
Photo: David Fairclough

Pink snapper – see p. 11


Photo: Stan Shea

Ripe camouflage grouper in Fiji – see p. 12


Photo: Stan Shea

SCRFA

SOCIETY FOR THE CONSERVATION OF REEF FISH AGGREGATIONS

NEWSLETTER 15 • OCTOBER 2011

BREAKING NEWS

Fisheries collapse calls for urgent management for bass in California (p. 9)

Gladden Spit fighting for survival (p. 5)

Fiji ponders major management initiatives for coastal fisheries (p. 12)

CONTENTS

WORDS *from the chair*

The impacts we are having on our oceans are ever more apparent, with growing awareness of increasing fishing pressure on diminishing marine resources. However, I suspect that even though some people are aware of these impacts, the urgent need to address unsustainable fishing pressure, especially on vulnerable life history events like spawning aggregations, is not widely appreciated. Certainly proactive management is rarely practiced.

So what can we do? SCRFA is but one of many NGOs working on aspects of the global overfishing crisis and the massive challenge that we face to ensure sustainable practices. We focus on fish spawning aggregations because these reproductive events are critically important for fish population regeneration, support many important fisheries, are little managed and are disappearing quickly. They are also easy to understand and appreciate. Our work is not about lobbying, but rather we aim to understand this fascinating aspect of the life history of many species of fish, and package information in a way that is easy to appreciate by local communities, marine users, scientists, government authorities, and others. To build a better and wider understanding of reef fish spawning aggregations and their key role in fisheries and the marine ecosystem we also participate in international forums in the belief that knowledge of the significance, and beauty of these wildlife spectacles, will lead to their stewardship and conservation.

This newsletter is just one aspect of our many initiatives to broadcast far and wide the latest news on fish spawning aggregations from around the world. You will find work highlighting the vulnerability of aggregations and the need for their management, unravelling the secrets of aggregating species, and providing insights into the many challenges we continue to face.

Martin Russell
Chair/CEO, SCRFA

SCRFA *update*

Our work continues to focus on research and education with the aim of having aggregation protection become a standard of fishery management and conservation planning. Despite much improved awareness of the problems faced by many aggregating species, few today are effectively managed or their aggregations incorporated systematically into marine protected areas or into ecosystem planning. Our membership of the International Coral Reef Initiative (ICRI) has been an important part of our work over the past year. At the 25th General Meeting of ICRI meeting on 8-12 November 2010, in Apia, Samoa, the Ad Hoc Committee on 'Coral Reef Associated Fisheries' prepared an Advisory paper on "the importance of a sustainable management of coral reef spawning aggregations" for submission to the 7th Secretariat of the Pacific Community (SPC) Heads of Fisheries Meeting in New Caledonia earlier this year. The paper was presented by Dr. Eric Clua of the Coral Reef Initiative of the South Pacific (CRISP) on behalf of ICRI and SCRFA and was well-received (See: http://www.spc.int/fame/en/component/content/article/82-seventh-spc-heads-of-fisheries-meeting-working paper number 7 - WP7). Fishery heads are interested to learn more about their spawning aggregations in collaboration with SPC.

Two film projects have enabled us to get the word out on spawning aggregations to a wider public. In Palau, we worked with Roll'em Productions to produce a film entitled 'Fish for the Future'. It is a story of the reef fishery history and current condition in Palau and how spawning aggregations fit into the picture. It was released in November 2010 and intended to raise awareness about the precarious state of the coastal fishery in the country. Earlier this year, Dr. Clua (CRISP) invited my participation in a documentary on spawning aggregations. The film has some great spawning footage and will be available shortly. We hope it will reach a wide section of the general public. (See SPC Fisheries Newsletter: http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/135/FishNews135_16_Sadovy.pdf.)

Over the last year we have continued collaborations in Fiji, Belize, and The Bahamas. Our research results from our project with the Fiji Fisheries Research Division at the Naiqoro Passage marine protected area spawning aggregation in Kadavu are very encouraging and provide a good baseline for understanding this site (see article below). In Belize I am working with the Wildlife Conservation Society on a protocol for Nassau grouper aggregation monitoring. This involves trips (see article below) to Belize and a great chance to see Nassau groupers spawning again. It is also a pleasure to see in practice the work of the Belize Spawning Aggregation Working Group which has been very successful in generating multi-sector support for protective measures for this and several other species. In The Bahamas, I am working with University of British Columbia fishery expert Dr. William Cheung and staff from the Bahamas Fishery Department on a fishery model to assess the status of Nassau grouper in the country, with funding from the Caribbean Fishery Management Council. The model makes use of fishery data and fisher interviews and is a follow-up to an interview training workshop I conducted in Nassau in 2009.

