Crab	10	20-Jan-98	23	230
Lobster	5	16-Jan-98	40	200
Lobster	5	17-Jan-98	40	200
Lobster	8	17-Jen-98	40	320
Lobster	2	17-Jan-98	40	80
White Shrimp	4	19-Jan-98	23	92
White Shrimp	5	19-Jen-98	23	115
Tiger Prawn	2	15-Jan-98	32	64
Tiger Prawn	5	19-Jen-98	32	160

Query 6: (SQL)

```
SELECT
L_Species.Name_of_Species, Landings.Landings_Kg,
Landings.Date_Of_Lending, L_Species.Price_Per_Kg,
Landings.Landings_Kg*L_Species.Price_Per_Kg AS [Value],
Landings.Vessel_Code
FROM L_Vessel_Register
INNER JOIN (L_Species
INNER JOIN Landings
ON Landings.Species_Code = L_Species.Species_Code)
ON L_Vessel_Register.Vessel_Code = Landings.Vessel_Code
WHERE Landings.Species_Code  IN ('LOB','TPR','SCR','WSH')
AND Landings.Date_Of_Lending > #1/12/98#;
```

Query 6

Neme_of_Species	Landings_ Kg	Date_Of_Landing	Price_Per _Kg	Value	Vessel_Code
Tiger Prawn	2	15-Jan-98	32	64	HP83
Lobster	8	17-Jan-98	40	320	HP83
Lobster	2	17-Jan-98	40	80	HP83
White Shrimp	4	19-Jan-98	23	92	HP83
Tiger Prawn	5	19-Jan-98	32	160	HP83
Swimming Crab	4	20-Jan-98	23	92	HP83
Swimming Crab	15	17-Jan-98	23	345	HP17
Lobster	5	17-Jen-98	40	200	HP17
White Shrimp	5	19-Jan-98	23	115	HP17
Swimming Crab	10	20-Jan-98	23	230	HP17
Lobster	5	16-Jan-98	40	200	QN01

Table 6.6.2.c. Queries of hypothetical demonstration fisheries database (presented in SQL language and resulting table).

Query 7: (SQL)

```
SELECT

Landings.Landings_Kg,
Landings.Landings_Kg*L_Species.Price_Per_Kg AS [Value],
Landings.Vessel_Code
FROM L_Vessel_Register
INNER JOIN (L_Species
INNER JOIN Landings
ON Landings.Species_Code = L_Species.Species_Code)
ON L_Vessel_Register.Vessel_Code = Landings.Vessel_Code;
```

Query 7

Landings_Kg	Value	Vessel_Code
2	12	HP17
3	96	HP17
1	23	HP17
4	160	HP17
3	63	QN19
6	36	QN19
11	187	HP83
2	64	HP83
2	10	QN01
3	42	QN01
5	200	QN01
1	4	QN01
7	105	HP17
15	345	HP17
5	200	HP17
8	320	HP83
2	80	HP83
4	92	HP83
2	8	QN01
6	102	QN01
8	48	HP17
5	115	HP17
10	30	HP83
5	160	HP83
11	44	QN01
8	40	QN01
12	36	QN01
4	92	HP83
10	230	HP17

Query 8: (SQL)

```
SELECT
Landings.Vessel_Code,
SUM(Landings.Landings_Kg) AS [Total Kg landed],
SUM(Landings.Landings_Kg*L_Species.Price_Per_Kg) AS [Total Value]
FROM L_Vessel_Register
INNER JOIN (L_Species
INNER JOIN Landings
ON Landings.Species_Code = L_Species.Species_Code)
ON L_Vessel_Register.Vessel_Code = Landings.Vessel_Code

GROUP BY Landings.Vessel_Code;
```

Query 8

Vessel_Code	Total Kg landed	Total Value
HP17	60	1334
HP83	46	1025
QN01	50	486
QN19	9	99

Query 9: (SQL)

```
SELECT
        Sum([Query_8].[Total Kg landed]) AS [Sum Kg landed],
Sum([Query_8].[Total Value]) AS [Sum of Value],
Count(*) AS [Count Samples]

FROM Query_8;
```

Query 9

Sum Kg landed	Sum of Value	Count Samples
165	2944	4

6.7 DATA VALIDATION

We shall use the common term "data errors" to indicate any type of deviation from the correct value.

In this context we are dealing only with the "raw data", that is the direct observations from the field, not the processed data. As the computer does not make mistakes, the processing is always correct in the sense that the processing is always executed according to the specifications (e.g. SQL-commands, see Section 6.6).

The entry of data in the database should not be the final treatment of the "raw data". The raw data should be checked and validated in as many different ways as possible. For example, the inspection of processed data may reveal errors in the raw data.

Errors may occur for different reasons:

1. The enumerators may not understand the meaning of some fields of the interview form.
2. The interviewed person may not understand the question of the enumerators.
3. The enumerators may misinterpret the answer from the interviewed person, because of problems with the verbal communication.
4. The encoder may by mistake write a wrong value in a field (for example, put one zero too many in a weight field).
5. The enumerators may make a wrong identification of a commercial group.
6. The encoder may make a wrong species identification.
7. The interviewed person may not remember correctly what happened during the trip
8. The interviewed person may deliberately give wrong data.
9. The enumerator may deliberately give false data (e.g. made-up data, to meet the expected frequency of samples, without working).
10. Wrong recording of landings due to bad organisation of the interviewed person (for example if the landings are sold to many buyers or at several landing places).
11. Enumerator's lack of knowledge of the fishing operations, in particular when groups of vessels fish and land collectively.
12. Enumerators lack of knowledge of transfer of catches at sea.
13. The interviewed person may not possess the correct information about the vessel particulars, such as engine HP, gear specification etc.
14. The interviewed person may not collect detailed data on landings, but leave it to other persons who are not available to the enumerator.
15. The encoder may misinterpret the writing on the forms.
16. The encoder may misunderstand the form.
17. The encoder may make a keypunch error (hit the wrong key).
18. … etc.

Some data can be validated automatically at the time they are entered in the database. For example, the order of magnitude can be checked and rejected if a value has been given in kilograms where it should have been tonnes. In addition, dates can be validated. For example, lower and upper limits for acceptable dates can be specified, so that the database will give a warning when a date is outside the limits. These are examples of the easy-to-detect errors.

Data selected from look-up-tables will contain only values from the look-up-table, so the only possibility for error is that the wrong value is selected. Erroneous data from look-up tables may be detected from comparison of interviews which are expected to give approximate the same results. For example, one fleet, fishing at a given fishing ground during a given period. If one trip gives a completely different composition of commercial groups, if may be an erroneous vessel registration, for example that a purse seine was given the registration number of a shrimp trawler.

If a commercial group appears in a sample, but not in other similar samples, it may be an error. Some errors are easier to detect than others. For example, if a typical pelagic species appears in the catch of a typical demersal trawl. If a species appear in an area where it is has not been observed earlier, this might indicate an error. However, if there is enough data in the database, rare events will be expected and should not be removed simply because they are rare. The validation system should be careful to verify rather than automatically delete records or fields.

Where the input is a unique key (e.g. a vessel registration number) a relational database system will not accept it as a new value. Thus, the system will automatically check that all vessel registration codes are different, and whenever duplicates are observed, action can be taken.

Samples of individual enumerators may be compared to check if there are differences between enumerators, where they should not be expected. In addition, the performance of encoders can be compared. Different encoders could enter the same interview forms, and possible encoder-specific errors may be detected. The encoder should preferably have some knowledge about the fishing sector, for example, from participation in training courses and work in the field.

When both a vessel register is maintained and vessel details are collected during an interview, we have a situation with two independent sources for the same data. If the interview gives the same value as the vessel register, then this is an indication of high quality data, if it does not, the vessel register should be checked and possibly updated, as the interview is likely to be the most recent collection of data. Alternatively, the interview may be incorrect, and that can be checked by a new interview for the vessel in question.

In general, whenever possible, data from independent sources should be compared. If, for example, the buyer fills in a sales slip and the skipper fills in a logbook with the same information, the data can be compared. If auctions are used for sale of landings, the auction authority may keep records on the sale, which can be compared with the interview data.

Date for leaving and returning to harbour for different trips of the same vessel can be compared to check for consistency. Activity data (for example fishing days per months) may be compared with the effort recorded for the trips. Harbour authorities (police, coast guard) may record the activities of fishing vessels, which may be used to check the effort reported by the skippers.

Data from the commercial fishery may be compared with data from an experimental fishery, which for example, may reveal erroneous species identification.

Supervision and on-the-job-training of enumerators is a kind of double sampling, as the supervisor will check any data collected by the enumerator, and they will (hopefully) sort out any discrepancies between them. Supervision and discussion between programme staff is probably the most efficient tool for data validation.

