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MESSAGE FROM THE CHAIRs

Greetings All!

We are happy to issue the 15th Newsletter of the GWSG. Thank to the editors and to all who have taken the time to submit entries. The stories included reflect the many and diverse aspects of the work of the SG members, individually and together. Members have been busy publishing something so important for getting our work out and be heard. Not all of their work is reflected in this newsletter but much can be seen in their publications.

Activities completed or in progress range from a focus on individual species to improve or redo red list assessments at the global level (e.g. *Epinephelus itajara* and *Cheilinus undulatus* are being reassessed and several newly described species of grouper are being assessed for the first time) or regionally (Asian assessments). Ongoing work aims to address implementation of CITES II trade controls on *Cheilinus undulatus* through participation at the recent CITES meeting in Panama, and development of a facial recognition phone app tool for individual identification by enforcement officers in Hong Kong. The Fishery Management Plan in the Caribbean for two aggregating species, including *E. striatus*, was finalized by the FAO and implementation planning is ongoing.

We have had several opportunities to provide SG input in situations where robust scientific support for conclusions drawn was lacking and which threatened to lead, or did lead, to misleading conclusions or outcomes. These included provision of comments to WWF-Fiji on a recently released report that claimed an increase in groupers over about 2 decades but presented insufficient evidence; WWF modified their press release. Worryingly, the best available science has not been applied to the opening up of a fishery for *E. itajara* in Florida, with concerns that this species will be, yet again, further threatened. Our input, along with that of many other experts, was ignored and the fishery has just opened.

Other initiatives showcase some of the breadth of work being done on our lovely taxa. We are particularly pleased to see JP Barreiro's book of his wonderful grouper illustrations finally published, accompanied by an exhibition in the Azores. Work in Taiwan has built support for citizen science in the spearfishing sector. It is so important for the fishing community to become a part of what we are doing. Saudi Arabia is one of few countries that we are aware of where large *C. undulatus* can be found in local markets, and guest writer Song He tells us of his construction of its skeleton and its educational appeal and travels. We are challenged to think, yet again, about little understood migrations of *Mycteroperca bonaci,* about the importance of knowing and fully protecting short aggregation seasons, and to marvel at how much information some grouper otoliths can give us – if only we look carefully!

Our SG is only as good as what we do as members, both individually and collectively. So, finally, another call for everybody who can contribute to Sean Fennessy's important initiative to help understand the relationship, if there is any, between management plans, species threat level and outcomes of measures in place. Please support Sean to help understand how such relationships play out. We could all benefit in our work from knowing.

Yvonne Sadovy and Matthew Craig
Co-Chairs GWSG

This Issue:

IUCN SSC Species Survival Commission

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#15

Sagittae Shape Analysis in Various Grouper Species (Epinephelidae)

Shape analysis of the sagittal otolith of grouper species (Epinephelidae) from the northern coast of the Yucatan Peninsula, Mexico

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Otoliths are hard structures, composed of calcium carbonate, located in the inner ear of teleost fishes. They are responsible for equilibrium, acceleration, and sound transduction. Scientists have used these structures to understand the age, growth, and other aspects of life history (such as larval life, changes of habitat, recruitment and sexual maturation) of fishes. The growth rates of otoliths can be influenced by differences in size of the skull, endolymphatic sac, metabolic rates, among other factors. Therefore, scientists have used otolith shape for taxonomic, paleontological and trophic studies, and also for stock identification (Parisi-Baradad et al. 2005). Otoliths are paired structures, known as sagittae, lapilli and asteriscus, the sagittae (singular sagitta) being the largest and most widely used of the three pairs in sclerochronology studies. Sagittae are considered the hearing end organ due to their sensitivity to higher frequency sounds (Tuset et al. 2015). Even though the sagittal otolith shape is influenced by endogenous (genetic) and exogenous (environmental) factors (Cardinale et al. 2004), the latter seem to influence growth rate and therefore contribute to variations in shape. Sagittal otolith shape, therefore, can be an extremely useful tool to determine ecological and zoogeographic relationships in fishes, among other things.

In the southern Gulf of Mexico, about 20 grouper species (Epinephelidae, Epinephelinae) are distributed across the continental platform of Campeche Bank, off the northern coast of the Yucatan Peninsula, Mexico. While the Red, *Epinephelus morio*, the Black, *Mycteroperca bonaci,* and the Gag, *Mycteroperca microlepis*, groupers are the target species of the Red grouper fishery of Yucatan, many other groupers are also commercially exploited (Brulé et al. 2009, SAGARPA, 2014). The mean annual catch volume from the southern Gulf of Mexico and Mexican Caribbean Sea has reached 11,243 t, of which the Yucatan state coast contributes 60% of the landings (5, 715 t). Approximately 11, 844 fishers in Yucatan depend on this fishery, generating more than 25 million of US dollars from exports (SAGARPA, 2014; CONAPESCA, 2018).

Despite the economic and ecological importance of groupers in this geographic region, there is a lack of biological information on many exploited species, especially deep-water groupers. Theoretically, the adaptation of species to different water depths and to strategies to capture prey in different habitats may be reflected in their otolith shape (Tuset et al. 2015). This work briefly describes the relationships between depth and bottom type and otolith shape for multiple groupers in the southern Gulf of Mexico .

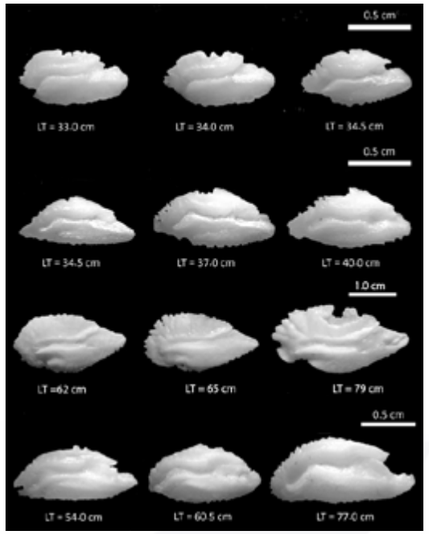

Figure 1. Sagittae of four grouper genera. Top to bottom: *Cephalopholis fulva, Epinephelus adscensionis, Hyporthodus flavolimbatus* and *Mycteroperca venenosa* showing differences in otolith shape within species due to ontogenic growth. LT: Total fish length.

We analyzed 464 sagittal otoliths from 16 grouper species (Escalante 2021), including *Cephalopholis fulva, Epinephelus adscensionis, E. drummondhayi, E. guttatus, E. morio, E, striatus, Hyporthodus flavolimbatus, H. mystacinus, H. nigritus, H. niveatus, Mycteroperca bonaci, M. interstitialis, M. microlepis, M. phenax, M. tigris* and *M. venenosa.* Among the environmental factors considered which are known to influence otolith shape in groupers are depth (1. Shallow, 2. Shallow-Medium, 3. Medium, and 4. Deep) and bottom type (1. Coral reefs, 2. Rocky reefs, 3. Hard bottoms, 4. Muddy bottoms, 5. Limestone slab bottoms, and 6. Sandy bottoms). The procedure analyzed the otolith shape involved including 21 morphometric and shape indices, and a description of the sulcus acusticus. These data were extracted from digital photographs using the Image Pro Plus software. A PERMANOVA analysis (999 permutations) was used to assess differences in otolith shape according to the following factors: grouper genus, depth and type of bottom. A Bootstrap average and Multi-Dimensional Scale (MDS) was used to compare the levels of each factor. SIMPER analyses were then performed to establish the euclidean distance between discriminating factors.

Our work allowed us to determine that *H. flavolimbatus* and *C. fulva* had the largest and the smallest sagittal otoliths, respectively (Escalante 2021). The most irregular otoliths were those of *E. morio*. Otoliths of *C. fulva, H. flavolimbatus* and *M. interstitialis* showed a rectangular shape, whereas *E. morio* and *M. phenax* showed rounder shapes. Nevertheless, individual variations by otolith morphometrics for each grouper species did not reveal a species-specific shape pattern (Fig. 1). Individual variations were observed in the post rostrum and post antirostrum of the otolith related to ontogenetic growth. A PERMANOVA analysis showed differences among the four genera, *Epinephelus, Mycteroperca, Hyporthodus, Cephalopholis* (Pseudo-F= 56.41; df= 3 & 409; P(perm)= 0.01), while the MDS analysis discriminated amongst them clearly, with otoliths of *Cephalopholis* spp. and *Hyporthodus* spp. showing the greatest distances (Fig. 2A).

Depth (Pseudo-F= 86.19; df= 3 & 409; P(perm)=0.001) and bottom type (Pseudo-F= 52.10; df= 7 & 405; P(perm)= 0.001) are associated with differences amongst otoliths, showing the greatest distance between otoliths of species from shallow and deep waters (Fig. 2B), and between species inhabiting coral reefs/rocky reefs and muddy/slabby/sandy bottoms (Fig. 2C). According to SIMPER analyses, the area of sulcus acusticus, ostium and cauda were the otolith features contributing the most to the discrimination between the tested factors in *E. morio, M. bonaci, M. microlepis,* and deep-water species such as *H. flavolimbatus, H. mystacinus* and *H. nigritus* with the biggest sulcus. A bigger ostium increases hearing capabilities because there is an augmentation in the proportion of horizontal-oriented sensory hair cells (Tuset et al. 2015). Additionally, a larger sulcus acusticus area in relation to otolith area might be related to fish movements between different habitats, depths or in search for food. These movements would create intense physical contact between the sensory hairs of the macula and the sulcus acusticus (Arellano et al. 1995). This is consistent to our findings, in the Campeche Bank, where *E. morio, M. bonaci* and *M. microlepis* had the largest sulcus area: otolith area ratio and change habitats from nearshore seagrass beds as juveniles to offshore rocky complex areas as adults.

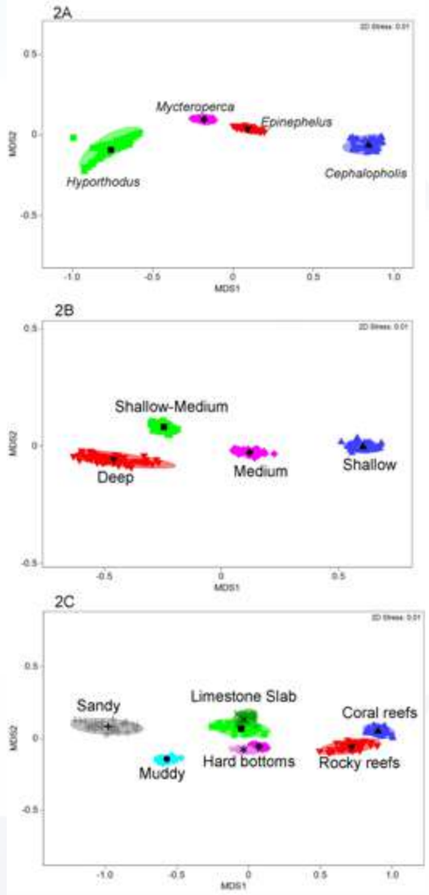

Figure 2. Bootstrap average and MDS arrangement diagram of Euclidean distances of sulcus acusticus morphometrics from factors in PERMANOVA: (A) Genera (B) Depth and (C) Type of bottom.

Fish species with bright colorful skin patterns, such as those displayed by *C. fulva, E. adscensionis, E. guttatus, E. striatus, M. tigris* and *M. venenosa* had smaller otoliths, which suggests a predominant visual communication between species which may be helpful in noisy areas, such as coral reefs where these species inhabit (Lombarte et al. 2010).

