Status Report
World's Fish Aggregations 2014

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Report by Science and Conservation of Fish Aggregations (SCRFA) in collaboration with the ICRI Ad Hoc Committee for Reef Associated Fisheries

Photo: Richard Barnden Photography. Red snapper aggregating to spawn in Palau.

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Executive Summary

Many coral reef fish species that have long been important for food and livelihoods reproduce by gathering in large, concentrated and predictable spawning aggregations. Particularly over the last two decades, these have become the target of expanding fishing pressure. Yet we are only recently beginning to understand their value to coral reef health, fishing communities and their vulnerability to fishing.

An analysis of 888 records of fish spawning aggregations for over 200 species from 44 families in 52 countries has revealed important information for science and management of fish aggregations and the fisheries they support. The records are maintained in a global web-based database managed by *Science and Conservation of Fish Aggregations* (SCRFA).

Currently over a quarter of the records show a declining trend in numbers of fish aggregating, and alarmingly 4% are documented as having disappeared entirely. Despite the limited information available on the level of management and monitoring of these aggregations, current information suggests that only about 35% have some form of management in place such as marine protected areas or seasonal protection from fishing, and only about 25% have some form of monitoring. Four case studies on the effectiveness of management of aggregations are provided for red hind in the tropical western Atlantic, square-tailed coral grouper in Melanesia, three species of grouper in Palau and Pohnpei, and white seabass in eastern Pacific.

This *Status Report* provides the current status based on the best available information for fish spawning aggregations globally. Additional records are needed on a range of species from more locations around the world to further understand aggregating species and exploitation of aggregations.

Introduction

At the 2013 ICRI General Meeting in Belize City, the ICRI Ad Hoc Committee on Coral Reef Associated Fisheries identified several key activities focussed on ensuring that fish aggregations are routinely considered in coral reef management planning. One output from these activities is a status report on the information currently available on fish aggregations globally.

This *Status Report – World's Fish Aggregations 2014* has been produced from information compiled and publicly available on-line in the *SCRFA Fish Aggregation Database*. The objective of this Report is to show the current state of knowledge and status of fish aggregations, to raise awareness about science and management of fish aggregations, and to demonstrate the urgent need to ensure that fish aggregations are included in coral reef management planning.

Dissemination of this Report will help engage countries and organisations in key issues about fish aggregations. This Report encourages workers to contribute information to the SCRFA Database, filling data gaps on fish aggregations globally concerning their status, management and relevant traditional knowledge. We also highlight the need for further research on fish aggregation locations and seasons to improve knowledge of their role in fisheries and explore means to protect them to contribute to the sustainability of fisheries that focus on aggregating species.

Comprehensive information about fish aggregations, including references, educational materials, short films and the SCRFA Database can be found at www.SCRFA.org. A recent and highly relevant publication on fish aggregation science and management is a book entitled *Reef Fish Spawning Aggregations: Biology, Research and Management*, by Sadovy de Mitcheson, Y. and Colin, P.L. (Eds.), published in 2012 in the Fish & Fisheries Series by Springer Science & Business Media.

What are Fish Spawning Aggregations?

A fish spawning aggregation is a grouping of a single species of fish that has gathered together in greater densities than during non-spawning times, with the specific purpose of reproducing. Typically such aggregations form at the same place(s) at approximately the same time(s) each year.

The timing of aggregation for a particular species at a particular location tends to be consistent, which makes them predictable; once they have been discovered, the aggregations are easy to find again at the same time(s) and place(s) each year. This can be a serious problem when fishing is not controlled and fishing effort too high to be sustained. For example, many spawning aggregations of the Nassau grouper (*Epinephelus striatus*) in the Caribbean have decreased or been eliminated largely, scientists believe, as a result of uncontrolled fishing on the aggregations. The declining population status of this species throughout its range led to it being included on the IUCN Red List of threatened flora and fauna in 2003 (Cornish and Eklund, 2003), and it is the first commercial reef fish being considered for the United States Endangered Species List. In response, the Western Central Atlantic Fishery Commission is developing a regional plan for management and conservation of fish species that aggregate to spawn, in particular the Nassau grouper.