The processed data should be evaluated by comparison with general knowledge and common sense. All computed total catches should be evaluated for their reasonability (i.e. not being too far from the expected value).

6.8 DESIGN OF FISHERIES REPORTS

The reports produced by the database and subsequent processing of the data (resource evaluation, CPUE analysis, stock assessment, bio-economics etc.) are the last step in the process described in the manual. Some of the staff of the data collection programme, notably the scientists, may be involved also in these final steps. As the data collection programme is a routine activity repeated every year, the majority of the reports should be annual or quarterly.

Examples of such regular reports have been given earlier in the manual. Regular fisheries reports produced from the regular fisheries data collection programme comprise:

1. Documentation of sampling programme (see Section 6.3);
2. Documentation of database (see Section 6.3);
3. Yearbook of Fisheries Statistics;
4. Fisheries sector profiles (see Section 6.9);
5. Summary vessel registration (Year book) or frame survey;
6. Detailed landings statistics (in weight and value) by fleet, commercial category, geographical area, species;
7. Detailed effort and CPUE statistics;
8. Detailed vessel registration;
9. In addition to the standard reports, the database can produce *ad hoc* reports, but this usually requires knowledge of SQL (see Section 6.6);
10. Resource evaluation (e.g. fish stock assessment, CPUE analyses, etc.);
11. Bio-economic report.

It is useful if the annual reports do not change too much between years, in order to maintain the compatibility between years. Readers will want to compare the figures of the current year to the figures of foregoing years. The design of regular reports should be changed only in cases where there is an important development in the fishing sector that cannot be covered by the present design. Therefore, the design of the regular reports is important, as it will affect the presentation of the fisheries statistics perhaps for many years.

Each report should contain tables and graphs, which illustrate the historical development of the fisheries sector. Thus, every year a new year-column or year-row is added to tables, and a new point or bar is added to graphs.

The designers of regular reports should get inspiration from regular fisheries reports of countries with a long tradition for production of such reports. The most useful guidance for design of reports is provided from countries with a similar fisheries sector and similar resources. However, ideas from countries with different fisheries may also prove useful, if due regard is given to the modification required before the design is transferred to your country.

As there are so many examples of regular fisheries statistics and regular fisheries reports, this manual shall not go further into the design of reports.

6.9 DESIGN OF FISHERIES SECTOR PROFILES

A fisheries sector profile may be considered an extended "frame survey", where it has been attempted to describe all elements of the fisheries sector of en edministretive division (a province) or the entire country, depending on the size of country.

A fisheries sector profile contains:

- Summary of the detailed catch and effort data in the fisheries database managed by the directorate of fisheries (the database of this manual).
- Additional data, relevent to menagement end development of the fisheries sector, which is not in the catch effort database.

The edditional data can often be found in other databases. They are not data collected by the programme described in this manual, but e recompilation of existing data.

The fisheries sector profiles are used by several groups of fisheries workers:

- Fisheries managers for an overall update of their background knowledge of the sector.
- Decision makers in fisheries (politicians end governments) for general background knowledge.
- Designers of data collection programme for stratification purposes.
- The fishing industry.
- The public in general.

Below follows a tentative checklist of additional data, which may or may not be included in the fisheries sector profiles, dependent on the local situation. The list may be supplemented and/or be reduced, to meet local needs.

CHECK-LIST OF FISHERIES PROFILE INFORMATION		
CATEGORY	**SUB-CATEGORY**	**DETAILS**
Map of province and provincial waters	**Part of map covering land**	Capital and major cities
		Districts, with major city
		Major rivers
		All major ports
		All major landing places
		Larger fishing villages
		Major roads
		Location of major fish processing industries
		Location of other major industries of relevance to fishing sector
	Part of map covering sea	Borders of provincial waters
		Depth contours, bottom types
		Fishing grounds
		Abundance of fish species of major commercial interest.
		Fisheries regulation boxes (e.g. areas closed for all fishing, trawling etc.)
Key figures of province (state or country):	**Population**	Total population
		Population by district (Table)
		Population of fishers and families by district (Table)
		Population of fisheries support personnel by district (Table)
	Sociological parameters	Demographic data (age distribution, family size,...)
		Religion
		Ethnic groups
		Education
		Women's position in society
		Sanitary, housing and health situation
		Fishers standard of living in general
		Income per capita
		Fishers alternative occupations
	Geography	Area of provincial waters
		List of coastal districts (Table)
		Length of coastline, total and by district (Table)
		Road system
	Main industries	List of main industries in province (summary employment and value of production)
	Political system	Structure of local governments, councils, committees, decision makers in general
		Relationship between local and central administration.
		Sources of income to local administration
		Local legislation contra central legislation
		Representation of central administration

CHECK-LIST OF FISHERIES PROFILE INFORMATION		
CATEGORY	**SUB-CATEGORY**	**DETAILS**
	Administrative structure	Province/government institutions
		Administration
		Departments, authorities etc.
Local fisheries administration	**Structure of fisheries administration**	Structure of provincial fisheries administration
		Structure of district fisheries administration
		Collaboration with central directorate of fisheries
	Registration	Registration of vessels at central, province and district level.
		Registration of fishers at central, province and district level.
	Local data collection	Local fisheries data collection (coverage, data sources, etc)
		Collection of landings statistics
		Collection of effort statistics
	Tax, fee, duties and subsidies to fisheries	Taxation in general and for fisheries sector in particular
		Fees/duties related to fisheries
		Fisheries licence system
	Safety	Inspection of fishing vessels for safety reasons
	Fisheries management	Management of fisheries
		Fisheries regulation
		Enforcement of fisheries regulation
		Compliance with fisheries regulation
	Development	Development of fisheries (local initiatives and central initiatives)
		Decommission of fishing vessels and other fisheries investments
		Education/training of fishers
		Fisheries extension service (subsidies/support given to fisheries)
	Inspection of sea products	Quality control of landings
		Post harvest regulation
		Inspection of processing plants
	Weather forecasts	Meteorological information service
	Literature	List of literature on fisheries sector of province
Other regulation, control or inspection	**Coast guard / Harbour police**	Authority and responsibility
		Legal power of authority
		Personnel
		Equipment (vessels etc.)
		Stations and sub-stations
		Number of inspectors
		Registrations
		Security
		Surveillance
		Collaboration with directorate of fisheries (local and central)

CHECK-LIST OF FISHERIES PROFILE INFORMATION		
CATEGORY	**SUB-CATEGORY**	**DETAILS**
Harvesting sector	**Overall structure**	List of fleets and number of units in each fleet
	Artisanal Fleets **Industrial fleets** **Other fishing devices (fixed gears etc.)**	***Specify for each major artisanal and industrial fleet and other fishing devices:***
		Fleet structure (number of vessels by fleet)
		Type of construction (material of hull)
		Gear(s). (primary gear and secondary gear(s))
		Average dimension of vessels (length, depth, width)
		Average engine power (HP)
		Average crew size
		Hold capacity
		Means of preservation of catch
		Ownership
		Navigation equipment
		Fish finding equipment
		Communication equipment
		Fishing techniques (light attraction, bait, FAD etc.)
		Group fishing (e.g. pair trawling)
		Processing of catch onboard (e.g. drying, cooking)
		Description of fishing trips
		Description of catching techniques
		Description of landing procedure
		Description of sale of landings
		Description of discarding
		Target species (groups) and bycatch species (groups)
		Sharing of profit
		Average income of fishers
		Seasonality of fishing
		Fishing grounds by season (migration of vessels)
		Base port(s) by season
		Investments in an average vessel of fleet
		Credit schemes (for investments in fleet)
		Routinely maintained records (notebooks, logbooks, sale-slips, accounting, etc.)
Fishers organisations	**Organisation**	Number of members (percent of total)
		Legal status
		Activities of organisation
		Power relative to government and industry
		Fee for membership

CHECK-LIST OF FISHERIES PROFILE INFORMATION		
CATEGORY	**SUB-CATEGORY**	**DETAILS**
Landing places	**Landing place**	Name of landing places
		Landings by fleet and commercial group
		Roads to landing places (Table)
		Facilities on landing place
		Population in landings place
		Fish markets
		Transport system
		Storage of sea products
		Export
		Relative importance of fishery
		Distribution of sea products on domestic market
Mari culture	**Summary description**	Location and type of mariculture
	Products	List of species and processing (if any)
	Annual production	Annual production in value and weight and as percentage of compatible capture production
Inland fisheries	**Summary description**	Main species and production
Processing sector	**Processing plant**	Production (quantity and quality)
		Employment
		Ownership
		Relationship to harvesting sector
		Relationship to merchants
		Import/Export
Fisheries support industry sector	**Ship yards**	Type of ship yard
		Annual production of fishing vessels(number of vessels and tonnage)
		Employment
		Ownership
	Repair shops	Annual production and employment
	Ice plants	Annual production and employment
	Gear manufacturing	Annual production and employment
Merchants structure	**Merchant or group of merchants**	Relationship to fishers
		Hierarchy of merchants
		Merchant's ownership of vessels
		Type of sea products purchased
		Relationship to processing sector
		Involvement in export and/or sale on domestic market
		Loans to fishers