Results of this work are part of Andy Manuel Escalante (2021). Otolith shape analysis in diverse species of groupers from the Campeche Bank (Análisis de la forma de otolitos sagittae de diversas especies de mero (Epinephelidae) del Banco de Campeche [master´s thesis]. CINVESTAV IPN Unidad Mérida. México.

References

Arellano, R. V., Hamerlynck, O., Vincx, M., Mees, J., Hostens, K., & Gijselinck, W. (1995). Changes in the ratio of the sulcus acusticus area to the sagitta area of *Pomatoschistus minutus* and *P. lozanoi* (Pisces, Gobiidae). Marine Biology, 122(3), 355-360.

Brulé, T., Nóh-Quiñones, V., Sánchez-Crespo M., Colás-Marrufo, T. & Pérez-Díaz, E. (2009). Composición de las Capturas Comerciales del Complejo Mero-pargo en el Sureste del Golfo de México e Implicaciones para el Manejo de su Pesquería. Gulf and Caribbean Fisheries Institute 61: 198-209.

Cardinale, M., Doering-Arjes, P., Kastowsky, M., & Mosegaard, H. (2004). Effects of sex, stock, and environment on the shape of known-age Atlantic cod (Gadus morhua) otoliths. Canadian Journal of Fisheries and Aquatic Sciences, 61(2), 158-167.

CONAPESCA. (2018). Anuario Estadístico de Acuacultura y Pesca. Comisión Nacional de acuacultura y pesca. https://www.gob.mx/conapesca/documentos/anuarioestadistico-de-acuacultura-y-pesca

Escalante AM. (2021) Otolith shape analysis in diverse species of groupers from the Campeche Bank (Análisis de la forma de otolitos sagittae de diversas especies de mero (Epinephelidae) del Banco de Campeche) [Master´s thesis]. CINVESTAV IPN Unidad Mérida. México.

Lombarte, A., Palmer, M., Matallanas, J., Gómez-Zurita, J., & Morales-Nin, B. (2010). Ecomorphological trends and phylogenetic inertia of otolith sagittae in Nototheniidae. Environmental Biology of Fishes, 89(3), 607-618.

Parisi-Baradad, V., Lombarte, A., García-Ladona, E., Cabestany, J., Piera, J., & Chic, O. (2005). Otolith shape contour analysis using affine transformation invariant wavelet transforms and curvature scale space representation. Marine and freshwater research, 56(5), 795-804.

SAGARPA. (2014). Acuerdo por el que se da a conocer el Plan de Manejo Pesquero de Mero (*Epinephelus morio*) y especies asociadas en la Península de Yucatán. [Agreement to notify the Red Grouper (*Epinephelus morio*) and associate species' fishing management plan of Yucatan Peninsula]. Pp. 23-98.

Face to Face with Groupers – a new book

A different perspective on groupers through scientific illustration techniques in Portugal

João P. Barreiros

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In our last Newsletter, I published a short note announcing my new book "Face to Face with Groupers". The book is finally completed and I have begun its distribution worldwide. Although I was always shy when talking about my own work illustrating groupers, I realized that, for many people, it is a novelty. I hope that you are all able to get a copy to enjoy a different perspective on groupers through scientific illustration techniques, portraying them as if they were alive and interacting with the reader – at least, I tried to show them in this way.

The official inauguration (26 March 2022) was held in the Museum of Angra do Heroísmo, Azores, Portugal, where I also inaugurated an exhibition on 22 January 2022 of some of the original drawings used in the book. The feedback, from both fellow scientists and, perhaps more importantly, from the public, was great. I hope this artistic perspective is contributing towards a better understanding by people that groupers are not just a food resource for fishing but also amazing and often beautiful fishes. Sure, they are tasty – but many exploited grouper species require adequate monitoring and protection measures for their populations to persist. The exhibit travelled to other Museums in the Azores and went to the National Museum of Natural History in Science in Lisbon later in 2022.

The book is bilingual (Portuguese/English) and is available from the publisher's website at https://www.letraslavadas.pt/meros-do-mundo/.

Besides the illustrations, the book includes data on basic ecology and distribution for each of the 50 species portrayed and additional information on occurrence, fishing pressure, distribution, and biological characteristics. Yvonne Sadovy was very kind in writing the book's Foreword.

References

Barreiros, J.P. (2022). Meros do Mundo – Uma Colecção de Retratos/ Face to Face with Groupers – A collection of portraits. Edição Bilingue/Bilingual (Português/ English). Letras Lavadas, Edições, Ponta Delgada. 125pp. ISBN 978-989-735-369-7.

Reducing Illegal Trade

Saving a Fish by its Face to Reduce its Illegal Trade

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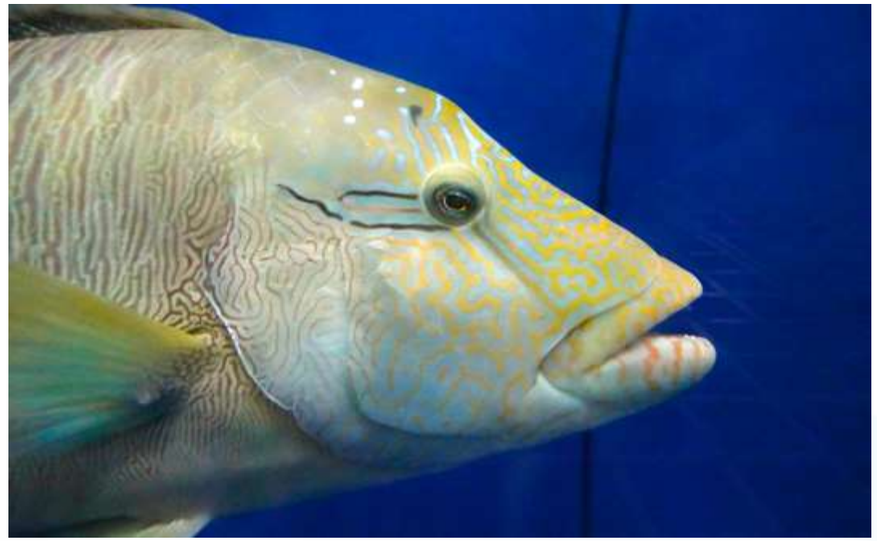
It is probably only those who are truly passionate about fish who may think about them as individuals. And even among their most ardent fans I know few people who give names to fish, other than, perhaps, to favourite aquarium or dive site residents. One reason for this is that for any given species, fish are not easy for us to tell apart, to distinguish one from the other. But there are a few noteworthy exceptions which we can also use to advantage.

A big fish, and a big exception, is the Napoleon (or Humphead) wrasse, *Cheilinus undulatus*. This massive fish of the family Labridae, reaching more than 1.5 m and 30 years of age, is among the largest of all reef-associated dwellers. It is also one of the most highly valued fishes in the live seafood trade, which supplies a heavy demand for luxury seafood in Hong Kong and mainland China. Retail prices of these highly desired fishes (mainly groupers with some wrasses and snappers) can reach $850 USD per kilo, in the case of Napoleon, in top-end restaurants. Napoleon is naturally rare throughout much of its

Humphead wrasse facial patterns. Note that left (upper) and right (below) face sides of the same fish have different markings. Photos taken at Ocean Park aquarium, shown in next page, Hong Kong. Fish face photos by Loby Hau.



References

Hau, C. Y. & Sadovy de Mitcheson, Y. (2019). A facial recognition tool and legislative changes for improved enforcement of the CITES Appendix II listing of the humphead wrasse, Cheilinus undulatus. Aquatic Conserv: Mar Freshw Ecosyst 29 (12):2071-2091 DOI: 10.1002/ aqc.3199

distribution. The high interest from traders to source and sell it has pushed populations down in most countries that export it. The Napoleon wrasse was listed on the Convention on International Trade in Endangered Species of Flora and Fauna (CITES) App II in 2004 requiring that its international trade is kept within sustainable levels and does not threaten its populations. Many countries stopped exporting it altogether due to this listing and because they either could not control the trade or local fish numbers were too low. During the last decade or so, the only legal trade source has been Indonesia, with Hong Kong/ mainland China as the major importer. Under CITES, trading countries (known as Parties) are required to report all legal fish traded annually.

While progress has been made to reduce trade to levels that pose much less of a threat to Napoleon's wild populations than in the past, illegal trade has continued. We know this latter is happening in Hong Kong, where more animals are found on sale than have been legally imported into Hong Kong markets. Napoleon is still regularly sold in mainland China despite no records of imports and notwithstanding its recognized Class II protected status (since 2019). To implement CITES in Hong Kong there are government inspection officers who regularly check retail outlets (shops displaying the fish to the public) that sell this fish to ensure that sales are legal. Although each outlet has a legal limit to the maximum number of fish it can sell, they can easily get around the law by laundering illegal imports as legally imported fish (the fish are not tagged), as long as they never have more than their allocated maximum on show in their shops at the same time.

Since Napoleon in trade are not tagged individually it is not possible to distinguish among different fish of the same size (most are sold in the 35-45 cm length range) and hence to separate legal from illegal imports. However, a set complex and beautiful facial markings characteristic of this species are not only individually distinguishable, but the distinctive patterns remain the same for years. Left and right sides of the same fish can have very different markings (Hau and Sadovy de Mitcheson 2019).

To test whether Napoleon's own face could provide individually identifiable 'fingerprints' to aid enforcement of controls on its trade a series of studies and software developments were funded. Fish were kept in a local public for almost three years to test the consistency of the facial markings. Two young tech start-ups were contracted from the University of Hong Kong, partly funded by Ocean Park Conservation Foundation Hong Kong (a theme park with a large public aquarium), to develop a facial recognition model for this species. This model has been integrated it into a novel mobile phone app for use by both the general public and by government law enforcement officers of the Agriculture, Fisheries and Conservation Department (AFCD).

The app was released under the name of 'Saving Face' in Hong Kong for Beta testing and is now undergoing improvements. The app processes photos taken by the phone, or uploaded from a gallery, so could be used on fish photographed in the field or by a separate camera. The app has been trialed by enforcement officers, and the Hong Kong government CITES office has now requested the programme app interface be adapted for their use because officers found the app suitable and practical for monitoring individual fish. By comparing photographs of legally imported Napoleons, and then photographing fish in the same outlet later on, they (and members of the public too) can detect whether there have been changes in the individually distinctive animals sold, irrespective of numbers of fish on sale. Since the Napoleon only stays a few weeks in the retail outlets, inspections done monthly should readily be able to detect any possible laundering.

The app is now precise enough for enforcement, with ongoing work to increase the model's precision. Its use obviates the need for a physical tag, which could be stressful for the fish and unpopular with traders. The hope is to have a thriving and legal trade that does not threaten the Napoleon and continues to bring benefits to people.

Additional information

https://hakaimagazine.com/news/hong-kongs-napoleon-wrasse-complex/

https://www.scmp.com/author/simon-parrv

Facebook link:
https://www.facebook.com/hhwwatch/photos/a.172194700808704 2/3213910298890698

Is there Hope for Nassau grouper?

"Island of hope for the threatened Nassau grouper" by Yvonne Sadovy de Mitcheson

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In February 2020, Yvonne Sadovy de Mitcheson published a commentary in the journal PNAS (see reference below), which sheds some "light of hope" for the Nassau Grouper, *Epinephelus striatus* (Bloch, 1792) stemming from successful work in the Cayman Islands and recently published by Waterhouse et al. (2020) .

