

Supplied by Brad Erisman



*Brad Erisman (centre) and Casuarina McKinney-Lambert (left) with Sea Pigeon crew, Brown and Krista in The Bahamas searching for Nassau grouper*

Yvonne Sadovy



*Quick consultation while surveying groupers in Ebiil Passage, Scott and Asap (formerly) of Palau Conservation Society*

Yvonne Sadovy



*Camouflage grouper, *Epinephelus polyphekadion*, forms some of the largest known grouper aggregations in the Indo-Pacific*



# SCRFA

SCIENCE AND CONSERVATION  
OF FISH AGGREGATIONS

NEWSLETTER 17 • JUNE 2013

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# WORDS *from the chair*

Nassau's, chubs and getting out there, doing surveys, and doing them right, are the key topics of this Newsletter. But first a few announcements.

## **SCRFA Student Travel Award**

This year SCRFA for the first time will offer a Student Travel Award (US\$800) to a student working in the Caribbean Region to attend the next Gulf and Caribbean Fisheries Institute (GCFI) meeting. GCFI was founded in 1947 to promote the exchange of current information on the use and management of marine resources in the Gulf and Caribbean region. SCRFA has been actively engaged in GCFI meetings for many years.

Information on the Award can be found on [www.GCFI.org](http://www.GCFI.org); or [www.SCRFA.org](http://www.SCRFA.org). For additional questions, please contact [martinrussell99@gmail.com](mailto:martinrussell99@gmail.com)

Interested applicants must:

- be currently enrolled as a fulltime student;
- present a paper or poster on fish aggregations at GCFI, Corpus Christi, November 2013;
- submit a short letter to SCRFA detailing the importance of attending GCFI to future career goals; and
- include in the letter their major professor "certification", stating the current academic standing of the student, verifying they are full time, and their progress toward their degree

The paper or poster should be on current or proposed study on fish aggregations, including for example, fish spawning and feeding

aggregations, novel monitoring ideas or community based education.

## **SCRFA chairs ICRI Committee on Coral Reef Associated Fisheries**

SCRFA in partnership with Coral Reef Initiatives for the Pacific (CRISP) has been chairing this committee since it was established at the International Coral Reef Initiative (ICRI) General Meeting in Monaco, 2010. Now that the CRISP programme has ended, SCRFA assumes chairmanship.

The Committee has several important tasks targeted at getting coral reef associated fisheries higher on the international agenda. A component of this is to highlight the importance of sustainable management for coral reef fish spawning aggregations.

Towards this goal the committee has:

- participated in the South Pacific Commission (SPC) Heads of Fisheries meeting, March 2011 [www.spc.int/fame/en/component/content/article/82-seventh-spc-heads-of-fisheries-meeting](http://www.spc.int/fame/en/component/content/article/82-seventh-spc-heads-of-fisheries-meeting);
- compiled of a comprehensive global list of Regional Fisheries Management Organisations (RFMOs);
- published an educational flier success stories on reef fisheries management in the Pacific; and
- produced a film to raise awareness about spawning aggregations: Spawning for survival [www.youtube.com/watch?v=Za6v\\_Zddd2Q&feature=youtube](http://www.youtube.com/watch?v=Za6v_Zddd2Q&feature=youtube)



*Available in short version (see above youtube link) taken from longer film version by Eric Clua*

The committee will continue to encourage relevant fisheries organizations to identify the economic importance of coral reef-associated fishes with indications of current status and sustainability, highlight the importance and relevance of illegal, unregulated and unmonitored trade, and determine whether current monitoring and capacity are sufficient and appropriate to address current and future management planning, or fishing pressure.

Further work identified by the committee includes four components to better manage and utilize reef fish resources.

(1) Application of novel technologies or activities that may represent either threats or solutions for sustainable reef-associated fisheries.

(2) Consideration of the sustainability of the post-larval capture and culture of reef fishes as new

source of income and an option to reduce the pressure on fish stocks.

(3) Compilation of lessons learned in supporting and fostering sustainable management of coral reef-associated fisheries.

