

Controversial opening of a limited fishery for Atlantic Goliath Grouper in the United States: implications for population recovery

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Abstract

Laws protecting the Atlantic Goliath Grouper *Epinephelus itajara* from fishing in federal and state waters of the United States (US) occurred in 1990 after the species was identified as being severely overfished. Population increases that occurred during the first 20 years of the closure were followed by a decline in the 10 years thereafter. Despite the National Oceanic and Atmospheric Administration's call to retain full protection for this species in federal waters, the Florida Fish and Wildlife Conservation Commission (FWC) decided to open a limited fishery in state waters for juveniles. Here, we review the literature demonstrating the initial recovery of Goliath Grouper in the U.S., the limits of that recovery, and the ensuing factors that precipitated its subsequent decline; we discuss the risks associated with management decisions that ignore the best available scientific information; and we compare management differences and difficulties among nations within the Atlantic Goliath Grouper's global range. The major findings are that Goliath Grouper populations have not fully recovered and that FWC has not sought to conserve and protect them. Resolving these problems will require the Governor of the State of Florida to appoint Commissioners that

represent a range of stakeholders with expertise in ecology, conservation, and management beyond that provided by the FWC agency; to better train appointees lacking in those areas; and to choose candidates who embrace use of the best available science in making critical decisions that affect Florida ecosystems, native species, and Florida residents.

Keywords: Goliath Grouper; Marine conservation; Cold water events; Red tide; Catch-and-release fishing; Mercury bioaccumulation; Mangroves; Florida Fish and Wildlife Commission; Best available science

Data Availability

Data for graphs were provided by colleagues who were not co-authors. This paper is primarily a review of management decisions made related to the Atlantic Goliath Grouper.

Introduction

The Atlantic Goliath Grouper *Epinephelus itajara* (Lichtenstein, 1822) is the largest fish in the family Epinephelidae in the Atlantic Ocean, reaching ≥ 2.0 m TL (total length) and 400 kg [1]. Western Atlantic populations occur from Florida in the United States (U.S.), throughout the Gulf of Mexico, Caribbean Sea, south to Santa Catarina, Brazil [2] whereas the eastern Atlantic population (Angola to Senegal), anecdotally reported on Gabon oil platforms [3], approaches extinction [2]. Atlantic and eastern Pacific populations, once considered conspecifics, are now identified as genetically distinct [4]. This work will address only the Atlantic Goliath Grouper (indicated as Goliath Grouper hereafter).

Goliath Grouper reside primarily in mangroves as juveniles [5], moving offshore as they mature to join adult populations [6–9]. Like many epinephelids, they are vulnerable to rapid overfishing due to: (1) their longevity (known maximum age 37 years [10]); (2) their late maturity (5–7 years); and (3) the ease with which fishers locate their offshore spawning sites [11]. Spawning occurs from August through October or November in the U.S. and typically consists of < 100 individuals (Fig. 1) [12].



Figure 1. Spawning aggregation of Atlantic Goliath Grouper *Epinephelus itajara* off the east coast of south Florida, USA. Aggregation size is typically < 100 individuals. Photo by Walt Stearns.

These fish, once relatively abundant in U.S. waters in the 1890s to early 1900s [13], experienced extreme overfishing thereafter, approaching extinction by the 1980s [1]. While severe declines have occurred elsewhere throughout their geographic range, the data are insufficient to verify the

extent. Poor data presents a serious conservation concern, as noted by the IUCN listing this species as critically endangered in 2011 [14] and vulnerable in 2018 [2] – a status change resulting more from a stricter application of IUCN Red List assessment criteria and improved data interpretation than to any change in population status (Y. Sadovy, personal communication 28 July 2021).

The National Oceanic and Atmospheric Administration (NOAA), responsible for fisheries management in U.S. federal waters, closed the Goliath Grouper fishery throughout its jurisdiction in the southeastern U.S. in 1990,¹ triggering closures of state waters in Florida, Alabama, Mississippi, Louisiana and Texas [15]. Federal waters include the entire Exclusive Economic Zone, as defined under the *U.S. Magnuson-Stevens Fishery Conservation and Management Act (Magnuson Act)* [16], having a shared inner seaward boundary with each coastal state and an outer boundary extending 200 nm thereafter. State waters in Florida and in all other southeastern states extend three nautical miles (nm) offshore on the U.S. east coast whereas in the Gulf of Mexico, only Florida and Texas have a 9 nm limit.