CHECK-LIST OF FISHERIES PROFILE INFORMATION		
CATEGORY	**SUB-CATEGORY**	**DETAILS**
Fishing companies	**Fishing company**	Name and location of fishing company
		Ownership
		Number and types of vessels
		Employment (land and sea based)
		Annual production in weight and value
		Relationship to processing sector
Co-operatives	**Co-operative**	Type of co-operative
		Number of vessels
		Number of fishers
		Activities
		Members contribution (fee, investment, share of profit)
		Annual production in value and weight
Joint ventures	**Joint venture**	Type of joint venture
		Number of vessels
		Number of fishers
		Activities
		Contribution (fee, investment, share of profit)
		Annual production in value and weight
Local History of fishery	**Time series of number of vessels.**	
	Time series of production, effort and CPUE	
	Historical assessments of fisheries sector and resources	
	Other historical statistic of fisheries	
Future of local fishery	**Development plans**	
Literature on provincial fisheries sector not included elsewhere		

6.10 AN EXAMPLE FISHERIES DATABASE

The "FDDB" (Fisheries Demonstration DataBase) was constructed as a tool for teaching the theory and practice of fisheries databases. It was used by the author in the implementation of a fisheries database for Viet Nam's commercial marine capture fishery, the "VIETFISHBase". FDDB is a simplified and reduced version of VIETFISHBase. However, FDDB contains all the essential features of the commercial fishery part of the database, except for spatial information, such as landing places and fishing grounds by statistical rectangles and divisions of rectangles. Nor does FDDB contain information about landing places or gears. Only "provinces" and "fleets" are considered.

This Section is presented as an example and it aims only at introducing the basic principles of fisheries databases to those who have not got experience in fisheries databases. By working through the example, you should be in better position to understand a full-scale fisheries database, which is a complex system.

FDDB is implemented in ACCESS (the database module of Microsoft Office, see Section 6.2). The database application contained a full set of data and the forms of FDDB. The FDDB was created exclusively using "wizards". Wizards are utilities for easy generation of simple applications.

6.10.1 Tables of FDDB

FDDB comprises 10 Tables, of which 5 are look-up tables (see Figure 6.10.1). The names assigned to tables and fields of tables (columns) are assumed to be self-explanatory (It is recommended always to use more or less self-explanatory names of fields and tables).

The look-up tables all start their name with "L_". Except for the vessel register, the only purpose of the look-up tables is to translate a code into a name in the English language. The vessel register contains another type of information, namely the definition of fleets, as it assigns each vessel to a fleet.

The field ""LgtUnit" indicates the length measurement unit, such as "MM" or "CM", and could also have had a look-up table associated with it. However, as this is a small static list of values, it will appear as a "List-box", which is fixed and cannot be changed easily.

All field names starting with "ID_" are keys. Whenever they appear as the first field in a table, they are unique keys for that table. All the relations are "one-to-many-relations", between the key-fields. The other fields are "data", such as landings and effort. Tables 6.10.2-6 present a complete example of the tables with data.

Note the hierarchy of data tables

1st Level in hierarchy: Table: "Interview", key "ID_Interview"

2nd Level in hierarchy: Table: "Commer_Gr_Weigth", key: "ID_CommGr_Wgt"

3rd Level in hierarchy: Table: "Species_Composition", key: "ID_Spec_Comp"

4th Level in hierarchy: Table: "LgtFrq", key: "ID_LgtFrq."

Each relationship is "one-to-many" downwards in the hierarchy. The links are from the first (unique) key in the higher level to the second field in the lower hierarchical level.

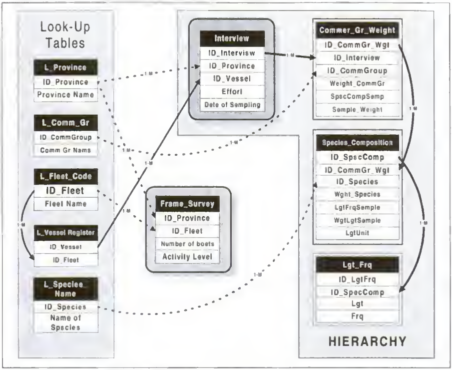


Figure 6.10.1 Tables and relations of FDDB.

6.10.2 Forms of FDDB

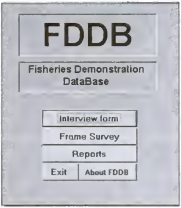


Figure 6.10.2. The main menu of FDDB.

Figure 6.10.2 shows the main menu of the FDDB. There are two options for entry of data, namely "Interview data" and "Frame survey data". Then there is one option for reports, which in turn leads to a new menu with many options. The FDDB menu for reports contains only the administrative reports, as the exercise behind the present annex is to create the reports, using the SQL language. "About FDDB" is a short description of the software.

Figure 6.10.3 shows a list of the controls of the FDDB forms, that is "buttons" you can "click" on with the mouse, to instruct the FDDB. These controls are the standard Windows controls. It is tacitly assumed that the reader is already (more or less) familiar with these controls from other software packages.

	Close form. Go back to the foregoing form.
	Delete record (row in a table).
	Display/print table (report control, see Fig. 6.10.7)
LgtFrq	Change from interview form to length frequency form
NTMH	Show Look-Up table. Select item from the list, to enter in a field of a row.
	Scroll bar. Navigate between rows in a table. Navigate on the screen.
	Go to next record
	Go to last record
	Add new record
Record: 1 of 33327	Record selector
	Record (row) pointer Pointer to new record (row)

Figure 6.10.3 Controls of the forms.

Figure 6.10.4 shows the form for entry of interview data, which actually contains three forms, "INTERVIEW", "WEIGHT OF COMMERCIAL GROUP" and "SPECIES COMPOSITION" organised in a hierarchy, as illustrated in Figure 6.10.5. "Hierarchy" means here that you cannot fill in a form before all forms "higher up in the hierarchy" have been filled in. The "SPECIES COMPOSITION" form contains a control "LgtFrq" (Length Frequency). By clicking on "LgtFrq" you enter the "LENGTH FREQUENCY" form, which is the form on the fourth level in the hierarchy. Thus, the interview forms contain the structured hierarchically:

1st level in Hierarchy: "INTERVIEW"

2nd level in Hierarchy: "WEIGHT OF COMMERCIAL GROUP"

3rd level in Hierarchy: "SPECIES COMPOSITION"

4th level in Hierarchy: "LENGTH FREQUENCY"

Level 1 always has to be filled in to create a record in the database, but then you may fill in from zero to any number of level 2 forms. For each level 2 you may fill in from zero to any number of "species composition forms", and for each of them any number of "length frequency forms". Each form corresponds to one record. The length frequency form (Figure 6.10.6) is actually a list of forms, as each line corresponds to a record.

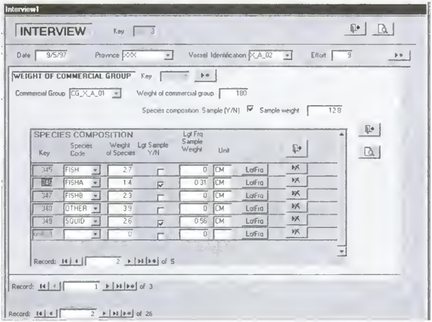


Figure 6.10.4 Interview form

Figure 6.10.5 The hierarchical structure of interview sub-forms

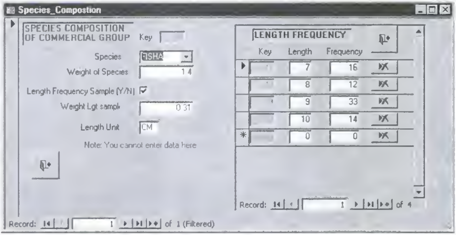


Figure 6.10.6 Length frequency form.

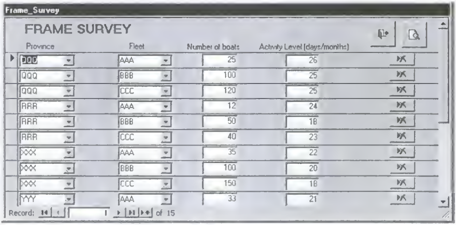


Figure 6.10.7 Frame survey form

The effect of the "report" control is shown in Figure 6.10.7, which shows the complete set of input data to the frame survey. The table also shows the subtotal and the estimated total number of boat days per month (= (number of boats) * (Fishing days / month)).

