

# **Manual for the Study and Conservation of Reef Fish Spawning Aggregations**

**by**

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and Michael L. Domeier**



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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veracity. The difficulty is that once in print, even in gray literature, such information tends to be considered fact, and the problem with false records is that these can lead to wasted resources and a poorer understanding of spawning aggregation related patterns in general.

#### **II. D. The Responsibility to Verify Information before Publication or Distribution**

It is incumbent upon observers to verify what they believe to be spawning aggregations before reporting their findings in the literature. This includes both the scientific and gray literature, such as newsletters and circulated reports. SCRFA can assist in this regard with any questions. Unverified reports of possible spawning aggregations are still valuable, but workers should avoid at all costs the impression that a spawning aggregation has been confirmed as such when the two criteria (spawning and aggregation) have not been met. Unverified information can be reported, but the limits of the data or observations must always be part of the reporting (e.g., Lindeman and Claro, 2003). Otherwise, others who might not be aware of the limits of the information will assume that the report is scientific "fact".

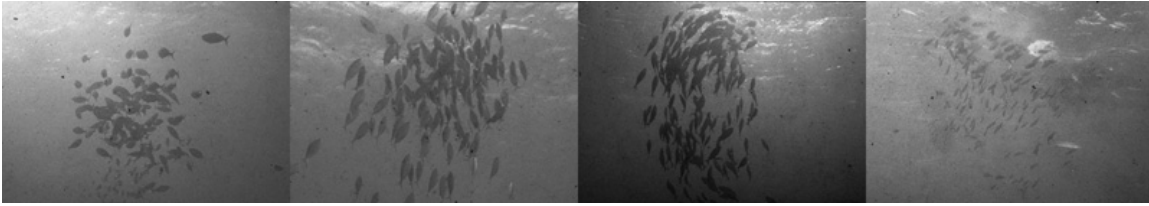
### **Section III. Discovering Spawning Aggregations:**

There is still a very active "discovery component" to work on spawning aggregations. Quite a few species, presently not known to form spawning aggregations, may eventually be found to have them, while many aggregations remain undiscovered. Discovering the unknown is never easy, especially when you are seeking a group of fish in 30 m of water somewhere along a hundred km of shelf edge that exists only for a short period each year. Consequently, scientists and managers need to use every resource available to increase the probability of success in finding spawning aggregations. Finding a previously unknown aggregation site is exciting and may provide valuable information but carries with it the responsibility to be careful about revealing its location prematurely to avoid its possible abuse.

#### **III. A. Talking to Fishermen**

To locate a spawning aggregation unknown to researchers, fishermen will often be the best initial resource (e.g. Johannes, 1981) (see Section VI). The knowledge level of fishermen varies greatly, but a truly knowledgeable, helpful individual is invaluable. Some fishermen with considerable knowledge of the fishes may not wish to share that information with anyone. For commercial fishing such information is often a business secret. Among subsistence fishers there is less commercial incentive, but disclosure of information may actually encourage commercial operators to move into what had previously been a subsistence fishery. Ideally the researcher can find knowledgeable fishermen with an active interest in getting their biological information recorded, either to pass on to future generations of subsistence fisheries, or to help establish workable regulations to maintain fishery yields. Always keep in mind what will happen when you make new information available to others. There may be cases where information needs to be kept confidential, such as in the case of specific locations of aggregations. You should always make certain your informants understand what you intend to do with their information.

It is important to make contact with fishermen prior to starting significant field work. This can be done in many ways, through fisheries co-ops, fish processing houses, village councils, and others. It never hurts to have some knowledge about the fish you are concerned with, but be careful about seeming to be a "know it all" when you make initial contacts. You are asking for help, and if you already know it all, why should someone help you?



*Figure 4. Caesio teres aggregation spawning, photographed at Enewetak Atoll, Marshall Islands (from Bell and Colin, 1986). In the left photograph the fish are coming together to spawn after engaging in a lengthy courtship. The remaining three photos show their ascent and swirling just beneath the surface during the actual spawning. This is an example of an aggregation discovered by "chance", in this case when behavior out of the ordinary was seen at a site that was regularly visited for other work.*

Spawning aggregations may or may not be known to local fishermen. In the cases where they are known, it is obviously advantageous to use this information to help plan field work. You should look for a fisherman, particularly someone senior (a "patriarch" fisherman), who has a longer-term perspective and is actively interested in research on an aggregation site. Try and make it clear what you are doing and why, and if appropriate consider hiring fishermen to work with you, either by taking you to the site or having them collect specimens for you. Try to involve local communities, if possible in the work, particularly in remote areas.