In her commentary, Yvonne briefly describes how, once abundant and healthy populations of this grouper in the 1970's and 1980's in The Bahamas, were subsequently overfished for decades by artisanal and traditional fisheries. Such heavy exploitation occurred as a result of fisheries adopting better technology, growing commercialization and an increase in the grouper's market value alongside weak management and lack of adequate monitoring of the fishery to understand trends in catches. This fishery situation led to the loss of an estimated 30 to 50 known spawning aggregation sites in the Bahamas, including some that were once famous at the time (Erisman et al., 2013). Without aggregation for spawning, the species does not reproduce and so the fish numbers declined leading to smaller and smaller catches.

However, in the Cayman Islands Waterhouse et al. (2020) revealed how efficient MPA's with adequate enforcement of protective measures can boost grouper numbers, allowing population recovery at protected spawning aggregation sites. This scenario in the Cayman Islands could readily easily be followed and applied in other geographic locations and countries where this grouper was once plentiful – from Belize and Mexico eastwards to the Dominican Republic and Puerto Rico, and beyond. In these countries, some fishery restrictions and fishing ban periods are in place, along with other measures, such as minimum sizes, which should help to improve grouper populations. However, these measures are typically poorly enforced with little or ineffective surveillance and monitoring.

Sadovy provides a powerful statement about spawning aggregations of the Nassau grouper in her commentary when referring to the potential for Nassau grouper recovery: "These fragile life-history events are saveable, with the Little Cayman spawning aggregation now the largest one currently known for this species, and merit the attention and commitment needed to preserve them and to ensure the future of the Nassau grouper".

Yes, there is definitely still hope for the Nassau grouper.

References

Erisman, B., McKinney-Lambert, C., Sadovy de Mitcheson, Y. (2013). Sad Farewell to C. Lavett-Smith's Iconic Nassau Spawning Aggregation Site. Proceedings of the 66th Gulf and Caribbean Fisheries Institute November 4 – 8, 2013 pp. 421-422

Sadovy de Mitcheson, Y. (2020). Island of hope for the threatened Nassau grouper Proceedings of the National Academy of Sciences, 117(5): 2243-2244 www.pnas.org/cgi/doi/10.1073/pnas.1922301117

Waterhouse, L. et al., (2020) Recovery of critically endangered Nassau grouper (*Epinephelus striatus*) in the Cayman Islands following targeted conservation actions. Proc. Natl. Acad. Sci. U.S.A. 117, 1587–1595.

Reassessing the Atlantic Goliath Grouper

An initiative to reassess the global population of the Atlantic Goliath Grouper *Epinephelus itajara*

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We are embarking on a global update of the conservation status of the Atlantic Goliath Grouper (AGG) *Epinephelus itajara*. The justification for this update is the recent decline of AGG in the United States (US) and in Brazil. Primary causes of US declines include an extreme cold event that occurred in 2010 and annually occurring red tide events in coastal waters. In Brazil, the primary cause of decline is rampant poaching. While Bertoncini et al. (2018) conducted a review 5 years ago, much additional data have emerged since then to justify an update.

Epinephelus itajara is a subtropical-tropical species that cannot tolerate water temperatures below 15°C (Sadovy and Eklund 1999). In the winter of 2010, water temperatures in coastal South Florida fell below 5°C for 14 days, resulting in the deaths of most juveniles and adults living in mangrove habitat. Juveniles mature at 5 to 6 years of age which is when they start to migrate offshore to recruit to adult populations. Their deaths not only eliminated recruitment for 2011, but caused it to persist for at least the following five years. Recruitment rates to adult offshore habitat showed no signs of recovery until 2018 or 2019.

Recurring harmful algal blooms (HABs) of the dinoflagellate *Karenia brevis* and associated hypoxia primarily on the West Florida Shelf (USA) are responsible for periodic massive fish kills largely affecting groupers, drums, and crabs (Turley et al. 2022). An extreme HAB occurred in 2018 causing massive kills of many species, including both juvenile and adult AGG. In 2021, a large fish kill occurred in Tampa Bay that included various age classes of AGG. This particular event appears to have been fed by millions of gallons of contaminated wastewater released in April from an old phosphate fertilizer plant, exacerbating the regional outbreak of red tide, a type of HAB.

Along the Brazilian coast, despite a moratorium implemented in 2002, fishing of AGG continues (Giglio et al. 2014). Indeed, poaching seizures have been reported by the National Environmental agencies (i.e., IBAMA), including a single seizure of AGG in March 2021 of two tons, which suggests that spawning aggregations (the only times that the species are known to spawn) are being targeted by poachers. Smaller seizures occurring during austral summer months are consistent with the timing of spawning aggregation formation.

Although AGG population recovery ensued following full protection for them in the 1990s in the US and in 2002 in Brazil, events such as persistent cold temperatures, large-scale HABs, unfettered poaching, diminished water quality, the loss of essential juvenile habitat, and, most recently, a rule by Florida Fish and Wildlife Conservation Commission to allow a limited harvest of juvenile AGG in state waters (FWC 2022), starting in March 2023, makes full recovery of these populations uncertain.

We continue to obtain data by contacting colleagues and agencies worldwide who work on AGG and reach out to the IUCN Species Survival Commission Groupers & Wrasses Specialist Group. If you have information, or can provide any guidance, please let us know by contacting fcoleman@fsu.edu. Many thanks in advance for your interest and help..

The Atlantic Goliath Grouper *Epinephelus itajara*. Photo Walt Stearns.

References

FWC. 2022. FWC approves limited recreational harvest of goliath grouper in state waters. https://myfwc.com/news/all-news/goliath-comm-322/ (accessed 10 August 2022).

Giglio VJ, Bertoncini AA, Ferreira BP, Hostim-Silva M, Freitas MO (2014) Landings of Goliath Grouper, Epinephelus itajara, in Brazil: despite prohibited over ten years, fishing continues. Nat. Conservação 12:118–123

Sadovy, Y., and A. M. Eklund. 1999. Synopsis of biological information on the Nassau Grouper, Epinephelus striatus (Bloch 1792), and the Jewfish, E. itajara (Lichtenstein 1822). NOAA Technical Report NMFS 146:1–65. https://www.nrc.gov/docs/ML1224/ML12240A298.pdf

Turley, B. D., Karnauskas, M., Campbell, M. D., Hanisko, D. S., & Kelble, C. R. (2022). Relationships between blooms of Karenia brevis and hypoxia across the West Florida Shelf. Harmful Algae, 114, 102223.

A Perilous Blunder

Florida Fish and Wildlife Conservation Commission in United States Ignores Best Available Science to Open Fishery for Atlantic Goliath Grouper

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FCC retired from the FSUCML where she holds a Courtesy Faculty position.
CCK retired from the FSUCML.

"The Atlantic Goliath Grouper AGG, E*pinephelus itajara*, a large and indigenous, tropical reef fish, approached local extinction in the U. S. waters by the 1980s due to intense fishing pressure. In 1990, federal and state laws intervened to protect AGG. The resulting fishery closure, over the following years, allowed limited but slow population recovery in Florida waters, while populations outside of the U.S. remained vulnerable (IUCN: Bertoncini et al. 2018). The closure led to the blossoming of a dive ecotourism industry catering to local and international divers seeking opportunities to see and photograph these enormous fish. This scenario fundamentally changes the paradigm for AGG from a fishery resource to a non-extractive resource with a commercial value vastly greater than that gained through fishing." Koenig et al. 2020.

For years, the Florida Fish and Wildlife Conservation Commission (FWC) has tried to re-establish a fishery for the iconic, native AGG *Epinephelus itajara* (Figure 1), calling for three separate stock assessments between 2011 and 2020. All of these assessments were rejected after peer review, which prompted us to write a review about the ongoing controversy surrounding its protection and the drawbacks of re-establishing a fishery.

The FWC has demonstrated a complacency towards evidence-based, peer-reviewed science that is considered the best available scientific information. This has become an all-too-common phenomenon recently among state management and conservation organizations, thereby leading to decisions that do little to protect natural communities (Sutherland and Wordley 2017), the very aspects of which the FWC commissioners are directed to protect. A few examples highlight these concerns.

Figure 1. Adult Atlantic Goliath Grouper *Epinephelus itajara*, off southeast Florida coast, United States. Photo courtesy of Walt Stearns.

1. The FWC provided no scientific basis for, or rebuttal to, the flawed public perception that native AGG are non-native, but invasive and destroying reef ecology and the populations of other species in the snapper-grouper complex. The best available science shows that AGG, both juveniles and adults, eat primarily crabs and slow-moving fishes (Figure 2), and that they can locally enhance habitat complexity as well as the biodiversity and abundance of species through habitat engineering (Koenig & Coleman 2009, Koenig et al. 2011).

2. Recovery of AGG populations is hampered by;

a. tremendous loss (80-90%) of essential nursery mangrove habitat (where these fish live for 5-6 years before recruiting to adult populations),

b. increasingly destructive episodic eutrophication events in coastal waters – the primary acute symptoms of which are hypoxia and harmful algal blooms, such as red tide (Figure 4) that kills all age classes of AGG and many other species,

c. a cold snap in the Everglades National Park in 2010 killed more than 90% of resident juveniles (ages 1-6 years old), with no recovery at all after 7-8 years. (Note that AGG juveniles succumb to water temperatures below 15°C (59°F), which now occur on about a ten-year cycle in shallow waters of South Florida)

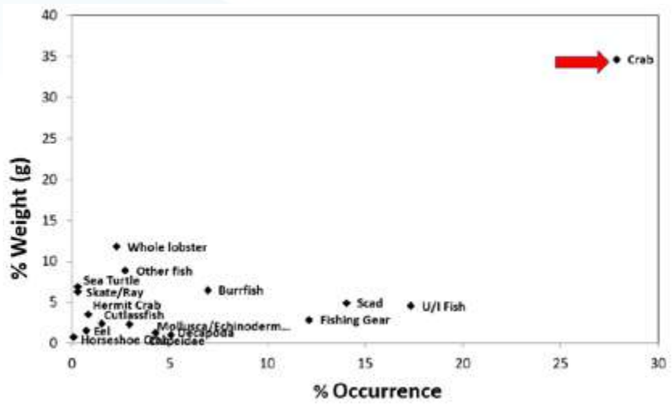

Figure 2. Adult Atlantic Goliath Grouper *Epinephelus itajara* diet (N=408) shows that the primary diet is composed of different species of crabs (Koenig and Coleman 2016, Malinowski 2019b).

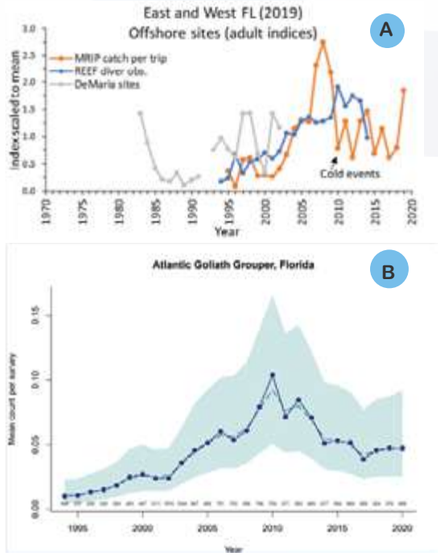

Figure 3. Trend in Florida Atlantic Goliath Grouper *Epinephelus itajara* population abundance upper panel shows the National Oceanic and Atmospheric Administration's (NOAA) Marine Recreational Information Program (MRIP) data through 2019 and the Reef Environmental Education Foundation (REEF) data through 2015 (FWC 2020). Note however in the lower panel that REEF data existed through 2020 (figure by Dan Greenberg, Ph. D., Research Associate).

d. the effects of mercury contamination on AGG health, reproductive potential, and survival (Koenig et al. 2020, Malinowski et al. 2021).