(4) Promotion of research on known spawning aggregation areas to improve knowledge on their key role in the sustainability of fisheries and highlight the need to protect them.

The committee will next meet at the ICRI General Meeting in Belize, 14-18 October 2013.

Cheers

**Martin Russell**

Chair/CEO, SCRFA

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Yvonne Sadovy

*Fig. 1. Community leaders and Fiji Fisheries Research staff leaving Matasulevu after the Naiqoro Passage workshop*

Another busy year and an exciting natural extension of our work to move beyond reef species to cover all fishes that aggregate to spawn or feed. Our website will soon reflect this advance with new articles, case studies, and taxonomic coverage. [Significantly we are working on a major update to the online fish aggregation database to cover all fish that aggregate \(spawning and feeding\), and so now will include temperate, estuarine and rivers, and pelagic ecosystems. This expansion you will also see reflected in our new publications listing.](#)

In the Pacific we have continued our work in Fiji and Palau, while in the western Atlantic we now have a focus on activities in The Bahamas and Belize (see articles below). After 4 years we finished our work at the Naiqoro Passage aggregation site in Kadavu, an island south of Suva, Fiji (Newsletters 13, 15). Although fish numbers are very much

reduced from previous (i.e. local knowledge) estimates, this site has had stable numbers of three grouper species for several years and is protected by a local community, Matasulevu. In winding up the project we presented the outcomes from our work to this community, and highlighted the importance of the passage for the species as well as for the income they receive from dive tourism. Together with the Fiji Fisheries Research Division we presented the community with a computer and printer as a contribution to their marine office and produced a 2013 calendar about the Passage to illustrate its beauty and importance. SCRFA is also working together with the Wildlife Conservation Society and others in Fiji on a campaign led by SeaWeb to further understanding and appreciation of the importance of aggregations for fisheries in the country to better promote their protection.

In Palau we had a wonderful opportunity to

revisit the protected Ebiil aggregation for which we established a baseline profile of species, numbers and timing in 2009 along with a monitoring protocol in collaboration with the Palau Conservation Society. Radio Television Hong Kong funded a series of programmes on marine issues and the Director, Jerry Tai of Monster Productions, selected our spawning aggregation work for one segment in the series. The episode on Palau will be aired later this year. The visit also gave us the opportunity to monitor this site again, three years after we finished our initial work. We found that the numbers of three species of groupers appear to be similar to our original counts in 2009.

In the western Atlantic, the Nassau grouper is finally attracting much needed attention (see also 'Perspectives'). One of the most threatened of all groupers, largely due to aggregation fishing, enormous declines in landings and reproductive gatherings have occurred everywhere in its range (see also accounts from Mexico and the Bahamas below). The United States government is conducting a review of the species in relation to the Endangered Species Act and I recently presented its plight in relation to the Protocol concerning Specially Protected Areas and Wildlife (SPAW Protocol; Dominican

Republic, October 2012) a body that addresses regional management and which, to date, has not listed any marine fish. The Caribbean Fishery Management Council, together with Western Central Atlantic Fishery Commission (WECAFC of FAO), has a working group on the Nassau grouper that has now been extended to cover all aggregating species of commercial importance. The species will be reassessed this year for its conservation status according to the IUCN categories and criteria; if you have or know of unpublished data on this species, please let me know.

Over the last 12 months SCRFA has also supported initiatives to increase protection of aggregations or to improve monitoring methods. These range from the Belize workshop (see article), to provision of data for a Nature Conservancy assessment in the Coral Triangle, to development of a simple methods manual for the study of reef fishes and conference sessions focusing on aggregations. We are most grateful for funding support from the Packard Foundation and the Christensen Fund, among others.