The forms show the key (in the actual implementation of FDDB as red characters on blue background, whereas other characters are in black and white). Normally, keys are used for the internal bookkeeping of the database, and are of no immediate interest to the user. Keys, which are (arbitrary) numbers, will normally not be shown on the forms. When they are shown on the screen forms of FDDB, it is to demonstrate the structure of the database. Keys, which are also codes, (for example the vessel code) can be of interest to the user, and they will usually be shown on the screen.

The frame survey is executed in parallel to the interviews (see Table 6.10.1), thus it is not a part of the hierarchy of landings data. As appears from Tables 6.10.1 and 6.10.2, there are five provinces and three fleets. This generates 5*3 = 15 combinations, which is the number of records (rows) in the frame survey table (see Table 6.10.2). In this simplified example, there is only one frame survey. In a realistic case, the frame survey would be repeated regularly, if infrequently. With 15 records, the present frame survey represents a complete enumeration. The interview samples, however, are sampled only from three of the five provinces, as can be seen from Table 6.10.3.

Table 6.10.1 Frame survey report showing the input data

INPUT TO FRAMESURVEY				
ID_Province	**Fleet**	**Number of boats**	**Fishing days/month**	**Total fishing days**
QQQ	AAA	25	26	650
	BBB	100	25	2500
	CCC	120	25	3000
	Total Province	**245**		**6150**
RRR	AAA	12	24	288
	BBB	50	18	900
	CCC	40	23	920
	Total Province	**102**		**2108**
XXX	AAA	35	22	770
	BBB	100	20	2000
	CCC	150	18	2700
	Total Province	**285**		**5470**
YYY	AAA	33	21	693
	BBB	70	17	1190
	CCC	21	19	399
	Total Province	124		2282
ZZZ	AAA	63	25	1575
	BBB	47	28	1316
	CCC	59	27	1593
	Total Province	**169**		**4484**
ALL PROVINCES	***GRAND TOTAL***	***925***		***20494***

Table 6.10.2 Example of tables with data of FDDB

Look-Up: Fleet-Names

ID_Fleet	Fleet Name
BBB	Fleet 1
CCC	Fleet 2
AAA	Fleet 3

Look-Up: Species Names

ID_Species	Name of species
FISH	A fishy fish
FISHA	Another fishy fish
FISHB	Flatfish
FISHC	Roundfish
OTHER	Whitefish
SQUID	Octopus

Look-Up: Commercial groups

ID_CommGroup	Comm Gr Name
CG_X_A_01	Comm. Gr. 1
CG_X_A_02	Comm. Gr. 2
CG_X_A_03	Comm. Gr. 3
CG_X_B_01	Comm. Gr. 4
CG_X_B_02	Comm. Gr. 5
CG_X_C_01	Comm. Gr. 6
CG_X_C_02	Comm. Gr. 7
CG_Y_A_01	Comm. Gr. 8
CG_Y_A_02	Comm. Gr. 9
CG_Y_A_03	Comm. Gr. 10
CG_Y_B_01	Comm. Gr. 11
CG_Y_B_02	Comm. Gr. 12
CG_Y_C_01	Comm. Gr. 13
CG_Y_C_02	Comm. Gr. 14
CG_Z_A_01	Comm. Gr. 15
CG_Z_A_02	Comm. Gr. 16
CG_Z_A_03	Comm. Gr. 17
CG_Z_B_01	Comm. Gr. 18
CG_Z_B_02	Comm. Gr. 19
CG_Z_C_01	Comm. Gr. 20
CG_Z_C_02	Comm. Gr. 21

(Note: Commercial groups are fleet and province specific)

Look-Up: Province Names

ID_Province	Province Name
XXX	Province 1
YYY	Province 2
ZZZ	Province 3
QQQ	Province 4
RRR	Province 5

(There are 5 provinces in the country)

(Not complete) **VESSEL REGISTER**

ID_Vessel	Fleet
X_A_01	AAA
X_A_02	AAA
X_A_03	AAA
X_B_01	BBB
X_B_02	BBB
X_B_03	BBB
X_C_01	CCC
X_C_02	CCC
Y_A_01	AAA
Y_A_02	AAA
Y_A_03	AAA
Y_B_01	BBB
Y_B_02	BBB
Y_B_03	BBB
Y_C_01	CCC
Y_C_02	CCC
Z_A_01	AAA
Z_A_02	AAA
Z_A_03	AAA
Z_B_01	BBB
Z_B_02	BBB
Z_B_03	BBB
Z_C_01	CCC
Z_C_02	CCC

(First letter indicates province)

FRAME SURVEY

Province	Fleet	Number of boats	Activity Level	
XXX	BBB	100	20	Interview samples
XXX	CCC	150	18	
XXX	AAA	35	22	
YYY	BBB	70	17	
YYY	CCC	21	19	
YYY	AAA	33	21	
ZZZ	BBB	47	28	
ZZZ	CCC	59	27	
ZZZ	AAA	63	25	
QQQ	BBB	100	25	No interviews sampled
QQQ	CCC	120	25	
QQQ	AAA	25	26	
RRR	BBB	50	18	
RRR	CCC	40	23	
RRR	AAA	12	24	

Table 6.10.3 Example of tables with data of FDDB.

INTERVIEWS

ID_IntvieW	ID_Province	ID_Vessel	Effort	Date of Sampling
2	XXX	X_A_01	9	04-Sep-97
3	XXX	X_A_02	9	05-Sep-97
4	XXX	X_A_03	8	06-Sep-97
5	XXX	X_B_01	5	07-Sep-97
6	XXX	X_B_02	8	08-Sep-97
7	XXX	X_B_03	6	09-Sep-97
8	XXX	X_C_01	9	10-Sep-97
9	XXX	X_C_02	9	11-Sep-97
10	YYY	Y_A_01	4	12-Sep-97
11	YYY	Y_A_02	6	13-Sep-97
12	YYY	Y_A_03	7	14-Sep-97
13	YYY	Y_B_01	8	15-Sep-97
14	YYY	Y_B_02	6	16-Sep-97
15	YYY	Y_B_03	3	17-Sep-97
16	YYY	Y_C_01	4	18-Sep-97
17	YYY	Y_C_02	8	19-Sep-97
18	ZZZ	Z_A_01	6	20-Sep-97
19	ZZZ	Z_A_02	5	21-Sep-97
20	ZZZ	Z_A_03	8	22-Sep-97
21	ZZZ	Z_B_01	9	23-Sep-97
22	ZZZ	Z_B_02	6	24-Sep-97
23	ZZZ	Z_B_03	6	25-Sep-97
24	ZZZ	Z_C_01	6	26-Sep-97
25	ZZZ	Z_C_02	7	27-Sep-97
26	ZZZ	X_C_02	12	05-Sep-97
27	ZZZ	Z_B_03	12	04-Sep-97

EXERCISE

The exercise is to raise the samples to total country, (or division of country) as explained in the manual. The raising is for all three types of data:

1. Catch by commercial category
2. Catch by species.
3. Length frequencies.

What you should do is take the tables from FDDB, and send them to EXCEL (the spread sheet module of Microsoft Office), and then do the raising in EXCEL. This could also be done in ACCESS, but that is a job for experts.

One of the problems you will have to deal with is "how to calculate mean values of CPUE (Catch Per Unit of Effort)?

Effort = Fishing days

CPUE = Catch per days

We want to calculate the mean CPUE for a fleet (similar boats). We observe the number of days per trip and the total catch of the trip. Which method to use, A or B?

Method A	*Effort*	*Catch*	*CPUE*
Vessel 1	1	100	100.00
Vessel 2	5	200	40.00
Vessel 3	10	500	50.00
	Mean CPUE		**63.33**

Method B	*Effort*	*Catch*	*Mean CPUE*
Vessel 1	1	100	
Vessel 2	5	200	
Vessel 3	10	500	
Total	**16**	**800**	50.00

If the number of fishing days per trip remains constant, the two methods give the same results.

Method A	*Effort*	*Catch*	*CPUE*
Vessel 1	5	150	30.00
Vessel 2	5	200	40.00
Vessel 3	5	250	50.00
	Mean CPUE		40.00

Method B	*Effort*	*Catch*	*Mean CPUE*
Vessel 1	5	150	
Vessel 2	5	200	
Vessel 3	5	250	
Total	**15**	**600**	40.00

Table 6.10.4 Example of tables with data of FDDB.

