

Restoring Big Fish: Cooperative Research, Conservation, and Management Program for Spawning Aggregations in the Wider Caribbean

Restaurando Big Fish: Programa Cooperativo de Investigación, Conservación y Administración de las Agregaciones de Desove en el Gran Caribe

Restauration Big Fish: Programme Coopérative de Recherche, Conservation et la Gestion pour les Agrégations le Frai des dans les Caraïbes

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EXTENDED ABSTRACT

The Challenge

Millions of people throughout the wider Caribbean depend on reef and coastal fisheries resources for their livelihoods, food security, and cultural identity. Many of the most valuable and highly sought species, e.g. many of the groupers and snappers, reproduce within fish spawning aggregations (FSA)s, where they are highly vulnerable to fishing. Many FSA sites serve as productivity hotspots where multiple species congregate for breeding and feeding and where protecting small areas of ocean can offer disproportionately large benefits to fisheries management and marine ecosystem conservation (Heyman 2014, Erisman et al. 2017).

FSAs are relatively small in area but are distributed within large geographic species' ranges that transcend national boundaries. The range of Nassau grouper (*Epinephelus striatus*) for example, includes much of the wider Caribbean, while other species such as black grouper (*Mycteroperca bonaci*) and mutton snapper (*Lutjanus analis*) are distributed within the entire Western Central Atlantic (Figure1). While there are various successful examples of FSA research, management and conservation throughout the region e.g. COBI's work in Mexico (see below), there is a severe lack of coordinated efforts to integrate the study and application of FSAs to support management policies.

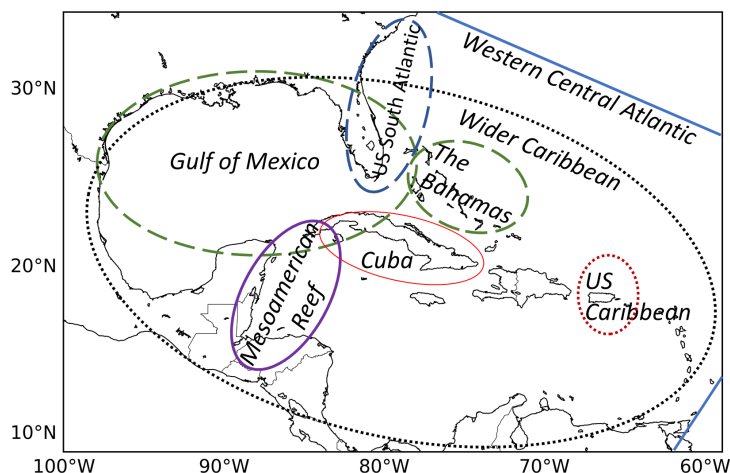


Figure 1. Big Fish is a project aimed at the network of monitored and protected multi-species fish spawning aggregation sites throughout the Western Central Atlantic. Subprojects are being developed in the Mesoamerican Reef, the Gulf of Mexico, the US South Atlantic, the Wider Caribbean, and Cuba.

Roadmap to Success: The Big Fish Initiative

The Big Fish Initiative (BFI) is an organically evolving entity designed to address the challenges above, holistically and comprehensively. The BFI is gradually evolving into a regional network from a foundation of site-based work conducted by a loose affiliation of partners (including fishers, scientists, and managers) that share a common vision. Partners have consistently demonstrated their support and effort to cooperatively research, monitor and conserve multi-species FSAs. We see the BFI as way to work towards the broad scale recovery and resilience of FSAs and the regional fisheries, functional marine ecosystems and coastal communities and economies that depend on them.

In order to achieve its lofty objectives, BFI serves as the umbrella for several thematic, geographic, and institutional sub programs with a view to ensuring its coherent and comprehensive implementation. Big Fish is built on two thematic pillars:

- i) Cooperative research and monitoring, and
- ii) Strategic communications.

Together, the cooperative research program and communications products will in turn support local partners to conduct the monitoring, disseminate results and construct cohesive communications messaging, and guide conservation policy to effectively manage FSAs. Big Fish will support the regional harmonization and integration of these activities towards sustainable management of the FSAs and the fisheries that depend on them.