**Yvonne Sadovy de Mitcheson**

Director SCRFA





Krista Brown



*Fig. 1. Smith's site, once teeming with spawning Nassau grouper, is now empty during the reproductive season*

### *Sad farewell to Smith's iconic Nassau spawning aggregation site*

In January 1971, C. Lavett Smith, a renowned North American ichthyologist, witnessed a spectacular event off the coast of Bimini, Bahamas (Smith 1972). At the shelf edge just a short distance west of Little Cat Cay, following up on reports from fishers, he witnessed a massive gathering of Nassau groupers about to spawn. Smith estimated that between 30,000 and 100,000 fish were present. His was the very first underwater observation of a reef fish spawning aggregation ever recorded for a reef in the scientific literature. Nothing has been reported from this site since Smith's initial publication which remains today, 40 years on, one of the largest fish aggregations ever reported for a reef fish, anywhere in the world. Given that most spawning aggregations of this species have now either disappeared, or at best precipitously declined, and given that the Nassau grouper is currently being assessed under the Endangered Species Act, SCRFA felt it important to resurvey the site and see whether "Smith's" aggregation still exists.

In January 2013, Brad Erisman, SCRFA Board member from the Scripps Institution of Oceanography, joined Casuarina McKinney-Lambert of Bahamas Reef Environment Educational Foundation (BREEF) to revisit Smith's site. The description from Smith's paper, recent discussion with Dr. Smith, and local knowledge in Bimini clearly identified a small shelf edge area of around 2 miles within which the site must lie. Between 25-30 January over the full moon phase when the species is known to aggregate, Brad and Casuarina, on board the Sea Pigeon, re-surveyed an extensive area covering 4.5 linear miles that encompasses Smith's 1971 survey area. Over 6 days of surveys they found only 5 Nassau groupers, none of which showed any evidence of spawning. Nor was there evidence of commercial fishing anywhere in the area in relation to grouper aggregations. Indeed, local fishermen commented that the aggregation had disappeared by the early 1980s and that grouper had not been a focus of seasonal fishing in the area for a long time (Fig. 1).

We sadly concluded that the site reported by Smith was long gone. A site that once represented a global baseline for how large a reef fish aggregation can be no longer exists (see more details on our blog on [www.SCRFA.org](http://www.SCRFA.org)).



*Fig. 2. Fish illegally caught by Dominicans during the protected season in southern Bahamas*



Photos supplied by Casuarina McKinney-Lambert

Even with protection there would seem to be little hope of recovery for this famous site. Very little regulation of fishing activities exists in Bimini or Cat Cay. **There is a long history of commercial poaching in The Bahamas by Dominicans, and other Caribbean fishers (Fig. 2). The site is very close to South Florida, and according to discussions with local residents, Florida sport fishers pay little heed to Bahamian fishing laws.** So even if a minor recovery should occur, it is likely to be quickly diminished. Despite our disappointing, albeit not surprising, finding and the unlikely potential for recovery of this lost site under such conditions, the disappearance of Smith's aggregation site should send a strong and clear signal that urgent action is required so we don't lose the remaining aggregation sites in the region. Bahamas began implementing a country-wide annual closed reproductive season for Nassau grouper in 2004, and is currently considering amending fisheries legislation to implement a fixed annual three-month closure. Although this will be too late for Smith's Bimini aggregation, it is an essential management tool to help sustain remaining Nassau grouper aggregations.

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WCS staff

Fig. 1. Nassau grouper survey team 2012 at Glovers Reef, Yvonne working with members of NGWG



## *Nassau grouper in Belize – protected and still counting*

**The Nassau grouper working group (NGWG) of Belize has been established for over a decade and has made considerable progress in conserving the Nassau grouper, *Epinephelus striatus*.** This species, once of enormous commercial significance for many Belizean communities, has undergone massive declines since the 1960s due to overfishing, especially of its spawning aggregations, combined with lack of management. Concerted and integrated work by the multi-sectoral NGWG has, as of 2012 with the protection of the 15th spawning site, achieved management of all known Nassau grouper aggregations in the country. Combined with the minimum size regulation, the species has an opportunity to recover, although poor protection in neighbouring Honduras and Mexico have the potential to undermine these efforts depending on population structure.