For release in November, 2011, is the first book dedicated completely to aggregations, entitled "Reef Fish Spawning Aggregations: Biology, Research and Management" (eds. myself and Patrick L. Colin) due out next month. (<http://www.springer.com/life+sciences/animal+sciences/book/978-94-007-1979-8>http://www.springer.com/life+sciences/animal+sciences/book/978-94-007-1979-8). We hope that the book will raise the profile of aggregations and attract much needed attention.

Yvonne Sadovy de Mitcheson,
Director SCRFA

Belize

Photo: Enric Sala

Nassau grouper in spawning aggregation just starting to rise up into midwater prior to forming the midwater 'ball' at dusk.

Nassau grouper research in Belize

In January 2011, I visited Belize to work with Janet Gibson and the Wildlife Conservation Society and help evaluate the monitoring protocol used to count Nassau grouper, *Epinephelus striatus*, in their spawning aggregations. I visited the two biggest aggregations monitored regularly by Belize's national Spawning Aggregation Working Group (SAWG); Northeast Pt, Glover's Reef (1,800 fish in 2011) monitored by WCS and partners, and Lighthouse reef, Sandbore, with the University of Belize monitoring team (1,300 fish in 2011). The cross-sector SAWG was established in 2001 following a nationwide survey of Nassau grouper which showed that many of their spawning aggregations had low fish numbers (hundreds to a few thousands) compared to historical highs of tens of thousands. The WG has played a pivotal role in the introduction of various legislation, including protection of all aggregation sites, a four-month closed season and a minimum capture size for Nassau grouper in Belize. It is a noteworthy model for collaboration and cooperation in aggregation management at the national level (www.spagbelize.org).

After the January field trip, my first experience diving in Belize's beautiful waters, I attended a special meeting of the SAWG to present information on the management requirements of aggregating species and to discuss the sampling protocols being used. The 21 participants at the meeting comprised staff of the Fisheries Department and the University of Belize, conservation NGOs, co-managers of marine reserves and a fisherman. SAWG members have been monitoring seven of the 11 known aggregation sites for Nassau grouper since 2003. In 2011 fish numbers continued to be low for most sites, with no Nassau groupers reported at two of the aggregation locations. Some of the low counts could be due to rough weather experienced in February, when many dives had to be cancelled. In addition, groupers may not spawn every season, which can result in smaller aggregations sometimes. The Nassau grouper is particularly challenging to count in aggregations because, just prior to spawning, the fish gather together from all over the aggregation site to rise up from the substrate and form large mobile spheres or 'balls' that move slowly away as divers approach. We are discussing different methods for counting fish numbers in these 'balls' and plan to trial them in January 2012.

BELIZE Information Circular No. 9, The Belize Spawning Aggregation Working Group. (2011). http://www.gloversreef.org/grc/pdf/WCS_GloversReef_Final_SPAG_Report_2005_2011.pdf
http://www.youtube.com/watch?v=JFbJsj8KdSI&feature=related

Yvonne Sadovy de Mitcheson
SCRFA yjsadovy@hku.hk

Cubera snappers (*Lutjanus cyanopterus*) congregating in pre-spawning courtship and rushes at Gladden Spit

Photo: R. T. Graham

The struggles to protect the last commercially fished spawning aggregation on the Mesoamerican Barrier Reef

When Belize passed its eyebrow-raising legislation in 2003 that protected nine of its known 11 spawning aggregation sites,scientists, conservationists and many fishers cheered the world over. But what of Belize's jewel in the spawning aggregation crown, Gladden Spit, now a thorny management issue that few wish to tackle?

Famous for the stunning underwater operatic event where thousands of snappers (cubera snapper, *Lutjanus cyanopterus*- see photo and dog snapper, *L. jocu*) aggregate and spawn near dusk between March and July, Gladden Spit is also fished by traditional fishers who target spawning mutton (*L. analis*) and yellowtail (*Ocyurus chrysurus*) snappers. Despite the declaration of this site as a marine reserve in 2000 and co-management under a novel agreement between the government and a non-governmental organization, and notwithstanding the extirpation of almost all other spawning sites in the region, fishing continues at unsustainable levels. And the situation may be about to get much worse.

Fishers at Gladden Spit noted in the late 1990s that despite the fact that the fishery only comprised an average of 6-10 boats and 20-25 fishers, they were working harder to catch the same or fewer fish than previously and that the fish were getting smaller, both signs of overfishing. Assessment of catch per unit effort over three years and analysis of landings over six years confirmed their concerns (Graham et al. 2008). This information was made available to both marine reserve co-managers and fishers who supported management measures but preferred to focus on excluding foreign fishers, who fished illegally. Moreover there were increasing conflicts with the tourism industry selling the unique encounter experience with whale sharks and spawning aggregation phenomenon, as they overlapped in space and time with the fishers. Notably, many fishers and tour-guides had family ties, creating new inter-generational stressors.