ID_ComGr _Wgt	ID_IntvieW	ID_Comm Group	Weight CommGr	SpecComp Samp	Sample Weight
2	2	CG_X_A_01	142	TRUE	18.9
3	2	CG_X_A_02	188	FALSE	0
4	2	CG_X_A_03	108	FALSE	0
5	3	CG_X_A_01	180	TRUE	12.8
6	3	CG_X_A_02	106	FALSE	0
7	3	CG_X_A_03	166	FALSE	0
8	4	CG_X_A_01	135	FALSE	0
9	4	CG_X_A_02	110	FALSE	0
10	4	CG_X_A_03	139	TRUE	15.2
11	5	CG_X_B_01	121	TRUE	14.2
12	5	CG_X_B_02	132	TRUE	18.8
13	6	CG_X_B_01	183	FALSE	0
14	6	CG_X_B_02	139	FALSE	0
15	7	CG_X_B_01	188	FALSE	0
18	7	CG_X_B_02	122	TRUE	10.1
17	8	CG_X_C_01	127	TRUE	15.2
18	8	CG_X_C_02	191	FALSE	0
19	9	CG_X_C_01	111	FALSE	0
20	9	CG_X_C_02	134	FALSE	0
21	10	CG_Y_A_01	142	FALSE	0
22	10	CG_Y_A_02	161	FALSE	0
23	10	CG_Y_A_03	129	FALSE	0
24	11	CG_Y_A_01	104	FALSE	0
25	11	CG_Y_A_02	150	TRUE	18
26	11	CG_Y_A_03	135	FALSE	0
27	12	CG_Y_A_01	132	TRUE	18.8
28	12	CG_Y_A_02	190	FALSE	0
29	12	CG_Y_A_03	107	TRUE	12.6
30	13	CG_Y_B_01	174	FALSE	0
31	13	CG_Y_B_02	144	FALSE	0
32	14	CG_Y_B_01	107	FALSE	0
33	14	CG_Y_B_02	122	TRUE	10.1
34	15	CG_Y_B_01	156	FALSE	0
35	15	CG_Y_B_02	102	TRUE	10.8
36	16	CG_Y_C_01	108	FALSE	0
37	16	CG_Y_C_02	147	FALSE	0
38	17	CG_Y_C_01	108	FALSE	0

ID_ComGr_Wgt	ID_IntvieW	ID_Comm Group	Weight CommGr	SpecComp Samp	Sample Weight
39	17	CG_Y_C_02	114	FALSE	0
40	18	CG_Z_A_01	150	FALSE	0
41	18	CG_Z_A_02	142	TRUE	16.8
42	18	CG_Z_A_03	145	FALSE	0
43	19	CG_Z_A_01	175	FALSE	0
44	19	CG_Z_A_02	169	FALSE	0
45	19	CG_Z_A_03	158	FALSE	0
46	20	CG_Z_A_01	163	FALSE	0
47	20	CG_Z_A_02	128	FALSE	0
48	20	CG_Z_A_03	159	FALSE	0
49	21	CG_Z_B_01	162	TRUE	16.6
50	21	CG_Z_B_02	129	FALSE	0
51	22	CG_Z_B_01	102	TRUE	7.2
52	22	CG_Z_B_02	174	TRUE	9.3
53	23	CG_Z_B_01	143	FALSE	0
54	23	CG_Z_B_02	179	FALSE	0
55	24	CG_Z_C_01	125	FALSE	0
56	24	CG_Z_C_02	128	FALSE	0
57	25	CG_Z_C_01	131	TRUE	14.2
58	25	CG_Z_C_02	133	TRUE	14
59	26	CG_X_A_02	120	FALSE	0
60	27	CG_Z_B_01	130	TRUE	25

Table 6.10.5 Example of tables with data of FDDB

SPECIES COMPOSITION						
ID_Spec Comp	ID_ComGr _Wgt	Species	Wght Species	LgtFrq Sample	WgtLGT sample	Lgt Unit
340	2	FISH	2.9	FALSE	0	CM
341	2	FISHA	2.4	FALSE	0	CM
342	2	FISHB	0.7	FALSE	0	CM
343	2	OTHER	6.6	FALSE	0	CM
344	2	SQUID	6.5	FALSE	0	CM
345	5	FISH	2.7	FALSE	0	CM
346	5	FISHA	1.4	TRUE	0.31	CM
347	5	FISHB	2.3	FALSE	0	CM
348	5	OTHER	3.9	FALSE	0	CM
349	5	SQUID	2.6	TRUE	0.56	CM
350	10	FISH	4.7	FALSE	0	CM
351	10	FISHA	3.3	FALSE	0	CM
352	10	FISHB	2.6	FALSE	0	CM
353	10	OTHER	3.4	FALSE	0	CM
354	10	SQUID	1.2	FALSE	0	CM
355	11	FISH	4.7	FALSE	0	CM
356	11	OTHER	3.4	FALSE	0	CM
357	11	SQUID	6.1	FALSE	0	CM
358	12	FISH	5.4	FALSE	0	CM
359	12	FISHA	2.6	FALSE	0	CM
360	12	FISHB	2.9	FALSE	0	CM
361	12	FISHC	1.3	FALSE	0	CM
362	12	OTHER	1.7	FALSE	0	CM
363	12	SQUID	3	FALSE	0	CM
364	16	FISH	1.6	FALSE	0	CM
365	16	FISHA	0.9	FALSE	0	CM
366	16	FISHB	3	TRUE	0.65	CM
367	16	FISHC	1.6	FALSE	0	CM
368	16	OTHER	1.7	FALSE	0	CM
369	16	SQUID	1.3	FALSE	0	CM
370	17	FISH	4.5	TRUE	0.96	CM
371	17	FISHA	3.1	FALSE	0	CM
372	17	FISHB	1.2	FALSE	0	CM
373	17	OTHER	2.1	FALSE	0	CM
374	17	SQUID	4.3	FALSE	0	CM
375	25	FISH	4.4	TRUE	0.85	CM
376	25	FISHA	1.8	FALSE	0	CM

SPECIES COMPOSITION						
ID_Spec Comp	ID_ComGr _Wgt	Species	Wght Species	LgtFrq Sample	WgtLGT sample	Lgt Unit
377	25	FISHB	3.8	FALSE	0	CM
378	25	OTHER	3.5	FALSE	0	CM
379	25	SQUID	2.4	FALSE	0	CM
380	27	FISH	3.2	FALSE	0	CM
381	27	FISHB	1.2	FALSE	0	CM
382	27	FISHC	5.3	FALSE	0	CM
383	27	OTHER	2.1	FALSE	0	CM
384	27	SQUID	5.1	FALSE	0	CM
385	29	FISH	0.5	FALSE	0	CM
386	29	FISHA	1.1	FALSE	0	CM
387	29	FISHB	3.8	FALSE	0	CM
388	29	OTHER	4	FALSE	0	CM
389	29	SQUID	3.2	FALSE	0	CM
390	33	FISH	0.9	FALSE	0	CM
391	33	FISHA	2.6	FALSE	0	CM
392	33	FISHB	1.7	TRUE	0.09	CM
393	33	FISHC	0.4	FALSE	0	CM
394	33	OTHER	2.7	FALSE	0	CM
395	33	SQUID	1.9	FALSE	0	CM
396	35	FISH	1.7	FALSE	0	CM
397	35	FISHA	1.1	FALSE	0	CM
398	35	FISHB	2.6	TRUE	0.53	CM
399	35	FISHC	1	FALSE	0	CM
400	35	OTHER	1.6	FALSE	0	CM
401	35	SQUID	2.6	FALSE	0	CM
402	41	FISH	6.3	TRUE	1.56	CM
403	41	FISHA	2.1	FALSE	0	CM
404	41	FISHB	2.3	FALSE	0	CM

Table 6.10.5 (Continued) Example of tables with data of FDDB

SPECIES COMPOSITION						
ID_Spec Comp	ID_ComGr _Wgt	Species	Wght Species	LgtFrq Sample	WgtLGT sample	Lgt Unit
405	41	OTHER	4.1	FALSE	0	CM
406	41	SQUID	2.2	FALSE	0	CM
407	49	FISH	3.1	FALSE	0	CM
408	49	FISHB	5.5	TRUE	1.02	CM
409	49	OTHER	5.5	FALSE	0	CM
410	49	SQUID	2.5	FALSE	0	CM
411	51	FISH	1.6	FALSE	0	CM
412	51	FISHA	0.5	FALSE	0	CM
413	51	FISHB	0.9	TRUE	0.23	CM
414	51	FISHC	1.2	FALSE	0	CM
415	51	OTHER	0.7	FALSE	0	CM
416	51	SQUID	2.3	TRUE	0.48	CM
417	52	FISH	1.8	FALSE	0	CM
418	52	FISHB	4.5	FALSE	0	CM
419	52	OTHER	1.2	FALSE	0	CM
420	52	SQUID	1.9	TRUE	0.41	CM
421	57	FISH	1.9	FALSE	0	CM
422	57	FISHA	2.1	FALSE	0	CM
423	57	FISHB	1.2	FALSE	0	CM
424	57	FISHC	5.2	FALSE	0	CM
425	57	OTHER	3.4	FALSE	0	CM
426	57	SQUID	0.6	FALSE	0	CM
427	58	FISH	3.1	FALSE	0	CM
428	58	FISHA	5.1	FALSE	0	CM
429	58	FISHB	2.2	FALSE	0	CM
430	58	OTHER	1.3	FALSE	0	CM
431	58	SQUID	2.4	FALSE	0	CM
432	60	FISHA	6	FALSE	0	CM
433	60	FISHC	5	FALSE	0	CM
434	60	SQUID	8	TRUE	3	CM
435	60	FISH	8	TRUE	2	CM

Table 6.10.6 Example of tables with data of FDDB.