If you do not have a specific contact person, there may still be hope of finding aggregations. If the general area where an aggregation occurs is known, it might be possible to pinpoint the actual aggregation site looking for fishermen working the area or buoys from traps set on the aggregation site at the right time of year. For Nassau grouper aggregations, for example, aerial surveys can locate boats working at aggregations or spot the floats from traps in remote areas. While this may tell you where the fishermen think an aggregation will occur, without some information about actual catches, you will not know whether fish are actually present. For some groupers, for example, fishermen will often set traps to fish known aggregation sites, without fish being present, in the hopes they will show up and be caught.

Snooping around aggregation sites can arouse, and rightly so, sensitivities among fishermen, who may view the presence of scientists (or any non-fishermen) as a negative. Objections can range from your presence disturbing the fish (particularly if you dive on the site) or "driving them away" to "you are here to make laws to stop us fishing, so we don't want you here". Ideally, scientists can operate directly under national or local government auspices, or have the support of local fishermen who see a decrease in catches from an aggregation and want to know why, but this is by no means always the case. If researchers lack these connections, it is important to try to prepare fishermen for your presence in advance and if possible, obtain their permission to work on the aggregation site. Since fishermen are usually on the site for economic gain, it is useful if you can provide some economic benefit by your activities, such as buying specimen fish at a premium price. The time of dives or other activities might be scheduled to occur when fishermen are not actively working the aggregation. In the Bahamas, for example, most fishermen leave the Nassau grouper aggregation sites in late afternoon to return home before dark, and sites were clear of fishing activity when spawning was occurring at dusk (Colin, 1992), making diving less contentious.

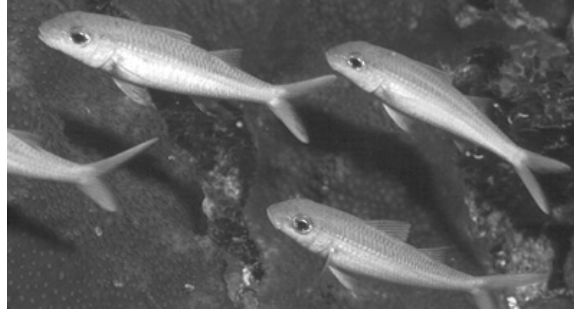
Interviews of fishermen are often very useful, particularly if you know what questions to ask and how to ask them. Johannes (1981:8-9) provides some useful tips for interviews, such as asking a question you already know the answer to, so that you can assess the accuracy of other

information the fisherman is giving you. Have a map of the area of interest, so you can be shown things on the map. Be ready to draw or write all over the map (photocopies of maps are useful for this) while your source is giving you information. Before you interview, be prepared and have basic knowledge of the fishes of concern. It might be useful to have photographs of the fishes of interest and make sure you have the local names so that you are certain that everybody is talking about the same fish. Be prepared to listen to all stories, no matter how unlikely and remember that it is often the case that a particular and interesting phenomenon may be widely known but that its understanding or interpretation may not be completely correct (Johannes, 1981). When possible, at some point well after the interview has started, provide at least some information that lets those you are interviewing know you have some knowledge of the fish of concern and the ocean in general. You must demonstrate that you are not totally ignorant about what they are telling you, but that their information is important to build upon what is already known. Get the person's name, phone number (if relevant) and postal address, if possible, and give them your contact information. Don't be a ghost who fades away after you learn what you want to know. Write down notes about what this person has told you as soon as possible. If fishermen know one another, you can mention you have talked with 'so and so' and you can ask whether the person you are talking with agrees with the information someone else gave you. Careful corroboration of information obtained through interviews is a critical part of the interview approach. Think about providing a small gesture of thanks for being interviewed, such as a t-shirt or a book (fish field guide?). If possible, give talks at the local school or village council about your work and always provide reports or feedback of your results to the local community or government, wherever possible.

