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Solomon Islands Spawning Aggregation Monitoring Training Workshop Report

Gizo, Western Province, Solomon Islands
13-21 March 2004

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Cover photo: Group photograph of participants at the 2004 Solomon Islands Spawning Aggregation Monitoring Training Workshop, Gizo (D. Kennedy)

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BACKGROUND

Among coral reef fishes, some of the most susceptible to over-fishing are commercially important members of groupers (Serranidae) and wrasse (Labridae) that form spawning aggregations. These fishes, and many others, aggregate to spawn at predictable sites and times and are often heavily targeted by fishers. As a result of heavy fishing on spawning aggregations, aggregation loss, declines in genetic diversity and altered reproductive output have been recorded, with the potential for negative changes in trophic food webs and coral reef ecosystems.

The vulnerability of spawning aggregations to over-fishing is now widely recognized, as is the need to conserve and manage some fish populations at the aggregation level. To design meaningful management and conservation protocols and examine the effects of conservation actions on populations forming spawning aggregations, some form of monitoring is usually required. Toward this end, The Nature Conservancy is conducting spawning aggregation monitoring training workshops among areas of the western Pacific that are being affected by local or commercial over-fishing. Workshops focus on areas affected primarily by the live reef food fish trade (LRFFT). The workshops are designed to promote an awareness of the importance of spawning aggregations and their vulnerability, and to introduce local resource managers and conservationists to basic monitoring techniques for identifying, recording and responding to changes within spawning populations.[1]

The following report highlights monitoring skills training exercises and findings from the 13-21 March 2004 monitoring training workshop conducted at Gizo, Western Province, Solomon Islands at an undisclosed grouper spawning aggregation site. The monitoring training program introduced basic data-gathering techniques to practitioners for managing spawning aggregations, including the determination of reproductive season, identification of spawning aggregation sites, site mapping and area determination, species identification and aggregation behavior, species abundance estimation and data collection, processing and analysis. The workshop focused primarily on the use of underwater visual census techniques and was designed to accommodate local resource managers in the Solomon Islands interested in establishing long-term monitoring programs for management and conservation purposes.

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[1] The workshops are a part of a larger project that The Nature Conservancy has received funding from the East Asia and Pacific Environmental Initiative (EAPEI), the David and Lucile Packard Foundation and the Oak Foundation to conserve coral reef biodiversity by reducing the depletion of aggregating reef fish in Pacific Island countries. This project aims to improve resource management and spawning aggregation site protection, increase awareness of these resources' vulnerability to over-exploitation, and enhance capacity to manage reef fish spawning aggregations and MPAs that incorporate these sites. It has three objectives: (1) to develop and facilitate the application of cost-effective management controls on the exploitation of aggregating reef fish resources; (2) to strengthen the capacity to assess, monitor, and manage aggregating reef fish resources; and (3) to raise the awareness and appreciation among stakeholders of the vulnerability of aggregating reef fish populations and associated ecosystems, the nature and significance of spawning aggregations, and options for improving management.

TARGET FISH SPECIES

The monitoring training program focused on three species of grouper (Family Serranidae). Those species observed aggregating during training exercises included the brown-marbled grouper, *Epinephelus fuscoguttatus* (Figure 1.1), squaretail coralgrouper, *Plectropomus areolatus* (Figure 1.2) and camouflage grouper, *E. polyphekadion* (Figure 1.3). Prior to underwater training, participants learned to identify the target species during reproductive and non-reproductive periods using body characteristics and color patterns. Other species aggregating and likely spawning during the same period were the Titan triggerfish, *Balistoides viridescens*, Black snapper, *Macolor niger*, Yellow-spotted trevally, *Carangoides orthogramus*, Bigeye trevally, *Caranx sexfasciatus*, and humphead wrasse, *Cheilinus undulatus*, the latter seen spawning (R. Hamilton).