LENGTH FREQUENCIES							
ID_ LgtFrq	ID_Spec Comp	Lgt	Frq	ID_ LgtFrq	ID_Spec Comp	Lgt	Frq
49	346	9	33	78	402	6	1
50	346	10	14	79	402	7	29
51	349	8	15	80	402	9	24
52	349	9	11	81	402	10	19
53	349	10	32	82	408	6	4
54	349	11	11	83	408	7	20
55	349	12	5	84	408	8	37
56	366	8	15	85	408	9	13
57	366	9	13	86	408	10	9
58	366	10	34	87	413	8	15
59	366	12	16	88	413	9	29
60	370	8	16	89	413	10	20
81	370	9	27	90	413	11	20
62	370	10	22	91	416	6	7
63	370	11	18	92	418	7	12
64	370	12	15	93	416	8	27
85	375	7	8	94	418	9	12
66	375	8	16	95	416	10	5
67	375	9	37	96	420	8	1
68	375	10	26	97	420	10	36
89	375	11	7	98	420	11	24
70	392	7	13	100	434	5	4
71	392	8	22	101	434	8	7
72	392	9	10	102	434	3	2
73	392	10	14	103	435	3	5
74	398	8	9	104	435	4	11
75	398	9	11	105	435	5	6

7 IMPLEMENTATION OF SAMPLING PROGRAMME

The optimum implementation of a sampling programme depends on the situation in the country and its sub-divisions. The sampling programme is also dependent on the objectives and the funds and personnel available for the sampling. Thus, no universal best solution exists and the following is only a collection of general advice. The list of advice is not exhaustive, although it has been attempted to include all major issues.

7.1 PILOT SAMPLING PROGRAMME

Never start up a full-scale sampling programme based on theoretical considerations and assumptions about the actual situation in the field, but use practical trials to test procedures. A pilot sampling programme covers a limited area and will usually last one to six months. However, the number of staff involved in a pilot programme is much bigger than in the full programme, because staff categories should participate in the field work, not only the enumerators. The programme management should test all procedures, in order to obtain the maximum background knowledge.

A pilot programme may be used in three cases:

- When starting up the sampling programme from scratch.
- When extending the number of data types to be collected.
- When extending the sampling programme in space.

Collect as much information as possible about the pilot area and its fisheries and from data collection programmes under similar conditions (e.g. from neighbouring countries), before going into the field. Study the relevant manuals and textbooks used for fisheries data collection in the region and other similar places. A pilot programme should ideally include the following activities.

1. Form study groups within the programme staff.
2. Organise training in data collection methodology and workshops on the objectives of data collection (possibly using external consultants).
3. Organise consultations with the users of the data collection programme, primarily the central and local fisheries administration and the bodies dealing with management and development of fisheries.
4. Establish rules for reporting from meeting (minutes) and duty travel reports ("Back to office reports"), so that the entire staff can share the accumulated experience.
5. Try to identify a pilot area where you expect the problems to be minimal. Do not start with the most complex case first. If necessary, make two pilot studies, an "easy case" and "a complex case", but start with the easy one.
6. Search for literature on fisheries and fishing communities.
7. Search for literature on the living resources in the pilot area.
8. Check existing statistics related to fisheries data collection.
9. Discuss the objectives of the sampling programme with the central fisheries management and administration.
10. Discuss the objectives of the sampling programme with the local fisheries management and administration.

11. Check the legal basis for the provision of information by the industry.
12. Check the existing legislation, regulations and registration of fishing vessels and fishers.
13. Check the licence system, and obligations to provide information.
14. Discuss changes/extension of the legislation if necessary.
15. Make a preliminary strategy for data collection.
16. Discuss the preliminary plans with the fisheries management body and fisheries administration.
17. Sources of data. Where to get the data?
18. How to get the data? How to approach the data source.
19. When to get the data.
20. Create contacts with local authorities, associations, co-operatives etc.
21. Make contact with selected fishers, preferably representatives of the fisher communities.
22. Organise information meetings with local representatives.
23. Organise information meetings with fishers.
24. Organise any event which may improve the relationship with the fishing community (for example, participate in festivals, give donations etc.)
25. Make pamphlets and posters in the local language for distribution.
26. Contact other sampling programmes (if applicable) for co-ordination and possible briefing.
27. Make a profile of the fishery in the pilot area.
28. Test out practical procedures and modify them until they work.
29. Note the costs of sampling, and test ways of maximising the data collected while minimising the cost.
30. Note the time it takes to collect the different types of samples, interviews, biological samples, frame survey, costs and earnings etc.
31. Note the need for manpower.
32. Note the need for transport, vehicles etc.
33. Note the need for subsistence payments to enumerators
34. Send observers onboard the vessels during fishing trips
35. Let all staff, from the team leader to encoder, participate in the pilot sampling.
36. Train new enumerators on the job, and by training courses on:
    - How to approach the fishers and interview techniques.
    - Species identification
    - Fleet identification (how to collect data on vessel details)
    - How to collect biological data (e.g. length, sex, maturity)
37. Make fleet stratification, - define fleets in the pilot area both for the sampling programme (raising) and for management/development purposes.
38. Test various equipment (photocopy, camera, scales, measuring devices).

39. Design preliminary data forms.
40. Design the preliminary computerised database system.
41. Enter data in the preliminary database, and check that data collected can be used to estimate the desired parameters.
42. Collect information on the experience of enumerators and organise meetings. Use the advice from the field workers.

Whatever positive relationship has been established with the fisher community should be continued and possibly extended.

7.2 BUDGET OF SAMPLING PROGRAMME

This section lists some possible items for considerations when preparing a budget of a data collection programme. It is not possible to prepare a generic budget for a data collection programme, due to the variability of local conditions.

RECURRENT COSTS

1. Salary, enumerators
2. Salary, supervisors
3. Salary, encoders
4. Salary, support staff (e.g. programmers, secretaries, accountants, drivers)
5. Communication (mail, telephone, fax, email)
6. Enumerators transport (including Daily Subsistence Allowance - DSA) to landing places
7. Supervisors transport (including DSA) to landing places
8. Training courses/seminars for enumerators
9. Consultants (e.g. information technologists or artists)
10. Participation in workshops, international conferences etc. abroad
11. Organisation of (inter)national workshops, conferences etc. in country
12. Study tours
13. Hospitality
14. Consultative meetings (with industry, government, local administrations)
15. On-the-job training - costs of trainers
16. Costs of samples
17. Costs of reporting
18. Sundries
19. Office running costs
20. Dissemination of information (publications)

INVESTMENTS

21. Equipment for measurements
22. Computers, printers, networks, backup, software, etc.
23. Photocopy and fax machines, telephones
24. Transport (cars, motor bikes, boats, etc)
25. Office space

7.3 TRAINING

Training is one of the most crucial components in the preparation and successful implementation of a data collection programme and must always be given high priority.

Training during the planning and implementation phases is different from the routine training of an on-going data collection programme. Regular training is an indispensable part of a sampling programme. New staff members on each level obviously have a need for training, but all personnel at all levels needs regular training to maintain work quality.

Training courses and workshops should target a representative number of staff involved in the preparatory and operational phases of a fishery data collection programme and should thus be an on-going activity. Participants should include fishers, data collectors, supervisors, researchers, computer operators, directly responsible data producers and users, and decision makers.

On-the-job-training is good for addressing technical (practical) problems. At the same time, the trainers on the job will increase their knowledge about the local situation. The training is most often a two-way communication, and that applies in particular when the training takes place in the environment of the trainee, who often has good background knowledge of the local situation.

