

Manual for the Study and Conservation of Reef Fish Spawning Aggregations

by

**Patrick L. Colin, Yvonne J. Sadovy
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While effort has been made to verify and check the information included in this manual, no guarantees are made as to the accuracy or utility of any information included herein. It is essential that all activities undertaken on or in the water be properly planned and carried out. The methods described in this manual have been based on the experiences of the authors and others, however all users are advised to remember the conditions they encounter may not be the same and should take appropriate measures to modify the contents of this manual based on their local conditions. The authors are grateful to Ken Lindeman and Melita Samoily for their comments on sections of the manuscript, and to Environmental Defense for funding the first print run of the manual.

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Section VI. Documenting the Fishery

Nearly all known aggregations of the larger food fishes will have some type of fishery associated with them; no published studies of spawning aggregations of food fishes have been conducted in the absence of a fishery. Studying an unfished aggregation could lead to some valuable comparative data, but will likely require traveling to a very remote location, requiring substantial resources. Because most aggregations are going to have a fishery, documenting fisheries that are targeting spawning aggregations has become the most important task for field workers. While the behavioral ecology aspects of spawning aggregations are typically more interesting to researchers, there is a need to have every available aggregation that is exploited documented, which inevitably includes documenting the level of exploitation. In this era of global fisheries markets and efficient fishing technologies, aggregation fishing that goes undocumented and unchecked could lead to the rapid extirpation of targeted aggregations. All researchers who venture into the field to study spawning aggregations must understand their responsibility to place a high priority on collecting fishery information.

Several approaches can be taken to document a fishery, including government catch statistics, fishery-dependent surveys and interviews. The interviewing skills discussed in Section III are also important for documenting aggregation fisheries. Much of the information needed to write a summary of a particular fishery can be collected at the dock through interviews and observation. Observations made in the field are valuable for confirming information obtained through interviews or collecting data independent from interviews. Through these interviews it may be possible to arrange for a trip on a fishing vessel to observe the fishery directly.

VI. A. Types of Information on the Fishery and Information Sources

The types of information typically gathered from fishers or obtained from examining the catch include the following.

Fishery Catch Statistics

Of course, many fishery departments collect records and it is hoped that annual or monthly landings data are collected with a properly designed sampling program. It is critical that any sampling protocol is properly documented and consistently applied over time if the data are to be of value in assessing trends in a fishery. When referring to departmental records for historic datasets, it is important to refer carefully to the methodology applied to determine to what extent past and present data might be comparable. For example, often landings are collected with no reference to effort. Knowledgeable fishery officials could be consulted to determine whether important changes in effort might have occurred that could significantly have affected available data in departmental records. Ideally CPUE data should be used (but refer to Section IV.E.). If there is no reason to suppose significant changes in effort over time, landings data can still be useful.

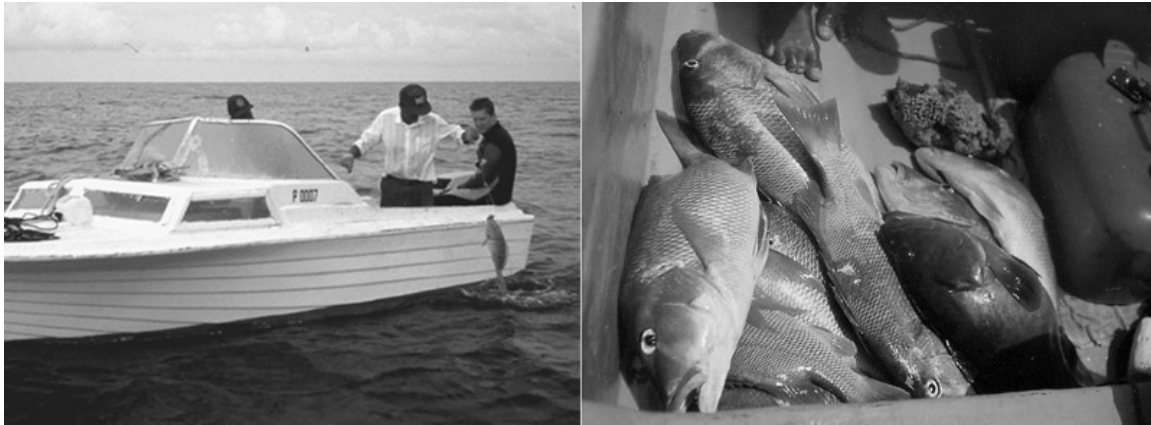
Fishery Gear

Describing the method of take for the aggregation fishery is important and relatively easy. Common gear types include hook and line, fish traps, and speargun. In some cases nets (gill net or other) may be used. Each gear type has many variations so details are necessary to adequately describe the fishery. For example, hook and line fisheries can vary from a single hook

on a handline to a large vessel putting out miles of longline with thousands of hooks. Fish traps vary in size and design as well as methods for baiting, deploying and retrieving.