Figure 1.1

Latin: *Epinephelus fuscoguttatus*
FAO: Brown-marbled grouper
Pidgin: Big Mouth
Roviana: Pazara veata

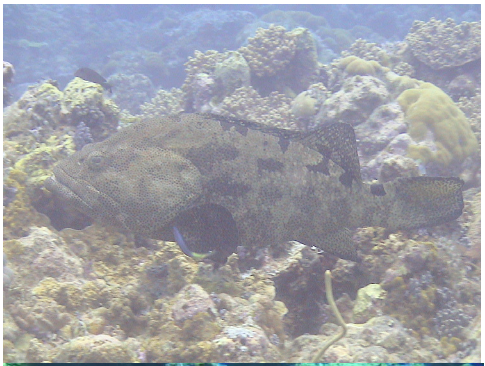

Figure 1.2

Latin: *Plectropomus areolatus*
FAO: Squaretail coralgrouper
Pidgin: Big Mouth
Roviana: Pazara haquma

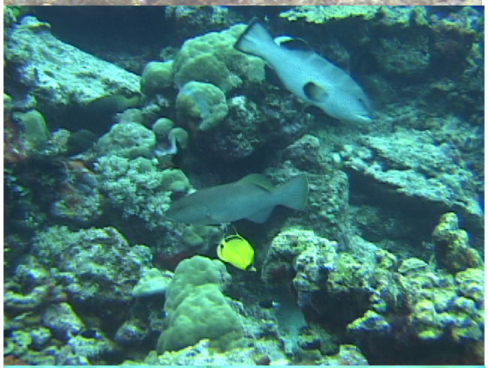

Figure 1.3

Latin: *Epinephelus polyphekadion*
FAO: camouflage grouper
Pidgin: Big Mouth
Roviana: Pazara

Figure 1: Target species for the Solomon Islands monitoring training workshop (A Smith and K Rhodes)

TRAINING SESSIONS AND MATERIALS

Workshop training sessions focused on the skills necessary to conduct basic monitoring of spawning aggregations. The skill sessions included:

1. Fish species identification
   - Still photographs
   - Plastic identification cards (SPC/TNC/IMA)
   - PowerPoint® presentations
   - Underwater video (Pohnpei and Palau)
   - Printed references (e.g. Micronesian Reef Fishes, Robert Myers; LRFFT Awareness package, SPC/TNC/IMA)

2. Spawning signs
   - Underwater video (Pohnpei and Palau)
   - PowerPoint® presentations
   - On-site training and recognition

3. Abundance counts
   - Underwater monitoring of aggregation sites
   - Classroom presentation using video

4. Site mapping: tools and techniques
   - Classroom presentations
   - Site-based mapping

WORKSHOP PARTICIPANTS

Participants from national government agencies and local non-government organizations (NGOs) participated in the workshop. Participants and their affiliations are as follows (contact details given in Appendix 1):

1. Arnavons Group-Chris Rebi, Dickson Motui, Moses Pema
2. Roviana and Vonavona Marine Resource Management and Development Program—Michael Giningele, Warren Kama, Richard Hamilton, Sunga Boso, Gumi Gadepeta
3. Solomon Islands Department of Fisheries & Marine Resources—Peter Ramohia, Peter Rex
4. Uepi Island Resort—Peter Mare, Moses Pema
5. International Waters Project—Patrick Mesia
6. Dive Gizo-Allan Soaki, Rueben Napo
7. Worldwide Fund for Nature-Tingo Leve, Alec Hughes, Joseph Tasker
8. The Nature Conservancy—Alison Green, Ferral Lasi, Willie Atu