**The NGWG also has an impressive history of aggregation monitoring, with seven aggregation sites assessed by teams of divers regularly since 2003 year ([www.spagbelize.org](http://www.spagbelize.org)).** Almost certainly the protection achieved by this group, the knowledge gained by field surveys and the widespread support

from the public, including the fishing community, due to excellent education and consultation, has slowed and possibly stemmed declines in this species in the country. The initiative is also an excellent model applicable elsewhere. For several years, SCRFA, supported by the Wildlife Conservation Society, has joined the WG in its survey of the Glover's Reef site the biggest remaining aggregation of the species (Fig. 1). Most recently, in November, 2012, we assisted in a workshop to update and refine the field monitoring protocol, using the Gladden Spit spawning bank as the training field site. During this workshop we further standardized the counting procedures to meet the very considerable challenge of counting large numbers of fish that assemble in three dimensional balls for short periods of time, and sometimes at considerable depth. Multiple counts on each dive can provide an indication of precision while video-recording gives an alternative means of estimating fish numbers. We also carried out field mapping exercises.

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## *Mexico*

### **Obituary for a Nassau grouper aggregation site in the Mexican Caribbean**

**A traditional site, where the Nassau grouper used to spawn in large aggregations, was recently confirmed as no longer active.** The site, characterized in the 1990s by aggregations of more than 3,000 groupers per reproductive season, is located off the coast of Mahahual in the Southern Mexican Caribbean. Veteran fishermen's accounts claim that this site supported more than 5,000 groupers during the 1950s, when fishermen caught them by hook and line. For six years (1990-1996) the aggregation was monitored and some of its demographic aspects analyzed. However, for the first time in the six-year period, the aggregation did not show up in 1996. This unfortunate situation moved the fishery authorities to establish a fishing ban in 1997, during the reproductive season of the species. Due to lack of enforcement, however, fishermen continued catching groupers. The aggregation's disappearance apparently surprised the fishermen who changed their fishing activity in response: rather than waiting for the groupers to arrive at the site, they searched for groupers south of the aggregation tracking down and catching small grouper congregations moving towards the site.

The traditional aggregation site of Mahahual remained unmonitored for 17 years. In January 2013, I was able to resurvey the aggregation site by diving during the full moon period, when the aggregation had previously occurred, and also interviewed veteran fishers. I confirmed that the Nassau grouper no longer return to this traditional site. Veteran fishers believe that a combination of irresponsible fishing (dynamite use in the past, various fishing gears such as hook and line, spear gun, gillnets, and use of SCUBA) had severely affected the aggregation.

They confirmed that the grouper aggregation has not formed at the traditional site for many years (since the last time I visited the site in 1996). In addition, another assumed stress is the influence of cruise ships. A cruise ship pier was built just half a mile from this nearshore site and began operations in 2001, with about 400 ship arrivals each year (before Hurricane Dean in 2007). The survey I conducted this January revealed no groupers present at the site and there were no fishing boats present. Nowadays, many fishers consider it pointless to fish at the site and most of them opportunistically venture southwards searching for groupers.

**Despite the gloomy situation with the traditional site off Mahahual, the Nassau grouper has not disappeared entirely from the Mexican Caribbean. Veteran fishers say that groupers migrate along deeper reefs (>33 m) in large groups.** While other sites have been reported, only three of these, other than Mahahual, have been confirmed and substantial effort is needed to study/validate these aggregations and to enforce protection. Hopefully, new regulation by the fishery authority will provide more effective management. The new two-month ban for several grouper species, including the Nassau grouper, is good news. Currently protection is only for one month (15 February-15 March) (Newsletter 16). However, effective enforcement is essential if the regulation is to promote recovery of protected species.

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## United States Virgin Islands



Rick Nemeth

Fig. 1. Technical diver using Megaladon closed circuit rebreather

### Confirmed spawning in aggregations for Chubs

Although the body of work on spawning aggregations has been growing, there is little information on the reproductive biology and behaviour of many fish species. Nearly 60 species from 14 families are suspected to spawn in aggregations but only anecdotal records occur for some species. Among tropical reef fishes, almost nothing is known of the life history or reproductive biology of Chubs (Family Kyphosidae) although they are suspected of spawning in aggregations (Sadovy de Mitcheson and Colin 2012).