- i) Big Fish's theory of change recognizes that most commercially and recreationally important species that form FSAs that: Sustain coastal communities with needed protein and support fishing and tourism economies
- ii) Migrate and spawn at FSAs that serve as productivity hotspots
- iii) Are harvested in small-scale, multi-species fisheries that are largely unassessed or data poor
- iv) Are vulnerable to fishing and many species are declining or threatened with extinction throughout the region

Focal Geographies

Big Fish activities are bounded within the Western Central Atlantic (Figure 1), area 31 of the United Nations Food and Agriculture Organization's Western Central Atlantic Fisheries Commission (FAO WECAFC). Based on the regionally identified importance of FSAs in the region, FAO WECAFC supported the formation of the Spawning Aggregations Working Group (SAWG). This group of experts from throughout the region met in 2013 and 2018, with the support of the Caribbean Fisheries Management Council (CFMC) and FAO WECAFC. Heyman, (Big Fish co-founder and Executive Director) convened the 2018 meeting of the SAWG during which, some of the objectives of Big Fish received broad endorsement and commitment, evidenced in the SAWG work plan (WECAFC 2019).

Regional variations in species composition, fleet dynamics, governance regimes, local culture, and institutional capacity dictate the need for nation-specific workplans.

Big Fish is currently supporting the development of research, monitoring, communications, and conservation programs within the Western Central Atlantic Region and sub programs in the US Gulf of Mexico, the US South Atlantic, Mexico, the Mesoamerican Reef, The Bahamas, the US Caribbean, and Cuba (Figure 1). Given the ambitious geographic and multidisciplinary scope of this initiative, we are working closely with prestigious anchor-institutions at the regional scale, and within each sub-region. In the US Gulf of Mexico, we are collaborating with The Gulf of Mexico Coastal Ocean Observing System (GCOOS), the Charter Fishermen's Association, University of Texas and the Florida Fish and Wildlife Commission with support from the RESTORE Science Program. In the US South Atlantic, Big Fish is working with the South Atlantic Fishery Management Council. In the Bahamas, Big Fish is collaborating with the Perry Institute. At the scale of the Western Central Atlantic, primary partners include The Caribbean Fishery Management Council (CFMC), WECAFC SAWG and NOAA's Office of Protected Species more specifically with the CFMC in the US Caribbean. In Cuba, the *Centro de Investigación de Ecosistemas Costeros* (CIEC) serves as the host institution (Figure 1).

The program in the Mesoamerican Reef (MAR) region serves as an emerging and successful sub-regional example of the BFI in action. With recent funding from the French Fund for the Global Environment, The Mesoamerican Reef Fund (MAR Fund), the Healthy Reefs Initiative and local partners (COBI, TIDE, FUNDAECO, SEA, EDF and the Belize Fisheries Department) are beginning a three-year project called "*MAR Fish*" - *Knowledge, monitoring and protection of Mesoamerican reef's fish spawning aggregations*. Partners manage and monitor multi-species FSAs, e.g. SEA at Gladden Spit and COBI at Punta Allen and Punta Herrero (Figure 2) following standard research and monitoring protocols (Heyman et al. 2004). SEA has managed and monitored the FSA site at Gladden Spit since 2003 and participates in the Belize National Spawning Aggregations Working Group. More recently, COBI has worked with local fishers to monitor and create several new marine protected areas in the Mexican Caribbean and initiated another FSA Working Group in the Mexican Caribbean (Fulton et al. 2018).

Cooperative Research

One of the two primary pillars of BFI is a cooperative research and monitoring program currently implemented to conduct monitoring of a network of what we call, 'sentinel' sites. We define sentinel sites as regionally important, multi-species FSA sites that are managed and monitored by local partners following standard protocols (e.g. Heyman et al. 2004, 2017). The information collected at the sentinel sites is shared with others in the BFI under specially designed data sharing agreements. Some FSAs that are already considered sentinel sites (e.g. Gladden Spit, Punta Allen, and Punta Herero) in the MAR Fish Project, based on the affiliated partners' existing efforts that embody BFI principles, techniques and protocols. As BFI gains formality, additional sentinel sites and partners will be added to the network through a process that is based on national and regional priorities based on standardized criteria.

At each sentinel site, *in situ* instrument bundles provide remote sensing capacity to monitor both biological activity and environmental conditions over time. Reproductive behaviors, migrations and spawning activity are documented with underwater video and passive acoustic monitoring for some species (e.g. Schärer et al. 2012). Arrival and departure of fishes bearing telemetry tags can be recorded with a grid of acoustic receivers (e.g. Biggs and Nemeth 2016). Temperature, conductivity, and water level can be monitored with temperature loggers or a CTD, the speed and direction of currents can be monitored with an Acoustic Doppler Current Profiler (ADCP) (Figure 3).