MONITORING TRAINING AND OBSERVATIONS

At the dive training site, spawning aggregations of each of the three target species were observed: squaretail coralgrouper, camouflage grouper and brown-marbled grouper. Of the three species, the brown-marbled grouper aggregation was the most well-defined and abundant and became the primary target for workshop exercises. Initial observations of the aggregation showed brown-marbled grouper to be distributed along approximately 100 m of reef beginning at 20 m depth and continuing down to 50 m depth. The aggregation was mostly confined during initial surveys to a reef platform that sloped perpendicular to the main reef at approximately 10^o from horizontal. Camouflage grouper were sparsely distributed along a similar area during the initial workshop period (14-18 March) and the aggregation was not defined well enough to map or establish meaningful transects within it. During the final days of the workshop, the camouflage grouper aggregation was located in a well-defined space between 50 and 60 m off the edge of the platform—normally considered too deep for routine monitoring on SCUBA. Camouflage grouper were not counted at any time during the workshop and the aggregation was not mapped. Squaretail coralgrouper were widely scattered along the top of the reef in low numbers in 5-14 m of water in a loose aggregation during initial dives. By the end of the workshop the aggregation became somewhat more defined, although still difficult to map. Similar to camouflage grouper aggregations, squaretail coralgrouper were not counted and the aggregation was not properly mapped. There is no specific data on reproductive season for these three species at the training site or other nearby aggregation sites, although local knowledge places the dates around February through April. Future monitoring will require a detailed assessment of reproductive season and aggregation areas for these three species.

TRAINING SKILLS: MAPPING AND TRANSECT PLACEMENT

For the workshop training, participants began with site mapping. Site mapping began with presentations on the use of standardized protocols for monitoring. Practitioner skills training involved (1) recognizing aggregation boundaries, (2) recognizing permanent transect areas, (4) marking transect boundaries using underwater markers and (4) measuring and calculating aggregation areas based on the markers.

During the training workshop, site mapping was conducted prior to the days of peak abundance owing to time constraints to complete all skills training. (Optimally, site mapping should be initiated and completed during the days of maximum abundance for each individual species.) Accordingly, the total areas for the brown-marbled grouper aggregation was calculated as approximate for the purpose of estimating total abundance. To initiate mapping, trainees were instructed on the use of float lines to delineate the aggregation boundaries. Using string tied to water bottles (as floats), trainees located aggregation boundaries underwater and sent float lines to the surface to gain a general impression of the aggregation shape. Following this exercise, trainees discussed and agreed that the aggregation appeared to be located along the reef platform in the general shape of a triangle. On a subsequent dive, trainees the measured the lengths of each 'leg' of the aggregation using an underwater tape measure. The brown-marbled grouper aggregation was triangular in shape with a linear distance along the top (20 m depth) of 75 m. The length along the middle of the aggregation (top-to-bottom) was 50 m (Figure 2). Based on these measurements and using the equation for the area of a triangle (base x height/2), with the base is 75 m and the height is 50 m, the area of the aggregation was estimated to be 1,875 m^2.

The second mapping exercise was to determine optimal locations for transect placement. Following group discussions on the general layout of the aggregation, trainees decided two transects would be needed to accurately characterize the aggregation and measure abundance. Trainees decided on placing the two 50 m X 10 m (500 m^2) transects within the aggregation—one at 25 m depth and a second at 35 m depth for a total monitoring area of 1,000 m^2, or slightly more than half the entire aggregation area. Divers initially used the vinyl measuring tape as the centerline of the transect and placed concrete rebar along the length. Subsequently, to identify transect boundaries, plastic surveyor's tape was placed exactly 5 m along both sides out from the centerline and float lines marked the beginning and end of each transect. A diagrammatic representation of the transects are shown in Figure 3.

TRAINING SKILLS: ABUNDANCE COUNTS

Upon completion of transect placement and site mapping exercises, trainees learned to perform abundance counts on brown-marbled grouper, based on the two transects placed within the aggregation. Trainees were familiarized with simple methods for counting fish in large aggregations using group counts of 1, 5, 10, 20 or 50 individuals. Participants were also familiarized with the changes in abundance that occur within aggregations daily, weekly, monthly and yearly and an exercise was performed to show the manner in which diurnal differences may occur (Figure 6).