The best-known examples of reef fish aggregations are for species of Epinephelidae (groupers) and Lutjanidae (snappers), but many Acanthuridae (surgeonfishes), Siganidae (rabbitfishes), Scaridae (parrotfishes), Labridae (wrasses) and other species also aggregate to spawn. There is a great deal of variability among different species in the dynamics of aggregation formation. For instance, spawning aggregations of some small wrasses may consist of just ten individuals travelling short distances from their home ranges to spawning sites (resident aggregations). At the other end of the spectrum, some snappers and large groupers such as two-spot red snapper (*Lutjanus bohar*) and goliath grouper (*Epinephelus itajara*), (Fig 1) may travel tens to hundreds of kilometres to form aggregations of hundreds to thousands of fish (transient aggregations)

at specific sites. The coral grouper (*Plectropomus leopardus*) is somewhere between these two extremes, and typically forms many small aggregations of up to a few hundred fish during the spawning season. Surgeonfishes, rabbitfishes and emperors (Lethrinidae) are known to gather in their thousands, while humphead wrasse (*Cheilinus undulatus*) form small groups of a few to hundreds of fish at most.

(a) *Photo: Tony Wu* (b) *Photo: Walt Sterns*

Fig 1. (a) Two spot red snapper aggregating to spawn in Palau, and (b) goliath grouper aggregating to spawn in Florida.

The duration of a spawning aggregation, or the number of times a species aggregates during its annual spawning season, varies markedly across species and also to some extent geographically. Some parrotfishes, surgeonfishes and small species of wrasse aggregate almost daily, or at least regularly, according to the lunar cycle for many months of the year. At the other extreme, certain large groupers such as the Nassau grouper in the Caribbean, and the Indo-Pacific tiger grouper (*E. fuscoguttatus*), aggregate for about a week in each of a few consecutive months annually. There is also variation apparent even within species. The camouflage grouper (*E. polyphekadion*), for example, shows regional variability, forming a few large aggregations in a region, but at different lunar phases in different regions.

Different species associate with different habitat types under a range of oceanographic conditions. In the Indo-Pacific, for example, several species of grouper aggregate in distinct tide-influenced channels that pass through outer reefs leading to the open ocean. Humphead wrasse form smaller aggregations at multiple locations along outer reef slopes with spawning occurring according to tidal cycles. For some species, especially in the tropical western Atlantic, prominent features along outer reef slopes such as promontories are used as spawning sites.

Certain fishes, like rabbitfishes and mullets (Mugilidae) spawn in coastal/lagoon areas after migrating in large numbers along the coast, while fishes like the coral trout assemble on their resident reefs on reef slopes, channels and promontories. Scientists do not know why there is such a diversity of spawning sites and why different species select one over another, although many hypotheses have been proposed.

Management Challenges

Fishing aggregations is a challenge for fisheries managers because these concentrations of fish make it much easier for fishers to catch greater numbers than at other times of the year when the fish are not aggregated. Fishers typically discover aggregations before researchers and fishery officers do and, in most areas, controls on fishing are slow to implement and difficult to enforce. If too many fish are removed, aggregations may cease to form and this can happen within a few years of discovery; there is no evidence that aggregations, once decimated, can reform. This is possibly because young fish learn from older fish where to spawn, and if few or no older fish remain, that knowledge is lost. Such 'cultural' transmission of information has been experimentally demonstrated in relation to fish migration routes, so is certainly a possibility. It is also possible that fishing aggregations can disrupt reproductive behaviour of the fish, as has been shown

in cod (Gadidae). Most importantly, the loss of spawning aggregations seriously compromises reproduction, which leads to loss of important and valuable fisheries, and affects the health and resilience of coral reefs.

A key example of a once massive aggregation that was fished to extinction is at Cat Cay in the Bahamas. In 1971, C. Lavett-Smith was told about this site by local fishers and observed a single aggregation of Nassau grouper that he estimated to contain between 30,000 – 100,000 fish. He was one of the first scientists to document a spawning aggregation in the water. People had fished this aggregation for decades and when only a few fishers were involved, annual catches were evidently sustained. However, once the number of fishers increased, and in the absence of management, the aggregation was fished to extinction. SCRFA re-surveyed the site and interviewed local fishers in 2013, sadly determining that the aggregation no longer exists, and its status is now classed as "Gone".