Rhodes (2003) reported *Kyphosus bigibbus*, *K. cinerascens*, and *K. vaigensis* in large aggregations in the western Pacific and on an outer reef slope off Pohnpei, Micronesia, and Yamaguchi et al. (2011) reported that *K. bigibbus* were reproductively active only during June through October off the reefs of Kyushu, Japan. These reports were based on the collection of gravid females, but direct observations of spawning or spawning aggregations have not been published for any species in the family. Recently however, direct evidence of spawning has emerged. In the eastern Pacific, spawning and courting in the Cortez chub, *Kyphosus elegans*, was observed. Courtship behaviour was most evident in the afternoon and evening and occurred within groups of 20-100 fish (B. Erisman, personal communication). Putative males temporarily turned light grey with black spots covering their bodies during courtship periods. Spawning was observed at dusk during summer and fall months on shallow reefs in the southern Sea of Cortez. Similar behaviour in the rainbow chub (*Sectator ocyurus*) was also observed by Brad Erisman during the same months, times, and reefs as *K. elegans*. In the evening, *S. ocyurus* swim rapidly around in the open water over reefs in subgroups of 10-50 fish and one spawning rush was observed before dark in August 2010.

In the Caribbean, the Bermuda chub, *Kyphosus sectatrix*, was observed by divers on closed circuit rebreathers aggregating south of St. Thomas, United States Virgin Islands along a deep (40 m) shelf edge reef (Figure 1). They co-occur at this site in a multi-species aggregation along with yellowfin (*Mycteroperca venenosa*) and Nassau grouper (*Epinephelus striatus*) from January through March for about one to 12 days after the full moon (dafm). On 16 February 2012 (9 dafm) an aggregation of about 150 Bermuda chub swam approximately 10 m above the bottom. Two chubs (presumably a male and female) ascended rapidly approximately 5 m above the rest of aggregation in a spawning rush, released gametes and descended back into the aggregation (R. Nemeth, personal observation).



Figure 2. Mass spawning of Bermuda chub (*Kyphosus sectatrix*) near St. Thomas, US Virgin Islands. Note the two gamete clouds, one above the other.

This pair spawning was observed twice around 15:45. Later, during the same day, group spawning was observed and videotaped three times between 17:42 and 17:44 (R. Nemeth and E. Kadison, personal observation). The entire aggregation ascended as a long stream of fish from near the bottom at 40 m to about 15 m depth. **As the majority of chubs joined the aggregation the entire group of fish formed a very compact ball and began releasing massive amounts of sperm and eggs so that the entire ball of fish was nearly obscured by gamete clouds.** While about half the aggregation descended, the remainder ascended about 3 m and spawned again (Figure 2). Within a few seconds, the entire school of fish descended and began milling about 5 m above the bottom. This was repeated two more times over the next few minutes. Besides the two pair spawns earlier in the day, no apparent courtship was observed. Coloration of *K. sectatrix* changed slightly from its normal silvery state to a blackening of the caudal fin and outer margins of the anal and dorsal fins. **These recent observations have confirmed that certain kyphosids form spawning aggregations in the Caribbean and Pacific regions.**

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Yamaguchi, A., G. Kume, et al. (2011). Spawning season and size at sexual maturity of *Kyphosus bigibbus* (Kyphosidae) from northwest Kyushu, Japan. Ichthyological Research 58(3): 283-287.

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## Spawning aggregation research at Guam, Mariana Islands

Guam, an American territory located south of Japan and east of the Philippines, is the largest (549 km<sup>2</sup>) and southern-most island of the Mariana Archipelago, and is also the largest island in Micronesia. Research at the University of Guam Marine Laboratory on Guam's reef fish spawning aggregations began in late 1999 and has focused mainly upon species harvested by subsistence and artisanal fisheries. This research was prompted by declines in the number of species taken in local fisheries but also because of inadequate knowledge necessary to conserve and manage aggregation-spawning species.