A key issue for managers was who should be considered a 'traditional' fisher, and hence a stakeholder who should continue to be allowed to fish at Gladden Spit? While this was being evaluated "special licences" were issued to any fisher who applied for one with few restrictions regarding the fishers' origin. Although the co-management agreement enabled relatively good enforcement measures at Gladden Spit, it has also created problems. For example, licencing has long been carried out by the Department of Fisheries but in the case of Gladden Spit, a (different) local co-manager (currently the Southern Environment Association--SEA) is also able to provide licences and acted to limit the number issued. Disgruntled fishers bypassed the co-managers and travelled directly to petition Fisheries enabling them to receive licences and undermine SEA's management. On the other hand, although patriarch fishers were retiring and

Photo: R. T. Graham

A whale shark (*Rhincodon typus*) moves in to filter feed on cubera snapper spawn

Photo: R. T. Graham

The original traditional Belizean fishers fishing the mutton snapper spawning aggregation

leaving the fishery, with the economic downturn reducing overnight tourism several of the young tour-guides who had switched from fishing to guiding, had to switch back to fishing to make ends meet, thereby driving up fishing pressure.

More recently, outside pressures have intensified. In 2008, Jamaican fishers travelled to Gladden Spit and purchased all the fish that fishers could sell them. In late 2009, they returned with a fleet of boats laden with fish traps ready to take advantage of the CARICOM fisheries agreement that enables fishers from the Caribbean to fish in the territorial waters of other states with relatively few restrictions. Although heavy resistance from Belizeans prevented the Jamaican “invasion”, foreign fishers married to Belizeans were then in a position to obtain fishing permits, further increasing fishing pressure. With little effective restriction on fishing at Gladden and with increased demand from new markets in Jamaica, the spawning aggregations and their progeny are at increased risk from overfishing.

After 13 years and many efforts by many people, the magnificent and possibly unique Gladden Spit is still under threat. It will take significant political and local will and clout to improve the situation. If SEA bases its final assessment of the relatively limited number of fishers who should be issued permits based on their traditional use of the site for the period 1998-2003, then spawning aggregations at Gladden Spit stand a fighting chance at surviving in a sea where most other aggregations have been fished out.

Rachel Graham, PhD
Wildlife Conservation Society
rgraham@wcs.org

Graham, R., R. Carcamo, K. Rhodes, C. Roberts, N. Requena (2008) Historical and contemporary evidence of a mutton snapper (*Lutjanus analis* Cuvier, 1828) spawning aggregation fishery in decline. Coral Reefs 27: 311-319

Bermuda

Research and adaptive management lead to better protection of spawning aggregations in Bermuda

Photo: Brian Luckhurst

Black grouper in specially designed cradle for tagging

The discovery of a black grouper (*Mycteroperca bonaci*) spawning aggregation site in 2004 located between two seasonally protected (May to August) areas for red hind (*Epinephelus guttatus*) at the eastern end of Bermuda led to the incorporation of this site into a newly configured seasonally protected area encompassing all three sites. Initial observations of abundance and behaviour of black grouper were made in 2005 to confirm the nature of the aggregation (Luckhurst, 2010). The closure of the red hind sites was based on their known spawning period during the summer months. However, the duration of the spawning period for black grouper was poorly documented and this presented a management challenge as black grouper would be vulnerable to fishing pressure if they continued to aggregate outside the four month closure period. To better understand the dynamics and duration of this black grouper aggregation, an acoustic tagging programme was initiated in 2008. 'Vemco' acoustic transmitter tags were surgically implanted into the body cavities of 37 black grouper during the first two summers of field work and an array of acoustic receivers was set up around the aggregation site (see photo of tagging cradle).

Due to uncertainty over the duration of the aggregation period of black grouper and the possibility of capturing tagged fish at the site, a management decision was taken to extend the closure period of the area around the black grouper aggregation until November. This was done using a provision for emergency site closures under the Fisheries Act. Under this provision, the Minister responsible for fisheries may declare a defined geographical area closed to fishing for a period of up to 90 days if the Minister believes that there is a significant threat of overfishing at the site. This declaration only requires publication of the notice in the Official Gazette. This has proved to be a powerful management tool in Bermuda as it provides the opportunity for scientists to study an aggregation considered vulnerable without being in conflict with fishermen at the site. The information gained can then be used to refine legislation to adequately protect an aggregation both spatially and temporally.

Data downloaded from the receivers subsequently demonstrated that tagged black grouper were present at the aggregation site from May to November with the highest activity levels from June through October. Abundance was greatest in the period after the full moon in each aggregation month. These data suggest that black grouper have a more protracted spawning period than red hind and validate the decision to extend the closure period. As a result, the existing legislation is being amended to maintain the extended closure period on a permanent basis.