Although there is currently a lack of effective management globally for aggregations, there has been progress by governments and conservation groups towards better management. For example, seasonal bans on fishing for a variety of groupers have been established in Bermuda, Bahamas, Brazil, Mexico, Palau, Philippines and United States. Catching and selling groupers and/or snappers during their reproductive season is prohibited in several countries including the Bahamas, Puerto Rico and US Virgin Islands. Some spawning sites for groupers and snappers have been declared as marine reserves in an increasing number of locations, including Australia, Belize, Cayman Islands, Melanesia, Palau, Pohnpei, Puerto Rico and US Virgin Islands. We have selected four of the above examples as management case studies (Appendix 1): 1) red hind - tropical western Atlantic; 2) square-tailed coral grouper – Melanesia; 3) square-tailed coral grouper, camouflage grouper and brown marbled grouper – Palau and Pohnpei; and 4) white seabass - eastern Pacific.

SCRFA's Fish Aggregation Database

SCRFA's Fish Aggregation Database holds extensive information on the world's fish aggregations, including spatial and temporal characteristics and the current status according to published and unpublished literature, natural history accounts, traditional knowledge and field research. The Database currently holds 888 records for over 200 species of fish from 44 fish families in 52 countries. Most records are for Epinephelidae (groupers) and Lutjanidae (snappers), with other families that contain several aggregating species being Carangidae, Acanthuridae, Siganidae, Labridae, and Scaridae.

Each record in the Database is for one species at one aggregation site. Hence, if an aggregation site is used by multiple species, each species has a separate record. The Database contains key parameters describing the characteristics of an aggregation including location, habitat, lunar and solar phase, fishing gear used, status, management and monitoring.

The Database is publically available on-line, provides an important baseline of current knowledge, and is available for query, reference and additions. The Database establishes a basis for planning, education and research, and for identifying conservation and management needs. We continue to supplement the Database with new records and updated information. Although general aggregation site locations can be viewed per country or using a GIS interface (1 degree grid), detailed site-specific data are not made publicly available to protect sites from additional exploitation and respect confidentiality of traditional knowledge.

Status of the World's Fish Aggregations

There are five status categories for aggregation records in the Database: *unknown, decreasing, gone, increasing*, and *same*. Fig 2 shows the number of records and the status of aggregations for each of the 52 countries. For most of the records the status is unknown. However, and alarmingly, many for which status is known are decreasing, and 4% are documented as having disappeared entirely. To date, we have limited information on the level of management and monitoring, if any, of these aggregations. From these records, we understand that about 35% have some form of management in place such as marine protected areas, seasonal protection from fishing and/or sale, or fisheries harvest controls, and about 25% have some form of monitoring, such as fish counts.

