Title: ***Interim guidance on data needs for assessing and monitoring the fish resources in the multispecies trawl fisheries of Ba Ria-Vung Tau, Vietnam.***

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Contents

1. Introduction – fisheries management and the Ba Ria–Vung Tau fishery

1.1 The role of the management framework

Ensuring the sustainability of a fishery requires the implementation of management measures which need to be designed to ensure that fishery objectives are achieved. These objectives are best determined in a co-management partnership between stakeholders and government such that each group has a shared understanding of what to expect from utilising the fishery resources and what needs to be done to address any issues that may arise.

A fishery management framework has the following elements:

1. A governance structure that is accepted by the key players and provides an avenue for discussion and participation in the decision-making processes.
2. Clear objectives for the biological, ecological, social and economic aspects of the fishery.
3. Sources of information and data that stakeholders and government can use to evaluate how the fishery is performing against the objectives they have set
4. A set of management rules designed to ensure that catches are controlled and the benefits of accessing the fishery resources are distributed in accordance with government policy.
5. Mechanisms for ensuring compliance to those rules, which are backed by legislation.
6. A feedback and review mechanism to ensure that the management is kept up to date and is delivering on expectations.

A fishery can support the businesses and livelihoods of many people. However, without active management the benefits can easily be lost, with negative impacts for both people and the marine ecosystem. Once overfishing occurs there can be many associated issues such as too much illegal fishing, loss of jobs both on vessels and onshore, and increased conflict amongst fishers, amongst many other issues. Having a functioning fisheries management framework which is informed by good data and information helps stakeholders and government to ensure that the benefits can be maintained into the future.

1.2. Objectives

This advisory document focuses on point (3) above and, in particular, on mechanisms for the regular collection (as compared to one-off research projects focused on a particular issue) of data and information that are needed for management purposes.

Collecting data and information has associated costs and therefore it is important to be focused on what is needed that provides fishery managers and stakeholders with the information they need. A case in point is the choice of indicators, of which there are many potential options. However, a priority has to be given to those that are linked to reference points (see below) such that important triggers for management action can be supported by good information.

The report has been labelled “interim” as more detailed guidance may be needed a result of having:

- More information on the current situation of data collection in Ba Ria – Vung Tau province;
- Knowledge of resources and budget available for data collection;
- A clearer definition of policy objectives, operational objectives and fisheries management measures implemented through a Fisheries Management plan;
- More information on the stock assessment methods that will be used to assess the status of the fisheries resources.

Data needs for stock assessment is a separate but related topic that requires further guidance. Different stock assessments methods ranging from “data rich” to “data poor”. In effect the method used will be determined by what data are available. These range from catch-only methods and their derivatives such as the latest refined version of the Catch-MSY method (CMSY+,) Stock Reduction Analysis Plus (SRA+); production modelling for single species and aggregate species; multispecies modelling that is an extension of the surplus production model that includes multiple species (or species groups) that are connected via trophic interactions between species and technical interaction between fishing fleets; length frequency analysis that include traditional methods such as ELEFAN and FiSAT and more recent methods, including Spawning Potential Ratio; size based (or size spectra) models; and ecosystem models such as Ecopath with Ecosim (EwE).

1.3. Management approaches

Tropical multispecies fisheries are complex to evaluate and manage no matter in which country they are located. Gaining a good understanding of fishery (e.g. the volume of catches and the species composition) is essential if fishery managers and stakeholders are to have scientifically valid information on how the management of the exploited stocks is performing.

Most fisheries in more temperate waters are managed to maximise the production of a single species or a small number of species. Management measures aim to ensure that these target species are maintained in a sustainable state. Experience in tropical Asia (if not elsewhere) has shown that such measures do not work well as fishers that are dependent on a large number of species.

In recent years the management paradigm has been changing to enable viable fisheries management regimes to be designed based on seeking to maintain multispecies yields, based on multispecies assessment methods (e.g. aggregate production models). This approach dictates a catch sampling protocol that seeks to support management measures aimed at constraining the total catch and protecting species that may be particularly vulnerable to fishing pressure (but not necessarily conservation dependent). This is the approach adopted by the MarinTrust in their ”Multispecies Assessment Template”.

Experience has also showed that just considering the fishery resources and fishers was not sufficient to sustainably manage a fishery. This realisation lead to a broadening of fisheries management to include the impact of the fishery on the environment (e.g. critical habitats,

endangered, threatened and protected species (ETPs) and ecosystem structure and function and the impact of the environment on the fishery (e.g. climate cycles and climate warming). These newer approaches were championed by the fisheries sector as the "Ecosystem Approach to Fisheries Management (EAFM) and by the environment sector as "Ecosystem-based fisheries management (EBFM). The overall principles of both EAFM and EABFM are the same, with the latter putting more emphasis on environmental conservation and protection than the former.

1.4. Overview of fishery characteristics

The fisheries relevant to this advice are focused on the capture of fish and invertebrates which are used for direct human food, processed food and animal feed (fish meal). The industry sectors are able to make use of a wide variety of species and this creates a variety of challenges for sampling of catches if costs and sampling effort are to be manageable.

There are no clear target species as such, because many species are directed to supply chains depending on size, quality and demand. In similar fisheries in Vietnam the same species may enter different supply chains depending on these factors, and these may vary according to how the vessel has maintained the catch once it is onboard.

1.4.1. Bia Ria-Vung Tau fisheries

There was a total of 5,738 vessels reported as operating in December 2021 in Ba Ria-Vung Tau province. These included offshore fishing vessels comprised of 2,831 vessels (49.4%) of total length (i.e., >15 m; LOA – Length of Overall); near-shore vessels comprised of 724 vessels (12.6%) of mid-length (i.e., 12 – 15 m); and coastal vessels comprised of 2,183 vessels (38%) of short-length (i.e., <12 m) (see Table 1).

Table 1: The distribution of fishing vessels in Vung Tau by length (LAO) and location (Source: Ba Ria-Vung Tau DARD, 2022).

No.	Local	Total	LOA < 12m	LOA 12 – < 15m	LOA > 15m
01	Vung Tau city	2,165	1,203	146	815
02	Long Dien	1,776	269	260	1,246
03	Dat Do	694	12	94	588
04	Xuyen Moc	519	145	199	175
05	Phu My	411	396	14	1
06	Ba Ria City	136	124	8	4
07	Con Dao island	36	34	2	-
08	Chau Duc	3	-	1	2
Total		**5,738**	**2,183**	**724**	**2,831**

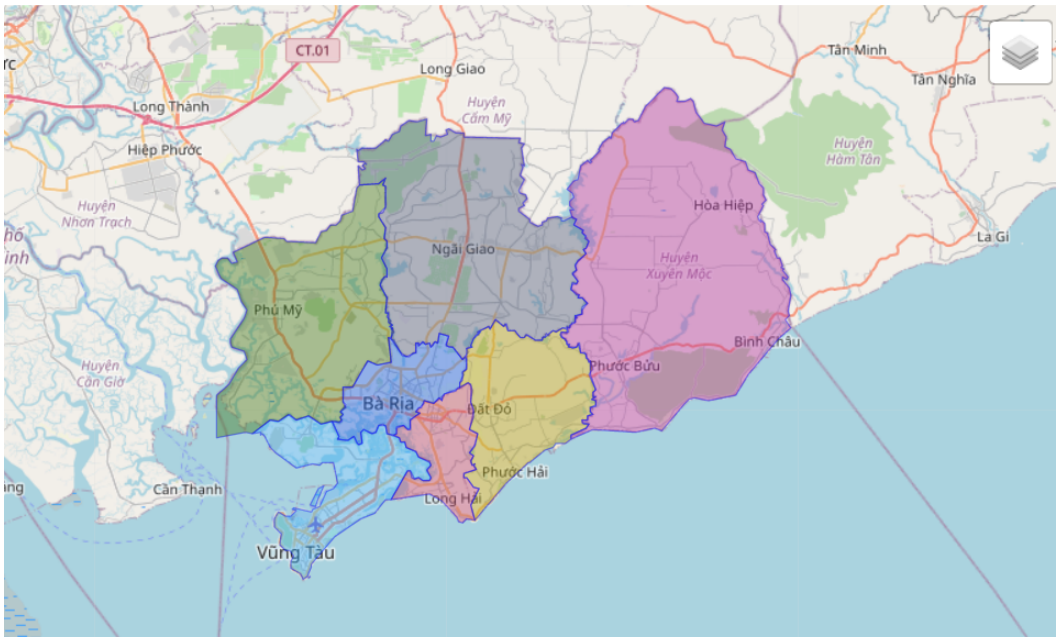


Figure 1 Districts of Vung Tau province. Source: Database of Global Administrative Areas, Global Map of Vietnam ©ISCGM, Ministry of Natural Resources and Environment -Vietnam.

The fisheries in Ba Ria-Vung Tau province are structured by fishing method (see Figure. 2). The most significant contributors were the trawl fisheries comprised of 1,452 vessels (25.3%) (see 1.3.2. Bia Ria-Vung Tau Trawl Fisheries), followed by squid jig fisheries with 864 vessels (15.1%) and purse seine fisheries with 247 vessels (4.3%). The remaining fishing methods (i.e., crab traps, fisheries services, and other small-scale methods) accounted for 39% of total vessels.

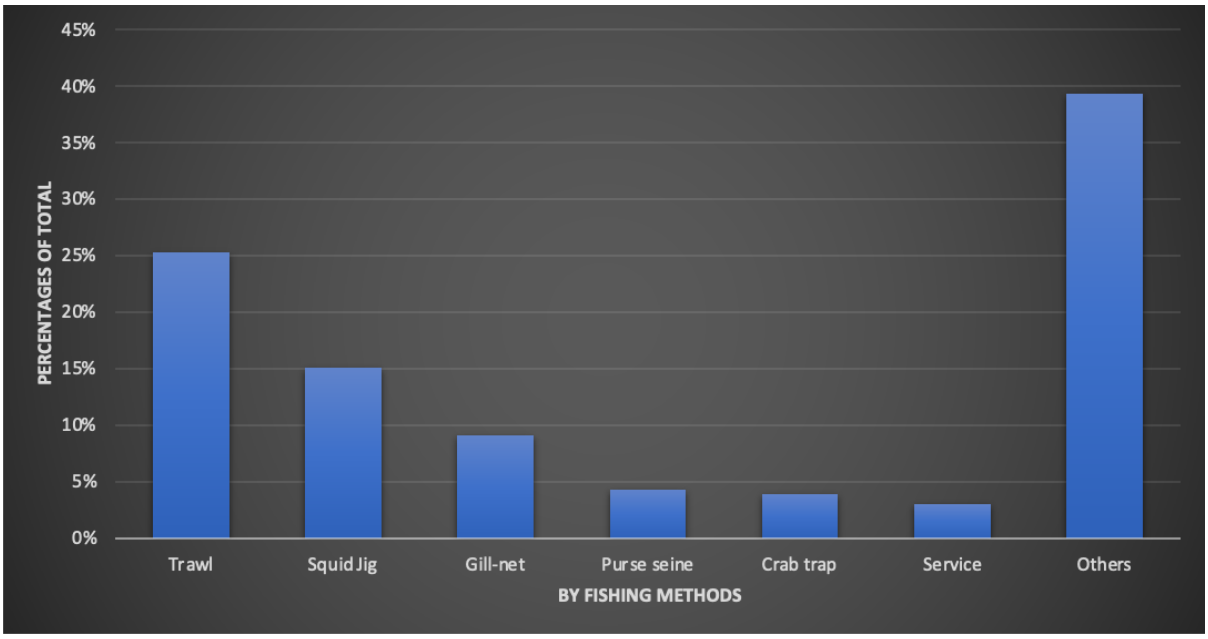


Figure 2: The structure of Vung Tao fisheries by fishing methods (Source: Ba Ria Vung Tau DARD, 2022).

The distribution of fishing vessels in Ba Ria-Vung Tau province are structured by locality (see Figure 1 and 3). Most fishing vessels were located in Vung Tau city and comprised of 2,165 vessels and account for 37% of total vessels within the province, followed by Long Dien district comprised of 1,176 vessels accounting for 31%. Other noteworthy contributors are distributed in Dat Do district (12%), Xuyen Moc town (9%) and Phy My district (7%). Additional small-scale localities, including Con Dao Island and Chau Duc district, comprise the remaining 3%.