Ultimately, all of these data streams are captured, processed, uploaded, cleaned and stored locally with the intent of sharing products within a regional database to be housed by GCOOS or other partners that can provide that capacity (Figure 2). A prototype of the database has been in use for over 20 years (Heyman and Adrien 2006) and is presently being upgraded. The data management protocol and accompanying database are designed to facilitate standardized monitoring of different parameters at each FSA. As additional data are gathered at each site, the database will include queries that allow partners to visualize their own data, such as generating time-series plots on FSA dynamics

(e.g. abundance by species) in relation to local physical conditions (e.g. temperature, date and moon phase). As more sites are added and the data stream extends in time and space, the system can be used for comparative and regional analyses, e.g. connectivity and its variability given changing current patterns, and the impacts regional differences in environmental conditions, temperature anomalies and the of impacts of climate change, phenology and potential changes in species distributions. Evidence confirming timing and location of FSAs at single sites can support site-specific management measures including MPA establishment, seasonal closures and planning for research expeditions. Comparisons on the timing of FSAs across sites can be used to support national or regional seasonal harvest or sales bans to protect spawning fish.

Communications

The second pillar of BFI, a unified communication strategy to support FSA conservation throughout the Wider Caribbean, emerged as a high priority within the WECAFC SAWG workplan (WECAFC 2019). To develop and produce the unified communication strategy, Ana Salceda (Big Fish co-founder and Communication Direc-

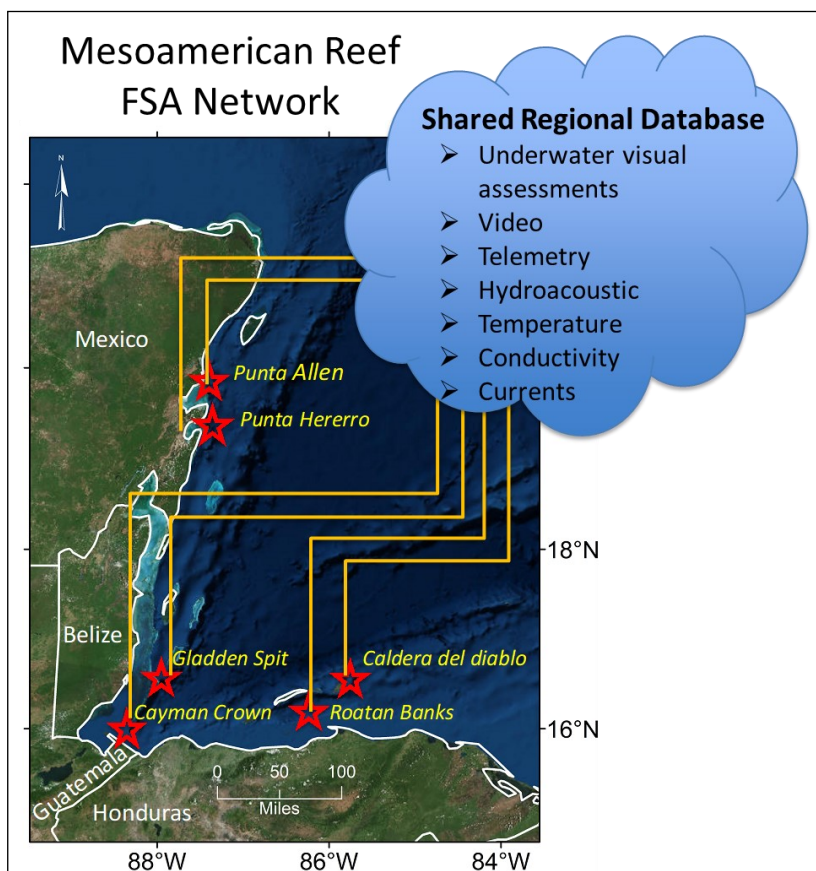


Figure 2. Mesoamerican Reef network of sentinel sites - monitored and protected, multi-species fish spawning aggregation sites will share data through a shared on-line database with a view to ensuring coherent and comprehensive implementation of Big Fish objectives

tor) catalyzed formation of the WECAFC-SAWG's Communication Sub-Committee, whose members have knowledge and experience in science, outreach, education and public engagement. Members have provided critical input to the strategy regarding the places where they work and informed perspective on the regional needs and challenges for the strategy. Since August 2018, this vibrant team of scientists, fishers, managers and institutional experts has been working in close collaboration with communication experts, press, and media producers with the financial support of CFMC and NOAA. Building upon previous communication efforts, the interdisciplinary team has made remarkable progress on the development of the communication strategy "Recovering Big Fish" (BelugaSmile Productions et al. 2019).