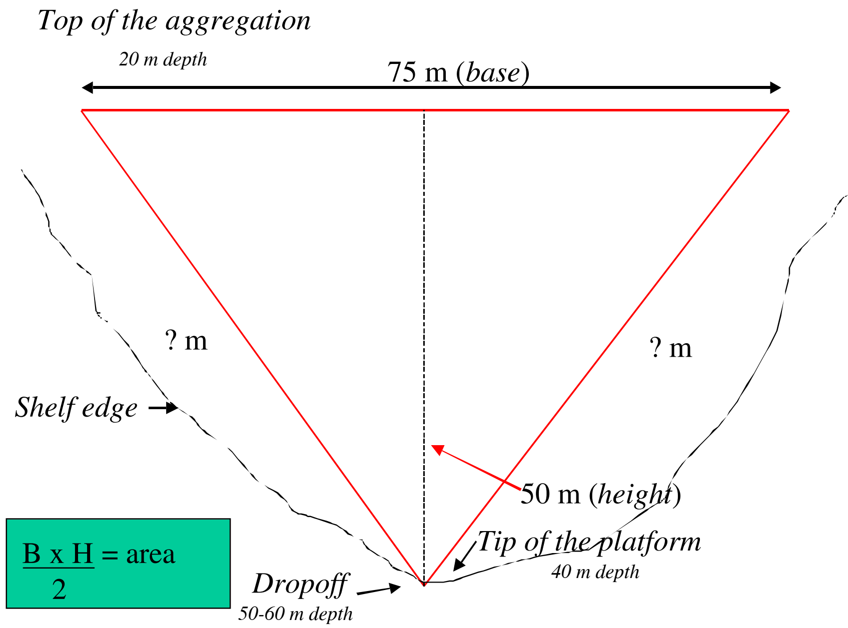

Figure 2: Diagrammatic sketch of the brown-marbled grouper aggregation at the aggregation site on Day 3 of the workshop (top view). Formula is for the area of triangle, where B=base (75 m) and H=height (50 m)

Abundance counts varied by individual (Figure 4) during initial exercises, but became more consistent by the end of the workshop. The graph shows the importance of diver training prior to monitoring to gain consistency in counts among monitors.

Figure 5 shows abundance trends for brown-marbled grouper during the period of the workshop A typical abundance profile was observed for brown-marbled grouper, whereby increases occur leading up to spawning. It is noteworthy that no gravid females were observed during the final day of the workshop and that fish were still present at the site the day following the workshop. The abundance decline seen on 21 March was likely anomaly associated with the morning count that was conducted that day, whereas previous counts were made in late afternoon. Spawning in brown-marbled grouper likely occurred during the evenings following the workshop (i.e. 22 March onward).