Training courses and workshops are a good means for addressing methodological and operational problems encountered in the implementation of data collection programmes. They provide the opportunity for bringing together staff with different responsibilities and activities, such as data collectors and supervisors, data operators, statisticians and researchers.

Enumerators and their supervisors are the backbone of a data collection system since they are in direct contact with the fishers and have first-hand experience regarding field operations. Their participation will make them feel part of the entire survey programme and that will greatly assist in the identification of problem areas related to data collection operations. Participation of data operators is also important since their observations regarding inputting and data storage operations may bring out suggestions for improving the format of source forms and their compilation by the data collectors.

The aspects of gathering all personnel at one spot as frequently as possible should not be underestimated. Enumerators located at remote landing places, who are infrequently visited by the staff of the headquarters, or who have not had the opportunity to meet their colleagues in similar situations (for exchange of experience) may gradually lose their interest in the programme. This will result in a loss of loyalty to the programme, and therefore in a lower quality and quantity of data collected.

The training courses and workshops should address all aspects of the sampling programme, since it is important that staff at all levels understand and support the overall idea behind the programme. Enumerators, for example, are often in a situation where they are questioned by fishers about the data collection programme and they should preferably agree with the programme and be able to explain and justify it.

The key questions should be explained and discussed with all types of staff, although the topics should be dealt with in a way matching the different staff groups. Key questions are:

1. Why collect data? (objectives of data collection programme);
2. Who are the customers? (who should we collect data for);
3. Which data to collect? (say, from commercial fishery or from experimental fishery?);
4. How to collect data? (What are the sources of data?);
5. How to store and process data? (Including databases and bio-economics and fish stock assessment);

6. How to report on fisheries? Which groups of customers should get which type of reports?;

7. What are the costs of data collection, and where does the funding come from?

The programme should make use of existing manuals on data collection in general and fisheries data collection in particular, but general manuals (like the present one) are never sufficient to meet the special requests. It is recommended that the programme prepare its own manuals (in the national language) on its own procedures and methods.

7.3.1 Training of Data Manager and Supervisors

Training of leading staff may be executed within the data collection programme by consultants or outside the programme, for example in universities, in international organisations or by study tours, visits to other data collection programmes (collecting similar data) or fisheries data collection programmes in other countries.

Training of leaders will often be "training of trainers". That is, the leader will convey her/his newly acquired knowledge to the staff of the programme. The leaders participating in external training activities should report on the experience gained, and, if appropriate, explain how the new knowledge can be utilised in the programme.

The selection of training or participation in meetings and conferences outside the programme should always be justified by its value for the programme. Participation in external activities is usually costly, and must always be justifiable, relative to the other costs of the sampling programme.

However, participation in training courses and conferences outside the data collection programme is absolutely necessary, if the programme should keep pace with the development. This applies in particular to management and development issues (objectives of data collection) as well as information technology (databases, publications, communication etc.).

It is not recommended to have special workshops and training courses for leaders inside the programme. For example, leaders who are not computer experts should not get a special computer course for leaders. They should participate in the training course together with other staff categories. Special training courses for leaders are required in fields of expertise, which are not covered by the current staff of the programme.

7.3.2 Training of Enumerators, Encoders and Support Staff

The training of enumerators, encoders and support staff may be executed either by the managers or supervisors or more experienced enumerators/encoders. Training courses/workshops may also be attended by the managers/supervisors as participants.

In a training course, one would mainly think of one-way communication, whereas a workshop should allow for discussions and analyses of what has been done and what is being taught. The purpose of a workshop is to try out the theory, exchange experience between the participants, and eventually produce results for distribution outside the data collection programme. It is recommended to combine training courses and workshops as much as possible, so that the participants get a good understanding of the relationship between theory and practice.

It is important that the encoders have a good understanding of the enumerator's work. Actually, encoders and enumerators may partly be the same persons. Thus, both encoders and enumerators should participate at the same courses/workshops.

These courses should cover also the important issues of data collection mentioned above. The enumerator is the representative of the programme, and she/he should have the understanding of the issues, which enable a convincing justification of the programme. In general, the training should not be confined to the narrow field of the enumerators/encoders daily work. The enumerators should report on questions encountered during their service, and the handling of the specific question should be addressed to the benefit of the entire group.

Enumerator/Encoder specific training issues:

1. The fishing sector (general information about the fisheries);
2. The national and the local fisheries administration;
3. Interview techniques (how to approach fishers for interview);
4. Relationship to fishers (in addition to the situation of interview);
5. Relationship to local administration;
6. Planning of work;
7. Species identification;
8. Fleet identification;
9. Entry of data in forms and database;
10. Reporting to headquarters (activities, accounting, needs, problems encountered);
11. Sampling theory (e.g. Neyman criteria);
12. Fishing grounds identification;
13. Vessel registration;
14. Information technology (e.g. databases);

Workshop issues for enumerators/encoders:

15. Definition of fleets (discussion of current fleet definitions, and possible new definitions based on recent developments);
16. Definition of commercial groups (discussion of current definition of commercial groups, and possible new definitions based on recent developments);
17. Production of reports for local distribution (e.g. Provincial annual fisheries statistics);
18. Production of national reports (e.g. National annual fisheries statistics);
19. Production of written material for distribution to fishers and other local groups (e.g. a pamphlet explaining the key issues of the data collection programme);
20. Planning local meetings with fishers and the local administration.

Support staff, which includes computer experts, accountants, office manager and secretaries, may need specialised training, but they should also participate in part of the training for enumerators and encoders.

The above list of topics for training courses and workshops should be extended with topics specific to the local situation.

7.4 CONSULTATION

The programme should prepare material to inform the industry and the local administration about the sampling programme and hold meetings where it can be presented and discussed. A pamphlet of a maximum of 20 pages with many illustrations, aiming at the public as a whole, should be prepared. The data collection programme may get assistance from professional information experts (e.g. journalists or artists) to formulate the text and the illustrations of the pamphlet to reach a wide audience, but with special emphasis on the target group, the fishing community. The programme should design e logo to make the programme easily recognisable and visible and may prepare other material, like a presentation, tee-shirts and note books with the logo of the programme etc.

The main purposes of the meetings are:

1. To establish good relationships with the fishers and their organisations/associations;
2. To establish agreements on exchange of deta;
3. To get advice and information about the sector;
4. To inform about the data collection programme (objectives and methodology).

Funds must be allocated to this type of activity, as a bad relationship with the industry may destroy en otherwise well-designed data collection programme.

7.4.1 Consultations with Fisheries Administrators

The fisheries administrators (the staff of Fisheries Departments in central end local governments) are the primary users of the data collection programme. There must be a good relationship between them and the data collection programme. Therefore, reguler meetings end consultations should be arranged. Some of the administrators will also be responsible for the implementation of management regulations.

The edministretors need support end training to ensure they interpret the data in the correct way and are aware of the limitations in the data collection system.

Some of the administrators will usually direct the staff managers of the dete collection programme, and ideally, it is they who should take the initiative to organise meetings. If they ere hesitant, the management of the data collection programme must take the initiative.

Standing committees on fishery statistics (i.e. stock assessment, statistic standardisation groups) can play a key role in the co-ordination of data collection programmes, particularly in those cases where different agencies or institutions ere involved in various applications sectors and components of an overall survey system. Their terms of reference may include:

1. Set-up priorities and provide advice related to statistical development activities;
2. Provide e forum for consultetions end co-ordination regarding progress evaluetion, performance and diagnostics;
3. Use feedbeck information from National Workshops for the preparation of reports with findings, conclusions and recommendations;
4. Advise on correction of data collection progremme if end when needed;
5. Recommend on utilisation of steff and other resources for data collection.

Statistical Committees should meet on a regular besis and their composition end level of euthority should allow submission of their recommendations to higher government euthorities for consideration and action.

Working groups should be established to:

- Discuss the relevance of the output produced by the data collection programme;
- Standardise measurements and reporting;
- Set up data utilities and functions.

7.4.2 Consultations with Fisheries Managers and the Fishing Industry

"Fisheries manegers" are the decision makers, starting with the Minister of Fisheries (or the minister under which fisheries belongs) and all others involved in the decision-making process. Some of these persons are the superiors of the administrators. It may be natural to invite the decision makers together with the industrial sector they are responsible for, but they may also be invited together with their civil servants.

These meetings are the data collection meetings on the highest level, and the meetings may well have data collection as one item amongst others on the agenda. The task of the data programme will be to get on the agenda, and to use suitable opportunities to make the programme visible. The primary message to get through is that information is the prerequisite for rational management and development, but that information costs money, as explained in various international agreements, such as the "Code of Conduct for Responsible Fishing". Whenever appropriate, the data collection programme should use such occasions to point at its problems (usually funding) and to convince the decision makers about the value of data.