Fishing Vessels

Record the type and size of boats that are fishing the aggregation. Information on what ports/villages the boats originate from is valuable as well as the place they offload their catch. Often aggregation fisheries are operated out of small boats (Fig. 54) making it difficult to monitor a large proportion of vessels involved. Nonetheless, as many boats as possible should be monitored, and the total number of boats known, to enable catch and effort to be estimated.



*Figure 54. (Left) Handliner fishing from a small outboard boat capturing mutton snapper, *Lutjanus analis*, from a spawning aggregation. (Right) Catch of mutton snapper along with one grouper taken from the area of a spawning aggregation (MLD).*

Sampling the Catch

Measurements taken from a random sample of fish being landed can provide biological and fishery information. Of course sampling can only be done with the permission of the fisher or buyer. Getting permission can be difficult when the fish are landed/shipped live. Even in these circumstances there may be mortalities that you will be allowed to examine. By examining gonads fish can be sexed and if gonad samples can be taken, data can be collected for gonadal somatic index (GSI) and ovaries can be examined for the presence of hydrated eggs and/or post ovulatory follicles (see Section IV.D.). Recording lengths and weights is important for converting numbers of fish caught to weight of catch. Although it is tempting to use these samples to characterize the aggregation (sex ratio, size frequency etc.) one must be careful to consider the possible selectivity of the gear (for size or sex of fish, for example).

Even crude estimates of catch and effort are better than no data. Information gathered simply from interviews can be used to estimate catch. Fishers may give rough numbers for how many fish they take per day or per year from the aggregation. Average catches per boat can be expanded by the number of boats known to be fishing to estimate total catch. The buyers may know the approximate biomass of the catch. More detailed catch and effort data are extremely valuable if they can be obtained. For example, CPUE expressed as a fish per unit gear (e.g. number/weight of fish per trap or per hook) or per unit time (number/weight fish caught per hour fished) can be obtained through observation and interview. These data are critical for documenting trends in the fishery. Below are specifics on collecting catch data.

Fish Market Surveys

Where there are just a few markets and all or the majority of the catch is landed at these markets, market surveys can provide a good indication of seasonality in landings (although as already noted above, landings can vary because of fisher behavior which can be assessed by speaking to fishers directly). Regular visits to markets to carry out a pre-determined sampling protocol is advised but careful decisions need to be made concerning how many fish to sample, how many stalls or shops to sample, and how often and which species to sample. How will the data be organized and what is the objective of collecting the data? These are the kinds of questions that must be asked, and answered, in order to develop an appropriate sampling program. There are plenty of examples of this kind of sampling and it is not difficult to plan a program, but if there is no planning then the data may mean very little and much time, money and valuable information may be lost. CPUE data could be estimated by calculating the number of fishers and some measure of their effort such as number of days or hours they fish per day. Standardized forms should be developed so that different workers are sure to sample in the same way and over the long term. This means that forms should be clear and simple, with as little unnecessary detail as possible.

Market Records

Some large and well-organized markets keep records of sales. These may or may not be useful depending on how they are taken and whether species are reliably and **individually** recorded (i.e., each fish is recorded to species level). Again, an estimate of fishing effort will be needed unless it can reasonably be assumed that effort is not changing over time. In some cases, market surveys might not be of any use for evaluating catches in local waters. For example, in Hong Kong, although all chilled fish caught by Hong Kong vessels must, by law, be sold through local markets, since Hong Kong vessels largely fish outside of local (Hong Kong) waters, market records tell us nothing about local Hong Kong catches (also, there is much fish sold outside of legal channels). Be aware when inspecting market records (as well as for other types of market surveys) what the numbers are actually telling you. For example, chilled, filleted and live fish may well be handled by different market sectors so be sure to check how your species of interest are marketed. Some might be sent directly to restaurants without ever passing through a retail market, for example, or culturally important species may go directly to the local community.

Port Surveys

In some fisheries it is possible to sub-sample the catches of boats as they come into port. There are well-established methods for doing this and the usual considerations of which fish species to sample, how many boats and how often to sample, etc., must be made. As for any types of surveys, planning is essential and knowing your fishery is important. For example, port surveys have long been practiced in Puerto Rico, providing valuable fishery data. It was discovered, however, that a couple of species were under-sampled because they were particularly preferred by fishers and taken home to their families. These species had gone largely unrecorded in port-collected samples but, realizing the situation enabled suitably cautious interpretation of data.

Fisher Interviews

Interviews of fishers can also provide valuable information on both catches and effort (see also Section III). Again, the basic questions of how many, how often and standardization of the approach are essential. It is also important to have some means of verifying responses. This

could be achieved by including, amongst survey questions, questions with answers known to the interviewer but not to the fisher. Often interviews can only be undertaken sporadically but even more qualitative information can provide useful indications of trends in catches within the year and over the long term and how and where a particular fishery is conducted. One particular advantage of fisher interviews is that questions can be asked regarding whether fish were releasing milt or eggs at capture, thereby identifying possible spawning aggregations.