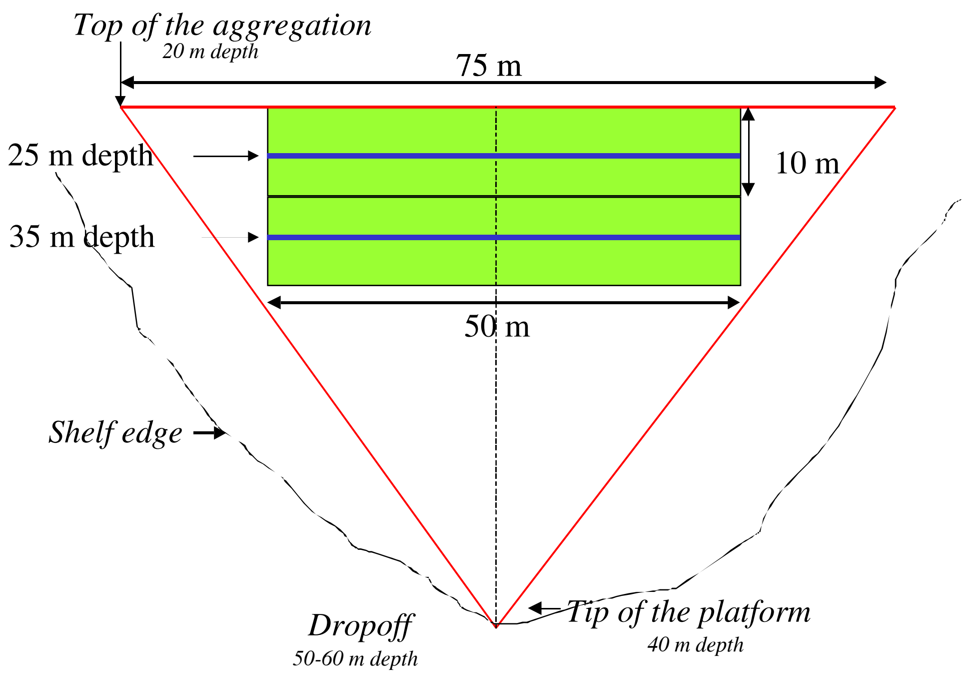

Figure 3: Diagrammatic representation of the placement, location and area covered by transects at the aggregation site during training exercises

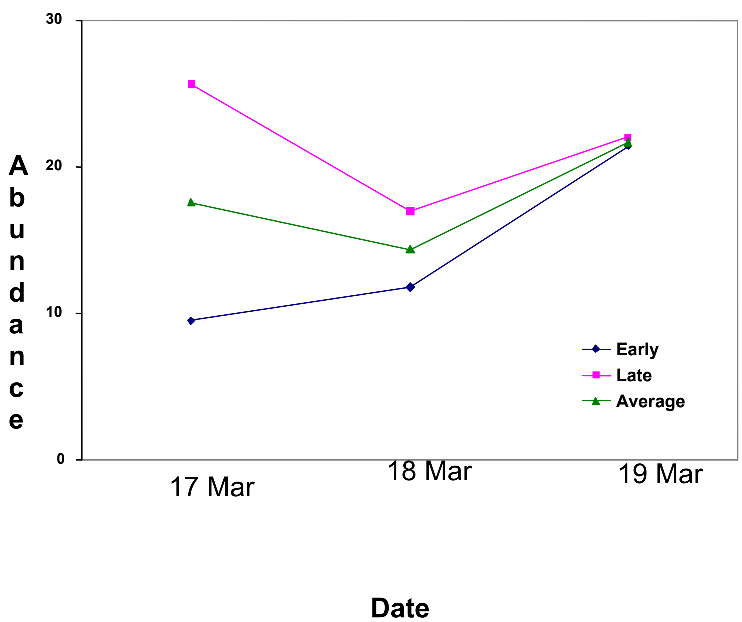

Figure 4: Results of early and late afternoon counts of brown-marbled grouper to demonstrate diurnal differences in abundance within aggregations

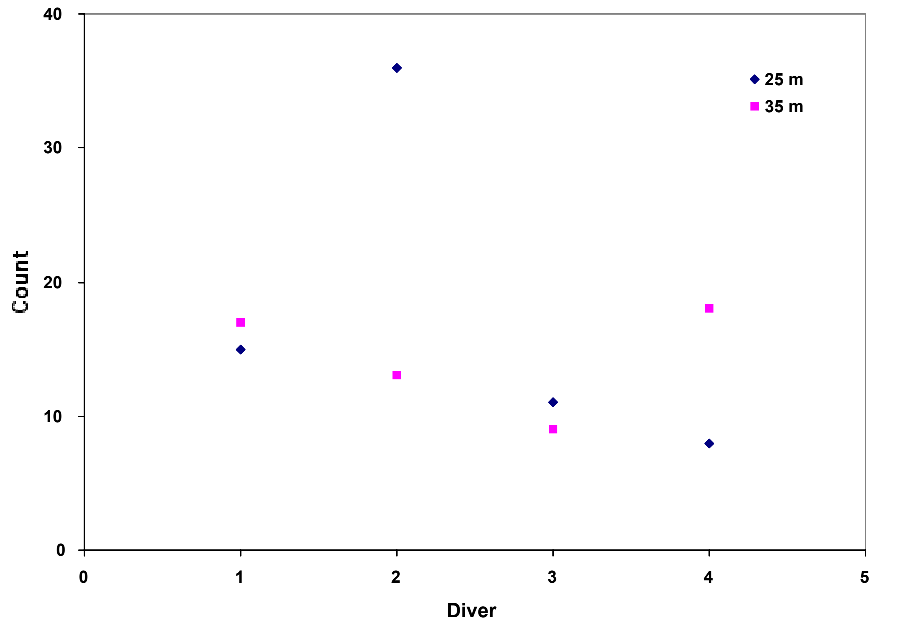

Figure 5: Representative dive counts showing variation among divers on Day 1 of the training