In addition, there is a human health risk associated with consuming fish, like AGG, that have excessively high mercury loads (Malinowski 2019a), and one would think that the argument to reopen the fishery would disappear. Yet, the FWC recently approved a limited fishery for juvenile AGG (https://myfwc.com/news/all-news/goliath-comm-322/) (which have lower mercury content than adults) beginning in March 2023, ignoring the overwhelming scientific data supporting continued protection for this species.

3. The FWC compared data from the National Oceanic and Atmospheric Administration (NOAA) Marine Recreational Information Program (MRIP) through 2019 with data from the Reef Environmental Education Foundation (REEF) through 2015 (Figure 3a). FWC, however, excluded REEF data that extended through 2020 (Figure 3b). While the NOAA data confirmed a population decline from 2009 through 2018 after the extreme cold event in South Florida in 2010, the uptick in 2019 not only contradicts the REEF survey (Figure 3b), but a single data point cannot be used to indicate an upward trend.

4. The FWC has provided no monitoring strategy for AGG populations to determine the effects of either the proposed fishery or of events over which they have no control, such as cold fronts or red tides detailed above, that further put into question the fate of this species under this Commission. The FWC stated that they expected a continued positive trend in population growth and minimal impact of a limited catch for AGG. Yet, during a massive red tide in 2021 in southwest Florida, the FWC could not determine its impact on AGG, which is known

References

Bertoncini, AA, A Aguilar-Perera, J Barreiros, MT Craig, B Ferreira, C Koenig. 2018. *Epinephelus itajara.* The IUCN Red List of Threatened Species. Available: http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T195409A145206345.en

Dayton PK, S Thrush and FC Coleman. 2002. Ecological effects of fishing in marine ecosystems of the United States. Pew Oceans Commission, Arlington, VA. 45 p.

FWC. 2022. Goliath Grouper. Final Rule March 3. 2022. p. 4. https://myfwc.com/media/28524/9a-presentation-goliathgrouper.pdf

Greening, H, A Janicki, ET Sherwood, R Pribble, JOR Johansson. 2014. Ecosystem responses to long-term nutrient management in an urban estuary: Tampa Bay, Florida, USA. Estuarine, Coastal and Shelf Science 151: A1-A16.

Figure 4. Map of mangrove habitat condition and water quality in major estuaries of South Florida (from Koenig et al. 2020).

to suffer high mortalities during such events. Thus, we question how FWC could state so confidently that catches would not affect their recovery, around which there remains far too much uncertainty.

5. The FWC left out essential information in statements they made about status changes for AGG by NOAA and the International Union for the Conservation of Nature (IUCN).

• The FWC pointed out that NOAA Fisheries in 2006 removed AGG from the Species of Special Concern list due to data showing an increase in abundance in the U.S. population. They neglected to mention two critical points: (1) that NOAA, following the Magnuson-Stevens Conservation Act, still considers AGG overfished and still prohibits fatal catch; and (2) the decision to remove AGG from the Species of Special Concern list occurred prior to the significant cold-water events and red tide that drove both the adult and juvenile populations down.

• The FWC pointed out that the IUCN in 2018 changed their listing of AGG on the Red List of Threatened Species from "critically endangered" to "vulnerable." What they neglected to include was the reason for the status change. According to the IUCN World Conservation Union Specialist Group on Groupers & Wrasses, the change followed a stricter application of the criteria used for IUCN Red List assessments and improved data interpretation; it was not due to any genuine change in status of the species.

6. The FWC will require permit holders for juvenile AGG catch to collect data on the date of catch, general location, and water depth where the fish was caught and the total length of the fish. They will also require the collection of a fin clip for genetic analysis. The FWC states that these data and biological samples would contribute data for evaluating the genetic diversity and genetic effective population size. Although this may be true, what they fail to mention is that these data and samples can easily be collected non-lethally by recreational catch-and-release fishers and by scientists without the need to kill individuals.

CONCLUSIONS AND RECOMMENDATIONS

Based on this brief review; it is clear that a fishery for AAG should not be opened in Florida at this time. AAG's full recovery depends on factors that need to be addressed immediately by relevant state agencies and other issues need consideration:

1. Reversing habitat loss and eutrophication in South Florida estuaries (Figure 4)– this action will increase production of Goliath Grouper (and many other fishery species) and reduce the destructive intensity of red tides. Tampa Bay, serves as an excellent example of how this can be approached (Greening et al. 2014, Koenig et al. 2020).

2. Conducting a thorough analysis of the age and size structure of the population to determine whether full recovery has occurred.

3. Shifting the burden of proof related to fishing impacts from managers to fishers to show that a fishery will not have unacceptable repercussions on either the intended target or any associated resources, including habitat (Dayton et al. 2002).

4. Promoting non-consumptive ecotourism diving industry in Florida with Atlantic Goliath Grouper as the flagship species, is a far better financial enterprise for the State of Florida, its citizens, and the ecosystems in which Goliath Grouper occur than the proposed fishery (Shidler and Pierce 2016, Koenig et al. 2020.

Koenig, CC, FC Coleman. 2009. MARFIN Project FINAL Report Population density, demographics, and predation effects of adult goliath grouper Project NA05NMF4540045 (FSU Project No. 016604) October 2006 - September 2009. http://www.reef.org/reef_files/SEDAR23_RD_19_GoliathFINAL.pdf

Koenig, CC, FC Coleman. 2013. The recovering goliath grouper population of the southeastern US: non-consumptive investigations for stock assessment. 2010 – 2013. Final Report to the National Oceanic and Atmospheric Administration NA10NMF4330123.

Koenig, CC, FC Coleman. 2016. Regional age structure, reproductive biology and trophic patterns of adult Goliath Grouper in Florida. MARFIN Project (NA11NMF4330123 NOAA/NMFS Final Report).

Koenig, CC, FC Coleman, K Kingon. 2011. Pattern of recovery of the Goliath Grouper *Epinephelus itajara* (Lichtenstein, 1822) population in the southeastern U.S. Bulletin of Marine Science 87:891–911.

Koenig, CC, FC Coleman, CR Malinowski. 2020. Atlantic Goliath Grouper of Florida: To Fish or Not to Fish. Fisheries, 45(1), 20-32.

Malinowski, C.R., 2019a. High mercury concentrations in Atlantic Goliath Grouper: spatial analysis of a vulnerable species. Marine Pollution Bulletin, 143, pp.81-91.

Malinowski, CR. 2019b. Spawning Patterns, Trophic Ecology, and Toxicology: Conservation-Related Research of an Iconic Reef Fish, the Atlantic Goliath Grouper. Doctoral dissertation, The Florida State University.

Malinowski, CR, NI Stacy, FC Coleman, JA Cusick, CM Dugan, CC Koenig, NK Ragbeer, NJR Perrault. 2021. Mercury offloading in gametes and potential adverse effects of high mercury concentrations in blood and tissues of Atlantic Goliath Grouper *Epinephelus itajara* in the southeastern United States. Science of The Total Environment 779:146437.

Shideler, GS, B Pierce. 2016. Recreational diver willingness to pay for goliath grouper encounters during the months of their spawning aggregation off eastern Florida, USA. Ocean & Coastal Management 129: 36-43.

Sutherland, WJ and CFR Wordley. 2017. Evidence complacency hampers conservation. Nature Ecology & Evolution 1(2017)1:215-1216.

A careful look at Taiwan groupers

Recreational spear fishers as citizen scientists for grouper surveys in Taiwan

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In Taiwan, intensive recreational and commercial fishing have diminished grouper populations to a level at which only small groupers, such as *Cephalopholis* species, are recorded during Underwater Visual Censuses (UVCs). This scenario presents a challenge for scientists who wish to investigate grouper community, biology or behavior from the coral reefs of Taiwan.

Fortunately, a sector of the recreational fishing community has a high level of environmental awareness. This is evident through their keen interest in biological conservation issues such as collaborating in campaigns to reduce marine debris and through their interest in

Fig 1. Freediving spear fishers have better access to groupers as compared to noisy scuba divers.

sustainable fishing. In 2017, despite a lack of evidence, the general public was misled into believing that spearfishing was a major cause of coral reef overfishing, which resulted in a public outcry and a call to ban spearguns.

A group of spear fishers rose up against the public misunderstanding of spearfishing to clarify the selective, and thus potentially sustainable, manner that they conducted spearfishing. The Tunghai Fish lab supported the perspectives of this spear fisher group, and we called for a more comprehensive recreational fishery management plan which addresses all fishing methods instead of an outright ban on just one. This collaboration and support brought the Lab closer to the fishing community, and, as a result, the Taiwan Sustainable Fishery and Spearfishing Association (TSFSA) was established to support scientific research and to educate the public on the potential for sustainability in spearfishing. This initiative achieved the goal of legalization and management of recreational spearfishing through bag limits, size limits, and the implementation of marine protected areas.

Currently, we are working on two projects with the spear fisher community as citizen scientists. One project is related to invasive hybrid groupers *Epinephelus fuscoguttatus* × *E. lanceolatus*, escapees from mariculture operations, which are occasionally spotted on coral reefs. However, the population and distribution of this grouper are yet unknown. Our citizen scientists assisted in reporting sightings and currently they have sent in 47 hybrid grouper samples for analysis.

In response to ciguatera poisoning cases among fishers in Southern Taiwan, our second project focuses on investigating the prevalence of the toxin, types of fish contaminated, and safe size limits for consumption, as well as educating the community to avoid high risk fish species and fish parts. Our citizen scientists have since provided 26 grouper samples, and 74 samples of other fish. Draft reports intended for the scientific community and briefs for the government are also in the pipeline.

With support from citizen scientists, we now have many additional pairs of eyes watching our coral reefs and helping us to understand many problematic issues. Also, this scenario represents a platform for public awareness, education and environmental activism. Moving forward, our challenge is to maintain optimal levels of engagement with the public through frequent activities, as well as to continue gathering and providing the evidence necessary for science-based sustainable recreational fishery management, particularly in relation to the grouper fishery.

Fig 3. Ciguatera toxins can accumulate in certain medium to large reef fish, including groupers, causing ciguatera in humans that consume toxic fish. Understanding the patterns associated with the accumulation of this toxin in fish species and according to body size contributes to information on food safety.

Fig 2. Removing invasive hybrid groupers could aid in restoring the natural balance of reef fish communities.safety.

A Mystery Threatened

The Black Grouper aggregation in north-east Brazil

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The Black Grouper, *Mycteroperca bonaci* (Poey, 1860), is a large member of the family Epinephelidae (can attain 157 cm total length; weight 100 kg) that lives in relatively low density on natural and artificial reefs. Despite an abundance estimated to have declined by 30-50% in its last two generations in Brazil (Teixeira et al., 2004; Padovani-Ferreira et al., 2018), Black grouper continue to represent an important fishery resource (Ponte et al., 2022). It is currently on the national red list of Brazil as vulnerable, being partially protected with established criteria for fishing regulations (MMA, 2018). On the Brazilian continental shelf, this species performs a phenomenon called “correção” (“running”), described by Teixeira et al., (2004) in the State of Pernambuco. The Black grouper correção as an aggregation of migration fish which originates near Ceará state and heads south to Abrolhos Bank, southern Bahia (>1,500 km). However, little is known about Black grouper fishing during this migration.