7.4.3 Exchange of Experiences with Other Countries or International Organisations

Irrespective of differences in type and size of fishing industries, fishery data collection programmes are generally based on certain basic and commonly accepted methodological and operational concepts. It may thus be of interest for a country to benefit from the experience and knowledge of other countries that have already made good progress in the implementation of fishery data collection programmes.

Exchange of such expertise can be facilitated by:

1. Regional workshops and expert consultations;
2. Study tours;
3. Exchange of information, including manuals, forms etc.;

Where regional co-ordinated data collection has been implemented international meeting of data managers may deal with:

4. Regional workshops on processing of combined data (including fish stock assessment and bio-economic analyses);
5. Standardisation of data format, for exchange of data;
6. Establishment of regional databases;
7. Co-ordination of data collection from shared resources;
8. Co-ordination of data collection from vessels not landing in the home country;
9. Exchange of data from shared resources.

As was the case with the training abroad, international activities are costly and should always be well justified.

7.5 DOCUMENTATION OF THE PROGRAMME

Documentation to be used as input for the sampling programme and database has the following main purposes:

1. To keep all staff up-to-date with the present status of the programme;
2. To keep other interested parties up-to-date with the present status of the programme;
3. To standardise the performance of all staff;
4. To educate and instruct new staff;
5. To ensure that development of the programme does not violate its integrity;
6. To report to government on activities and output;

7. To justify possible further investment in the programme;
8. To compare the programme with similar programmes (e.g. in other countries).

The programme's documentation comprises:

1. General information about the data collection programme, including objectives and general methodology;
2. Technical manuals for data collection, storage and processing of data;
3. Technical descriptions of data collection programme and database;
4. Budgets, accounting, investments, personnel and office reports;
5. Administrative reports;

The set of documentation should be regularly updated and modified. Whenever requested even at short notice, the sampling programme should be able to supply documentation for all elements of the programme. This is not only of value for the "customers" of the data collection programme, but also for data collected. By preparing these documents, the programme management will naturally evaluate the programme at the same time.

A pamphlet, explaining the main issues of the sampling programme, should be available in national language as well as English language. The "Yearbook of Fisheries Statistics" should also contain a brief description of the data collection programme and the contents of the database.

Documentation of the sampling programme should comprise:

6. Manuals for enumerators (Manual for interview of fishers, species identification, etc.);
7. Technical description of data collection programme;
8. Complete documentation of sampling programme;
9. Description of quantities and qualities of data collected (administrative report);
10. General background information about the fisheries sector (Fisheries sector profiles, National fisheries legislation, National policy for the fisheries sector, National fisheries legislation);

Documentation of the database should comprise:

11. Manual for encoders;
12. Manual for database users;
13. Complete documentation for database developers.

7.6 THE ITERATIVE PROCESS OF IMPLEMENTING A DATA COLLECTION PROGRAMME

The initial problem with the timing is not the sequence of events, but that all activities should be started at the same time, once the pilot programme is over.

It is of special importance that the sampling programme development and database development are synchronised, as the database can be used as a tool to test and improve the data collection programme. The meetings at various levels should not await the completion of the first version of the database as that may lock the design in an undesirable position. The designers should right from the beginning benefit from the responses of users and industry. The good relationship with the industry should await the completion of the first programme design.

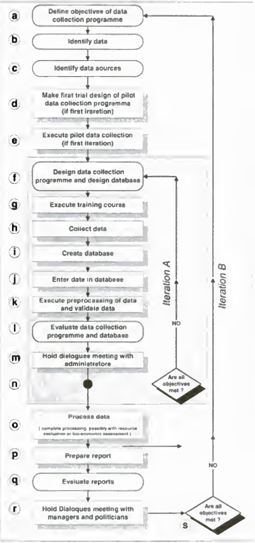


Figure 7.6.1 The iterative process of setting up a fisheries data collection programme (Compare with Figure 1.2.1). For further details, see text.

Often there is the need for a regular modification of the stratification to match the development in fisheries and resources.

Training courses and workshops as well as in-job training should be started up from the beginning, perhaps as one of the very first activities.

Production of manuals should start as soon as possible as a means for communication within the programme staff. The programme should not wait until it feels sure that it can produce the final version of the manuals. The programme should rather accept that the manuals are not permanent and will be revised regularly.

Once a programme has started, it will need to be regularly revised. Thus, the process of setting up a data collection programme calls for an iterative approach, as illustrated by Figure 7.6.1.

Figure 7.6.1 shows a double iterative process, where the inner iteration (A) is an internal exercise of the data collection programme (including the administrators in the "Directorate of Fisheries"), whereas the outer iteration (B) involves the interaction with the users (the decision-makers, the managers of fisheries in the government etc.). The interaction with the users are here called as **"user meetings"**, although this interaction may take other forms as well.

Although modifications of programme are needed more or less every year, the modifications should be made so that the compatibility with earlier years is maintained. If there are no major changes in the fisheries sector or the resources, the annual modifications should become gradually smaller.

The steps a, b,...,s in the iterative process in Figure 7.6.1 varies from case to case. Below follows an example of details for these boxes:

a) **Define objectives of data collection.** What type of general background information is required, which type of resource evaluation / bio-economic analyses is required?

b) **Identify data.** For example, what should be the content of the "Year book of Fisheries Statistics"? What is the input needed resource evaluation / bio-economic analyses?

c) **Identify data sources.** Who can supply information, where? Identify all parts collecting information or are keeping files about the fisheries sector.

d) Make first trial design of pilot data collection programme (if first iteration). See Section 7.1.

e) Execute pilot data collection (if first iteration). See Section 7.1.

f) **Design data collection programme and design database.** Construct a stratification on fleets, landing places, species and season. Select data collection stations, decide on frequency of sampling, allocate tasks to enumerators, design data forms for interview and for data entry, and make the budget.

g) **Execute training courses for enumerators, encoders and support staff.** Create a "team-attitude" – make all staff feel they are important for the programme.

h) **Collect data**. Design interviews and fill in forms, execute frame survey or vessel registration, execute on-the-job training, make contacts to fishers, distribute material of the sampling programme, pamphlet, tee-shirts, etc.

i) **Create database**. Select commercial software and create an application for fisheries database in collaboration with enumerators and encoders. Create a database to meet the requirement specified in a, b and c.

j) **Enter data in database.** Enter data into the computer and carry out preliminary validation, train enumerators and check their performance.

k) **Execute pre-processing of data and validate data.** Estimate the first raisings of data, and validate the raised data. Compare samples to identify extreme values and do other validation exercises (see Section 6.7)

l) **Evaluate data collection programme and database.** Prepare detailed administrative reports, compare plans with actual achievements. Compare actual costs with budget. Identify the problems and their solutions. Invite consultants for independent evaluation. Compare to other data collection programmes, for example, programmes in other countries.

m) **Arrange user meetings with administrators.** Administrators are here the senior staff in the fisheries directorate (central and provincial) who are associated with the data collection programme in the sense that they are the official publisher of the fisheries statistics and they are the supervisors of the data collection programme.

n) Feedback to f)

o) **Process data.** Complete processing, possibly with resource evaluation or bio-economic assessment.

p) **Prepare reports.** Administrative reports, catch/effort reports, resource evaluation report, bio-economic analysis, etc.

q) **Evaluate reports.** Do the reports contain the expected data? Do reports provide the analyses and advice expected? Is the current sampling frequency adequate? Are additional data required?

r) **Consult with managers, politicians and representatives from industry and fishers associations.** Are the primary users satisfied with the reports? Are there additional requests from the users. Do the managers actually apply the reports as a part of the basis for their management decisions?

s) Feedback to a)

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This manual deals with the practical implementation of a routine data collection programme. This programme is developed through a top-down approach, from the identification of the objectives down to the practical recording and management of data obtained from the fishery. The issues are dealt with through both detailed discussion and by using simple examples. These examples are mostly based on situations in tropical fisheries and, in particular, experience has been drawn from developing a data collection programme in Viet Nam. The main questions addressed in the manual are which fisheries data to collect, where and when to collect them. Only data collected from commercial marine capture fisheries are considered (data from freshwater fisheries, cultured fish and experimental fisheries are excluded). The methodologies used are mainly appropriate for a tropical developing country with many small (artisanal) vessels and a few large (industrial) vessels.

The methodology is the "sample-based approach" – the manual does not deal with a methodology that assumes complete enumeration. The data collection methodology presented attempts to utilize whatever information can be obtained in practice in a developing country. Processing and storing of data (fisheries databases) and staff training are partly covered.

ISBN [illegible]526 ISSN [illegible]934
TC/M X8923E 1 12.00 2700