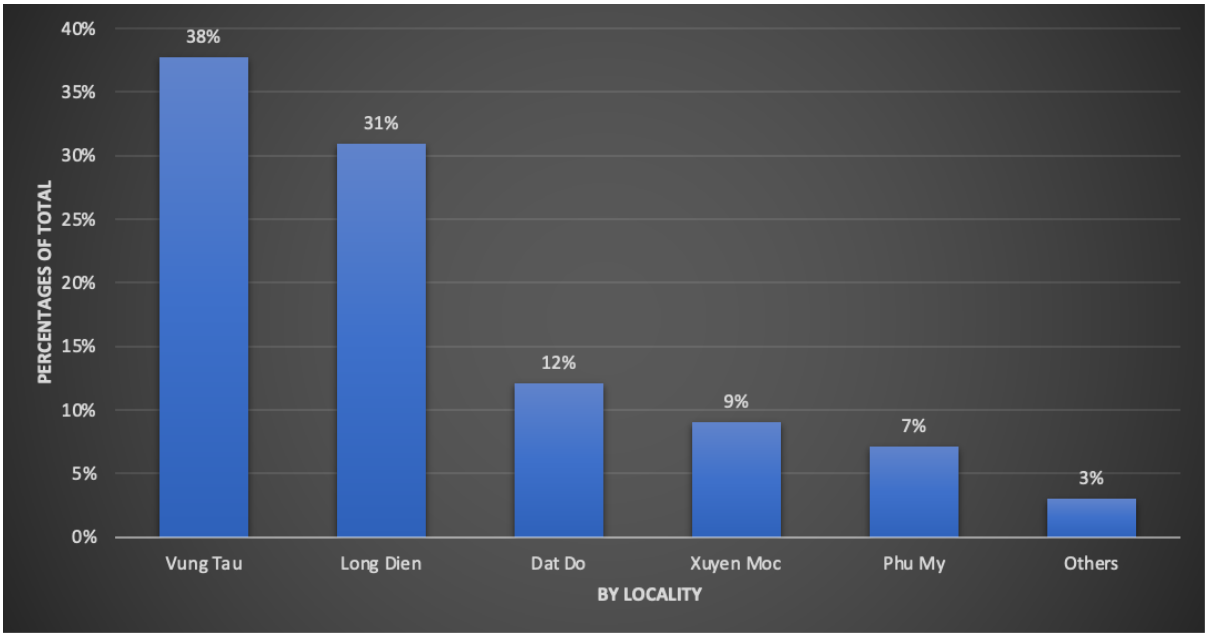


Figure 3: The structure of Vung Tau fisheries by locality (Source: Ba Ria-Vung Tau DARD, 2022).

1.4.2. Ba Ria-Vung Tau trawl fisheries

The Ba Ria-Vung Tau trawl fisheries consists of a total of 1,452 vessels (see Figure 4). The majority are pair-trawlers comprised of 1,283 vessels ranging from 15 – 24 m in length. These account for 88% of total trawl vessels in Ba Ria-Vung Tau province. There are 79 trawl vessels which are greater than 24 m in length and these account for 5.5%. The remaining vessels comprise 64 vessels of mid-length (i.e., 12 – 15 m) accounting for 4.5% and 26 vessels of short-length (i.e., <12 m) accounting for 2 %.

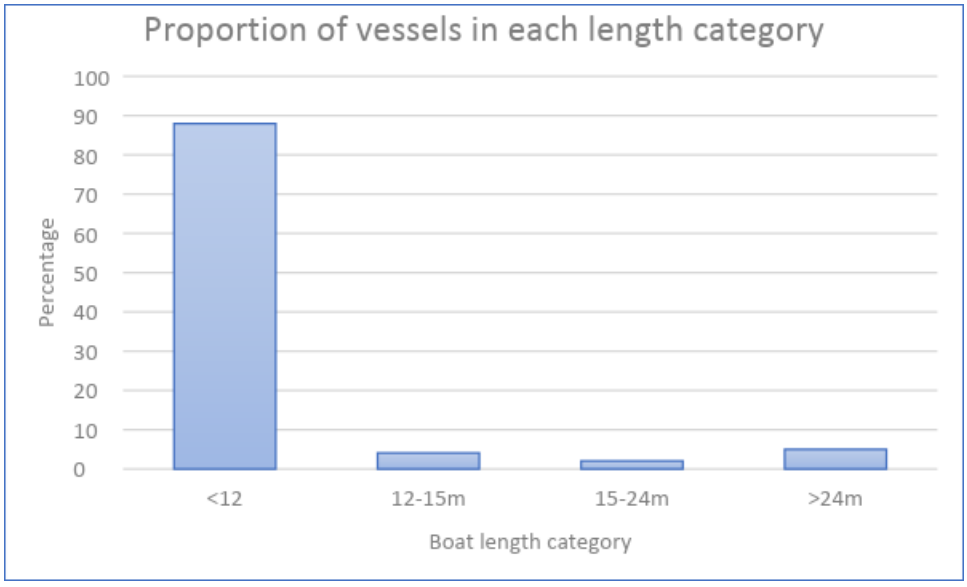


Figure 4: The structure of Vung Tau trawl fisheries by length (LOA) (Source: Ba Ria-Vung Tau DARD, 2022)

According to Vietnamese regulations, both registration and licensing is required for each vessel. Decree 26/2019/ND-CP dated 08/03/2019, Circular 23/2018/TT-BNNPTNT dated 15/11/2018 regulated that all motorized fishing vessels from 6m (LOA) must be registered. The central office of the Directorate of Fisheries (DFISH) of the Ministry of Agriculture and Rural Development (MARD) is in charge of registration for chartered fishing vessels, patrol vessels, research vessels, Vietnam fishing vessels operating outside Vietnam's EEZ and foreign fishing vessels operating in Vietnam waters. The provincial Department of Fisheries (Sub-DFISH) of the Directorate of Fisheries (DARD) is in charge of conducting the registration procedures for all local fishing vessels.

All the pair-trawlers have separate vessel registration & fishing license certificates. The Vung Tau Sub-DFISH record and count all the pair-trawlers as separate vessels and they are to be managed separately. Operationally, all the pair-trawlers are bottom-trawlers, meaning they contact the seabed on the fishing grounds. The bigger vessel of each pair is called the "Mother-vessel" and is used to store the catches, while the smaller vessel is normally used to store nets.

1.4.3 Total catch

The total catch from Ba Ria-Vung Tau fishery is not known with any certainty but has estimated to be 260-450 thousand tonnes per year in the period 2015-2019. In 2021 the total catch was estimated as 353,700 tonnes. This consisted of fish – 270,000 tonnes (76.7% of the total catch); shrimp – 18,000 tonnes (5.2%); crab and swimming crab – 20,000 and tonnes (5.8%); mollusc (squid and octopus) - nearly 26,000 tonnes (7.2%) and the other marine species - 17.5 thousand tonnes (5%) (Ba Ria-Vung Tau DARD, 2022).

The catch contains of a very large number of species and it is not feasible to research and understand all of them. Fishery managers need to focus on a selected group of species that

provide information to enable the fishery to be controlled within sustainable limits. Selecting species is based on a mix of factors such as biological attributes, economic contribution and social issues such as importance to communities. Documenting the rationale for the choice of species is important so that the results of monitoring and research can be correctly interpreted.

1.4.4 Species of interest

The dominant species are likely to play both an economic and ecological role. It should be noted that the percentages listed in Table 2 are a snap-shot in time and are very likely to change over the course of a year as it is known that species composition and overall abundance changes according to a variety of factors such as

- An interannual basis (see Figures 5, for catch volume) and Figures 6a and 6b for catch composition;
- Area – habitats and habitat availability changes along the coast of Vietnam with the north and south (east and west) having larger areas of trawlable habitat than the central area (Figures 7a and 7b); and
- Monsoon and dry seasons - have different species compositions (Figures 3a and 3b) and the monsoon/dry seasons also influence the location of fishing activity (Figures 8a and 8b), especially in northern Vietnam.

Note that these figures are for illustrative purposes only and are not specific to the BRVT fishery.

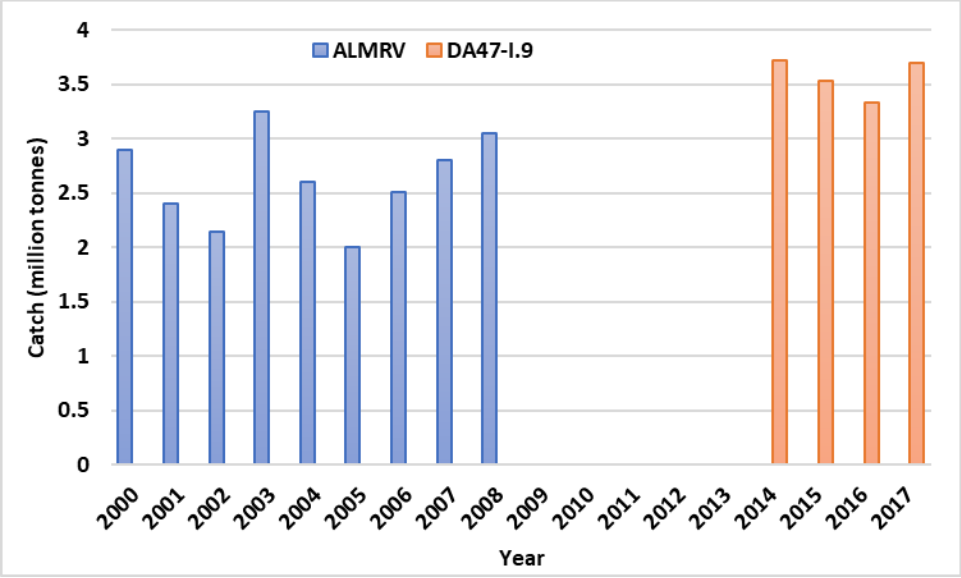
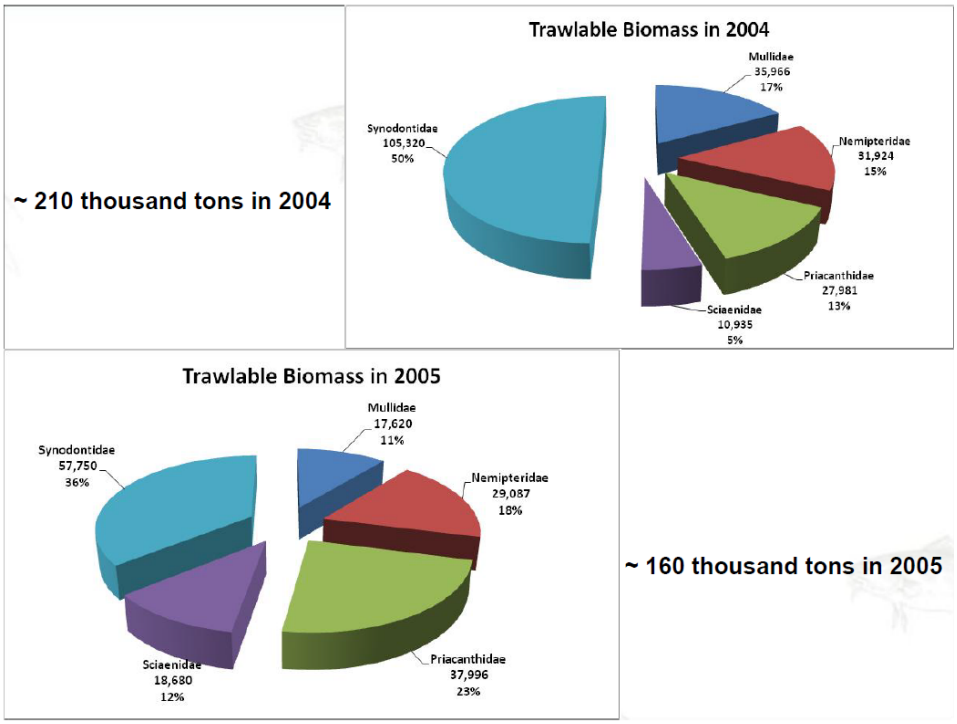
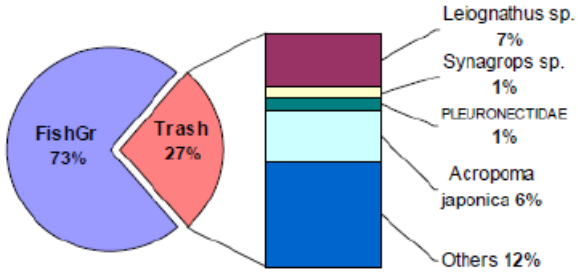
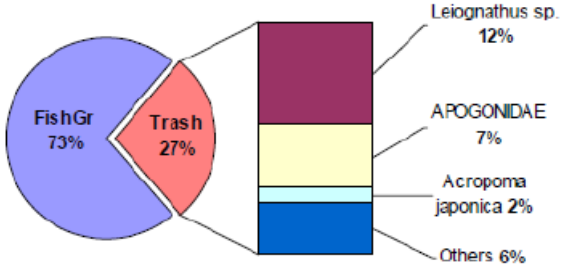


Figure 5: Changes in total catch for Vietnam on an interannual basis (*ALMRV = Assessment of Living Marine Resources in Vietnam project and DA47.19 = The comprehensive survey for marine fisheries resources in Vietnam)*



Figures 6a and 6b - Change in abundance of selected species groups on an interannual basis





Figures 7a and 7b – change in catch composition from the monsoon (North East 3a) and south west (3b) for North Vietnam.