We investigated black grouper landings through a participatory monitoring of artisanal fisheries, carried out in two important fishing ports in Alagoas state (Ports of Pontal de Coruripe and Piaçabuçu) between January 2014 and July 2018. During the monitoring, peaks of catches for Black grouper were identified, far exceeding

Figure 1a. Catches of *M. bonaci* by artisanal fisheries during the 2018 correção period, on the southern coast of Alagoas, Brazil.

Figure 1b. Catches of *M. bonaci* by artisanal fisheries during the 2018 correção period, on the southern coast of Alagoas, Brazil.

the proportional increase over non-aggregating times indicated to identify an aggregation (Colin et al., 2003), with the most relevant occurring between April and June 2018 when 17,911 kg were landed for the two fishing ports (Figure 1a, b). This volume represents 42% of all landings (42,336 kg) for the entire monitoring period.

The participatory monitoring of this species that is occurring does not use CPUE data, a better indication of trends in abundance of the species, however, so we sought to understand if there had been changes in the effort of artisanal fishers over this period through objective interviews, seeking local ecological knowledge (Colin et al., 2003; Malafaia et al., 2021). The large volume of landings was observed in situ by the researchers (Figure 2a, b), being confirmed for other ports in the state and described by specialist local fishers (n=13) as the “correção” event. In this period, the fishing is carried out with handlines and longlines, at depths between 50 and 160 m, usually near the continental shelf slope, eventually capturing large adult individuals and higher numbers of fish. According to fishers, the “correção” only occurs at intervals of three to four years

References

Colin, P.L., Sadovy, Y.J., Domeier, M.L. 2003. Manual for the Study and Conservation of Reef Fish Spawning Aggregations. Society for the Conservation of Reef Fish Aggregations Special Publication No. 1.(Ver. 1.0).

Freitas, M.O., Previero, M., Minte-Vera, C.V. et al. 2018. Reproductive biology and management of two commercially important groupers in the SW Atlantic. Environmental Biology of Fishes, 101, 79–94. https://doi.org/10.1007/s10641-017-0682-2

Lima-Júnior, M. J. C. A., Nunes, J. A. C. C., Albuquerque, T., Sampaio, C. L. S. 2022. Knowledge connections for conservation of the Atlantic Goliath Grouper, Epinephelus itajara: records of tropical Brazilian coast. Neotropical Ichthyology, v. 20, p. 1-21.

Malafaia, P., França, A., Olavo, G. 2021. Spawning aggregation sites of the cubera snapper, *Lutjanus cyanopterus,* on the continental shelf of Bahia state, Northeastern Brazil. Fisheries Research. 242. 106037. 10.1016/j.fishres.2021.106037.

MMA, Ministério do Meio Ambiente. 2018. Portaria Interministerial Nº 59-C, de 9 de novembro de 2018. Diário Oficial da União. Brasília, DF, Edi. 220-A, p. 2. 16.nov.2018, Seção 1, pt. Disponível em: https://abrir.link/Or0Vj

Padovani-Ferreira, B., Bertoncini, A.A., Pollard, D.A., Erisman, B., Sosa-Cordero, E., Rocha, L.A., Aguilar-Perera, A., Brule, T. 2018. *Mycteroperca bonaci.* The Iucn Red List of Threatened Species 2018: e.T132724A46916253

Figure 2a. Researchers *in situ* observing the landings of *M. bonaci* in the correção occurred in the year 2018, Alagoas, Brazil.

Figure 2b. Researchers *in situ* observing the landings of *M. bonaci* in the correção occurred in the year 2018, Alagoas, Brazil.

in some regions, such as Alagoas coast (Teixeira et al. 2004) and is expected to take place between October and January. Here, we registered an extension of the period, coinciding with the beginning of the reproductive period of the species, which is from June to October (Teixeira et al. 2004; Freitas et al. 2018).

Although the theory of migration associated with aggregation for feeding is defended in relation to predation on spawning snappers (Teixeira et al., 2004), the "correção" still represents a mystery to science and needs to be better investigated. However, the increasing captures during this period were corroborated. These migratory events are in danger of disappearing before we come to understand them. Overfishing over this period may prevent the recovery of Black grouper populations in Brazil. It is urgent to invest in research, implementation of environmental awareness actions aimed at fishers and the promotion of monitoring of fishing activities activities in the region.

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Pereira, P. H. C., Côrtes, L. G. F., Lima, G. V., Gomes, E., Pontes, A. V. F., Mattos, F., Araújo, M. E., Ferreira-Junior, F., Sampaio, C. L. S. 2021. Reef fishes biodiversityand conservation at the largest Brazilian coastal Marine Protected Area (MPA Costa dos Corais). Neotropical Ichthyology ,v. 19, p. 1-26.

Ponte, I. A. R., Vasconcelos, J.E., Feitosa, C.V., Padovani-Ferreira, B. 2022. Demography of the black grouper, *Mycteroperca bonaci* (Poey, 1860) (Teleostei: Epinephelidae) from the North Brazil Shelf. Journal of Fish Biology. 101. 10.1111/jfb.15085

Teixeira, S. F., Padovani-Ferreira, B. P., Padovan, I. P. 2004. Aspects of fishing and reproduction of the black grouper *Mycteroperca bonaci* (Poey, 1860) (Serranidae: Epinephelinae) in the northeastern Brazil. Neotropical Ichthyology. V, 2(1), 19–30.

Young *M. bonaci* at Brazilian reefs. Photo by Áthila Bertoncini.

Spawning Aggregations in Solomon Islands

Identifying Spawning Seasonality for Improved Fisheries Management in Solomon Islands

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In 2020, the Wildlife Conservation Society (WCS) was funded with a grant, from the U.S. National Oceanic and Atmospheric Administration's Coral Reef Conservation Program, to conduct a study entitled, "Advancing conservation and management of critical habitats, fisheries resources and life history function in Western Province, Solomon Islands, using an ecosystem approach to fisheries management." The objective was to identify the fish spawning sites, seasonality, and species composition around Roviana, Marovo and Vonavona lagoons by a combination of patriarch fisher interviews, underwater site surveys, and fish market analyses. Aims of the study were to collect fisheries data to assist local communities in developing Locally Managed Marine Areas to protect spawning sites and inform the Solomon Islands Government about spawning times for possible management improvement.

Currently, the Solomon Islands Government has restricted the catch and sales of groupers under a blanket seasonal ban from October through January. In addition, the government is imposing size limits on various grouper species. Maximum fines for violations are SBD$30,000 (roughly USD$3,600) and 3-month imprisonment. Previous studies by Johannes and Lam (1999), Hamilton et al. (2004, 2012) and Hughes et al. (2020) identified regional variability in spawning times that may impact the effectiveness of the current ban period and suggested that modifications would improve conservation of these groupers. Figure 1 summarizes the findings from previous surveys for Camouflage grouper (*Epinephelus polyphekadion*), Squaretail coralgrouper (*Plectropomus areolatus*) and Brown-marbled grouper (*E. fuscoguttatus*) and highlights variability in spawning times, which reduces the conservation impact of the current ban if not managed for.

While the total number of grouper species in the catch is greater than other fish families in nearshore Solomon Island fisheries (e.g., Rhodes et al. 2019), fishers themselves focus more efforts on other fishes, such as emperors (Lethrinidae) and snappers (Lutjanidae), which comprise a substantial proportion of artisanal and small-scale commercial catches (Table 1, current study;

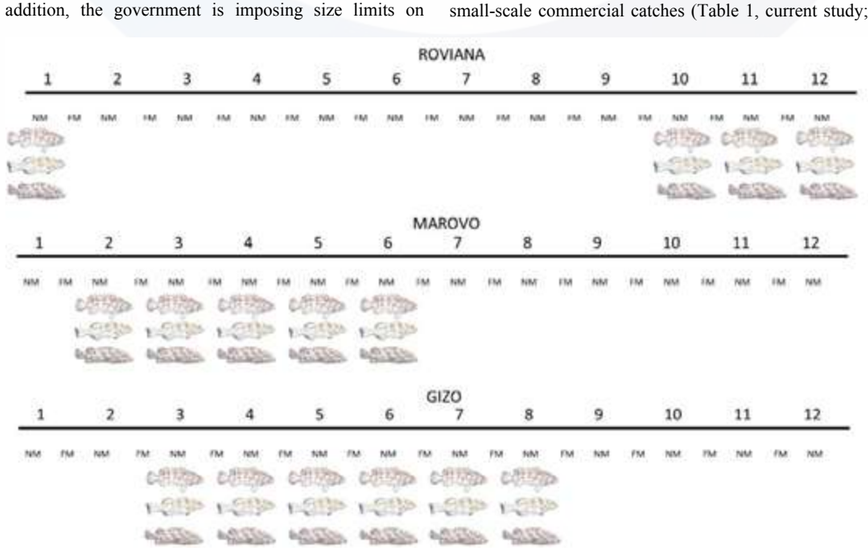

Figure 1. Calendar showing the timing of spawning forthree grouper species [From top to bottom (for each locale) are Brown-marbled grouper (*Epinephelus fuscoguttatus*), Squaretail coralgrouper (*Plectropomus areolatus*) and Camouflage grouper (*Epinephelus polyphekadion*).]. These species are known to aggregate and spawn during variable seasons off the Solomon Islands. Examples of this variability is shown in the above figure. Aggregations form and persist during the days leading up to new moon phases for the months indicated in each location. These species are under spawning aggregation management in Solomon Islands. Each species has shown notable population declines, where intensive surveys have been conducted, and remain a focus of management intervention. Months = 1 – Jan; 2 – Feb; 3 – Mar; 4 – Apr; 5 – May; 6 – Jun; 7 – Jul; 8 – Aug; 9 – Sep; 10 – Oct; 11 – Nov; 12 – Dec.

References

Grandcourt E, Al-Abdesselaam T, Francis F. and A Al Shamsi. 2007. Population biology and assessment of the white-spotted spinefoot, *Siganus canaliculatus* (Park, 1797), in the southern Arabian Gulf. Journal of Applied Ichthyology 23, 53–59.

Hamilton RJ, Giningele M, Aswani S and JL Echochard. 2012. Fishing in the dark-local knowledge, night spearfishing and spawning aggregations in the Western Solomon Islands. Biological Conservation 145:246-257.

Hamilton RJ, Matawai M and T Potuku. 2004. Spawning aggregations of coral reef fish in Roviana Lagoon, Western Province, Solomon Islands: Local knowledge fish survey report. (Unrestricted Access Version). Report prepared for the Pacific Islands Countries Coastal Marine Program, The Nature Conservancy. TNC Pacific Island Countries Report No. 5/04.