Brian E. Luckhurst, Tammy Trott and Joanna Pitt
brian.luckhurst@gmail.com

Luckhurst, B.E. (2010) Observations of a black grouper (*Mycteroperca bonaci*) spawning aggregation in Bermuda. Gulf Caribb Sci 22:1–8

Atlantic surgeonfish aggregation site revisited after 34 years

CARIBBEAN & ATLANTIC

Puerto Rico

In February 2011 an aggregation area for ocean surgeonfish (*Acanthurus bahianus*) and blue tang (*Acanthurus coeruleus*) on the south west shelf edge of Puerto Rico was re-surveyed. The original studies at this site took place between 1977 and 1979 and again in 1988, when the two surgeonfishes were seen to aggregate and spawn at a location on the shelf edge. The most recent survey was done to improve the spatial mapping of the original area (based on notes taken during the earlier research trips), and to resurvey the aggregation site for fish number and distribution.

Two dives were made on the original site and allowed mapping of areas and comparison of locations over time. On 21 February 2011 the dive started at 5.00 pm when fishes should have been aggregated and starting to spawn according to earlier data. Although there were no *Acanthurus* present at the original aggregation locations, spawning fishes were quickly located further east and towards the shelf edge break and within about 40-50 m of their previous aggregation centres. On 2nd February, a second 5.00 pm dive allowed the current aggregation areas to be delimited and mapped out by towing a GPS (Global Positioning System unit), while swimming on SCUBA. The 1977-79, mapped earlier, and 2011 distributions show minor differences (see maps below).

It appears that there has been a major change in numbers of ocean surgeonfish aggregating at the site, with a smaller change in blue tang, over the 30+ year intervening period. In the original 1970s surveys an estimated 20,000 (very approximate given the difficulty in counting large numbers of fish) ocean surgeonfish were present at the site during peak aggregation periods. During the two visits to the site this year, only about 200 or so ocean surgeonfish on the first day (3 days after full moon) and approximately 300-400 during the second day (4 days after full moon) were present. The fish were spread out over an area that could not be seen from a single location, so overall fish numbers had to be estimated while swimming over the larger area. However, there is no doubt that there had been a large decrease in fish numbers (to only perhaps 5-10% of previous numbers) since 1988. For blue tang, the initial aggregation size was roughly 7,000 fish and on both days during 2011 only about 2,000 fish were estimated. The blue tang vastly outnumbered the ocean surgeonfish while the opposite had been the case previously. Both species are commercially exploited and neither is managed. For more details see Colin and Clavijo (1988, in press) and Colin (1996). The trip was partially funded by SCRFA.

Patrick L. Colin crrf@palaunet.com
Coral Reef Research Foundation

Colin, P.L (1996) Longevity of some coral reef fish spawning aggregations. Copeia 1996(1):189-192

Colin P.L, Clavijo I.E (1988) Spawning activity of fishes producing pelagic eggs on a shelf edge coral reef, southwestern Puerto Rico. Bulletin of Marine Science 43(2):249-279

Colin P.L, Clavijo I.E (in press) Case Study: *Acanthurus bahianus* (ocean surgeonfish) and *Acanthurus coeruleus* (blue tang) in Puerto Rico: in Sadovy de Mitcheson, Y and PL Colin (2012), Reef Fish Spawning Aggregations: Biology, Research and Management, Springer, Berlin.

Changes in extent of surgeonfish aggregations, southwestern Puerto Rico between 1977-79 and 2011. (a) *Acanthurus bahianus.* (b) *Acanthurus coeruleus.*