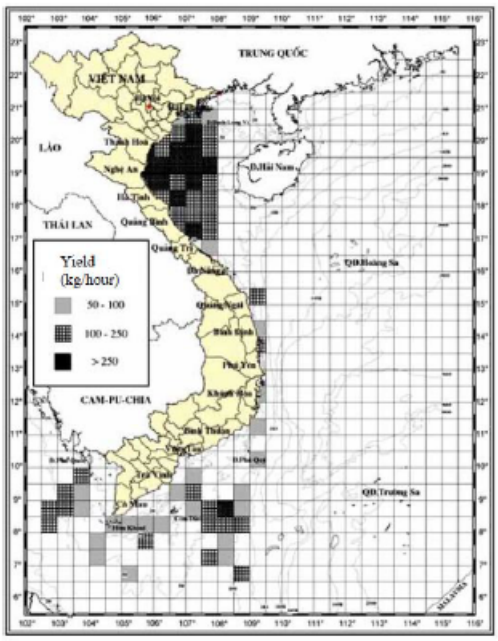


Figure 3: Fishing ground of trawl net/boats in South/rainy season, 2007

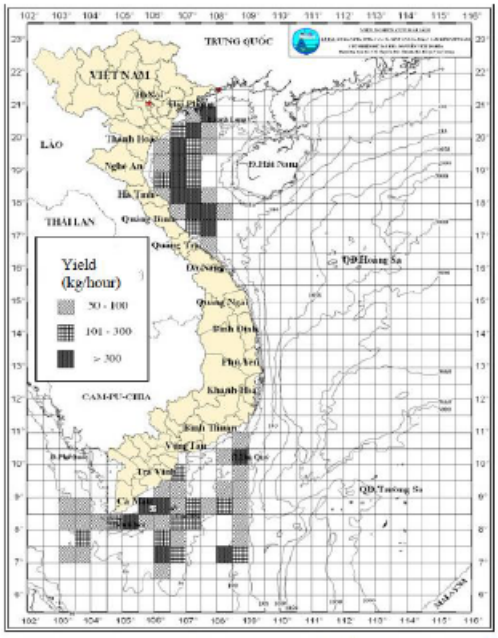


Figure 4: Fishing ground for trawl net/boats in Northen/dry season, 2007

Figures 8a and8b – change in distribution of fishing effort according to monsoon influence

Table 2 lists the dominant species caught by the BRVT trawl fishery in August 2018. The information on catch composition was derived from independent fisheries surveys conducted by the Research Institute for Marine Fisheries (Marin Trust Multispecies Fishery Assessment Report, 2021).

Table 2: Main specie caught by the Bia rai-Vung Tau trawler in August 2018.

Species Name	**Composition Estimate (%)**
Bottom Trawl	
Brushtooth Lizardfish (*Saurida undosquamis*)	14.6
Bluntnose Lizardfish (*Trachinocephalus myops*)	5.3
Mitre Squid (*Uroteuthis chinensis*)	5.1
Otter Trawl	
Whiskered Velvet (*Metapenaeopsis barbata*)	18.7
Bluntnose Lizardfish (*Trachinocephalus myops*)	11.2
Horn Dragonet (*Callionymus curvicornis*)	7.1
Loligo squid (*Loligo* sp.)	6.5

Brushtooth Lizardfish (*Saurida undosquamis*)	5.6
Greater Lizardfish (*Saurida tumbil*)	3.2
Southern Velvet Shrimp (*Metapenaeopsis palmensis*)	2.5
Pair Trawl	
Bigeye Scad (*Selar crumenophthalmus*)	17.1
Bluntnose Lizardfish (*Trachinocephalus myops*)	13.6
Yellowtail Scad (*Atule mate*)	12.1
Goldband Fusilier (*Pterocaesio chrysozona*)	10.5
Sulphur Goatfish (*Upeneus sulphureus*)	9.1
Moonfish	8.4
Other goatfish	3.9

1.4.5 Utilisation of the catches

The disposition of the catch is market driven and is affected by the species taken, the quality, size of the fish and market demands. The main categories of use are:

1. Larger, high quality (well handled) food fish/shellfish may be sold for local consumption in food service outlets (e.g. restaurants). The commonly used families of fish include the groupers, snappers and pomfrets. Crabs (mainly swimming crabs), squids and shrimps are also commonly found in this category.
2. Some species may be processed by canning or freezing for domestic sale or export.
3. Fish from the lizardfish, threadfin bream, goatfish, croaker and bigeye families are commonly used for surimi although an increasing number of pelagic species are also used.
4. Depending on the nature of local demand a variety of species may be dried or used for making pastes or fermented.
5. Fish which are unsuitable for human consumption due to excessively small size, poor handling (lack of chilling facilities on the vessel) or are simply not valued by people are sent to the fishmeal plants.

The same species may end up in either of these markets depending on the attributes mentioned above – size, quality and market demand at the time.

This has implications for shore-based sampling of the catches that need to be considered in the overall monitoring and catch assessment work.

1.4.6 Summary of supply chains

Landings form the trawl fleet supply a diversity of seafood products depending on the types of species caught, their quality and local demand. National policies guiding the development of the seafood industry have fostered the development of seafood processing, especially those with an export focus. The production of surimi paste and fishmeal, the latter

supporting the country's growing aquaculture industry, dominate the disposition of landings. Supply chains are complex and Figures 9a,b are highly simplified.

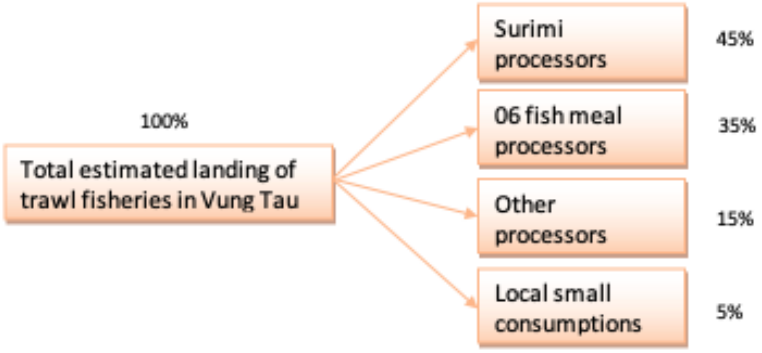


Figure 9a: The flows of trawl fishery catch in Vung Tau

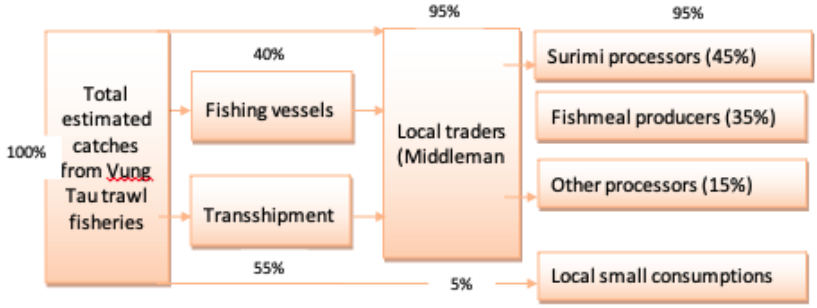


Figure 9b: The supply chains of trawl fisheries' catches in Ba Ria-Vung Tau

Understanding the supply chains is important as it provides opportunities to identify points to sample catches and estimate volumes.

2. Data needs for fisheries management

2.1 Factors influencing data requirements and availability

In this section we describe some of the main sources of data and information that fishery managers and stakeholders should have access to in order to assist them to make decisions in favour of sustainable use. We can divide these sources into two main categories:

1. Regular collection of data and information – this is probably the most important category as time series are important for understanding trends. Catches may vary from one season/year to the next under natural conditions and comparing data from one year to another may provide little insight into what may be causing any differences. Having data for multiple years provides far greater insight. At present (see 3. Current and past data collection) data are available on an occasional basis, usually linked to externally funded projects. This makes planning (including business planning) difficult and increases the uncertainties for businesses and dependent fishing communities.
2. Targeted research – there will always be a need for targeted research projects aimed at providing answers to specific questions. Unlike regular monitoring, such projects

will have a defined beginning and end. Such projects are important for fisheries management and need to be identified by fishery managers and stakeholders.

Regular collection of data and information, can be divided into (i) fisheries-dependent data such as commercial catch and effort data, and (ii) fisheries-independent data such as resource surveys and observers (provided these are conducted at regular intervals with standardized methods). This document focuses on the fisheries-dependent regular collection of data and information required for decision making and to provide feedback on how the fishery is performing against its adopted objectives.

The factors that feed in to the design of a data collection program are varied and have been reviewed in a number of guidance documents prepared by FAO, SEAFDEC and other fisheries agencies. These are listed in the reference list. In addition to the considerations the nature of the fishery (where and how it operates), the onshore supply chains and pragmatic considerations such as the costs and feasibility of different data collection mechanisms also need to be considered. As an example, the use of onboard observers could provide accurate data on catch and effort but to have a statistically robust, regular, observer program would be too expensive. There may be more cost-effective programs based on sampling at landing sites leaving observer programs to be undertaken as an occasional check.

Factors that need to be considered in the design of regular data collection for this fishery include:

1. The fishing pattern – the vessels may not return to port on a daily basis and, if they do, the catch they unload may not be representative of the catch that they have made for the day (see below re carrier vessels);
2. Vessels may sort their catch onboard and either transfer time-critical species (i.e. those that need to be landed fresh) to carrier boats or bring in multi-day catches.
3. Carrier vessels will have catches from multiple vessels taken over multiple days and this provides challenges for understanding the nature of overall catches from the fishery in terms of species composition and volumes
4. The fishing vessels and carrier boats may unload their catches in different places. For example, fish meal plants may be located in a different area to the landing site for human food fish and have their own unloading wharves.

Any sampling strategy needs to identify points in the supply chain where important information can be collected. The aim is to ensure that all the key product streams (fresh fish, fish for processing and fish for feed) are adequately sampled for both species composition and volume such that a full ‘picture’ of the removals by the fleet can be developed.

2.1 Data needs

The data needs are primarily driven by the agreed objectives of the fishery which could include:

1. Maintain healthy fish stocks – requires data to enable judgements about whether fish stocks are healthy and this includes information on elements such as landings, species composition and fishing effort, at a minimum.
2. Ensure a healthy ecosystem – requires information on the take of threatened species, any impacts on the seabed and any impacts on ecosystem structure and function.
3. Ensure profitable fisheries – requires information on costs and revenues for the fleet
4. Ensure socially beneficial fisheries – requires information on the disposition of catches and allocation of catches.