Hughes AT, Hamilton RJ, Choat JH and KL Rhodes. 2020. Declining grouper spawning aggregations in Western Province, Solomon Islands, signal the need for a modified management approach. PLoSONE, https://doi.org/10.1371/journal.pone.0230485

Species	Number	Percent
Lethrinus obsoletus	761	12.33
Lutjanus gibbus	565	9.16
Lethrinus lentjan	350	5.67
Hipposcarus longiceps	340	5.51
Lutjanus fulvus	200	3.24
Parupeneus barberinus	172	2.79
Lutjanus carponotatus	159	2.58
Lethrinus erythropterus	150	2.43
Lethrinus miniatus	146	2.37
Acanthurus nigricauda	127	2.06
Rastrelliger kanagurta	118	1.91
Lethrinus olivaceus	116	1.88
Lethrinus harak	108	1.75
Monotaxis grandoculis	100	1.62
Acanthurus xanthopterus	98	1.59
Caranx papuensis	93	1.51
Ctenochaetus striatus	84	1.36
Siganus doliatus	80	1.30
Siganus lineatus	79	1.28
Siganus canaliculatus	75	1.22

Table 1 (current study). Top 20 species noted in catch per unit effort surveys conducted by local fishers in Solomon Islands. Eleven species (pink) contributed to ≥50 of the catch numerically. Four species (*Hipposcarus longiceps, Lutjanus gibbus, Lethrinus obsoletus* and *Parupeneus barberinus*) were common to all survey areas. Various species listed are known to form spawning aggregations and are vulnerable to overfishing.

Table 2, Rhodes et al. 2019). The information on spawning aggregations of these latter fish families is even more limited compared to that of groupers in the Solomon Islands. However, fisher interviews have uncovered information on spawning aggregations of the Sailfin snapper (*Symphorichthys spilurus*) and Chinamanfish (*Symphorus nematophorus*), which are still being actively fished and thought to be in decline.

Information on life history useful for effective fishery management of many of the aforementioned species targeted by the fishers remains poor, including for wrasses and groupers. The current study supports earlier studies of reproductive periodicity for at least four grouper species and provides new information for an additional three grouper species. Results continue to be collected, with additional catch assessments, fisher interviews, and underwater censuses on grouper fish spawning aggregations planned for the coming months. This study is being led by Dr. Stacy Jupiter, Director of the WCS Melanesian Program, Dr. Alec Hughes, WCS Solomon Islands Program Manager, and Technical Fisheries Consultant and IUCN Specialist Dr. Kevin Rhodes.

Spear	T	M	Line	T	M
Acanthurus lineatus[a]	9.7	48.0	*Lutjanus gibbus*[a]	25.0	82.8
Parupeneus barberinus[a]	7.3	49.9	*Lethrinus lentjan*[a]	8.7	86.0
Siganus argenteus[c]	6.7	19.0	*Selar boops*	4.2	
Caesio caerulaurea	5.0		*Sphyraena forsteri*	3.6	
Scarus psittacus[b]	4.0	100.0	*Lethrinus obsoletus*[a]	3.2	81.6
Monotaxis grandoculis[a]	3.6	45.9	*Lutjanus bohar*[a]	2.9	46.8
Scarus niger	3.0		*Lutjanus rufolineatus*	2.9	
Acanthurus nigricauda	2.8	60.9	*Lutjanus quinquelineatus*	2.5	
Scarus dimidiatus	2.5	47.8	*Lutjanus kasmira*	2.4	
Caesio cuning	2.3		*Lethrinus xanthochilus*[a]	2.3	76.8
Hipposcarus longiceps[b]	2.3	47.6	*Lethrinus erythracanthus*	1.9	
Lutjanus gibbus[a]	2.2	75.9	*Lethrinus olivaceus*[a]	1.7	41.9
Naso vlamingii	2.1		*Lethrinus erythropterus*	1.6	
Pterocaesio tessellata	2.0		*Monotaxis grandoculis*[a]	1.3	83.3
Siganus canaliculatus[e]	2.0	100.0	*Sargocentron violaceum*	1.3	
Scarus rubroviolaceus[b]	2.0	13.9	*Lethrinus microdon*	1.2	47.0
Mulloidichthys vanicolensis	2.0	10.6	*Lethrinus atkinsoni*	1.2	
Siganus doliatus	2.0	80.0	*Myripristis adusta*	1.2	
Naso lituratus[d]	1.7	100.0	*Lethrinus amboinensis*	1.1	
Parupeneus crassilabris	1.5		*Euthynnus affinis*	1.1	
Ctenochaetus striatus	1.5		*Myripristis pralinia*	1.1	
Scarus quoyi	1.4		*Caranx sexfasciatus*	1.0	
Scarus oviceps	1.3		*Lutjanus biguttatus*	1.0	

Table 2: Top 25 species, and relative percentages of total catch (T) and sexually mature fish (M), from each respective gear type. Common species between gears are highlighted in grey. a = Prince (2017); b = Taylor and Choat (2014); c = Taylor et al. (2016); d = Taylor et al. (2014); e = Grandcourt et al. (2007). Taken from Rhodes et al. 2019.

Johannes RE and M Lam. 1999. The life reef food fish trade in the Solomon Islands. SPC Live Reef Fish Information Bulletin #5, April 1999, p 8-15.

Prince J. 2017. Informing community-based fisheries management with spawning potential surveys. SPC Fisheries Newsletter 154, 43–52.

Rhodes KL, Tua P, Sulu R, Pitakaka P, Kekete P, Uti M, Funu F and R Masu. 2019. Gear-based characterization of the Gizo, Solomon Islands, inshore commercial fishery. Regional Studies in Marine Science 32, https://doi.org/10.1016/j.rsma.2019.100807

Taylor BM, Gourley J and MS Trianni. 2016. Age, growth, reproductive biology and spawning periodicity of the forktail rabbitfish (*Siganus argenteus*) from the Mariana Islands. Marine and Freshwater Research 68, 1088–1097.

Taylor BM, Rhodes KL, Marshell A and JL McIlwain. 2014. Age-based demographic and reproductive assessment of orangespine *Naso lituratus* and bluespine *Naso unicornis* unicornfishes. Journal of Fish Biology 85, 901–916.

Taylor BM and JH Choat. 2014. Comparative demography of commercially important parrotfish species from Micronesia. Journal of Fish Biology 84, 383–402.

Seeing Inside the Humphead Wrasse

Humphead wrasse's skeleton for teaching and outreach

Guest submission
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Humphead (Napoleon) wrasses (*Cheilinus undulatus*) are frequently sold in Saudi Arabia's local fish markets at least once a week. This fish represents a valuable part of the local, conventional hand-line fisheries; its price is about twice that of groupers at about US50$ per kg for medium size 3-5 kg individuals. At auctions, the highest prices are always for large individuals although fishers tend to keep all the animals that they catch regardless of size. Regular catches gave me opportunities to obtain individuals of a range of ages/life stages. Large fish, however, wherever the species is exploited, tend to be uncommon, even rare.

Fig. 1. Auction at the fish market in Thuwal, Saudi Arabia.

On the 16th of April 2021, during a regular routine visit to the local fish market of Thuwal, a famous fishing port in Saudi Arabia (Fig. 1), I spotted a magnificent, adult male Humphead wrasse. During the auction, competitors attempting to buy the same fish were quickly defeated by my bottomless, deep pocket, and I eventually transferred the fish to the lab after paying $450 USD for it (Fig. 2).

A traditional Saudi family comprises around 10+ members, usually living in one huge house, and a large Humphead wrasse can feed everyone in a single meal.

People like to eat this fish grilled, and it may be served for festive events, such as weddings, big holiday banquets, and birthday celebrations.

The fish I bought in the auction was 67kg and took me considerable effort to lift and adjust its position during dissection at the lab. After more than one hour of flaying and filleting, the skeleton looked very promising and was ready for a bleaching bath. I cannot recall exactly how many bottles of bleach I purchased at the supermarket, but I can remember the terrified expression of the cashier when he saw the number of bottles that I purchased. He probably thought I was going to dispose of some corpses, which was partially true. Due to the setup of the lab, other more messy but less labor-intensive methods, like beetles and boiling, are not feasible in the facility.

Due to the massive size of the fish, the skeleton needed extra reinforcement to hold its own weight. Wires, hot glue, wood sticks, metal bars and all the scrap materials I could find in the lab storage room were used.

Fig. 2. A 67kg Humphead wrasse (*Cheilinus undulatus*) sold in the market.

Fig. 3. A skeleton of the Humphead wrasse (*Cheilinus undulatus*).

Later on, it looked pretty realistic when I finally was able to hold the completed skeleton up (Fig. 3).

At the beginning of my work, I did these skeleton reconstructions just for fun. It is like a Lego set produced by nature itself. During reconstruction, you get to learn about the bony structure of the fish and what they could eat, how they chew their food, and why they make certain movements in the water while feeding (Fig. 4).

Fig. 4. Skeletons of fishes used for outreach.

Skeletons like that of the Humphead wrasse are very good materials for teaching and for outreach events. People borrow them all the time for those purposes, such as for the library, museums, schools, and even kindergartens. This one and the other skeletons I have done reach many people in a lot of places.

Regarding the population status of Humphead wrasse in the Red Sea, I do not think there is reason for concern. They are catch regularly, but only in limited areas in Saudi Arabian waters. There are quite a few places where it is not permitted to remove the fish, including the Royal family-owned islands, big tourist development areas, and, of course, from no-fishing areas. All of these serve as no-take zones to help protect the Humphead wrasse population. In addition, in neighboring Sudan, where this fish also occurs, fishing is currently limited in a similar way to the controls in Saudi Arabia waters. I have the impression that Humphead wrasses are still very happy in these parts of the Red Sea.

The Atlantic Goliath Grouper Conservation Network

A kick-off during the 2022 UN Ocean Conference

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The Atlantic Goliath Grouper (AGG), *Epinephelus itajara*, is the largest grouper in the Atlantic Ocean, and has been protected in Brazil and the US waters. The AGG is a flagship species that has characteristics that provide a broad possibility to develop important ocean conservation themes, including its large size, vulnerability to fisheries, the yearly forming of aggregations and the fact that it inhabits coral reefs, rocky reefs, shipwrecks, estuaries and mangroves as nurseries. Vulnerable in the US, Critically Endangered in Brazil, still non protected in many countries as Mexico, Belize and French Guiana, the species main status still unknown in the African coast (from Angola to Senegal).

Projeto Meros do Brasil (Meros do Brasil Project) has developed, in the last 20 years, a conservation plan involving research, education and communication goals for the AGG and habitats along the Brazilian coast. One of them is leading the process of the first fish moratorium in Brazil, making AGG a conservation symbol of marine and coastal environments in the country. The involvement of some of PMB's researchers with the IUCN/GWSG, and knowing that efforts in Brazil could not be sufficient to protect the species along its occurrence, in 2022 Meros do Brasil has proposed the creation of The Atlantic Goliath Grouper Conservation Network (AGGCN).

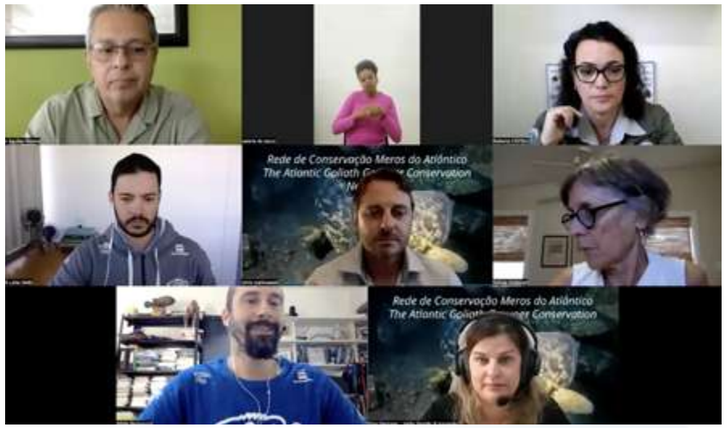
The Network aims to exchange experiences with researchers and stakeholders (government, fishers, civil society) of countries with distinct situations regarding conservation measures for the species and coastal marine habitats. The AGGCN also intends to consolidate a global movement focused on this key species and spread a message about its social and ecological relevance to society. The launch of the AGG Conservation Network was held at the 2022 UN Ocean Conference, and was the first move to bring key speakers together to think about AGG conservation throughout the Atlantic.