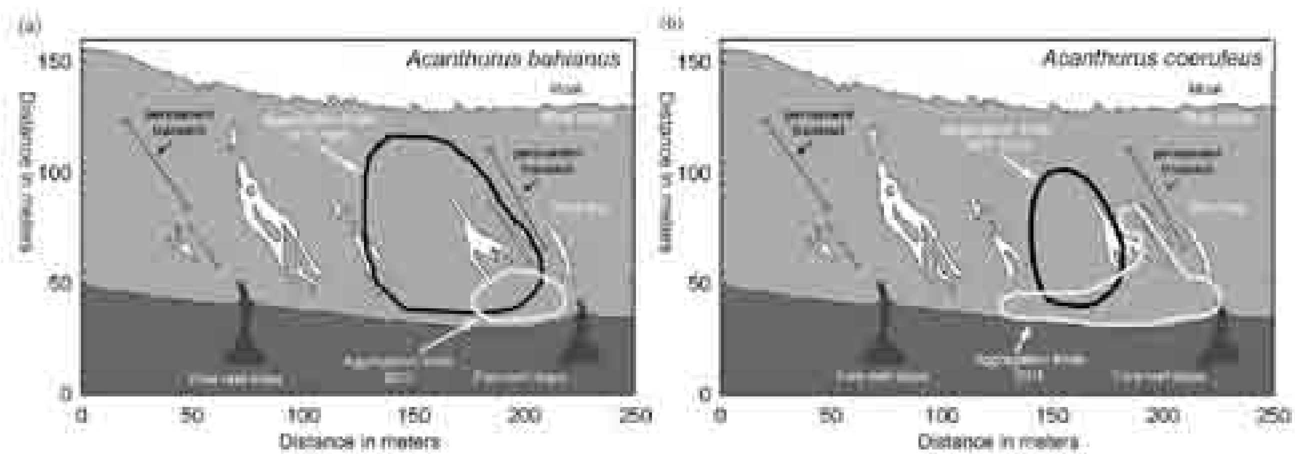

Photo: Brad Erisman

Dr. Larry Allen holding an adult female barred sand bass (*Paralabrax nebulifer*) collected from a spawning aggregation site near Long Beach, California.

Fisheries collapses highlight need for management of spawning aggregations in Southern California

The barred sand bass (*Paralabrax nebulifer*) and the kelp bass (*P. clathratus*) are two of the most numerically abundant seabasses in coastal waters of southern California (see photos). Both species form spawning aggregations during the summer months, although the spatial and temporal dynamics of spawning differ between the two species. Sand bass form small groups over inshore habitats for most of the year but migrate to form massive spawning aggregations over offshore sand flats during July and August at six main areas. Conversely, kelp bass aggregate on kelp beds and rocky reefs year-round and form localized spawning aggregations of several hundred fish from May to September.

Both species have been excluded from commercial harvest in California since 1953, but collectively have ranked as the two most important recreational marine fisheries in southern California since 1980. Between 1963 and 2008 approximately 80% of annual harvest of sand bass and kelp bass occurred during their spawning months, and their spawning aggregations represented the staple of the Commercial Passenger Fishing Vessel ("party boat") fleets during that period.

Analyses of long-term population trends from fisheries-dependent and fisheries-independent data indicate that regional stocks of both species have collapsed due to overfishing of spawning aggregations and changes in oceanographic and climatic conditions within Southern California. In barred sand bass, biomass declined by 90% since 1980 whereas catch and catch rates have decreased by 97% and 70% respectively since 2000. In kelp bass, biomass has decreased by 90% since 1980, adult densities have declined 80%, and catch and catch rates have dropped by more than 90% each since 1965.

Even more alarming than the declines is the fact that monitoring of fisheries trends provided little warning of imminent collapse for either species. Comparisons of fisheries and population data indicate that both fisheries exhibit hyperstability, in which catch rates remain high even as population sizes declined precipitously. As a result, harvest rates of both species appeared to be sustainable and no changes in management were implemented. The non-linear relationship between catch rates and true population size is a result of the aggregating behaviour of fish and the nonrandom targeting of aggregations by fishers (Sadovy and Domeier, 2005; Erisman et al., 2011).

The hyperstable relationship between catch rate and stock abundance suggests the urgent need to incorporate fisheries -independent monitoring within the management programmes of both species. However, while fisheries monitoring is a key part of management, such data alone are insufficient for an accurate assessment of stock condition. In fact, for barred sand bass, catch rates show no relationship at all to changes in population size!

Both fisheries have been managed by a 10-fish daily bag limit (collective daily limit for any of the three *Paralabrax* species that occur in the region) and a 27 cm minimum size limit since 1959. Given the large-scale declines in both fisheries, it is time to review the management plan and devise new strategies to bolster recovery and maintain more sustainable harvest levels. Such an effort would also benefit areas well beyond southern California, as both barred sand bass and kelp bass have emerged as two of the most productive artisanal fisheries along the coast of Baja California (Mexico), yet no regulations exist there to manage either fishery.

Brad Erisman
berisman@ucsd.edu
Scripps Institution of Oceanography & Society for the Conservation of Reef Fish Aggregations

Erisman, B.E., Allen, L. G., Claisse, J. T., Pondella II, D. J., Miller E. F. and Murray, J. H. (2011) The illusion of plenty: hyperstability masks collapses in two recreational fisheries that target fish spawning aggregations. Canadian Journal of Aquatic Sciences 68:1705-1716.

Sadovy, Y., and Domeier, M. (2005) Are aggregation fisheries sustainable: reef fish fisheries as a case study. Coral Reefs 24:254 - 262

Photo: Brad Erisman

Kelp bass (*Paralabrax clathratus*) from La Jolla, California.

Further information:
http://www.youtube.com/watch?v=oX2ILa4Asl4
http://www.frdc.com.au/documentlibrary/FISH%2018-4.pdf

Wakefield, C. B., Fairclough, D. V., Lenanton, R. C. J. and Potter, I. C. (2011). Spawning and nursery habitat partitioning and movement patterns of *Pagrus auratus* (Sparidae) on the lower west coast of Australia. Fisheries Research 109:243-251.