A brief overview of options is provided below.

Fishery objective	**Data needs**	**Potential sources of information**
Maintain healthy fish stocks	Landings Disposition –volumes/species per supply chain Catch composition Length Frequency Number of vessels Days fished Number of hauls per day and hours per haul	● Sampling as per Section 3 – landing sites and observer work ● Logbook analyses ● Company data sources ● Port In Port Out logs ● Captain declarations ● Resource surveys ● Research reports
Maintain a healthy ecosystem		● VMS data overlaid on habitat distribution ● Observer work for monitoring catches of ETP species ● Ecosystem modelling based on landings and species composition
Ensure profitable fisheries	Vessel operating costs Vessel revenues Value added by post-harvest sector	● Economic surveys ● Export data ● Company reports
Ensure socially beneficial fisheries	Landings by fleet sector Employment in the catching sector Employment in the post-harvest sector	● Local enumerators ● Log books (where available) ● Surveys of workforce (include gender disaggregated data)

2.3 Potential data and information sources

There is an existing system in place for collecting some management relevant data. These are described in more detail in 3. Current and past data collection in Ba Ria – Vung Tung. The main elements are as follows:

Data source	Types of data	Use for management	Issues
Logbooks	Catch and effort	Contribution to understanding landings and effort	Accuracy, frequency of preparation, entry of data into government systems
Port In, Port Out logs	Effort – days fished	Cross check on logbook data May be useful if a days fished management regime is pursued in the future	Relatively crude measure of effort but could be used in conjunction with other data sources (such as observer work) Limits related to what may actually be brought in (some material on carriers for example)
Landing site enumerators	Volume of landings and species composition?	Contribution to understanding volumes and composition of landings	Nature of data collected unknown (species?). Frequency of collection unknown Location of collection unknown
Government Statistics Office	Volumes of landings	Cross check on volumes	Algorithms used to scale up reports from local sources of information are unclear Data covers all fisheries, not just the FIP fishery
Observers	Species composition, catch volumes and effort, discarding (if any), interactions with ETP species	Detailed knowledge of species and volumes	Only carried out on an occasional basis
Research surveys	Species composition, biomass	Understanding of health of fish stocks	Only carried out on an occasional basis
Research projects	Project dependent	Project dependent	Only carried out on an occasional basis
Company purchase information	Volumes bought Species bought	Cross check with other data sources on volumes and species	Access to information likely to be an issue

2.4. Fisheries-dependent data: Collection methods for commercial trawl fisheries

As outlined above there are many options for sourcing data and information and the choice of which options are best suited requires a detailed assessment of the nature of the fishery coupled with some judgements about what may be the best mix of existing, cost effective and suitable information. Importantly there needs to be feedback from the decisions made about fishery objectives and related indicators and reference points.

The information below is, at this stage, indicative but provides a starting point, based upon existing published literature, including reports prepared specific to fisheries in South East Asia.

The report focuses on at-sea and port/landing site data collection, but sampling program at various points in the supply chain will help to triangulate results. For example, the fishery makes use of carrier vessels and the landings on any given day will vary depending on whether catcher vessels or carrier vessels (or both) have visited the port. Different components of the catch maybe sorted and go to different factories. Fish for surimi have to be sorted by species (or species group) and handled to ensure quality, in comparison to fish for fishmeal.

The large number of species makes it difficult to gather species by species data. Any reference to species in the following section may refer to formally identified indicator species (see 4.2 Indicator species), groups of species (as decided by fishery managers) and any species that may be of conservation significance (ETPs). It's important that the basis for any species groups is made clear to help interpret the data collected.

2.4.1. Surveys for commercial catch and effort data

2.4.1.1 General considerations

The fishery-dependent collection of data from commercial fisheries is used to estimate total landings, species composition, and fishing effort by boat and gear type. In general, variation in fishing grounds, fishing boats and fishing methods will influence catch and species composition and sampling and estimation should be conducted within limited geographical areas, commonly referred to as "minor stratum". The application of minor strata to sampling schemes increases homogeneity of the landings to be sampled which will improve reliability of the estimates. The collection of data should further be applied within the context of each boat/gear type, or of a group of boats/gear types to minimise the sampling effort. The boat/gear types are the basic statistical units, and it is necessary to collect data on catch and effort for each unit separately. The selected landing sites should subsequently cover each boat/gear type respectively as determined by census information (see 2.4.1.5 Frame Survey). The data should be sampled across space and time so that at a limited and representative number of landing sites will be visited on pre-selected sampling days. The data collectors should always apply random sampling or a close approximation of random sampling (systematic sampling) to ensure representative and unbiased data.

The general sampling scheme consists of four surveys which are needed to be able to estimate total catch volume:

1. Sample survey for total catch and Catch per Unit Effort (CPUE)
2. Sample survey for fishing effort

3. Survey for active fishing days
4. Frame survey

2.4.1.2. Sample-based estimation of total catch and fishing effort

The total catch volume for each boat/gear type is defined as the Catch per Unit Effort (CPUE) multiplied by the actual total effort for the boat/gear type.

Total catch = CPUE x total effort exerted by boat/gear type

The estimation of CPUE is given by one sample survey and will be used to formulate i) the species proportions of total catch (i.e., species composition), and ii) the sample CPUE by dividing the total sampled catch by the associating fishing effort.
The estimation of total effort is given by two sampling surveys used to describe i) average boat/gear activity for each boat/gear type, and ii) the average number of days that a fishing unit of each boat/gear type was active during a month, supplemented with a census (frame survey) of the total number of boats/gears that are operational in the geographical area.

The estimation of total catch for each boat/gear type is calculated by combining the information from these surveys.

The total effort is calculated by multiplying the total number of fishing units for a given day by the total number of active days during the month. The estimated total catch is then derived from the estimated total effort multiplied by the overall CPUE. The species compositions are subsequently calculated by taking the estimated total catch and the sample species proportions established by the CPUE survey.

Estimated total catch = Estimated total effort x overall CPUE

The sample CPUEs are robust and reliable if the sample design is appropriate and samples are taken from a few but well-selected representative landing sites. The most common challenges arise from i) estimation of fishing effort, ii) species identification, and iii) quick and effective assessment of weight of landings. Data collectors and processors should be aware of these difficulties and follow the recommended precautions.

2.4.1.1.3. Catch and CPUE surveys

The survey for catch per unit effort (CPUE) is essential to calculate the *overall* species composition and volume of catches and landings. The data for this survey is collected on the landed weight and the associated effort (i.e., fishing effort which produced the catch) to calculate CPUE. The form which may be used for the collection of data on catches and landings is shown in Annex II. The sample-based approach requires that only some landings are sampled for some pre-selected landing sites during randomly chosen days during the month. It is essential that estimates are made on a boat/gear basis. It is important that the species composition of the catch be assessed accurately. The data collectors should be familiar with the species being encountered and know how to identify and categorise them. Species composition can be estimated by evaluating the total weight of the landing with the species proportions of the catch. It is essential that the following data is collected for each

species or species group retained to provide robust composition data, and sub-samples are collected for respective indicator species (see “3.1.8. Length-Frequency Survey”).

In this survey the following data needs to be collected for each boat/gear type separately:

i. Sample **weight** of the landing, the weight of the landing needs to be measured and has to be recorded for each species or species group separately;
ii. **Effort** or the number of gear units used for the catch;
iii. **Price** per kilo, or the total value of the catch, on a species level, this will normally not change much on a day-to-day basis. It is enough to get a general idea of prices so the price and value can be recorded once a month and used for all the catches during that month; and
iv. **Number of fish**, or average size of the fish, on a species basis, can give very useful additional information. In practice it will not be possible to count all the fish, but by taking a sub-sample and counting the number of fish the average weight of a species in the landing can be calculated.
v. Where possible Length Frequency Data should be collected.

2.4.1.4. Fishing effort/active days surveys

Effort

The survey for fishing effort is used to describe the average boat/gear activity for each boat/gear type. The estimation of effort should be recorded at two levels, including i) the number of boats which went out with a certain gear, and ii) the number of gears that were used. It is essential that the gear and effort units are clear, and standardised units should be adopted wherever possible. The form which may be used for the collection of data on fishing effort is shown in Annex III. The sample-based approach suggests that only some landing sites are visited on some days of the month, although data collectors must ensure all boats which are out fishing from a landing site on a day are counted.

The recommended units of effort for commercial trawl fisheries include:

i. Total number of boat-days fishing (including all days, whether fish were caught or not)
ii. Total number of boat-days at-sea
iii. Total number of searching days (excluding the time spent in setting and hauling the net)
iv. Total number of trips (cruises) made per month
v. Total number of boats actually engaged in fishing
vi. Number of hauls made per day and number of hours per haul

Active days

The information on the average number of days that a fishing unit of each boat/gear type was active during a month is needed to estimate total catch. This information can be derived from empirical knowledge from data collectors (i.e., logbooks) and does not require its own survey. The active fishing days are defined as all the days on which there is fishing. The data on active fishing days needs to be collected for each boat/gear type separately.

2.4.1.5. Frame surveys

The frame survey is a complete enumeration (census) of the fishing units which could be operating within a stratum. The information obtained from the frame survey is essential for establishing the operational and methodological framework of the sample-based data collection scheme (i.e., sample surveys).

The results of a frame survey are a set of tables indicating the following:

i. Existing landing sites;
ii. Number and type of fishing vessels, motorized (HP-class) and non-motorized, and the size (classes) material used;
iii. Number and types of gear with the sizes possessed/used;
iv. Number of fishermen with indication of whether they own a boat or are crew members;
v. Fishing and landing patterns, when landings are expected (including seasonal changes), but also when certain gears are used; and
vi. Access routes to landings sites.

The most common approach to collect this information is by a combination of direct observation (i.e., counting) and interviewing informants (i.e., houses in a fishing village). The form which may be used for the collection of frame survey data is shown in Annex I. The pattern of rotation of a frame survey is a function of temporal changes in the size, distribution, and operational patterns of the fishing population. It is usually necessary to carry out a frame survey every one or two years to ensure the data are reliable and accurate for the sample-based approach.

Experience has shown that frame survey data can be one of the weakest elements in a sampling program. Frame surveys are used as extrapolating factors to derive general conclusions about total fishing effort (and at a much larger scale) from a rather limited number of sample-based fishing parameters. This data can misrepresent overall fishing patterns and introduces bias (positive or negative) in the estimation process, and can be inaccurate where temporal changes are more rapid. Data collectors and processors should be aware of these problems and regulate the sampling scheme accordingly.

2.4.1.5. Standards and classifications

The results of the frame survey, supplemented by species identification guidelines (classifications and groups) and a species list, should be organised into a set of tables containing the following information:

i. A table of major strata for reporting purposes;
ii. For each major stratum a table of associated minor strata. All sampling schemes and estimation procedures will each apply within the context of a minor stratum;
iii. For each minor stratum a table of landing sites that may be used as primary sampling points, including also the number of fishing craft and gear by boat/gear type;
iv. A table of species that will be used for species composition during CPUE sampling survey;
v. A table of all boat and gear types;
vi. For each minor stratum a table indicating all boat/gear types in the stratum and preliminary estimates as to the expected active days. This table will be due to

changes at the end of each survey month in order to include information not known in advance (such as periods of no fishing because of bad weather or management closures).

The sampling scheme should use a standard approach of conducting three parallel sample-based surveys (CPUE survey, boat/gear survey, active days survey), supplemented with a census (frame survey) required for raising the results to the whole population. There should be indicators for sample size, variation in space and time, and confidence limits for all produced estimates to facilitate revision and evaluation of the sampling scheme.