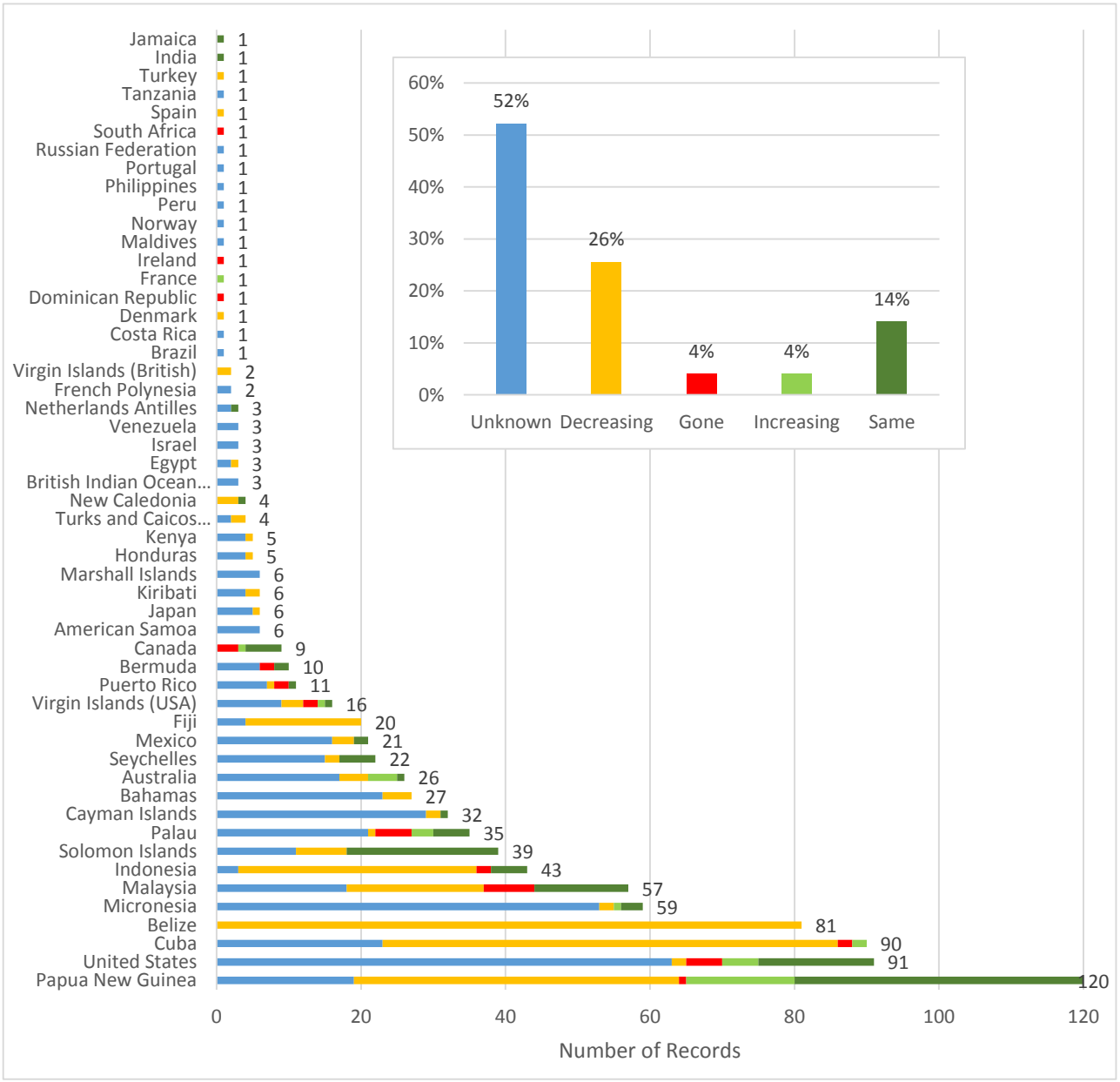

Fig 2. Status of spawning aggregations based on the SCRFA Database (888 records, 52 countries). Each bar indicates the number of records per country and current status. The insert graph shows the combined status of the world's fish aggregations.

Two families dominate the Database; Epinephelidae (groupers) and Lutjanidae (snappers). For each family the current status is shown in Fig 3, with both families showing a similar trend. Almost half of the records have an "unknown" status, about a third of the records show a "decreasing" status, and 5% of the grouper aggregations are recorded as "gone".