These fishery closures placed Goliath Grouper on a trajectory to recovery for 20 years [15,17]. Despite events in the last decade that precipitated another decline, the Florida Fish and Wildlife Conservation Commission (FWC) approved and opened a fishery for juveniles in state waters. The question is, why? The content of this report revolves around that question. The objectives were (1) to review the literature that demonstrates the initial recovery of Goliath Grouper in the U.S., the limits of that recovery, and the ensuing environmental and social factors that precipitated its subsequent decline; (2) to discuss the risks associated with management decisions that fail to acknowledge important scientific information and ignore the principles of a precautionary approach; and (3) to compare the management differences and difficulties among nations within its global range.

Methods

We conducted a literature review of Goliath Grouper through documents online using the platforms Web of Science, Google Scholar, and the authors' personal publications and resources (see references); and a review of its management and conservation using state, federal, and international documents from NOAA, FWC, The Reef Environmental Education Foundation (REEF), and The International Union for Conservation of Nature (IUCN), among others. Search terms included: Goliath Grouper, *Epinephelus itajara*, best available science, precautionary approach, mangroves, cold-water events, and red tide individually and/or in combination with ecology, life history, South Florida, Florida Fish and Wildlife Conservation Commission, fisheries management, and marine conservation. We cited documents that either related directly to the objectives of this report or informed the overarching issues related to management and conservation. We reviewed recordings of three FWC Commission meetings posted on the FWC website in which the limited fishery was discussed and the final rule made by the FWC Commissioners [18–20].

Results & Discussion

3.1 Trajectory of protection, recovery, and decline in the United States

While the Goliath Grouper population improved between 1990 and 2010, NOAA in 2006 found that fishing mortality remained high ($F_{50\%}$, i.e., greater than 0.05/year), suggesting that the

population had only a 40% chance of recovery by the year 2020 [21]. This is borne out in data provided by REEF's Volunteer Fish Survey Project conducted by citizen scientists, which shows a decline in adults from around 2010 through 2020 (Fig. 2A) [22].