The sampling scheme operates across space and time so that at a limited and representative number of landing sites will be visited on pre-selected sampling days. The sample-based approach may introduce sampling bias which should be accounted for and avoided. The following describes potential biases to consider:

i. Timing of landings; arrival of landings may peak at different times during the day dependent on the gear, fishing grounds, and accessibility. This may lead to bias in estimates where sampling preferences vessels landing more frequently than others (e.g., shorter routes/less remote fishing grounds). The sampling design should cover different peak times to account for timing bias.
ii. Landing sites; landings at different landing sites will not be the same. If one of the landing sites is near a market, processing plant, or has better accessibility the landed catch may have biased species composition. The sampling design should cover the whole area to account for site bias.
iii. Logistical constraints; the number of data collectors and the space and time constraints for their movements (i.e., distances, accessibility, time and duration of visits) can introduce estimate bias. The sampling design should cover all logistical arrangements for data collectors.
iv. Enumerators; enumerators themselves can introduce bias in sampling when selecting a sub-sample (i.e., preference for larger fish) or when collaborating with fishers (i.e., preference for age or ethnicity). The sampling scheme should provide strict rules for sampling and selection.

2.4.2. Logbook schemes

2.4.2.1. General considerations

The logbook scheme should provide low-cost information on quantities of fish retained for landing, fishing effort, fishing strategies, and details of fishing vessels. The logbook may also be used to collect additional information including quantities of discards to calculate CPUE.

The coverage of the logbook scheme should be made for each stratum separately and extrapolated for the whole survey area. The estimates for catch and effort from logbooks need to be made every month. The selection of participating fishers should be undertaken carefully with assistance of local fishery officers and any fisher leaders. Selection should not be fully randomised, but participating fishers chosen based on expertise. This scheme should select a fixed group of fishers to participate on a rotational basis (i.e., every month). This is important to ensure participants stay committed and enthusiastic and so that there is minimal biased data. It is vital that cooperation is not forced, as this may have negative impacts on the quality of data. There should be regular contacts with participating fishers

and local fishery officers. These should involve discussions explaining the survey and its results to encourage continuing interest, providing assistance and feedback to reduce errors or ambiguities, and collecting the filled logbooks.

The logbook scheme should cover all essential information required, although in some cases additional baseline information may be needed. This type of information can usually be established by means of household surveys (i.e., interviews). For more details on data collection via household surveys (interviews) see SEAFDEC (2005).

2.4.2.2. Design and tabulation

The following information should be recorded on daily log sheets and then transferred to fill a monthly logbook. Information (headings) should be pre-filled to minimise the workload for participants. Some information (i.e., each trip) can be copied from trip to trip this information changes less frequently. It is essential to remind participants that all trips should be recorded, including trips during which nothing is caught. The species list, including species groups, economic classifications and indicator species should be included to facilitate accurate species identification and classification. The Key Data Elements (KDEs) required by current regulations in Vietnam (Vietnam National Fishery Laws No. 18/2017/GH14) should be recorded as a minimum.

Table 3: A summary of data that should be recorded for participating fishers implemented in a logbook scheme (Pilling, Cotter & Metcalfe, 2007). Data points (*) denote the Key Data Elements (KDEs) for Vietnam as required by Vietnam National Fishery Laws No. 18/2017/QH14.

Frequency	Information required
For each trip:	Identification and registration of vessel, captain, or owner (i.e., Unique ID, fishing licenses)*
	Details of vessel including type, flag nationality, gross registered tonnage, power of engines, length, capacity for fish, number of fishing crew and the times of any shifts worked
	Date, time, and port departure and arrival including stops during the trip
	Time lost due to breakdowns, poor weather, or other interruptions
	Details of any trans-shipments or landings of fish made during the trip
	Specifications of fish finding equipment available on board
	Generalised details of fishing gear (excluding modifications made from set to set), including mesh sizes, twine type and constructions, net plan*

	Generalised details of fishing techniques and methods including shooting and hauling operations, typical fishing depths, immersion times, weather limitations on fishing*
	The target/priority species for the trip (i.e., scientific names, commercial or common names)*
	The names of fish species that will be identified in the catch log if caught (i.e., scientific names, commercial or common names)*
	Methods used to estimate quantities of fish retained and discarded (if possible)
For each day (including days with no catch):	Date
	Noon position
	Position of fishing activities*
	The times spent streaming, scouting for fish, and fishing
	Amount of fishing effort (hours) employed
	Catch by species (including endangered, threatened, and protected species)*
For each set (including sets with no fish production):	Gear deployed, enough details to calculate effective fishing effort for each set (.e., towing velocity and/or towing distance, width and height of mouth of the trawl)
	Positions and times of hauling, plus way-points if the vessel did not travel directly*
	Damage sustained by gear during fishing
	Weather and sea state
	The retained quantities of each species, and mix of species, as numbers or weights
	Estimates of discarded quantities of each species and mix (is possible)
At the end of each trip:	Total time in stated units spent looking for and catching fish
	Total quantity landed as registered by commercial scale, preferably for each species and mix of species

2.4.4. Length-frequency surveys

Length-frequency data, if collected regularly, can be used to monitor the status of the fishery. More irregular samples can be used in stock assessments. The information can be collected from several points along the supply chain. The ideal point for measuring fish is on-board the vessel at-sea as information can be recorded with the highest accuracy. The

most economical approach is measuring fish at the time of unloading (port/landing sites) as it only requires one or two enumerators and provides a safe and accessible sampling site. It is essential that data collectors have access to fishing logbooks (see “3.2. Logbook Scheme”) if this approach is adopted. Other sampling locations include sites during transhipments from a fishing boat to a carrier (transhipment) vessel , sites at cold storage or processing plants, and ports when carrier vessels are unloading (see 1.4.6 Summary of supply chains). These are more economical and should only be used when other methods cannot be pursued as tracing the origin of fish from these sites is challenging and sometimes impossible. These guidelines refer explicitly to measuring fish at the time of unloading (port/landing sites), although this advice can still be applied to all locations listed above.

The number of species for which this data will be collected should first be established. It is not necessary to sample all landings at the landing site as it is possible to measure a sub-sample of the total catch for a boat/gear type. It is generally recommended to select a few indicator species which can be used to monitor the fishery (see “2.2. List of Indicator Species”). The results will later be extrapolated for the whole catch and landings for the fishery.

2.5. Fisheries-independent data

Although not the focus of this report, some mention of fisheries-independent data is required. The caveat is that the fisheries-independent data need to be collected at regular interval to be of use in monitoring the fishery.

2.5.1. Research surveys

Research surveys, if conducted at regular intervals, provide valuable data on the changes in the amount of biomass (amount of fish in the sea). This can be in the form of relative biomass (CPUE – kg/hour) or converted to actual biomass using a swept area conversion in the case of a trawl surveys or acoustic signal strength in acoustic surveys.

Research surveys are probably the best way to standardize the fishing effort data obtained from commercial catch sampling. The fishing effort of a commercial fleet can be influenced by changes in fishing operations (e.g. changes in vessel size and power, changes in fishing gear, increased technology for finding and catching fish etc) and the CPUE based on this estimate is often not a good measure of abundance. Research vessel CPUE, on the other hand, gives a better picture of relative abundance of the fish as it is based on standardized vessels and gears.

Research surveys are also probably the best source of data on changes in the structure and function of the ecosystem. Catch composition changes based on commercial catch data are influenced by both the changes in fishing operations and changes in the underlying ecosystem structure (e.g. changes in the balance of predators and prey as larger more vulnerable species are depleted), whereas research survey data directly reflects ecosystem changes.

Research surveys tend to be expensive in terms of both personnel needed and costs. However, as shown by countries in the world, where regular surveys are undertaken, the

added certainty about the fisheries resource has paid dividends in terms of better management and increased benefits to stakeholders.

2.5.2 Observers

Observers on board vessels provide an excellent way of cross-verifying reported data, as well as providing more detailed information on catch composition, including catch of ETPs.

3. Current and past data collection

There is no one reliable source of fisheries data in Vietnam. The most comprehensive data sets were collected during two projects – "Assessment of Living Marine Resources in Vietnam project (ALMRV)" funded by DANIDA in 1996-2005 and the "The comprehensive survey for marine fisheries resources in Vietnam" – "DA47-I.9" funded by Vietnam in 2011-2020. Unfortunately, as the funding for the projects stops, so does the data collection. Thus, there are only a few snapshots of the fishery situation in Vietnam and Ba Ria – Vung Tau that can be used to assess the status of the fishery and provide input in to fisheries management.

This section provides an overview of available data. Text in highlight indicates uncertainty that needs to be checked. The report is divided into:

1. Current procedures and protocols for data collection
2. Fisheries-dependent commercial data
3. Fisheries-independent survey data
4. Biological data

3.1 Procedures and protocols for data collection

3.1.1 Procedures at port

The current regulations established for Vietnam require that each vessel adhere to port-in/port-out procedures (Clause 4, Article 82, Fisheries Law 2017). The Fisheries Law 2017 (Decree 26/2019/ND-CP and Circular 21/2018/TT-BNNPTNT) regulates reporting and procedures on a (fishing) trip basis. The skipper from each vessel must inform fishing port authorities *one-hour* prior to entering or leaving the fishing port and provide documentation (i.e., vessel registration, size of vessel, and specific requirements for served if applicable) to authorities (see "Certification and Documentation"). The (port) authorities are responsible for validating and verifying the origin and quantity of raw materials to issue relevant certification, so it is essential that the skipper comply with the code and conducts of port operations. The successful implementation of fisheries regulations requires effective cooperation amongst authorities and fishers to implement state management activities for the fishing industry.

3.1.2 Certification and documentation

Caught fish are either brought onshore by fishing vessels or transhipping vessels and will undergo unloading and sorting processes for certification. The middlemen (i.e., buyers or seafood processors) are responsible for submitting documentation (i.e., vessel documents/licensing and logbooks) to port authorities. Once documentation has been provided and examined by port authorities, a Landing Statement (LS) and Statement of Catch (SC) can be issued. These documents can then be verified by Sub-DFISH and a Catch Certificate (CC) can be issued.

3.1.3 Protocols at landing sites

The landing sites available for data collection will be known to authorities one-hour prior to entering the port. Once at site, data collectors are required to i) provide official identification (i.e., ID cards), ii) state the reasoning for their presence (i.e., catch monitoring or research purposes), and iii) list and describe the data to be collected and the methods of data collection. The time available for data collection may be limited, although authorities will provide indication one-hour prior to a vessel planning to depart. Data collectors should prepare the following equipment and materials to minimise sampling time and effort:

3.1.3 Vietnam national fisheries database (VNFishbase)

Sub-DFISH staff are required to enter data from the fishery logbook into the Vietnam national fishery database - VNFishbase. This national, VNfishbase, was developed since 2010, funded by World Bank under the Coastal Resources for Sustainable Development (CRSD) project. Under CRSD, VNFishbase was integrated with a number of modules to manage information related to capture fisheries in eight provinces involved in the CRSD project (Thanh Hoa, Nghe An, Ha Tinh, Binh Dinh, Phu Yen, Khanh Hoa, Ca Mau and Soc Trang). In September of 2018, DFISH expanded VNFishbase to all 28 coastal provinces in the country.

The current regulations established for Vietnam require that all vessels (LOA >12 m) and transhipment vessels are to submit a daily logbook to fishing port authorities prior to landing (Clause 1, Article 3, Circular 01/2022/TT-BNNPTNT). Logbooks may either be paper-based or electronic and must be signed by the Captain or Unique (vessel) ID. The data obtained from logbooks should be entered into VNFishbase. Data entry is commonly conducted via landing/port authorities and provincial Sub-DFISH staff and is required to be entered on a regular basis (daily).

The VNFishbase system now covers all aspects of Vietnam fisheries including capture fisheries, vessels registrations, aquaculture as well as marine catches. Despite some qualified success and clear benefits in terms of vessel registration and authorization, landing and logbook data (intended to be included in VNFishbase) are generally not entered. Data quality and consistency varies across provinces, and in some areas only preliminary fisheries data are available for analysis.

3.2 fisheries-dependent data: Commercial catch and effort data

3.2.1 Viet Nam Government Statistical Office fisheries catch data

Data collection methodology: Official fishery statistics are collected and published annually by the Government Statistics Office (GSO). They are composed of annual total catch (catch = landings in Vietnam where there is little discarding) and other statistical data related to fisheries such as fishing vessels, fisheries labour, fisheries households The catch statistics at the district scale are estimated by the provincial GSO staff and the catch statistics of the community scale are estimated by the district GSO staff using a sample-based interview method. The total catch is then calculated by estimating the catch per unit effort (cpue) of a

given vessel and gear type multiplied up by the number of registered vessels of that gear type in the province.