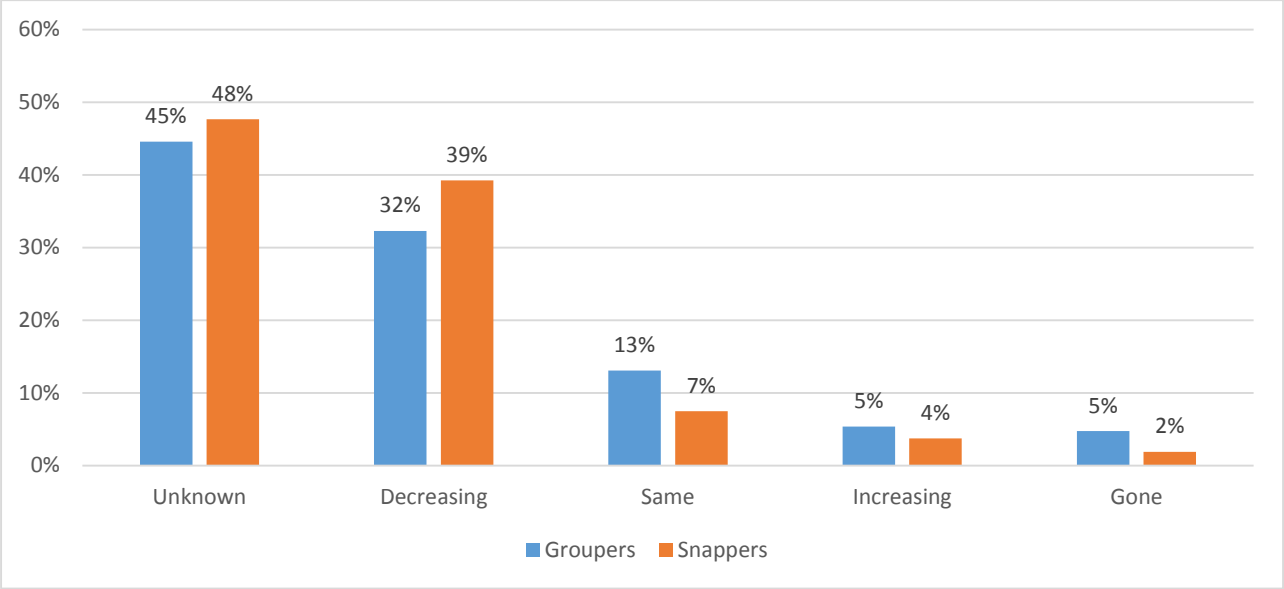

Fig 3. The current status of the world's grouper and snapper aggregations.

Combined for all countries, there are also identifiable trends on when groupers and snappers aggregate. Current information suggests that most aggregations reach their maximum numbers around the full moon at dusk, although this varies regionally. The new moon is more often associated with spawning for many grouper species than for snappers, while snappers are more often known to spawn at night (Fig 4). However, the data are somewhat influenced by high numbers of records of a few species, such as Nassau grouper, and the Database should be referred to regionally by workers interested in further details.

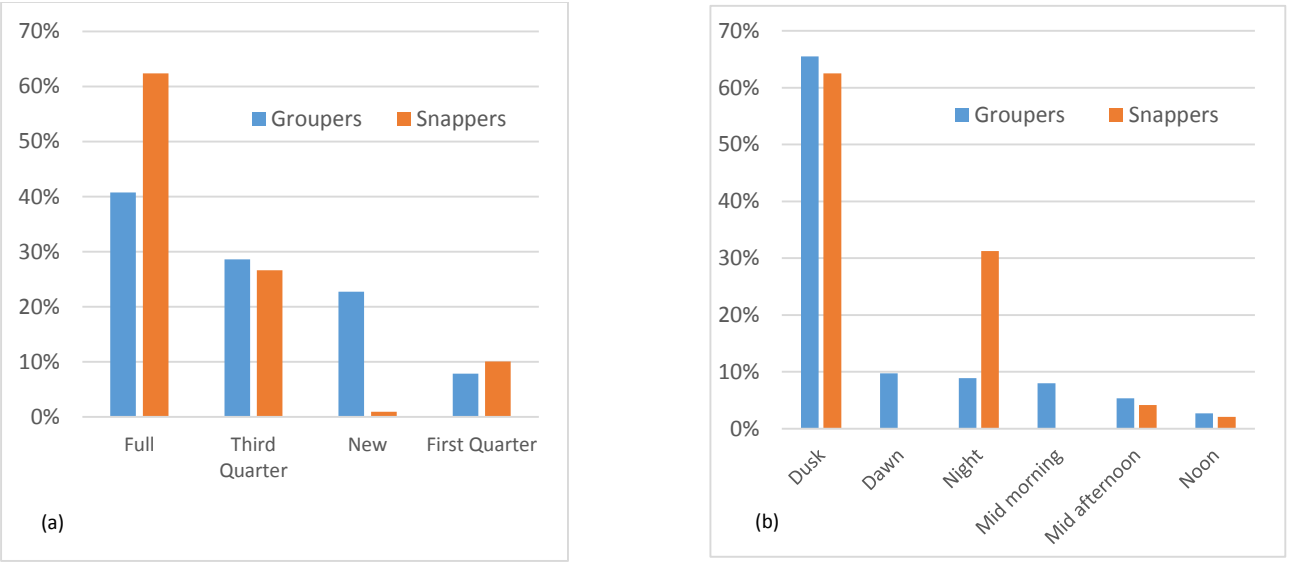

Fig 4. (a) Lunar phase and (b) solar phase associations for grouper and snapper aggregations.