Cockburn Sound spawning aggregation area, western Australia

Mark-recapture studies reveal secret lives of the pink snapper (Sparidae) in Australia

Snapper (*Pagrus auratus,* Sparidae) (see front cover of newsletter) is prized among demersal fish species caught by commercial and recreational line fishers throughout southern Australia, including the West Coast of Australia. Although widely distributed, spawning aggregations occur in relatively few embayments. One such well-documented location is Cockburn Sound, in metropolitan waters off Perth, Western Australia (W.A.) (see map). While spawning occurs elsewhere, juveniles produced in Cockburn Sound contribute widely to stocks along the West Coast (ca 800 km of coastline). As metropolitan waters are accessible to the largest human population in W.A. and subject to heavy fishing effort, and because Cockburn Sound contains industry and port facilities, there is significant risk to these aggregating fish and a seasonal closure to fishing was introduced to protect them.

Mark-recapture studies have demonstrated that aggregating snapper may either remain in Cockburn Sound outside the spawning period, or leave the Sound, some animals moving over 100 km away (Wakefield et al., 2011). We know little about the timing, pathways and behaviour of fish migrating to the aggregation location and the risks to these migrating fish. Our research is using acoustic telemetry to track the movements of 30 adult snapper to and from Cockburn Sound (see map). Using a system of receiver gates, we can detect when each individual fish moves into or out of the Sound, how fast it happens and whether it repeatedly migrates each year. The work will be completed in 2013 and will further inform a 'weight of evidence' approach to the assessment and management of stocks of this species. The research is funded by the Department of Fisheries Western Australia and also uses the facilities of the Ocean Tracking Network.

David Fairclough
Research Scientist, Department of Fisheries Western Australia.
david.fairclough@fish.wa.gov.au

INDO-PACIFIC

Fiji

Profile of a grouper spawning aggregation site in Fiji:
Naiqoro Passage, Kadavu

Photo: Stan Shea

Camouflage grouper moving together in a group of about 40 conspecifics into the lagoon after spawning has finished

Since 2003 SCRFA has worked with the Fisheries Research Division in Fiji, headed by Mr. Aisake Batibasaga. Initially, we conducted interviews around the country to discover what was known about spawning aggregations. We found evidence of many fished aggregations, as well as of declines in catch rates at the more accessible sites. At Naiqoro Passage, set in a marine protected area, our aims were to describe the timing and locations of the species that aggregate, establish a baseline against which to compare possible changes over time, and look at catchment area for the camouflage grouper by tagging and recapturing fish. We are also monitoring annual water temperature and doing outreach on marine conservation in local communities. Since divers pay a levy to dive in Naiqoro Passage to the village that stewards it, there is a strong local interest to protect the Passage from poaching and our results can, amongst other things, help to better plan which day or days enforcement is likely to be most effective.

Studying Naiqoro Passage is a challenge. Weather changes daily and this year we had long spells of wind and rain making access to the site impossible at worst, uncomfortable at best. The site is on an outer reef and exposed to unpredictable tides and currents. The maximum depth and size of the site barely allow us to complete all transects in one day although the area is just small enough to survey in its entirety in two dives with three divers swimming in parallel. The species that aggregate are the camouflage grouper, *Epinephelus polyphekadion*, brown-marbled grouper, *E. fuscoguttatus*, black-saddled coralgrouper, *Plectropomus laevis*, and squaretailed coralgrouper, *P. areolatus* (for more details of this study see - SCRFA Newsletter 13 and our 5-part BLOG [www.scrfa.org]).

Numbers of camouflage grouper increased daily over about 10 days to about 300 by the full moon when spawning occurred. The animals then disappeared, literally overnight. A couple of days before spawning we saw females full of hydrated eggs (see photo on front page of newsletter) and males spent much of their time fighting each other. Water temperature was lower (24-25ºC) than at other studied sites (e.g. Solomon Is., Palau, Pohnpei) in the Pacific at the time of spawning. The brown-marbled groupers (maximum about 120 fish) were restricted to a small area to the south of the study site, largely separate from the camouflage grouper and adjacent to the small black-saddled coral grouper aggregation (maximum about 50 fish). After spawning, all but a few of the 300 fish quickly left the site. We were lucky to see one 'school' of camouflage grouper, about 30-40 fish at 10 m, moving closely together into the lagoon through the reef passage and away from the aggregation site.

The government is currently discussing recommendations to be formalized in legislation/regulation by the end of 2011. These include complete protection/no fishing of aggregation sites for all larger reef-associated fishes such as bumphead parrotfish, Napoleon fish, giant sweetlips, sharks and rays. For the groupers, protection would be during 3-5 major spawning months (July-November). In addition reef passages and adjoining promontories, patch reef systems/and outer reef slopes where spawning aggregations occur would be incorporated into Marine Protected Areas and into the FLMMA community-based management network. Protection of these habitats would benefit large reef fishes and mega-fauna such as sharks, sea turtles, rays, manta rays, whales and dolphins etc.