Hai (2018)[1] identifies a number of weaknesses in the data collection methodology that includes

- Non-random selection of samples (i.e. not using random sampling nor random stratified sampling);
- Insufficient sample size;
- Total catch is calculated for broad aggregated groups (i.e. fish, squid, shrimp and others), and not classified by species or gear;
- Interviews conducted only twice per year and require recall of fishers; and
- Political interference in the analysis of the sample surveys to meet Master Plan targets.

As a result, the official GSO statistics probably do not accurately reflect the past history of the fishery development in the country overall, or of any one province. The catches steadily increase at a rate similar to that specified in the target catches in the Master plans. They do, however, give a rough ball park figure of the total catch (see Figure 10 below).

Source of data: The catch data (production data) is published annually in the "Statistical Year Book". PDFs of the yearbooks published since 2010 are available on the GSO website: https://www.gso.gov.vn/en/statistic-book/
However, the data are aggregated and include both inland and marine catch at the province level. One table (Table 230) refers to production of sea fish by province, but it is not clear whether this is the marine catch or only fish (not shrimp, crabs and squid etc).

The same data can be retrieved through a series of queries on the GSO Agriculture, forestry and fisheries website for the years after 1995.
https://www.gso.gov.vn/en/agriculture-forestry-and-fishery/, although extracting the data is not easy as the query names seem to be wrong compared with the results they produce.

The data are also reported to the FAO and the time series of catches, starting in 1950, aggregated for the whole of Vietnam are available on:
https://www.fao.org/fishery/en/statistics/software/fishstatj/en up until 2007.

3.2.2 Assessment of Living Marine Resources in Vietnam Project (ALMRV) data

Data collection methodology: The Phase I of the project covered 1996-2005 and Phase II 2006-2010. The project implemented (i) fisheries-independent surveys including trawl surveys for the demersal resources, acoustics surveys for small pelagic fish, and gillnet survey for the large pelagic fish (see below under 3.3 Fisheries-independent data) and (ii) fisheries surveys consisting of enumerators and the logbook program for the catch and effort data, observer program for the species and catch composition from the fisheries and the port sampling for the length-frequency data and biological information of selected species. The routine enumerator programme to collect catch and effort information from commercial Vietnamese fisheries was initiated in 1996 as a part of phase I of the ALMRV project. The

[1] Hai, V. D. (2018). *Fisheries Planning and Management in Vietnam: an explanation of ineffectiveness*. Aalborg Universitetsforlag. Ph.d.-serien for Det Tekniske Fakultet for IT og Design, Aalborg Universitet

data collection was conducted through interviews with commercial fishermen providing catch rate, effort and activity information. The initial programme covered 11 provinces, where the information was sampled through a stratified random approach. In 2000 the enumerator programme was modified reflecting the change towards an indicator-based and multi-disciplinary fisheries assessment implemented. The enumerator programme was expanded to cover all 28 coastal provinces.

The various types of indicator information available during this time were condensed and disseminated in a standardised report schemes: fleet summary sheets synthesising catch rates and catch composition, fishing effort and fishing activity and the economic performance of the fleets (enumerator; vessel and licensing database). Fleet summary sheets and fleet indicators report data on:

1. Catch per fishing day (total catch and catch per group);
2. Catch per unit effort (total catch and catch per group, effort measure depending on gear type);
3. Number of active days per month;
4. Trip length;
5. Turnover per trip;
6. Cost per trip;
7. Turnover per day;
8. Cost per day;
9. Number of crew members;
10. Percentage of catch composition (by main groups);
11. Percentage of turnover composition (by main groups);
12. Fish price (by main groups).

A second summary sheet titled “Resource and ecosystem indicators” that contain an overview of the status and development in natural resources and of the ecosystem based on the commercial sampling, survey and observer data were also produced.

Source of data: Data are held by RIMF

3.2.3 The Comprehensive Survey for Marine Fisheries Resources in Vietnam – DA47-I.9 Project and West Pacific East Asia Project “WPEA” project for tuna

Data collection methodology: The first phase of the project DA47-I.9 was from July 2014 to June 2015 and the second phase from July 2015 to June 2020, funded by the Government of Vietnam. Catch and fishing effort data were collected through a collaboration between the DFISH, RIMF and Sub-DFISH based on a sampling program of fisher’s log books. The data collection covered 12 types of fishing gears with a total of 64 fleets categorized based on fishing gears (passive and positive fishing gears) and vessel engine capacity. Trawls and purse seines data were collected for fishing boats categorized into 6 groups as <20HP, 20-50HP, 50-90HP, 90-250HP, 250-400HP and >400CHP. Gillnets, longlines, handlines, traps, falling net were categorized into 3 groups as <20HP, 20-90HP and >90HP. Among 64 fishing fleets, 53 fleets were involved in the logbook program of the “DA47-I.9” project and the tuna fleets were conducted by the “WPEA” project following the instruction of the Western & Central Pacific Fisheries Commission (WCPFC).

The Vietnam national fishing logbook developed after the Vietnam Fisheries Laws 2003 was adopted. It has been revised many times in order to adapt to international market requirements as well as regional fishery management organizations (RFMOs). For the general purposes of national fishery management, Vietnam fishing logbook is designed to record all Key Data Elements (KDEs) related to fish species, details information of fishing boats, fishing grounds, fishing seasons, the port in & port out process, landing process, fishing-set information, procedure to certify & verify the landing catches. The logbook program of the "DA47-I.9" project was implemented in 24 coastal provinces representative for four fishing areas - Tonkin Gulf, Central, Southeast and Southwest areas.

After the fishing trip, captain is required to submit their log-sheet to the fisheries officer of the Sub-DFISH when landing product. Information included in the log-sheet are:

- General information of fishing vessel: owner, registration number, province, landing place, fishing gear, number of crew, engine capacity.
- Fishing trip information: departure date, landing date, fishing ground(s), active day per trip, haul per day, active day last month and total catch.
- Catch information: commercial species groups and their catch in weight.

Not all captains submit log books but, it was estimated that a sufficient number provided a reliable estimate of the total fleet for the period of the "DA47-I.9" project.
The sampling scheme provided information on:

- Total catch by vessel size x gear x area x province
- Total fishing effort by vessel size x gear x area x province
- Species composition by gear x area x province

Source of data: Data are held by RIMF

3.2.4 Comparison of different data sets

Figure 10 shows the total Vietnam GSO catch data (as recorded by the FAO), and the catch data of the ALMRV and the DA47-1.9 projects. The total catch as estimated by the projects was higher than that estimated by the GSO, except in 2018 and 2019 when they converged. In contrast to the GSO data that show a steady increase in catch each year, the catch during the project periods showed considerable year-to-year variation. The average catch in the DA47-1.9 period was higher than that of the ALMRV period, but there is a suggetion of catches reaching a plateau.

Both the DA47-1.9 and the GSO data show that the more recent marine fish catch in Vietnam is around 3.2 to 3.5 million tonnes. On a per km^2 EEZ basis, this is 4-5 times greater than the catch in both Thailand and Cambodia.

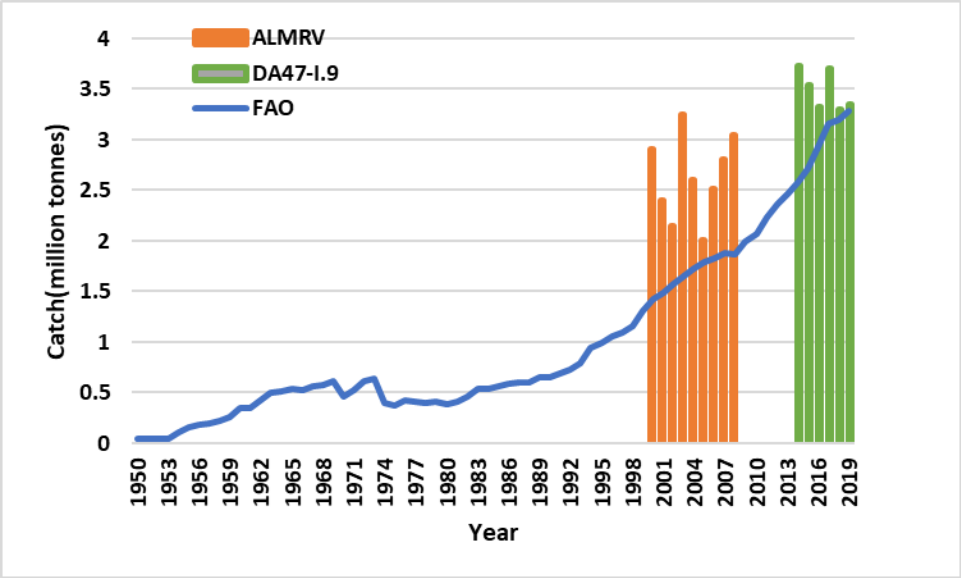


Figure 10: Comparison of catch data from two project periods (ALMRV and DA47-1.9) and from the Government Statistics Office (sourced from FAO). *ALMRV = Assessment of Living Marine Resources in Vietnam project, DA47-1.9 = The Comprehensive Survey for Marine Resources in Vietnam project and FAO = Food and Agriculture Organisation of the United Nations.*

3.3 Fisheries-independent data

3.3.1 Resource surveys

3.3.1.1 Early fisheries resource surveys

- Nga Trang Institute of Oceanography trawl surveys *1925-1930*
  - *52 surveys covering 500 stations*
- Research surveys under the NAGA program, 1959 – 1961 (Gulf of Tonkin).
- Surveys of Friendship ship and Kyoshin ship, 1968-1971???
- Scripps Institute of Oceanography 1978-1981.
- Joint Viet Xo fishing surveys 1978-1988.
  - 22 vessels covering 31 trips and 4,412 stations (1,312 deepwater)

3.3.1.2 Assessment of Living Marine Resources in Vietnam project (ALMRV) Phase 1 1996-1997

Two surveys were conducted in the Southeast area during phase 1, covering 292 stations (63 in the deep-sea area).

3.3.1.3 Assessment of Living Marine Resources in Vietnam project (ALMRV) Phase 2 2000-2005

The survey programme was initiated in 2000 and was composed of a bottom trawl survey and a gill-net survey. Two areas were covered by the surveys: (1) the Gulf of Tonkin and (2) the southern waters of the south-eastern (including fishing grounds of BRVT) and south-western fishery areas (Figure 11).

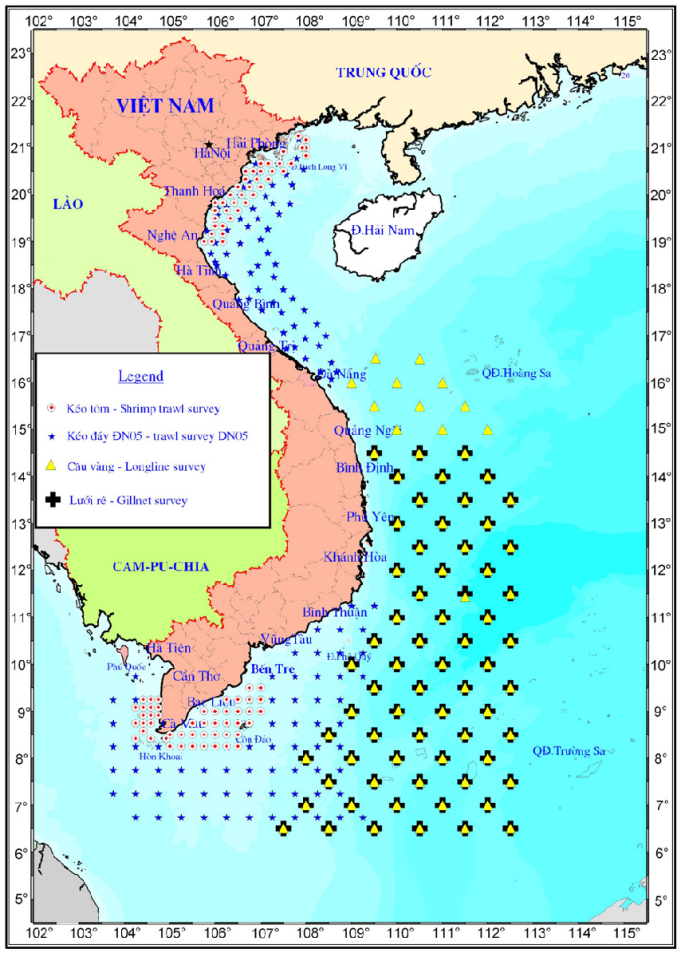


Figure 11: Map of stations covered in the research surveys

The bottom trawl survey in the southern water was carried out in July with 74 stations. Both surveys use a fixed station allocation and cover depths ranging from the near shore area out to 200 m. Until 2002 the bottom trawl surveys were performed in each area in both the south-west and the north-east monsoon period. However, to be able to cover all Vietnamese waters within the budget limitations, the two areas were covered only in alternate years. It was discovered that a better resolution of the temporal problem was achieved by choosing only one monsoon period for each area as this approach allowed all Vietnamese waters to be covered annually.