Looking at the data across all countries, groupers and snappers generally aggregate in similar geomorphic habitats such as reef promontories, outer reef slopes (more often recorded for snappers) and drop offs. Reef channels are only recorded for groupers. Further analysis of the data may reveal variation across geographic regions.

The most common type of fishing gear used to target grouper and snapper aggregations is hook and line. Trawling is also used to target snapper aggregations, but not grouper aggregations. Fish traps and spears are used to target both fish families (Fig 5).

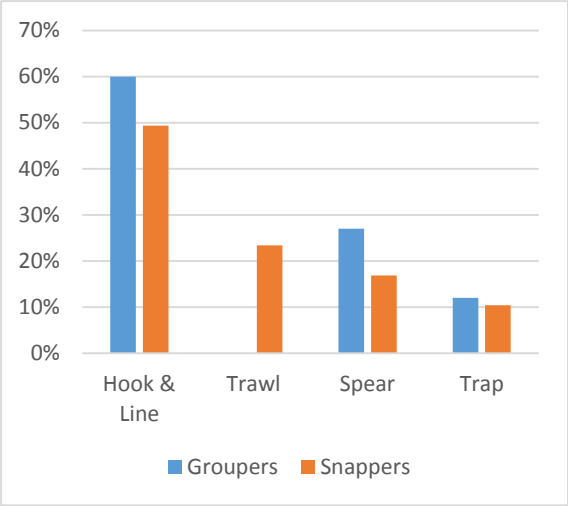

Fig 5. Fishing gears used to target grouper and snapper aggregations.

Conclusions

Current information, based largely on exploited aggregations and predominantly reflecting reef fishes, especially groupers and snappers, suggests that over a quarter of the world's known fish aggregations (mainly coral reef species) recorded in the SCRFA Database are decreasing and some have actually disappeared. Since these life history events are the only time that many fish species reproduce, it is imperative that action be taken to halt the decline and allow aggregating species to recover their former numbers. Spawning aggregations should be included in fisheries and conservation management planning as a matter of priority.

Appropriate management is needed globally to reduce and control the amount of fishing on aggregations so they can be sustained and thereby sustain many important fisheries, and help ensure healthy and resilient coral reefs. In general, records show that once subsistence fishing of aggregations changes to commercial use, the aggregations should be entirely protected and viewed as sources to help produce and ensure a sustainable fishery. The type of management needed will vary among countries and species, depending on the severity of exploitation, the local social and economic contexts and the fishing gears used. The removal of small numbers of fish may be sustainable in subsistence fisheries but, in most cases, experience has shown that fishing on aggregations even at low levels of fishing effort, requires management.

Addition of information and updates of records in the SCRFA Database on a range of species from more locations around the world would help us to further understand the dynamics, uses and conditions of aggregations. When sufficient additional information is gathered, it is proposed that an updated status report be produced to help inform and guide the better protection and management of these valuable biological events. We encourage contributions to our collective understanding by investigating aggregations and entering data into the SCRFA Database.

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A comprehensive list of relevant references can be found at:
www.scrfa.org/about-aggregations/publications.html

Appendix 1. Fish Aggregation Management Case Studies

Case Study 1

Red hind *Epinephelus guttatus* (grouper) – Tropical Western Atlantic

Brian E Luckhurst[5] and Richard S Nemeth[6]

Issue - During the mid-1970s to 1980s, throughout most of the Caribbean a rapid decline in red hind landings was documented primarily as a result of heavy fishing pressure at spawning aggregation sites. Fishers asked for protective legislation.

Response - In Bermuda (1974), and US Virgin Islands (St. Thomas and St. Croix, 1990's), seasonally protected areas were implemented at aggregation sites. Fishing gear was limited to hook and line only in Bermuda, and a permanent closed area was established at St. Thomas.

Outcome - Landings of red hind in Bermuda stabilized, and landings in St. Thomas increased following protection. In both Bermuda and St. Thomas, mean size and abundance of red hind increased significantly, and there has been a sustainable fishery for this species for the past few decades. In contrast, the St. Croix aggregation has continued to decline due to poaching.