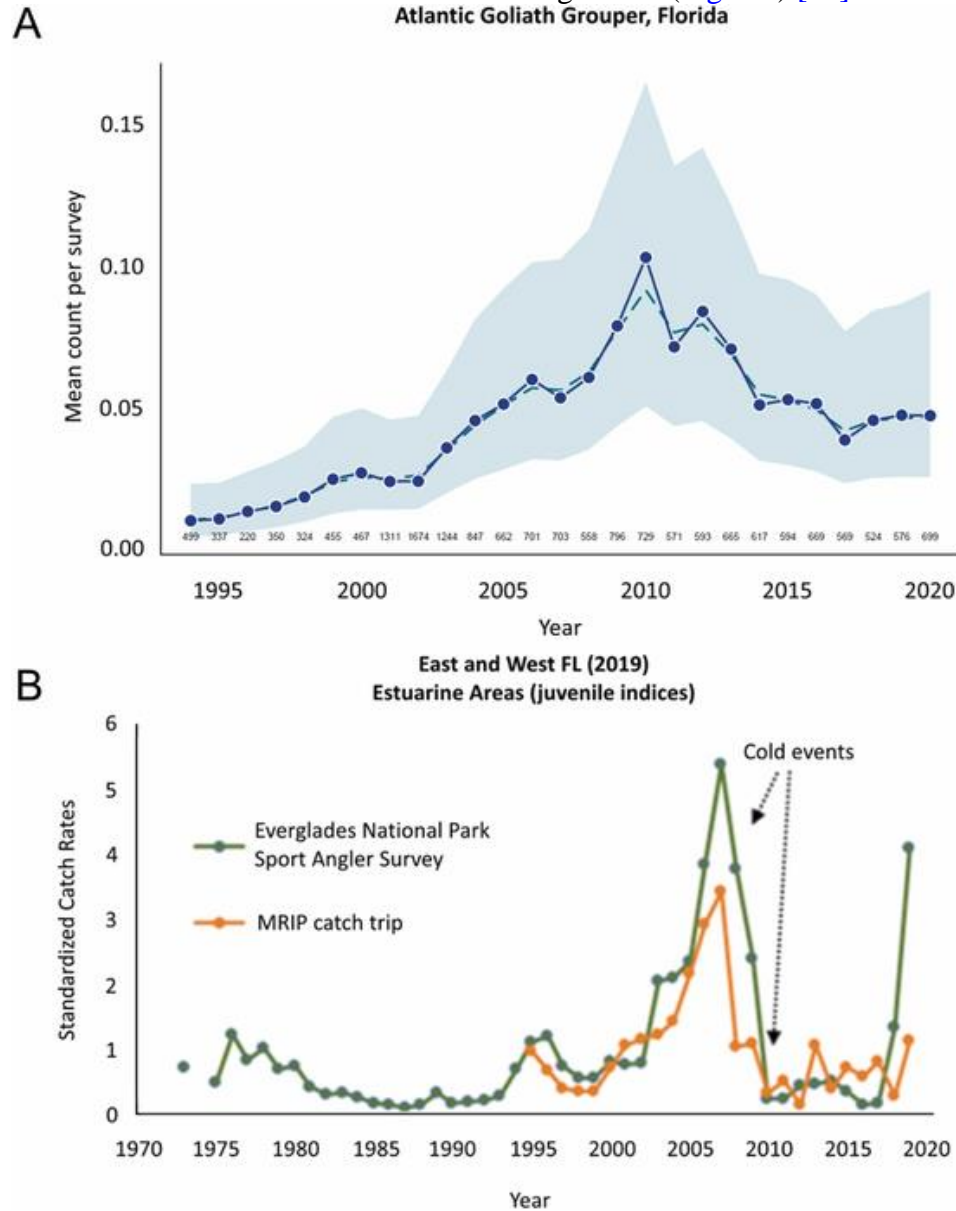


Figure 2. Population trajectory for Atlantic Goliath Grouper *Epinephelus itajara* in Florida. (A) Adults, based on 17,983 roving diver surveys collected by the REEF Volunteer Fish Survey Project. # non-spawning aggregation sites = 130. Solid points = expected mean annual estimated count per survey; dashed line = estimated population state; X-axis = year; numbers above years = # surveys at all sites each year. Y-axis = mean # of fish encountered on an average dive. Shaded area = 90% CI (-69.9%, -25.3%). *Source:* Dr. Dan Greenberg. (B) Standardized catch rates of juveniles. *Source:* Joe O’Hop, SEDAR 47, Figure 3.3.6, 2016, updated through 2019. MRIP = Marine Recreational Information Program (NOAA).

Juvenile populations have fared no better, as shown in data from NOAA's Marine Recreational Information Program (MRIP) and the Everglades National Park (ENP) Angler Creel Survey², both based on indirect surveys of fish populations conducted by agency staff (Fig. 2B). The MRIP and ENP standardized catch rate data tracked one another well until 2019 when a large uptick in ENP data was not repeated in MRIP data (Fig. 2B). A single uptick, while encouraging, does not represent a trend and should not be used as support for opening a fishery, no matter how limited. Despite that uptick, adult populations remain low with little apparent recruitment of young fish. These population declines are largely attributed to episodic events to which all age classes are susceptible – cold weather and red tides. Major cold-water events occurred in South Florida in 2008 and 2010 (Fig. 2B), the latter being more severe, lasting 14 days with temperatures of 3–5 °C (34–41°F) – significantly lower than the 15 °C (59°F) at which these fish succumb [1]. The resulting declines in juveniles and mangrove habitat [5,23] led to virtually no recruitment to adult populations during the ensuing years [15], another indication that full recovery has not occurred. Additional cold-water events occurred in December 2022 (5 days, 8.7 – 14.4 °C) and January 2023 (3 days, 13.7–16.7°C). The population-level effects of these events remain unclear (J. Rehage, personal communication, 16 January 2023).

A massive red tide in 2005 led to offshore declines in adult Goliath Grouper from 2006 to 2008 [15]. Red tides caused primarily by the native dinoflagellate *Karenia brevis* [24] have increased in frequency, intensity, size, and duration on the west coast of Florida over the last 100 years [25], at tremendous ecologic and economic costs [26,27]. Fed by eutrophication, now rampant in South Florida bays [24,28], they precipitated serious declines in seagrass and mangrove habitat [23, 24, 26, 28–30] and mass mortality of marine animals in coastal waters [31,32]. Controlling red tide requires targeted management of eutrophication and significant habitat restoration.

3.2 Other Causes of Decline

Other causes of Goliath Grouper decline are more difficult to trace. Among these are the bioaccumulation of mercury (Hg) and catch-and-release fishing. The notoriously high Hg levels in adults can compromise their health (e.g., impairing organ and cell function), lead to reduced spawning success by damaging eggs and developing embryos, and cause direct mortality [33]. Further, consumption of these fish can lead to neurological (including irreversible brain damage) and other health risks most evident in children [34].