The regional communication strategy has a twofold goal: first, to unite a diverse geographically dispersed set of collaborators, around a common vision and a common story with consisting messaging. The communication plan will provide a framework to develop sub-regional and local campaigns that will meet specific needs of participant countries and regions. Secondly, use communication to leverage the power of a growing constituency to inform public opinion, include FSAs on the political agenda, and support the decision-making process. To integrate the efforts, the communication strategy is designed as both "top-down" and "bottom-up." In this instance, top-down refers to attracting large international audiences through a documentary film for broadcast, associated social media and international press. Bottom-up refers to efforts at the nation-specific levels, such as fisher-to-fisher exchanges, local screenings and live events, local-based social media and press. In this way, the initiative creates awareness and constituencies from two directions, which meet in the middle.

Next Steps

BFI has audacious goals but has already made significant progress. We are developing strategic plans that will guide cooperative research and effective communication strategies to build broad consensus and cooperation among network partners and stakeholders. With significant and needed financial support, BFI will make exponential strides towards FSA conservation and fisheries management at local, national and regional scales.

KEYWORDS: Fish spawning aggregations, collaboration, communications

ACKNOWLEDGEMENTS

Big Fish is institutionalized under the direction of two primary organizations, LGL Ecological Research Associates, Inc. that leads the research and monitoring programs, while BelugaSmile Productions, LLC co-leads the initiative and directs the communication program and the entire initiative supports conservation and management. GCOOS serves as the data manager, COBI serves as "poster child" for the initiative. Big Fish and the programs that have been subsumed within it have received financial support from the Summit Foundation, Mesoamerican Reef Fund, the Pew Charitable Trusts, Caribbean Fishery Management Council, South Atlantic Fishery Management Council, the RESTORE Science Program, Environmental Defense, GCOOS, COBI, LGL Ecological Research Associates, Inc., Beluga Smiles Productions, LLC and many others.

LITERATURE CITED

- BelugaSmile Productions and the WECAFC SAWG Communication Sub-Committee. 2019. *Restoring Big Fish: Communication for Fish Spawning Aggregations Conservation and Management*. Caribbean Fishery Management Council, Puerto Rico.
- Biggs, C.R. and R.S. Nemeth. 2016. Spatial and temporal movement patterns of two snapper species at a multi-species spawning aggregation. *Marine Ecology Progress Series* **558**:129-142.



Figure 3. Each sentinel site will be equipped with an *in situ* instrument bundle including (left to right) a low frequency hydrophone recorder, acoustic doppler current meter, multi-parameter sonde, a telemetry receiver, and a self-cleaning underwater video camera (e.g. View into the Blue model shown here).

- FAO Western Central Atlantic Fishery Commission. 2019. Report of the second meeting of the CFMC/WECAFC/OSPESCA/CRFM Spawning Aggregations Working Group (SAWG), Miami, Florida, 27–29 March 2018. FAO, Barbados.
- Fulton, S., J. Caamal-Madrigal, A. Aguilar-Perera, L. Bourillón, and W. D. Heyman. 2018. Marine conservation outcomes are more likely when fishers participate as citizen scientists: Case Studies from the Mexican Mesoamerican Reef. *Citizen Science: Theory and Practice*, 3(1): 7:1–12. DOI: <https://doi.org/10.5334/cstp.118>
- Heyman, W.D. and G. Adrien. 2006. A protocol and database for monitoring transient multi-species reef fish spawning aggregations in the Mesoamerican Reef. *Proceedings of the Gulf and Caribbean Fisheries Institute* 57:445 - 449.
- Heyman, W.D., B. Erisman, S. Kobara, N.A. Farmer, C. Biggs, K. McCain, S. Lowerre-Barbieri, M. Karnauskus, J. Brenner, and S. Fulton. 2017. *Cooperative Research and Monitoring Protocols for Fish Spawning Aggregations in the Wider Gulf of Mexico*. LGL Ecological Research Associates, Inc. Bryan, TX. 37 pp. DOI:10.13140/RG.2.2.34415.23202
- Heyman, W., J. Azueta, O. Lara, I. Majil, D. Neal, B. Luckhurst, M. Paz, I. Morrison, K.L. Rhodes, B. Kjerfve, B. Wade, and N. Requena. 2004. *Spawning Aggregation Monitoring Protocol for the Mesoamerican Reef and the Wider Caribbean. Version 2.0*. Mesoamerican Barrier Reef Systems Project, Belize City, Belize.
- Schärer, M.T., T.J. Rowell, M.I. Nemeth, and R.S. Appeldoorn. 2012. Sound production associated with reproductive behavior of Nassau grouper *Epinephelus striatus* at spawning aggregations. *Endangered Species Research* 19(1):29 - 38.