Logbooks

In some fisheries, ship captains are required to keep logbooks and these can be used to determine catches for a known unit of time for a given vessel. Note, however, that it is essential that such logbooks be cross-checked periodically (for example by assigning on-board observers) and, in analyzing the data, it is essential that the resolution of the data is known. For example, it may be easiest for a captain to simply make an estimate of his monthly landings. This might provide a useful seasonal pattern of landings within an annual cycle but would not identify shorter-term patterns such as spawning aggregations that may occur for just a few days in a month. An interesting example of problems in interpretation occurred in the fishery of the coral trout, *Plectropomus leopardus*, on the Great Barrier Reef of eastern Australia. Logbooks provided monthly information that indicated an increase in catches during the known months of aggregation. However, the data were of insufficient resolution to detect whether the aggregations themselves were being specifically targeted during these months. Although reports by some fishers indicated that indeed aggregations were being targeted, the logbook data were used to suggest that there was no evidence of targeting of aggregations. This conclusion had consequences for the types of management measure subsequently considered. Again, as we have emphasized elsewhere, know your data and their limitations and interpret accordingly.

Export Records

In some countries there is an important export trade in reef fish species that aggregate to spawn. Aggregations may provide particularly attractive bounties for exporters. If export records are complete enough they may be suggestive of seasonality in catches. This will depend very much on the local situation. Since exports are very likely to be an amalgamation of fish caught from many places and, moreover, only represent part of the catch, they may show little trend even when there may be seasonality in some of the fishing areas involved. However, if much of the catch of certain species is exported and mostly through one or two ports or airports, inspection of export records might be of value. This will only be the case, of course, if exports are noted by species and these identifications are reported accurately.

Restaurant Surveys

If restaurants are a major purchaser of certain fish species (often the higher value ones), then periodic restaurant surveys might provide an idea of seasonality, or at least indicate changes in the availability of such species.

VI. B. Documenting Local Management

Determining the fishery management in effect for a given species would seem to be a relatively straightforward exercise. Often it is, but sometimes it can be difficult to obtain reliable information on local fishery related laws. This brief section covers several considerations that may need to be made when seeking such information; we do not consider it to be comprehensive but the examples should alert a wary reader to some of the possible problems that might arise.

The obvious place to start when seeking current local legislation is with government offices, most likely fishery departments or divisions or those that deal with fishery issues. Local fishery coops might also be helpful. Whatever approach is used or most convenient, it is advisable to obtain a paper copy of the relevant legislation. The reason for this is that often people who should know the law may not be up to date or may not be fully familiar with all the fine details of the law. How well do you know your own country's fishery laws? Note also that different jurisdictions may have different laws (e.g., State and Federal laws in the United States), or that some widely respected regulations may not be officially documented such as those where there is traditional marine tenure.

To determine the effectiveness of fishery-related regulations, one must determine the level of enforcement, numbers of enforcement personnel, and it might be valuable to ask about the number of convictions that have been effected. It is also important to determine how information on regulations is disseminated, how familiar local fishers and local judiciary are with the laws and how management might be modified as new information becomes available (i.e., the approach to co-management).

In some regions fisheries are managed at a local level through historical or cultural traditions. Documenting the history and effectiveness of these traditions could be useful for long-term management or allocation disputes as outside fishery influences change the dynamics of the fishery.

All of this information is important, especially if management recommendations are to be made, for understanding what kind of management might be effective, what is likely to be socially acceptable and how robust the recommendations might have to be. Summarizing and documenting management practices is helpful to other scientists/resource managers not familiar with the area you are studying. Finally, summarizing the level of enforcement is important to understand the effectiveness of any management.

Section VII. Spawning Aggregation Conservation Methods and Long Term Monitoring

VII. A. The Need for Conservation

Spawning aggregations are predictable in time and space and are particularly vulnerable to fishing. Moreover, many of the more vulnerable reef fish species (i.e., long lived, late maturing) are the ones that aggregate to spawn and are also particularly valued for food. The World Conservation Union (IUCN) Red List of Threatened Species includes a number of reef species that aggregate to spawn; several are presently listed as endangered or vulnerable, or are being considered for such a listing by the IUCN (<http://www.redlist.org>). These include the Nassau grouper (*Epinephelus striatus*), the humphead wrasse (*Cheilinus undulatus*), and several other groupers. Their inclusion in the Red List has much to do with their tendency to form spawning aggregations that are targeted by fishermen. In the Indo-Pacific, threatened or vulnerable species have been listed largely because of declines associated with demand for them in the Live Reef Fish Trade (LRFT). The LRFT is discussed below.

Most effort going into studying reef fish spawning aggregations is focused ultimately on their preservation through complete protection or management. Intelligent conservation decisions