### **III. B. Finding Unknown Aggregations**

Finding an aggregation unknown to anyone is likely to be a difficult proposition (see also Section VI). It is really a four dimensional problem compounded with all the factors that make working in the ocean so difficult. You need to find the right location, the right depth and the right time. Many aggregations are deep, and can not be easily seen from the surface. In the Bahamas, you could snorkel right over a large Nassau grouper aggregation and never know it was there, as the water is often not clear enough to see the fish over the dark bottom a hundred feet down. Any available information is important, as it can greatly improve your chances of success in locating an unknown aggregation. Check over records from fisheries departments, fish markets, fisheries literature and gonad data. Talk to dive operators, dive guides, tropical fish collectors, fishers and others who spend a lot of time on/in the water. Any of these may give you crucial hints as to "when" or "where" to look for aggregations.

Where you go to look for aggregations can affect your chances of success. Many species are known to spawn in shelf edge areas, reef promontories, pinnacles or passes so searching these areas can be productive. Identifying promising locations on a chart and searching from an airplane may prove effective for large aggregations in clear water. A vessel equipped with sonar and/or fathometer can also identify areas of high fish biomass that divers can then investigate. Also searching for aggregations during the late afternoon to sunset can be useful, as many species spawn during that time, but individuals might not be so obviously concentrated early in the day. If you work in an area with distinct tidal currents through passes or across reefs, many species spawn during the falling tide in the hours after high tide. Few, if any, are known to spawn on the rising tide. But don't just limit yourself to the most likely times and places. You never know what you will find if you are out there. Even aggregations already known at specific sites or for certain species can vary somewhat in location and timing from year to year.



**Figure 5. These goatfish, *Mulloidichthys martinicus*, are not presently known to form spawning aggregations, however, the only other shallow water western Atlantic goatfish, *Pseudupeneus maculatus*, does. It would not be surprising if *M. martinicus* is eventually discovered to form aggregations. (MLD)**

If conducting studies in one area over a long period of time, you can look for changes in presence and abundance of fishes that imply aggregation somewhere. It is possible to observe regular migrations of fishes through an area (Fig. 5) and then follow the migrating fish to determine whether they are moving to a spawning site. This worked well in the Bahamas for *Acanthurus coeruleus* (Colin, 1996) and for a variety of parrotfishes and surgeonfishes in Palau. The following of a migration route was also used to find surgeonfish aggregations in the Red Sea (Myrberg *et al.*, 1988). If large fish disappear from an area one year during the spawning season (but where they went to is unknown), you might consider tagging some fish the following year with sonic tags and then trying to locate them once they have gone to a potential aggregation site.

Finally there is the "pure dumb luck factor" that increases the more time you spend on and in the water. This is how the first spawning aggregations of Atlantic ocean surgeonfishes were discovered in Puerto Rico, which led to several years of study on these sites (Colin and Clavijo, 1988), and for *Caesio teres* at Enewetak Atoll (Fig. 4) (Bell and Colin, 1986). If a general season of spawning activity is known, such as for western Atlantic groupers (December to February), this is the time to be out looking around. To maximize the area covered during a search for aggregations, you can use manta tow boards or diver propulsion vehicles (DPV's or dive scooters). Manta tows allow covering large areas at a reasonable speed, but limit travel to the route the boat takes. DPV's allow more freedom, but have less range and speed.

#### **Section IV. Documenting Aggregations**

Once an aggregation is known or located, we need to learn something about its **physical and biological characteristics**. The uses of this information are diverse. It may have fisheries and conservation value, to preserve aggregations for both exploitation and to serve as a source population for future generations of fish. Scientists may be interested in aggregations for the same reasons, but also have the intention of trying to understand them as a biological phenomenon. A Marine Protected Area (MPA) may be centered on a large aggregation such that its physical location is critical to locating and sizing the MPA properly.

Aggregations can be documented in many ways. These can be as simple as using our eyes to count things and make observations, which are then recorded, or as complicated as instrumentation and equipment that provide a wealth of data on an aggregation and its environment. The ultimate value of work on aggregations depends on the skillful employment of the tools and resources that are available. Like most things, it is useful to learn the skills