My laboratory has been conducting surveys of two groups of transient aggregation species, groupers (*Epinephelinae*: genus *Epinephelus*) and large triggerfishes (*Balistidae*). Surveys on Guam's reefs include visual census using GPS transects (GPS density surveys) to estimate abundance and density of target species during new, full and quarter moon periods, and GPS-manta tow surveys to identify potential spawning aggregation sites. The latter method has proven especially useful for detecting individual benthic spawning triggerfishes, especially the titan triggerfish (*Balistoides viridescens*) and the yellowmargin triggerfish (*Pseudobalistes flavimarginatus*), across relatively large areas, as well as spawning aggregations and spawning aggregation sites of these species as identified by concentrations of nests. These surveys have been augmented with the use of bioacoustic telemetry to track grouper and triggerfish movements to trace the movements of titan triggerfish to and from a spawning aggregation site on the west coast of Guam. Regrettably, groupers are now uncommon in Guam's waters, due to overfishing, and surveys and biotelemetry tracking have failed to detect the presence of grouper spawning aggregation sites. So, emphasis is shifting to sonar searches of possible aggregations in deeper waters.

*Increasingly, our work has included mapping of spawning aggregation sites using GPS-linked side-scan and down-scan sonar to characterize the physical attributes of sites. We are also examining patterns of behaviour and mating systems at spawning aggregation sites. Ultimately, we hope the knowledge gained will be incorporated into the development and implementation of effective management and conservation strategies by local and federal government agencies.*

Research on resident spawning aggregation species has focused mainly upon parrotfishes (*Labridae*: *Scarinae*), including the bullethead parrotfish (*Chlorurus sordidus*), the yellowband parrotfish (*Scarus schlegelii*), and the palenose parrotfish (*S. psittacus*). Using a combination of GPS-transects and GPS-manta tows, we have mapped the locations, relative sizes, and habitat characteristics of these species' aggregation sites, as inferred from observations of courting males during morning hours. Although individuals may court and spawn independently of an aggregation site, aggregations likely account for a significant amount of reproduction for these species. But they are not common in Guam's waters and tend to be limited to certain locations and habitat types. We are also engaged in locating other fish species' aggregation sites including surgeonfishes (*Acanthuridae*), rudderfishes (*Kyphosidae*) and snappers (*Lutjanidae*).

Support for our work has come from the U.S. Fish & Wildlife Service, the U.S. National Oceanographic and Atmospheric Administration, the U.S. National Park Service, the Guam Division of Aquatic and Wildlife Resources, and the Guam Coastal Management Program.

### **Terry J. Donaldson**

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**Establishing the population size of adult bumphead parrotfish (*Bolbometopon muricatum*) in Isabel Province, Solomon**



Fig. 1. Survey area (Map by Nate Peterson)

Photos supplied by Rick Hamilton



Fig. 2. Survey team



Fig. 3. GPS mounted on a floating device

*Diver pulling the rope attached to the floating device*



The coral reefs and lagoons in Kia District, Isabel Province, Solomon Islands, support high abundances of bumphead parrotfish, *Bolbometopon muricatum*. In the Kia District bumphead parrotfish also form the basis of a small scale nighttime spear fishery, which has provided an important source of income for rural communities over the past two decades. To help evaluate the sustainability of the existing fishery we conducted a two-week underwater visual census of this species in northern Isabel between the 14-28th of October 2012.

The survey was coordinated by The Nature Conservancy and the Isabel Provincial Fisheries Department. We conducted 150 SCUBA dives over approximately 200 km<sup>2</sup> of reef that make up the Kia District bumphead parrotfish fishing grounds (Figs. 1, 2). We sampled five reef strata (fringing reef, patch reef, back reef, fore reef and sub tidal reef flats). Survey sites were determined in advance by Don Stevens using a Generalized Random Tessellation Stratified (GRTS) variable probability design (Stevens & Olsen, 2004). SCUBA divers recorded on underwater paper both the size and number of bumphead parrotfish sighted during a 20-minute timed swim. Each dive was conducted by two divers, one counting fish while a second diver towed a floating GPS which recorded the location and distance surveyed (Figure 3).