Pelagic gill-net surveys targeting tunas and other large pelagic species were conducted in April in the central deep waters (6130N–14130N and 107100E–112130E). As gill-nets are highly size selective, different mesh sizes were used - 73, 85, 100, 123, 150 mm bar length. Stations are allocated after a fixed grid design with 66 fishing stations.

3.3.1.3 The Comprehensive Survey for Marine Fisheries Resources in Vietnam – DA47-I.9 project and West Pacific East Asia Project "WPEA" project for tuna

During the period 2016-2020, the fisheries resources surveys have been continuously conducted in Vietnam following the design of the ALMRV-II project. Bottom trawl survey targets demersal fish and shellfish communities; pelagic gillnet survey targets tunas and other large pelagic species and, acoustic survey has been used to investigate small pelagic fish resources.

The bottom trawl surveys were conducted in September – October 2016 and August - September 2018 within the EEZ. The survey area covered from shore down to 200m deep with a total of 160 fixed haul stations.

The acoustic survey applied a zigzag transect which was conducted by the M.V. SEAFDEC 2 of the South East Asia Fisheries Development Centre (SEAFDEC) during June-August 2017. The survey covered the EEZ of Vietnam in the Tonkin Gulf, South East and Southwest waters and from the shore to the longitude 111o00E in the Central waters. The acoustic registrations were verified by trawl conducted along the survey transects.

Table 4. Eight group of fishes used in acoustic biomass estimation in Vietnam

No	Group of fishes	Representative species
1.	Anchovies	*Encrachonina heteroloba*
2.	Carangids	*Parastromateus niger*
3.	Sardines	*Sardinella gibbosa*
4.	Scads	*Trachurus japonicus* *Decapterus maruadsi*
5.	Yellow tail scad and bigeye scad	*Atule mate*
6.	Largehead Hairtal	*Trichiurus lepturus*
7.	Indian mackerel and Short mackerel	*Rastrelliger kanagurta* *R.brachysoma*
8.	Other pelagic fishes	*Sphyraena obtusata*

The relative abundance of tunas and the other large pelagic fishes are estimated by the catch per unit effort (CPUE, kg/km net).

Total biomass of fisheries resources in Vietnam for the period 2016-2020 is estimated by sum-up the biomass of demersal resources from the trawl survey with biomass of small pelagic fishes from acoustic survey and biomass of large pelagic fishes that interpolated from biomass of Skipjack tuna and Yellowfin tuna.

3.2.1.4 Other ad hoc surveys

MV SEAFDEC 2 2006: Fish trap and bottom longline survey
MV SEAFDEC 2 2012: Trawl and acoustic survey – no results due to weather

Source of data
Data are available for the cruises summarized below:

Area	Years surveyed
Southwest Vietnam	2000, 2004, 2012, 2013,2016,2018
Southeast Vietnam	1996,2000,2003,2004,2013,2016,2018

Data are held by the RIMF.

3.3.2 Observer programs

3.3.2.1 The Comprehensive Survey for Marine Fisheries Resources in Vietnam – DA47-I.9 project

The observer onboard fishing vessel program was implemented to get information on fishing grounds, species composition and catch composition of the fishing fleets. In the period from Jul 2014 to Jun 2020, there were 48 observer trips conducted per year by the Research Institute for Marine Fisheries under the project DA47-I.9 covering the fleets of trawl, drift gillnet, purse seine and falling net. The observers were trained fisheries biologists who involve onboard to identify species composition and catch in weight of species before these are sorted into commercial groups.

3.3.3 Biological data

3.3.3.1 Assessment of Living Marine Resources in Vietnam project (ALMRV) data

The interviews conducted during the ALMRV project were supplemented by biological sampling that included species composition of the landings, length distributions, and sex and maturity information for selected species that provided information potentially useful for classical single stock assessment.

3.3.3.2 The Comprehensive Survey for Marine Fisheries Resources in Vietnam – DA47-I.9 project and West Pacific East Asia Project "WPEA" project for tuna

During 2015 to 2020, biological information of selected species was collected in some main landing sites. Monthly visits were made by staff from the RIMF and each month five samples (25-30 individuals/sample) for a selected species has been randomly sampled from the catch of the fishing vessels at landing sites. Biological data analysis for a sampled species included: measured the length (fork length or total length in fishes; mantle length for squids and carapace length for shrimps, in mm), weighted the body weight and gonad weight (in gram), identify the sex and maturity stage. Number of samples of selected species for biological analysis for the Southeast region is shown in Table 5.

Table 5: Species selected for biological sampling in the DA47-1.9 project.

Species	Common name	Sample number
Small pelagic fish		
Encrasicholina punctifer	Buccaneer anchovy	60
Decapterus maruadsi	Japanese scad	60

Rastrelliger kanagurta	Indian mackerel	60
Demersal fish		
Saurida tumbil	Greater lizardfish	60
Nemipterus fucosus	Fork-tailed threadfin bream	60
Upeneus japonicus	Japanese goatfish	60
Priacanthus maracanthus	Red bigeye	60
Large pelagic fish[2]		
Katsuwonus pelamis	Skipjack tuna	60
Auxis rochei	Bullet tuna	60
Auxis thazard	Frigate tuna	60
Squid and Shrimp		
Loligo duvaucelli	Indian squid	60
Parapenaeopsis sculptilis	Rainbow shrimp	60
Total		**720**

Stock assessment were conducted for selected species based on the length-frequency data, using the FAO-ICLARM Stock Assessment Tools II (FiSAT II).

Source of data

The length frequency data and stock assessment are held by RIMF.

4. Indicators and reference points for management

Managing a fishery requires data and information to provide an understanding if the objectives set by stakeholders and fishery managers are being achieved. In consultation with stakeholders, fishery managers should establish reference points and indicators, plus their links to management objectives in the context of a fishery management plan.

4.1 Linking reference points, indicators and management

Both reference points and indicators are part of the management cycle as shown in Figure 12. In Vietnam the high-level policy goals are set out by the government in documents such as the Master Plan. For the BRVT trawl fishery there is currently no management plan and thus the broad objectives for the fishery are not clearly specified although they may be inferred from the law and various policy documents.

[2] Length frequency of the oceanic tuna (*Thunnus albacares* and *Thunnus obesus*) was conducted by the WPEA project

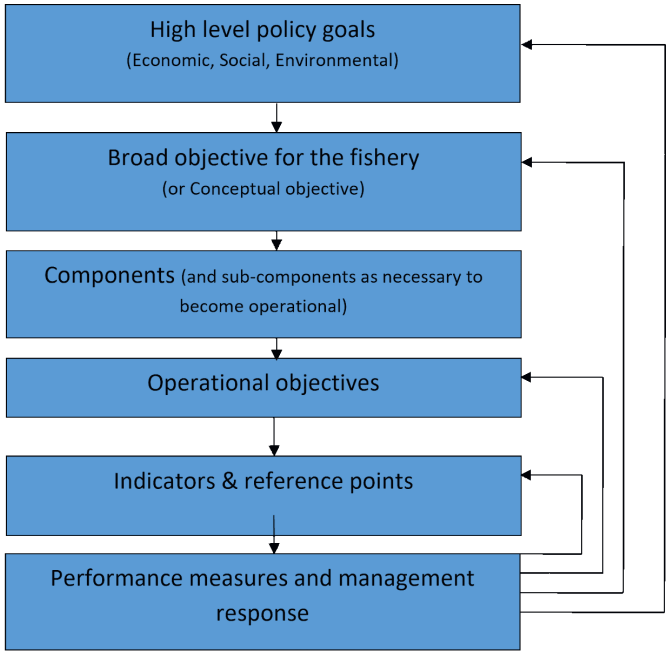


Figure 12: The fisheries management cycle. The arrows show feedback loops that are initiated through regular reviews and evaluation of management performance. Source: FAO (2003)

The operational objectives that follow on from the broad objectives are more specific objectives that can be addressed by management measures. Having clarity on these operational objectives provides guidance for the choice of indicators and reference points. When there are explicit social and economic operational objectives established for the fishery then this demands the collection of suitable information to track if the objectives are being achieved. For example, if a socio-economic objective is to increase fisher income then the right information needs to be collected and trigger points established to generate analyses and discussions if the data show that growth is not being achieved.

1. Reference points – are agreed performance measures that define the boundaries in which the fishery is expected to perform and points which may trigger and management response. Reference points are either targets or limits. Targets are where you want to be while limits are where you don't want to be. An example of a target is an agreed biomass of fish and/or fishing effort that needs to be maintained in order to support a viable fishery (e.g. produce maximum sustainable yield (MSY). A limit may be based on a biomass of concern (e.g. the point of recruitment impairment (PRI), below which fishing should either cease or be significantly cut back.

   The most commonly used reference points refer to the fishery resources and commonly focus on either stock biomass or fishing mortality. However, under an ecosystem approach to fisheries management, reference points may also ecological, economic or social in nature and may be quantitative or qualitative.

Reference points are a key part of the management system and need to be linked into the governance structures oversighting the management of the fishery such that managers and stakeholders can compare information received via monitoring with the agreed reference points and make decisions accordingly. Many management systems incorporate trigger points in addition to target and limit reference points. These are so called because they are linked to management responses. For example, a trigger point may be set at a higher biomass level than the limit reference point such that if the trigger is breached then some management action (which could be a meeting of the management committee, a detailed review of available information, reductions in catches etc) can be taken prior to more serious actions being required if the biomass declines further.

Choosing the right reference points requires some decisions to have been taken about the type of management system that has been agreed. For example, the choice of reference point(s) may be different for a multispecies fishery as compared to a single species fishery. Determining if a reference point has been triggered requires relevant and accurate information on indicators (see below) which needs to be funded.

There is a considerable amount of guidance material available on the process for determining and the choice of suitable reference points. Some useful references are provided in the reference list.

2. Indicators – in fisheries, indicators are measures of some aspect of the fishery that is relevant to management and/or stakeholders. They need to be designed to provide important information on how the fishery is performing in biological, ecological, social or economic terms. For any given fishery there are potentially dozens or even hundreds of potential indicators and careful consideration needs to be devoted to the choice of which to adopt otherwise the data collection costs may be too high and the information from the indicators may not be usable in a management context. Some broad categories of indicators include:

    - Fleet or fishing capacity indicators, including the number of fishing boats, fishing power in terms of horse power or gross tonnage, fishing time, and type and number of fishing gear;
    - Harvesting or resource indicators, including landing volume, CPUE, biomass, catch composition, number of species caught, fishing ground, average fish size, and size of mature fish; and
    - Economic and social indicators, including landing value, Revenue per Unit Effort (RPUE), export and import (in quantity and value), per capita fish consumption, investment in fisheries, number of fishers, number of employees in the fishery sectors, and fishers' profits.

    The choice of indicators is dependent on the type of fishery managed and how its management system is designed. As mentioned above, a multispecies fishery will be managed differently to a single species fishery and will therefore require a different suite of indicators.