Yvonne Sadovy de Mitcheson and
Aisake Batibatasaga
SCRFA and Fiji Fisheries Research Division
yjsadovy@hku.hk
abatibasaga@gmail.com

PERSPECTIVES

FSAs beyond MPAs

A common question we get from fishers, community groups, fishery, and marine protected area (MPA) managers is "How do we manage the use of spawning aggregations with MPAs, and if not, what is the most effective tool?" It is a hard question to answer, but here is a little more about how MPAs can at least be part of the solution.

Fish spawning aggregations (FSAs) are integral components of coral reef ecosystems. They are the only reproductive opportunities for many reef species and their persistence is important for replenishing fish populations, for the health of many exploited species and for the benefit of coastal fishing communities. Transient aggregations are particularly important and are formed by many larger reef species for short periods each year when they gather in their hundreds to tens of thousands. The movements of transient aggregators to and from aggregations can be extensive, representing an important component of adult connectivity and biomass flux across reefs. Because transient aggregations are highly predictable, they are often the focus of fishing. Indeed, many are in decline because few are effectively managed.

Marine protected areas (MPAs) are widely and heavily advocated as conservation tools for coral reef ecosystems, and are increasingly promoted for fishery management. MPAs can help to preserve coral reef habitat, and, because many reef-associated species are relatively sedentary as adults, 'no-take' MPAs can effectively protect sub-populations of such species from fishing. This protection allows them to grow larger and persist at higher densities than in nearby exploited areas. MPAs are being introduced in many tropical coastal areas to address both conservation and fishery management. In some cases they are the only protective measure in place.

Unfortunately, species that form transient spawning aggregations are not well protected by MPAs as a sole measure because they are not sedentary, because most are also fished outside of the reproductive season (and hence outside of aggregations) and because MPAs are not typically located in the habitat where most transient aggregations occur. The majority of MPAs are smaller in area than 10 km^2, far smaller than the typical home range (inclusive of annual migration distances of 10s to 100s of km to and from spawning sites) areas of most aggregating fishes and are typically located close to shore. Many aggregations, however, form in outer reef and reef drop-off areas, offshore locations not regularly incorporated into MPAs, partly because their protection is difficult to enforce. Moreover, since most aggregating species are also fished outside of the spawning season some control on fishing effort is called for.

As we learn more about transient FSAs, appreciate their role in coral reef ecosystems and coastal fisheries, and as management embraces a more holistic ecosystem approach we recognize the importance of outer reef drop-off habitat for biodiversity and its increasing exposure to fishing (e.g. Olavo, G., Costa, P.A.S, Martins, A.S. and Ferriera, B.P. (2011) Shelf-edge reefs as priority areas for conservation of reef fish diversity in the tropical Atlantic. Aquatic Conservation Marine Freshwater Ecosystem 2011 Published online in Wiley Online Library wileyonlinelibrary.com. DOI: 10.1002/aqc.1174). Aggregations are key life history events for many fish species, including some that are threatened and are easily overfished. The deep reef habitat and associated reef slope and reef passage areas are refuges for heavily fished shallow water species and home to a distinctive deep reef fish assemblage. This habitat also contains many transient spawning aggregation sites. MPA's and MPA networks need to incorporate such habitats and aggregating species need to be managed well beyond MPA boundaries if they are to persist as healthy populations and continue to contribute significantly to food security and societal well-being. (See also: Protecting the Spawning and Nursery Habitats of Fish: The Use of MPAs to Safeguard Critical Life-History Stages for Marine Life: http://depts.washington.edu/mpanews/MPA77.pdf)

NEW PUBLICATIONS

Cherubin L.M., R. S. Nemeth, N. Idrisi (2011) Flow and transport characteristics at an *Epinephelus gutattus* (red hind grouper)spawning aggregations site in St. Thomas (US Virgin Islands). Ecological Modelling, 222: 3132-3148

Coleman F.C., K. M. Scanlon, C.C. Koenig (2011) Groupers on the Edge: Shelf Edge Spawning Habitat in and Around Marine Reserves of the Northeastern Gulf of Mexico. The Professional Geographer, DOI 10.1080/0030124.2011.585076

Craig M.T., Y.J. Sadovy de Mitcheson, P.C. Heemstra (2011) Groupers of the World: A Field and Market Guide. Grahamstown: NISC (Pty) Ltd. 424pp