Preliminary results indicate that the adult (> 60 cm TL) bumphead parrotfish population in the entire Kia fishing grounds consists of approximately 25,000 fish. Some areas supported much higher abundances than others, which appear to relate to different levels of historical fishing effort, highlighting the vulnerability of this species to fishing. **The species is particularly vulnerable to fishing not because of congregatory spawning but largely because it forms highly predictable nocturnal resting aggregations in shallow water. Precautionary recommendations such as banning fishing in lagoons (where juvenile bumphead parrotfish reside) and, establishing large managed areas where night spearing is banned are currently being discussed with local stakeholders and government officials.**

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# PERSPECTIVES

## *Nassau grouper yet again: symbol of more to come?*

The threatened Nassau grouper, continues to decline throughout its geographic range. Unaddressed and newly emerging threats are set to worsen the situation (Sadovy de Mitcheson 2012). And yet, as the species disappears from fisheries, there appears to be less interest to do anything to help the species to recover. Does failure to find the means and political will to save the Nassau grouper set the scene for sequential loss of the next most vulnerable species? If so, there are serious consequences for food security down the line for many communities in the Caribbean region, and ongoing threats to marine ecosystem biodiversity. The Nassau grouper is testing our ability to tackle the core challenge of fishery management; balancing current use against long-term population maintenance. Time will tell whether this iconic species also comes to symbolize our ability, or otherwise to manage our seas.

Moreover, additional possible threats are emerging. As demand for seafood grows globally and wild fish populations of favoured reef fish species decline in many areas, several new activities have significant potential to add to the pressures of overfishing if

management does not contain them. Compressor-supply diving is being considered or introduced to extend fishing depths and in search of high commodity export items such as sea cucumber (beche de mer). This opens up areas previously inaccessible to traditional fishing gear, remaining natural refuges for many species, and is easily co-opted to other fishing sectors. International trade is ever easier due to improving transport links and demand is increasing for wild fish with a wealthy customer base that makes expensive air transportation economically viable (examples are the shark fin and live reef food fish trades of Chinese communities) (Sadovy de Mitcheson 2012). As stocks of favoured finfish species decline, pressure grows to catch undersize fish and retain them in captivity until they reach market size, as is seen extensively in Southeast Asia. This practice, known as fattening, ranching or capture-based aquaculture might be introduced in the Caribbean, if economically viable, where it could drive further growth and recruitment overfishing.

Sadovy de Mitcheson, Y (2012) Status update: The NASSAU GROUPER, I. Report to the Caribbean Fishery Management Council, San Juan, Puerto Rico. 70 pp



# NEW PUBLICATIONS



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Archer S.K., S.A. Heppell, B.X. Semmens, C.V. Pattengill-Semmens, P. Bush, C.M. McCoy, B.C. Johnson (2012) Patterns of color phase indicate spawn timing at a Nassau grouper *Epinephelus striatus* spawning aggregation. *Current Zoology*, 58 (1): 73-83

Armstrong M.P., M.J. Dean, W.S. Hoffman, D.R. Zemeckis, T.A. Nies, D.E. Pierce, P.J. Diodati, D.J. McKiernan (2013) The application of small scale fishery closures to protect Atlantic cod spawning aggregations in the inshore Gulf of Maine. *Fisheries Research*, 141: 62-69

Bijoux J., L. Dagorn, J. Robinson (2012) Comparison of spawning aggregation dynamics of brown-marbled, *Epinephelus fuscoguttatus*, (Forsskal, 1775) and camouflage grouper, *E. polyphemus*, (Bleeker, 1849) at a mixed-species aggregation site. Chapter 8 in: Robinson, J, and Samoilys MA (eds). (in press) Status and Management of Reef Fish Spawning Aggregations in the Western Indian Ocean. WIOMSA/SIDA/SFA/CORDIO.

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