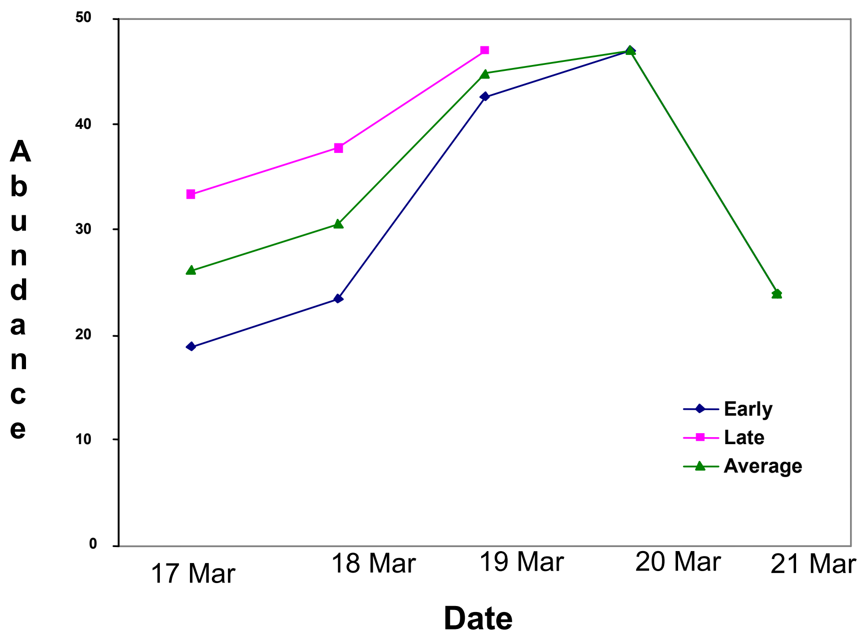

Figure 6: Abundance data trends for brown-marbled grouper taken from counts by participants at the aggregation site

TRAINING SKILLS: SPAWNING SIGNS AND BEHAVIOR ASSOCIATED WITH AGGREGATIONS

During the workshop, trainees learned to observe and record spawning signs and behaviors associated with aggregations. Within aggregations, color change (Figure 7), bite marks, courtship and aggression were observed for brown-marbled grouper. Gravid females were not observed. Observations for camouflage grouper and squaretail coralgrouper were incidental, but trainees reported witnessing color change and aggression in squaretail coralgrouper during the workshop. Gravid female coralgrouper were observed at a separate aggregation site on 22 March, 2 days after new moon, when spawning likely occurred.

Figure 7: Color change in a male brown-marbled grouper (Palau). (A Smith)

OBSERVATIONS: DISTRIBUTION, DENSITY AND ABUNDANCE

At the training site, distribution, density and abundance of brown-marbled grouper varied daily, as did camouflage grouper and squaretail coralgrouper. Initial observations showed brown-marbled grouper to be distributed from approximately 20 to 50 m depth on a reef platform that extended from the top of the reef seaward and down the slope past the platform. As the new moon approached, brown-marbled grouper distribution was extended to include areas above the platform to depths as shallow as 10 m. In addition, the aggregation was extended away from the platform northward for at least another 100 m, such that the aggregation area was approximately 2.5 times larger than that initially estimated (1,875 m^2), or approximately 5,000 m^2. As such, future monitoring should include these areas and consider using longer transects (e.g. 100-200 m)

RECOMMENDATIONS AND COMMENTS BASED ON FINDINGS

Monitoring spawning aggregation sites is an important component of effective marine resource management, particularly for documenting the effects of aggregation fishing and management effectiveness. Aggregations are site-specific and are typically comprised of a substantial portion of the total number of fish spawning within the local population. Formation of these aggregations is typically brief, e.g., 1-2 weeks over only a few months and around particular lunar phases. The loss of these aggregations from overfishing can have severe negative effects on local and regional populations, as well as the local communities that depend on these resources for food and income.