Danylchuk A.J., S. Cooke, T.L. Goldberg, C.D. Suski, K.J. Murchie, E. Sascha. A.D. Danylchuk, R. H., Christopher, E.J. Brooks, A. Oronti, J.B. Koppelman, D.P. Philipp (2011) Aggregations and offshore movements as indicators of spawning activity of bonefish (*Albula vulpes*) in The Bahamas. Marine Biology DOI: 10.1007/s00227-011-1707-6 Related Film: http://www.youtube.com/watch?v=Id0vO1DUxgs

Donaldson, T. Z.R. Foltz, K.A. Chop (2010) Spawning aggregations of two nesting triggerfishes (Balistidae). Proc. Gulf Caribb. Fish. Inst. 62: 280-281

Erisman B.E., L.G. Allen, J.T. Claisse, D.J Pondella II, E. F. Miller, J.H. Murray (2011) The illusion of plenty: hyperstability masks collapses in two recreational fisheries that target fish spawning aggregations. Canadian Journal of Fisheries and Aquatic Science, 68: 1705-1716

Fennessy S.T., P. Pradervand, P.A. de Bruyn (2010) Influence of the sardine run on selected nearshore predatory teleosts in KwaZulu-Natal. African Journal of Marine Science, 32(2): 375-382

Freitas M.O., V. Abilhoa, G.H. da Costa e Silva (2011) Feeding ecology of *Lutjanus analis* (*Teleostei: Lutjanidae*) from Abrolhos Bank, Eastern Brazil. Neotropical Ichthyology, 9(2): 411-418

Freitas M.O., R.L. de Moura, R.B. Francini-Filho, C.V. Minte-vera. (2011) Spawning patterns of commercially important reef fish (Lutjanidae and Serranidae) in the tropical western South Atlantic. Scientia Marina 75(1): 135-146

Kadison, E. R. Nemeth, J. Blondeau, T. Smith, J. Calnan (2010) Evidence for a Nassau grouper *Epinephelus striatus* spawning aggregation recovery on the Grammanik Bank, US Virgin Islands. Proc. Gulf Caribb. Fish. Inst. 62: 273-279

Karnauskas M., M. Cherubin, C.B. Paris (2011) Adaptive significance of the formation of multi-species fish spawning aggregations near submerged capes. PLoS One 6(7): e22067. Doi:10.1371/journal.pone.0022067

Kartawijaya T., Pardede S.T., Syaifudin Y., Mulyadi (2010). Spatial and temporal pattern in spawning aggregations of groupers (Serranidae) and napoleon wrasse (Labridae) in Karimunjawa National park. Paper submitted to International Symposium on Small Islands and Coral Reefs Management (ISSIC), held on August 4-6, 2010 at Ambon, Indonesia. email: t.kartawijaya@wcsip.org

Kojis, B. N. Quinn (2010) Validation of a mutton snapper *Lutjanus analis* spawning aggregation off St. Croix, U.S. Virgin Islands. Proc. Gulf Caribb. Fish. Inst. 62: 267-272

Luckhurst B.E. (2010) Observations of a black grouper (*Mycteroperca bonaci*) spawning aggregation in Bermuda. Gulf Caribb Sci 22: 1–8

Mangubhai S., M. Salah M., M.A. Suprayitno, A. Purwanto, K. L. Rhodes, K. Tjandra (2011).Do not stop: the importance of seamless monitoring and enforcement in an Indonesian marine protected area. Journal of Marine Biology, 2011: ID 501465, doi: 10.1155/2011/501465

Mann D., J. Locascio, M. Scharer, M. Nemeth, R. Appeldoorn (2010) Sound production by red hind *Epinephelus guttatus* in spatially segregated spawning aggregations. Aquatic Biology 10: 149-154

Previero M., C. Minte-Vera , M.O. Freitas, R. L. de Moura, C.Dei. Tos (2011) Age and growth of the dog snapper *Lutjanus jocu* (Bloch & Schneider, 1801) in Abrolhos Bank, Northeastern Brazil. Neotropical Ichthyology, 9(2): 393-401

Rhodes K.L., B.M. Taylor, J.L. McIlwain (2011) Detailed demographic analysis of an *Epinephelus polyphekadion* spawning aggregation and fishery. Marine Ecology Progress Series, 421: 183-198

Sadovy de Mitcheson, Y.J., P.L. Colin, P. L. (2012) Reef Fish Spawning Aggregations: Biology, Research and Management. Springer Publisher. http://www.springer.com/life+sciences/animal+sciences/book/978-94-007-1979-8

Sharer M.T., M. I. Nemeth, R. S. Appeldoorn (2010) Protecting a multi-species spawning aggregations at Mona Island, Puerto Rico. Proc. Gulf Caribb. Fish. Inst. 62: 252-259

Trott, T.M., M. Luckhurst, B.E. Pitt, J.M. (2010) Occurrence and management of a spawning aggregation of bluestriped grunt *Haemulon sciurus* in Bermuda. Proc. Gulf Caribb. Fish. Inst. 62: 260-266