The event was organized by Instituto Meros do Brasil (IMB) (Brazil) and the following invited partners: Brazilian Ministry of Environment - Centro Nacional de Pesquisa e Conservação da Biodiversidade Marinha do Sudeste e Sul (CEPSUL) (Brazil), Florida State University (USA), MarAlliance (Panamá), Universidade Federal do Pará (Brazil), Universidade Federal de Pernambuco (Brazil), Universidade Federal de Alagoas (Brazil), Movimento Cultural Arte Manha (Brazil), Universidade de São Tomé e Príncipe (São Tomé), Universidade Federal do Espírito Santo/CEUNES (Brazil), Instituto de Pesca de São Paulo (Brazil), Museu de História Natural Capão da Imbuia (Brazil), Universidade Federal de Santa Catarina (Brazil), Universidad Autónoma de Yucatán (Mexico), Ocean First Institute (USA), Acuario Islas del Rosário (Colombia) Groupe d'Etude et de Protection des Oiseaux en Guyane (GEPOG).

The main contribution of this event was to call attention to the importance of fish conservation in the Restoration and Ocean Decades, making a statement of sustainable development goals (SDG) 14, 17 to seek for near future solutions for the conservation of marine-coastal environments through a flagship species. For 2023, a new meeting is expected to be held along the second semester. Keep an eye on the Project's social media! https://www.instagram.com/merosdobrasil/

Watch The Atlantic Goliath Grouper Conservation Network kick-off during the 2022 UN Ocean Conference here (English version): https://youtu.be/2vyWCPvurZk

About Projeto Meros do Brasil (PMB): In the last year PMB reached 17,470 people in direct environmental education actions and more than 413,000 people accessed information about AGG from awareness actions, cultural and scientific events and exhibitions. Research activities for the conservation of the species sum up 238 groupers identified, sampled and returned alive to the Ocean. In addition to AGG, another 30 species are in the focus of the Project's activities, spread along nine Brazilian coastal states, reaching over 40 municipalities and 21 marine protected areas. A total of 12 publications were produced for the conservation of species and their living habitats. To know more visit: merosdobrasil.org



Launch of the AGG Conservation Network at the 2022 UN Ocean conference side ewvent.

GWSG Members' Publications

de Abreu R. Ponte, I., de Vasconcelos Filho, J. E., Feitosa, C. V., & Ferreira, B. P. 2022. Demography of the black grouper, *Mycteroperca bonaci* (Poey, 1860) (Teleostei: Epinephelidae) from the North Brazil Shelf. Journal of Fish Biology, 101(1), 190– 203. https://doi.org/10.1111/jfb.15085

Acácio, M., Lima, M.A.L., Martins, V.F.S., Macêdo Filho, H.F., Lourenço, I.H., Barreiros, J.P. & Anjos, M.R. (2022) Incidental fishing of *Epinephelus itajara* (Lichtenstein, 1822): the vulnerability of a critically endangered species of the Brazilian coast. Research, Society and Development, 11(12), e594111234769. DOI:10.33448/rsd-v11i12.34769.

Aguilar-Perera A. 2020. Situación actual de conservación y manejo pesquero de meros y pargos en el sureste del Golfo de México y Mar Caribe Mexicano. Gobernanza y Manejo de las Costas y Mares ante la Incertidumbre. Una Guía para Tomadores de Decisiones. Instituto de Ecología, Pesquerías y Oceanografía del Golfo de México (EPOMEX) Universidad Autónoma de Campeche (pp 855-877) https://drive.google.com/file/d/1a-tzAIDhv_yB1qec7CwkX5QY7la4nPKH/view?usp=sharing

Akhilesh, K.V., Rajan, P.T., Vineesh, N., Idreesbabu, K.K., Bineesh, K.K., Muktha, M., Anulekshmi, C., Manjebrayakath, H., Gladston, Y. & Nashad M. 2021. Checklist of serranid and epinephelid fishes (Perciformes: Serranidae & Epinephelidae) of India. Journal of the Ocean Science Foundation, 38. pp. 35-65. DOI:10.5281/zenodo.5151903

Akhilesh, K.V., Kishore, T.G., Muktha, M., Lisher, M.W., Ambarish, Gop P., & C. Anulekshmi (2020) Pseudanthias vizagensis, a junior synonym of Pseudanthias pillai Heemstra & Akhilesh, 2012 (Perciformes: Serranidae). Zootaxa, 4890 (1). pp. 135-147. DOI: 10.11646/zootaxa.4890.1.9

Almeida, L. L. and Stallings, C.D. and Condini, M.V., Garcia, A.M, Tzadik, O.E., Koenig, C.C. and Hostim-Silva, M.. 2022. Nonlethal stable isotope analysis reveals consistent trophic growth of juvenile Atlantic goliath grouper *Epinephelus itajara* in Brazilian estuaries. Bulletin of Marine Science, 98:17-26. https://doi.org/10.5343/bms.2021.0025

Barreiros, J.P. 2022. Meros do Mundo – Uma Colecção de Retratos/Face to Face with Groupers – A collection of portraits. Edição Bilingue (Inglês). Letras Lavadas, Edições, Ponta Delgada. 125pp. ISBN 978-989-735-369-7.

Cromileptes altivelis, in Hong Kong. Photo by Allen To.

GWSG Members' Publications

Brulé T., X Renán & T. Colás-Marrufo. 2022. Potential impact of climate change on fish reproductive phenology: A case study in gonochoric and hermaphrodite commercially important species from the southern Gulf of Mexico. Fishes 7, 156. https://doi.org/10.3390/fishes7040156

Chung A, See GCL, Lam SY, Yiu WH, Shea SKH. 2023. Thirty-one new records of reef fish species for Hong Kong waters. Journal of the Marine Biological Association of the United Kingdom 103, e16, 1–13. https://doi.org/10.1017/ S0025315423000036

Condini MV, Malinowski CR, Hoeinghaus DJ, Harried BL, Roberts AP, Soulen BK, Roark KJ, Khursigara AJ, Fischer LG, Possamai B, Hostim-Silva M, Garcia AM. 2022. Spatial analysis of mercury and stable isotopes in the vulnerable Dusky Grouper *Epinephelus marginatus* along the Brazilian coast. Mar Pollut Bull. 2023 Feb;187:114526. https://doi.10.1016/j.marpolbul.2022.114526. Epub 2023 Jan 6. PMID: 36621302.

Dos Santos, J. B. Q., Mazur Chiessi, C. Crivellari, S. de Vasconcelos Filho, J. E. Silva Pereira, N., Oliveira Freitas, M., & Padovani Ferreira, B. 2022. Identification of western South Atlantic stocks of the Lane snapper (*Lutjanus synagris*) from an otolith based multi-proxy approach. Fisheries Research, 253. https://doi.org/10.1016/j.fishres.2022.106356.

Hau. C. Y., Sadovy de Mitcheson, Y. J. 2023. Mortality and management matter: Case study on use and misuse of 'ranching' for a CITES Appendix II-listed fish, humphead wrasse (*Cheilinus undulatus*). Marine Policy 149 https://doi.org/10.1016/j.marpol.2023.105515

Feitosa, J.L.L., Chaves, L.C.T., Queiroz-Véras, L.V.M.V., R. J. Miranda, C. G. A. Ormond & B. P. Ferreira. 2021. Effects of social organization on the feeding of the striped parrotfish, *Scarus iseri.* Coral Reefs 40, 951–957. https://doi.org/10.1007/s00338-021-02080-3

Locatelli, A. C. P., Bastos, R. F., Oliveira, M. A., & Ferreira, B. P. 2023. Scientometric analysis and literature synthesis of 60 years of science on the Atlantic goliath grouper (*Epinephelus itajara*). Journal of Fish Biology, 1– 17. https://doi.org/10.1111/jfb.15312

Malinowski, C.R., N.I. Stacy, F.C. Coleman, J.A. Cusick, C.M. Dugan, C.C. Koenig, N.K. Ragbeer, and J.R. Perrault. 2021. Mercury offloading in gametes and potential adverse effects of high mercury concentrations in blood and tissues of Atlantic Goliath Grouper *Epinephelus itajara* in the southeastern United States. Science of the Total Environment, 146437.

Mann BQ, Daly R, Jordaan GL, Dalton WN, Fennessy ST. 2022. Movement behaviour of catface rockcod *Mycteroperca* (*Epinephelus*) *andersoni* (Family: Epinephelidae) off the eastern seaboard of southern Africa. African Journal of Marine Science. 44:2, 125-137

Moreno-Santos, R. A, Condini, M. C., Lopes Almeida, L., Soeth, M. Bertoncini, A. . & Hostim-Silva, M. 2022. Unveiling the first steps of juvenile Atlantic goliath grouper *Epinephelus itajara* (Perciformes: Epinephelidae) in a tropical estuary at the southwestern Atlantic coast, Marine Biology Research, 18:5-6, 372-379, DOI: 10.1080/17451000.2022.2119251

Myers, Robert. 2023. Sea Clicks: Images from the Coral Triangle and Beyond - wonderfully ongoing. https://www.coraltriangleinitiative.org/index.php?q=ts

Nair, R. J, Seetha, P K and Sunil, K T S and Radhakrishnan, M. 2021. Length weight relationships of demersal reef fishes from south west coast of India. Journal of the Marine Biological Association of India, 63 (1). pp. 40-48.

Obura, D., Gudka, M., Samoilys, M. et al. 2022. Vulnerability to collapse of coral reef ecosystems in the Western Indian Ocean. Nat Sustain 5, 104–113 https://doi.org/10.1038/s41893-021-00817-0

Osuka, K. E., Stewart, B. D. Samoilys, M., McClean, C. J., Musembi, P. Yahya, S. Hamad, A. R. & Mbugua, J., 2022. Depth and habitat are important drivers of abundance for predatory reef fish off Pemba Island, Tanzania. Marine Environmental Research, Volume 175,105587, https://doi.org/10.1016/j.marenvres.2022.105587.

Cephalopholis boenak, Hong Kong. Photo by: Eric Keung.

GWSG Members' Publications

Renán X., T. Brulé, G. Galindo-Cortes & T. Colás-Marrufo. 2022. Age-based life history of three groupers in the southern Gulf of Mexico. Journal of Fish biology, 1-17. https://doi.org/10.1111/jfb.15145

Roe P, Hashim AS, Evans V, & Sadovy de Mitcheson Y. 2022. Status of Napoleon wrasse in Laamu Atoll, Maldives, after three decades of protection. Endang Species Res 49:135-144. https://doi.org/10.3354/esr01210

Sadovy de Mitcheson, Y & Min Liu, M. 2022. Chapter 2.3 The Importance of Groupers and Threats to Their Future pp 191-230. In: Biology and Ecology of Groupers (eds. Félix-Hackradt, F. C. Hackradt, C. W., & García-Charton, J. A. CRC Press. 232 pp.