MONITORING

Investigations of abundance and distribution of spawning aggregations at the aggregation site can provide invaluable data for management and conservation of aggregating grouper (*Epinephelus polyphekadion*, *E. fuscoguttatus*, *P. areolatus*) and other species. Given the apparent small size (~ few hundred individuals per species) and close proximity to Gizo and other nearby villages, the aggregations are highly vulnerable to rapid overexploitation. For the same reasons, these aggregations should be easier to monitor and manage. The following points provide recommended steps to properly manage and monitor these spawning aggregations of grouper.

Determination of reproductive season and peak abundance periods within months

For the training site and any other local aggregations, any monitoring program must first establish the reproductive season for the species of interest. Knowledge on the reproductive season is necessary to: (1) be able to assess and compare changes within the aggregation in terms of abundance, area and length of individuals (if a goal) across time (e.g. year-to-year); (2) to determine the optimal times/months to monitor, particularly if monitoring activities are limited to only one-to a few months, and; (3) carefully manage monitoring resources, such as personnel, funding and time available. For example, reproductive seasons may be long (such as every month of the year), but periods of peak abundance may be only 3-4 consecutive months of the year. If funding is only available for 3-4 months, or even a single month, knowing the period of peak abundance provides monitors with the best possible information on when to monitor and collect the best possible data for comparisons. Also, since most of the fish within the population are probably present in those 3-4 months, changes to the population from fishing (for example) would best be determined by monitoring during those times.

At the training site, the area of the aggregation is now known and aggregations appear to be cued to new moon periods. Peak abundance for brown-marbled grouper (and probably others) was also during new moon, with spawning likely occurring just past new moon and possibly over a few days. Therefore, for the first year, monitors should be checking the site at new moon (during the late afternoon) every month to determine the spawning season. A similar pattern likely exists for the second nearby aggregation site visited.

Knowing the timing of the reproductive season will also be useful if the local government decides to implement a closed season for these groupers around the spawning season or during peak periods of reproduction. Without this information, seasonal closures are likely much less effective for management and conservation of the species.

Determine aggregation areas for brown-marbled grouper and other species

As discussed during the workshop, mapping is the first step toward establishing a meaningful monitoring plan. Since mapping exercises were conducted early in the workshop and the aggregation subsequently expanded to include a much larger area, monitors should allot additional time during peak aggregation months to establish the aggregation areas and decide where and how many transects should be placed within each species aggregation, remembering that transects should be placed within both high density and low density areas so as not to overestimate or underestimate abundance. More importantly, transects should be placed in areas safe for repetitive diving, i.e. less than 40 m depth. If aggregations, such as those of camouflage grouper, are greater than this depth, they should not be included in a monitoring plan.

Decide on a focus for monitoring

Monitoring should focus on key species that are vulnerable to exploitation from overfishing. The monitoring program should decide beforehand which species are vulnerable and which are important to local communities. For example, if most fishers target squaretail coralgrouper, but not brown-marbled grouper, monitors may decide to focus only on squaretail coralgrouper, thereby saving time, money and effort. In addition to determining the importance of which species to monitor, monitors should also consider which site to monitor. If resources allow for only one site to be investigated, focus on the site most vulnerable. If monitors have the resources for two sites, perhaps monitoring a fished site as well as an unfished site would be a good option for comparison. Ultimately, monitors will have to decide what is important for the local community and what objectives are trying to be met, for example, to show the impacts of fishing or the benefits of a marine protected area.

APPENDICES

APPENDIX 1: Workshop Participants' Contact Information

Name	Agency	Contact Address
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