The links between indicators and reference points are illustrated in Figures 13 and 14, below. Figure 13 represents a common situation where there is a quantitative estimate of the indicator value that can be monitored against a target and a limit reference point. In this case, the difference between the indicator and the reference point shows how well the management of the fishery is performing (performance measure) based on this indicator.

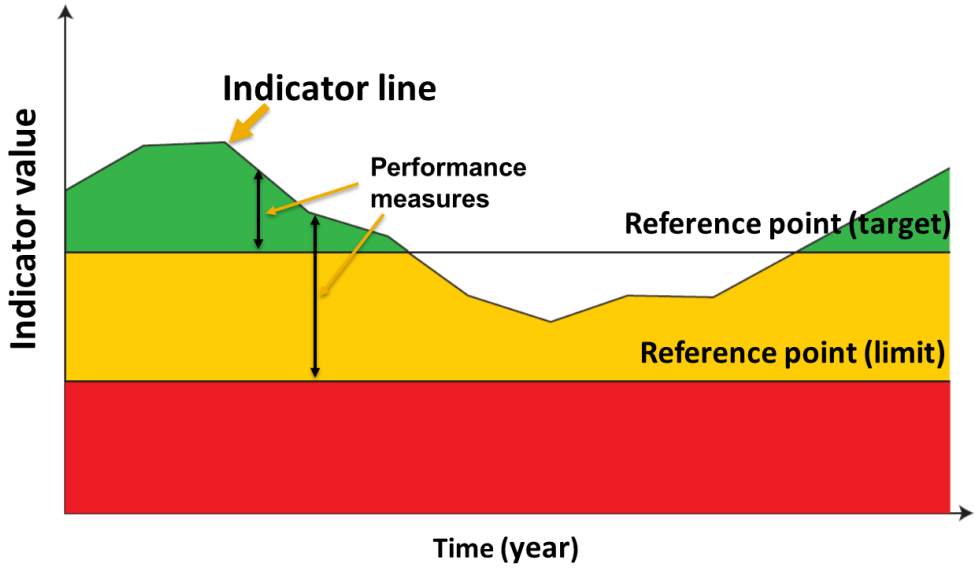


Figure 13: Relationship between an indicator and references points (target and limit). Adapted from FAO (2003)

Figure 14 would best describe a more qualitative approach where stakeholders may be involved in what would define a Great Result (above a qualitative reference point) and an unsatisfactory/unacceptable result (limit reference point). An example may be perceptions about the status of the fishery by fishers. These perceptions may be gained by interviews and fishers asked whether they think that the fishery is working well for them or not.

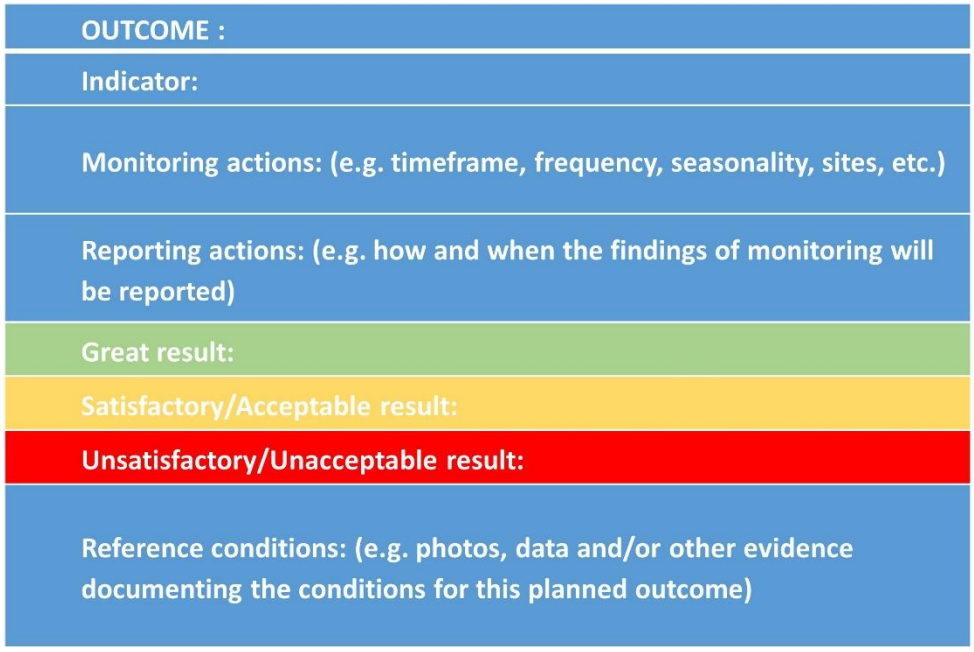


Figure 14: Qualitative relationship between indicators and reference point. Source Jones (2010).

4.2 The indicator species approach

Managing multispecies fisheries is challenging, especially when there are dozens if not hundreds of species involved. New approaches have been developed in recent years that seek to provide a way forward, including the so called 'indicator species approach' (REFS) which makes use of carefully selected species chosen to provide insights into how various components of the ecosystem potentially affected by fishing activities are faring. Indicator species that represent vulnerable species (slow growing, naturally rare, for example), species that are tolerant of managed fishing pressure and species that may be very tolerant of fishing (fast growing, abundant, for example). The concept implements an assumption that the indicators represent how other species in the same category may be responding to the fishing pressure and thus provide information back to fishery managers and stakeholders about the potential need for management interventions.

Indicator species are used to provide information about aspects of the fishery and the ecosystem that may require a management response. For example, if the numbers of vulnerable species in the catch declines then it may mean that fishing pressure is too high. Other indicator species may be chosen as they represent species of economic importance and ensuring that the fishery continues to support businesses may be a key objective for fishery stakeholders and government. In general the aim is to choose several species that represent those that are most sensitive to fishing pressure, some species which represent those that are relatively resilient to fishing pressure and a third group comprised of species that are very resilient.

4.2.1 Selection of indicator species

The suggested approach to the choice of indicator species is based on a logical approach publicly available in the peer reviewed literature.

The selection of indicator species should be based on the scoring of characteristics within three criteria: inherent vulnerability, current impact status, and management importance. Each criterion can be measured quantitatively (i.e., fully integrated models), semi-quantitatively (i.e., risk assessment), or qualitatively (i.e., risk assessment approaches). The species with the highest total scores are selected as the indicator species (maximum total score of 125) and are typically those with a score of 4 or higher in at least two criteria (Table 6). The number of indicator species may vary spatially to accommodate fisheries with different boat/gear types, captured/retained species, and ecosystem structures. It is essential that indicator species be regularly evaluated and reviewed (see "4. Planning and Evaluation). For more detailed information on the selection of indicator species see Newman et al. (2018). The scoring characteristic within each criterion are explained below:

Inherent vulnerability

Inherent vulnerability is assessed based on a combination of biological, ecological and fisheries attributes selected to reflect the productivity of the species and its vulnerability to exploitation (i.e., longevity, age at maturity, growth rate, reproductive strategy/investment, recruitment, distribution, stock structure and post-release mortality). Each attribute is allocated a score between 1 and 5 (ranging from least concern to vulnerable) (see Table 6). Each attribute has equal weighting, and the overall score should reflect the average score level.

Current impact status

The current impact to a species stock is assessed based on estimates of stock biomass which support maximum sustainable yield (B_{MSY}). The current impact status is determined by level of risk to stock biomass. The risk level is evaluated on a scale of 1 to 5 (ranging from negligible to severe). The current impact status reflects the current threats that are likely to change from short to medium term (i.e., level of fishing effort/catch, or environmental factors). The current impact status is fluid and should be reviewed on a regular bias (e.g. annually), and in relation to the level of inherent vulnerability where possible.

Management importance

The management importance of a species is determined by scoring the current management requirements, commercial values, customary importance, recreational importance, and conservation status of a species. Each attribute is allocated a score between 1 and 5 across each management category (ranging negligible to critical risk). Each attribute has equal weighting, and the overall score should reflect the average score level.

Table 6: Indicative scoring table for elements in selecting indicator species. The scores from each table can be multiplied to give an overall species score. Additional tables of this kind can be created for different sub-fisheries and for species requiring environmental protection (Newman et al., 2018).

Score	Description			
Inherent vulnerability				
1	Wide distribution & one stock; short lived (<5y) & early maturity (<1y); consistent productivity/ recruitment; limited availability to fishery			
2	Wide distribution & large stocks; short-moderate lived (5-15y) & maturity (2-4y); relatively consistent production/recruitment			
3	Endemic to region & single stock in fishery; medium lived (15-25y) & maturity (4-8y); moderately variable production/recruitment; widespread spawning			
4	Endemic to region & multiple stocks in fishery; medium-long lived (25-40y) & maturity (8-12y); variable production/recruitment; spawning aggregations			
5	Endemic to fishery; long lived (>40y) & slow maturity (>12y); very low fecundity; spawning aggregations			
Current impact status				
1	Minor or negligible impact			
2	Lightly exploited; underfished; likely above Bmsy			
3	Fully exploited; not recruitment overfished; broadly about Bmsy			
4	Heavily exploited; perhaps recruitment overfished; broadly about ½ Bmsy			
5	Very heavily exploited; recruitment overfished; collapsed/ now rare, below ½ Bmsy			
Management importance				
Score	Commercial value	Subsistence & customary value	Non-extractive value (existence, tourism etc)	Conservation status
1	Negligible	Negligible	Negligible	No concerns
2	Some -moderate	Some	Small	Some concerns
3	Medium	Moderate	Moderate	At risk, near threatened
4	High	Major	High	Vulnerable, endangered
5	Critically dependent	Primary importance	Critically dependent	Critically endangered

5. Conclusions and next steps

The report first outlines the ideal situation for collecting ongoing monitoring data for a fishery and then describes the current and past situation in Vietnam and Ba Ria-Vung Tau province. It very obvious that data collection was much more comprehensive when supported by project funds. As often the case with projects, although they demonstrate

what can be done and the benefits to the country, the national government does not continue the activity. Thus in Ba Ria-Vung Tau the following gaps can be identified:

- No reliable long-term time-series data on catch, fishing effort or species composition;
- Although the national VNFishbase is in place, limited regular data entry is occurring;
- No future research surveys have been funded (project proposal now being considered);
- No biological or length frequency data are being collected; and
- Little information on the composition of trash fish that is processed into fish meal/oil

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7.0 Appendices

Annex I: Frame Survey

Landing Site name:		**Date:**	
Name:		**Enumerator 1**	
Village:		**Enumerator 2**	
District:			
Province:		**GPS**	
	Boat/Gear category:	**# Boats:**	**# Gears:**
	Name # 1	...	...
	Name # 2	...	...
	Name # 3	...	...
	Name # 4	...	...
	etc.		

Landing Site name:		**Date:**	
Name:		**Enumerator 1**	
Village:		**Enumerator 2**	
District:			
Province:		**GPS**	
	Boat/Gear type:	**# Boats:**	**# Gears:**
	Name # 1	...	...
	Name # 2	...	...
	Name # 3	...	...
	Name # 4	...	...
	etc.		

Annex II: Data Collection Form for Catches and Landings (CPUE)

Site		**Boat/gear category**	
Date		**Time**	
# boats		**# gears**	**# days**

Supplementary information

Extrapolated weight		**Enumerator**	
Boat name		**Registration #**	
Fishing ground			
Observations			

Species Name	**code**	**Weight**	**Price**	**Value**	**# of fish**
Species 1					
Species 2					
Species 3					
etc.					

Annex III: Data Collection Form for Boat/Gear (Effort) Activities

Site	
Date	
Time	
Enumerator	

Boat/gear category		**Active boats**			**Active gears**		
motorized	**bottom gill net**		**of**			**of**	
unmotorized	**bottom gill net**		**of**			**of**	
motorized	**drift net**		**of**			**of**	
unmotorized	**drift net**		**of**			**of**	
motorized	**trammel gill net**		**of**			**of**	
unmotorized	**trammel gill net**		**of**			**of**	
motorized	**tiger mouth**		**of**			**of**	
unmotorized	**tiger mouth**		**of**			**of**	
etc.							