Prognosis - Very good for Bermuda and St. Thomas. The protection of spawning aggregations and limiting fishing to hook and line only is resulting in a high probability of maintaining a sustainable fishery. Lack of enforcement in St. Croix is likely to result in a continued red hind population decline.

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Case Study 2

Square-tailed coral grouper *Plectropomus areolatus* (grouper) – Melanesia

Richard Hamilton[4]

Issue - Heavily fished throughout Melanesia by small-scale commercial spear fishers who target aggregation sites at night using underwater flashlights. The shallow-water distribution of this species makes it particularly vulnerable to night spearfishing and widespread declines in many locations.

Response - Community-based MPAs implemented at several sites in Melanesia to reverse declining aggregation numbers of this species.

Outcome - Although aggregation numbers have increased in some locations, marked improvements have not been seen at most managed and monitored sites. Ongoing poaching by night spear fishers is believed to be the main reason for limited recovery at many sites.

Prognosis - This is a relatively fast growing species with limited larval dispersal and a prolonged spawning season in Melanesia; therefore aggregations should recover quickly if enforcement is effective. The prognosis for these aggregations and the fisheries they support would be improved if bans on selling or purchasing this species in the 10 days prior to and including the new moon spawning periods were enforced.

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Case Study 3

Square-tailed coral grouper *Plectropomus areolatus*, **camouflage grouper** *Epinephelus polyphekadion,* and **brown marbled grouper** *Epinephelus fuscoguttatus* – Palau and Pohnpei

Yvonne Sadovy[2] and Richard S Nemeth[6]

Issue – Over the past few decades, in western Palau, according to fisher interview, and Pohnpei Micronesia there have been marked declines in landings of the square-tailed coral grouper (*Plectropomus areolatus),* camouflage grouper (*Epinephelus polyphekadion*) and brown marbled grouper (*Epinephelus fuscoguttatus*).

Response – Seasonal closures to fishing were introduced for most months that aggregation and spawning occurs, and both the Palau (Ebiil since 2000) and Pohnpei (Kehpara) spawning sites are within MPAs. However, enforcement in Ebiil was minimal to begin with and poaching occurred, but in the last 5 years it was much improved due to improved funding for at-sea patrols, and an additional month was included in the seasonal closure. In contrast, relaxation of enforcement in Kehpara Marine Sanctuary, Pohnpei has occurred over the past 10 years.

Outcome - The square-tailed coral grouper at Ebiil has shown a clear increase in numbers over a 5-year period (2009-2014). The numbers of the other two groupers at the Ebiil site remained stable. The relatively faster life cycle of square-tailed coral grouper likely explains this quicker recovery. Limited enforcement in Pohnpei most likely contributed to increased poaching by night-time spear fishers and declines in spawning populations of all three species, in particular square-tailed coral grouper at shallow depths.

Prognosis - Excellent in Palau if regular effective enforcement at all hours of the day continues at Ebiil. In Pohnpei, improvements in enforcement and management will be needed to reverse declining trends.

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Case Study 4

White Seabass *Atractoscion nobilis* (croaker) - Eastern Pacific

Brad Erisman[3]

Issue – One of the most prized fishes by recreational and commercial fishers in California for nearly a century, landings reached historically low levels by the 1980s (i.e. 10% of historical catch) due to overfishing. The coastal gill net fishery, which targeted spawning aggregations of white seabass during the spring and summer months, is viewed as a major driver of the decline.

Response – In 1994, regulations were passed in California that prohibited the setting of gill nets in state waters (< 3 miles from coast and <1 mile from the Channel Islands). In 2002, fishing became restricted during a portion of the spawning season in Southern California, from March 15 to June 15.

Outcome – White seabass populations and landings by the commercial and recreational fisheries have all increased steadily since the late 90s in response to management regulations that protected near-shore spawning aggregations. Enforcement of and compliance with regulations have been successful.

Prognosis – The regional stock is considered healthy, the fishery is considered stable, a comprehensive management plan now regulates the fishery, and a formal stock assessment that includes a focus on the management of aggregations is in progress.

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