Sadovy de Mitcheson, Y. J., Prada Triana, M. C., Azueta, J. O., and Lindeman, K. C. 2022. Regional Fish Spawning Aggregation Fishery Management Plan: Focus on Nassau Grouper and Mutton Snapper (FSAMP). WESTERN CENTRAL ATLANTIC FISHERY COMMISSION (WECAFC), FAO. 133pp. https://www.fao.org/3/cc2977en/cc2977en.pdf

Samoilys, M.; Alvarez-Filip, L.; Myers, R.; Chabanet, P. 2022. Diversity of Coral Reef Fishes in the Western Indian Ocean: Implications for Conservation. Diversity, 14, 102. https://doi.org/10.3390/d14020102

Sharma, S R Krupesha and Nair, Rekha J and Sumithra, T G and Joshy, Aswathy and Peter, Reynold and Santhosh, B. 2021. A case of encysted endoparasitic copepods in the Spiny cheek grouper. Marine Fisheries Information Service, Technical and Extension Series, 248. p. 41. ISSN 0254-380X

Shepherd B, Pinheiro HT, Phelps TAY, Pérez-Matus A, Rocha LA. 2021. *Pseudanthias hangapiko*, a new anthiadine serranid (Teleostei, Serranidae, Anthiadinae) from Rapa Nui (Easter Island). Zookeys. 1054: 1-13. PMID 34393560 https://doi.org/10.3897/zookeys.1054.64508

Sorgon, K. E. S., & Abesamis, R. A. 2023. Foraging associations of *Lethrinus olivaceus, Cheilinus undulatus,* and other fishes in an isolated and protected coral reef. Galaxea, Journal of Coral Reef Studies, 25(1), 7-8.

Sorgon, K. E. S., Ticzon, V. S., Samaniego, B. R., Bacabac, M. M. A., & Fetil, J. G. C. 2021. On the use of the bumphead parrotfish (*Bolbometopon muricatum*) as a mobile shelter by a bluefin trevally (*Caranx melampygus*) in an oceanic reef system in the Philippines. Galaxea, Journal of Coral Reef Studies, 23(1), 7-8.

YK, Najeeb A, Rowlett J, Rocha LA. 2022. ***Cirrhilabrus finifenmaa* (Teleostei, Labridae), a new species of fairy wrasse from the Maldives, with comments on the taxonomic identity of *C. rubrisquamis* and *C. wakanda*.** Zookeys. 1088: 65-80. PMID 35437369 DOI: https://doi.org/10.3897/zookeys.1088.78139

Tovar Verba, J., Ferreira, C.E.L., Pennino, M.G., Linda Hagberg, Priscila F. M. Lopes, Beatrice Padovani Ferreira, Sergio Maia Queiroz Lima & Adam Stow. 2023. Genetic structure of the threatened Gray Parrotfish (*Sparisoma axillare*) in the Southwestern Atlantic. Coral Reefs 42, 105–117. https://doi.org/10.1007/s00338-022-02324-w

Vaini, J.O., Domingues, R.R., Ferrette, B.L.S., Hallerman, E.M., Mota, K.G., Barreiros, J.P. & Hilsdorf, A.W.S. 2021. Global population genetic structure of the sequential hermaphrodite, dusky grouper (*Epinephelus marginatus*). Aquatic Conservation-Marine and Freshwater Ecosystems, 31(8), 2119-2130. DOI:10.1002/aqc.3608

Velázquez-Abunader, I, T. Brulé, M. A. Cabrera, and J. A. López-Rocha. 2021. Length-weight relationships of four finfish commercial species from the southern Gulf of Mexico. Latin American Journal of Aquatic Research, 49(2): 369-375. https://doi.org/10.3856/vol49-issue2-fulltext-2505

Vincent, A.C.J., Foster, S.J., Fowler, S.L., Lieberman, S., & Sadovy de Mitcheson, Y. 2022. Implementing CITES Appendix II listings for marine fishes: a novel framework and a constructive analysis. Fisheries Centre Research Report. Vol. 30. No. 3. 189 pp.

Holotype of the recently described *Pseudanthias hangapiko*, male specimen (upper), 45.2 mm SL. Paratype CAS 247254, female specimen (lower), 33.2 mm SL. Photos by LA Rocha.

Future Events

Latin America and Caribbean Fisheries Congress Congreso Latinoamericano y del Caribe de Pesquerias

Cancun Convention Center, Cancun, Mexico

Mayo/May 15-18, 2023

https://lacfc.fisheries.org/

Indo-Pacific Fish Conference and the Australian Society for Fish Biology

Auckland, New Zealand

November 20-24, 2023

https://www.ipfc11-asfb.ac.nz/

Asia Pacific Coral Reef Symposium 2023

Nus, Singapore

June 19-23, 2023

https://www.apcrs2023.org/

FSBI 2023 Annual Symposium

Fish habitat ecology in a changing climate

University of Essex, Essex, England

July 24-28, 2023

https://fsbi.org.uk/symposium-2023/

GCFI #76

Early november 2023

https://www.gcfi.org/

Joint Meeting of Ichthyologists and Herpetologists

The American Society of Ichthyologists and Herpetologist

Norfolk, VA,

July 12-16, 2023

http://burkclients.com/JMIH/meetings/2023/site/index.html

GWSG Membership | 2021-2024 Quadrennium

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Species in the Spotlight!

In every News Letter, a Grouper/Wrasse species is featured, bringing information from its latest IUCN assessment. Check the source below the map!

Epinephelus fasciatomaculosus

(Peters, 1865)

Rock Grouper (E), Mérou Rocaille (F), Mero De Las Piedras (S)

Maximum Recorded Size

24 cm SL

Population Trend

Unknown

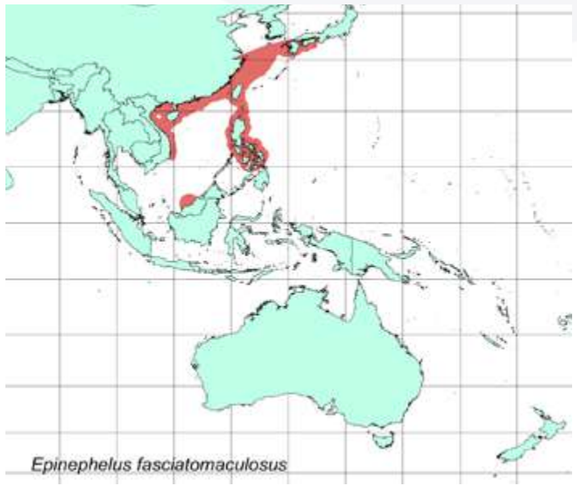
Distribution

Brunei Darussalam; China; Hong Kong; Japan; Macao; Malaysia; Philippines; Taiwan, Province of China; Viet Nam

Population

This species can be common and abundant in parts of its range. Population data are limited, but declines are not known at this time.

Photo by Eric Keung | Hong Kong Reef Fish Survey



Source of information: To, A. & Ma, K. 2018. *Epinephelus fasciatomaculosus*. The IUCN Red List of Threatened Species 2018: e.T132769A100543837. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T132769A100543837.en
Map: Craig M, Sadovy de Mitcheson, Heemstra PC 2012. h. 356 p. Boca Raton: CRC Press.

Habitat and ecology

This species inhabits shallow rocky areas of bedrock and boulders between 15 to 30 metres depth. It primarily consumes fishes, prawns, crabs, worms and gastropods. It is reportedly a protogynous hermaphrodite with females reaching maturity at 12.5 cm standard length and sex transition occurring at two or three years of age and 14 to 16 cm standard length. Its maximum standard length is 24 cm.

Major Threat

Heavy fishing pressure is a potential threat to this species on a localised level, but this is not known to be driving major declines on a global level at this time. As larger groupers become overfished within its native range, fishing pressure on smaller grouper species such this will likely increase. This is compounded by the absence of effective management in much of its range. In addition, this shallowwater species may be impacted by coastal development.

2018 IUCN Red List Status

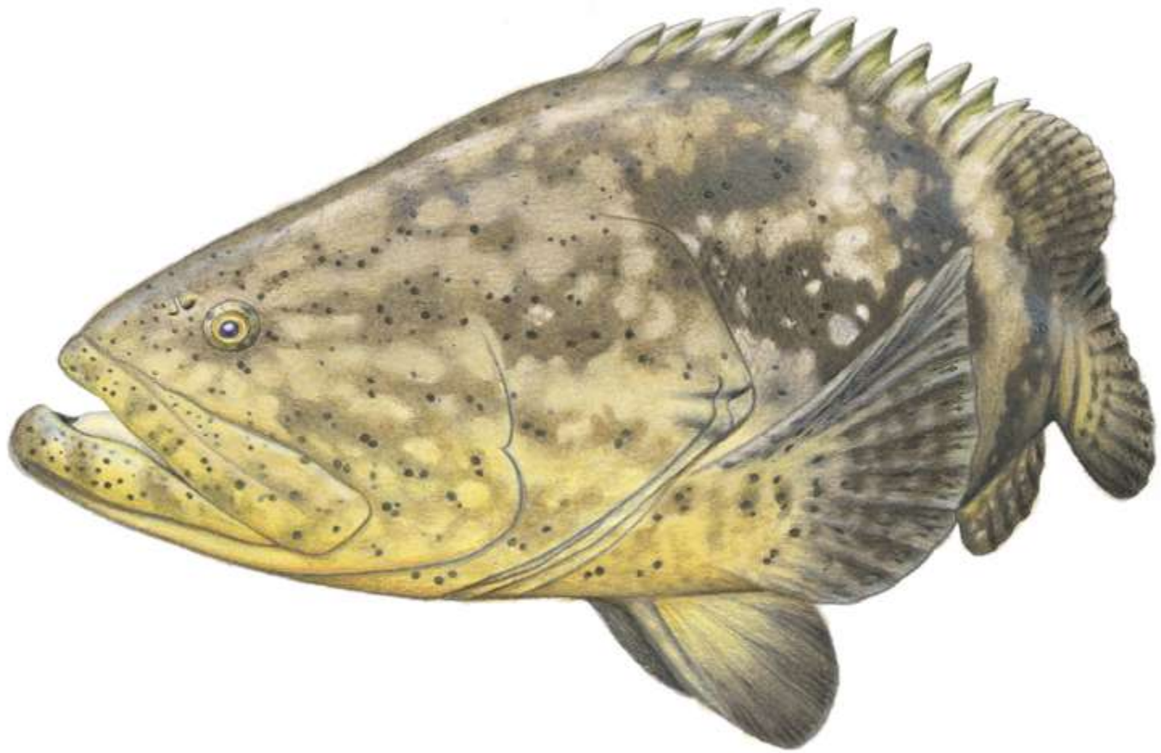
Least Concern

Important Note

This is not a well-known species, like many of the mid size groupers, and we encourage researchers to be aware of this and collect information in field/ market/fishery studies.

Groupers & Wrasses Art Gallery

Send your visual art work to gwsg.iucn@gmail.com for our next newsletter!



This colored pencil drawing depictis the Atlantic Goliath Grouper, *Epinephelus itajara*, and was prepared by Matheus Correa Guzi, in 2022. Matheus is a passionate student of Biology at the Federal University of Santa Catarina, South Brazil. Matheus prepared a series of drawings to celabrate the 20 years of Projeto Meros do Brasil, completed last September 2022. Besides his talent for nature drawings, he is also a nature photographer.

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