Targeted catch-and-release fishing of Goliath Grouper primarily occurs on spawning aggregations at depths from 20 to 32 m. This fishing, although not sanctioned by FWC, is more often considered as incidental catch. What is clear is that the repercussions from capture at these depths (e.g., barotrauma, potential disruption of spawning activity) can be severe [15,21,35,36]. FWC staff have expressed interest in closing a few sites off SE Florida [37], however no action to do so has yet occurred. A better approach would be to protect all aggregation sites, given this species' high vulnerability to fishing.

3.3 The Florida Fish & Wildlife Commission opens a limited fishery

The events described above hamper the recovery of Goliath Grouper in the U.S. and elsewhere. Yet, FWC Commissioners recently opened a limited recreational fishery for juveniles [38].

Through a random-draw lottery, fishers obtained special recreational harvest permits and tags (USD \$150.00 for residents, \$500.00 for non-residents) to legally harvest this species. The slot limit is 24 - 36 inches (61-91_{cm}_TL), harvest limited to one fish per person per open season

(March 1st through May 31st, and an annual quota of 200 fish. Further, anglers with appropriate permits and tags must submit biological samples with their harvest report, data more reliably obtained through scientific sampling. The stated rationale for the slot limit was to avoid the capture of adult fish [39]. Not stated however, but certainly relevant, is that the slot limit avoids capture and possible consumption of fish with the highest Hg loads—generally the oldest and largest fish. Despite that, many juveniles have Hg levels above those considered safe for human consumption by the U.S. Environmental Protection Agency [34].

The 200 fish quota for juveniles is less clear. The only statement in the ruling pertaining to the quota is this: “This unique recreational opportunity is possible through conservation efforts by state and federal agencies that aided in the Goliath Grouper population rebuilding over the course of three decades, following years of overfishing.” The data suggest otherwise (Fig. 2).

3.4 Flawed approach to Goliath Grouper management

Apparent in the FWC Commissioners’ decision to open the fishery is a limited understanding of the principles of the best available scientific information and the precautionary approach to management, the former by omission and the latter by absence of a requirement to adopt the approach, an approach that is richly covered in the literature [40–45]. The Florida Statutes (Chapter 379.2401 item 3b) require that FWC use the best scientific information available to them, ‘including biological, sociological, economic, and other information deemed relevant by the commission’ [46]. It does not suggest that any of these data be ignored.

This problematic approach to wildlife management decisions is not limited to Florida [47]. What is apparent is that a paradigm shift is needed wherein more agencies (including FWC) embrace conservation to enhance biological diversity and sustainability by using the best available science coupled with a precautionary approach. A precautionary approach is required whenever there is a high degree of uncertainty in the data [48,49]. Cold-water events, red tide, Hg bioaccumulation, and data deficiencies introduce such uncertainty for Goliath Grouper. A Florida Statute directing FWC to use this approach would be a tremendous improvement.

We offer two recommendations for moving forward. First, we suggest that the Governor diversify the make-up of the Commission to include scientists drawn from federal and academic institutions as well as stakeholders from the diving, fishing, and hunting industries so that the Commission itself has both internal (fellow Commissioners) and external (public input) sources of scientific and empirical expertise at their disposal thus broadening the input they receive. Second, we suggest that all Commissioners after appointment and before voting on matters important to Florida ecosystems, native species, and residents, receive more in-depth training that covers the ecology, conservation, and management of the species they are charged with protecting, and requires use of the best available scientific information and the precautionary approach.

3.5 Conditions for recovery

Recovery for Goliath Grouper is not helped by the juvenile fishery. Full recovery will require that FWC: (1) reduce eutrophication in South Florida estuaries [24]; (2) develop targeted mangrove and seagrass habitat restoration plans [24], and (3) reinstate full closure of any directed fishery (including catch-and-release) in favor of the more lucrative non-consumptive diving ecotourism industry wherein divers observe fishes *in situ* without loss to the population [24,50].

The first two suggestions come with hefty price tags and are in keeping with the Magnuson Act, which states that management should “. describe and identify essential fish habitat for the fishery,. minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat [16].” Florida, while not required to follow the Magnuson Act, would do well to adopt this principle if it wants to continue to claim the title of “Fishing Capital of the World” and to enjoy the natural and economic largesse that follows [51]. This goes far beyond the desire to protect Goliath Grouper because it is not the only species that would benefit from restoration of coastal habitats and better management practices discussed in this review. The third suggestion makes good conservation and economic sense.

3.6 Recognizing differences among nations

The actions recommended here provide a baseline for Goliath Grouper conservation in the U.S. and other countries that have the wherewithal to fund them. The reality is that countries differ markedly in Goliath Grouper status (e.g., IUCN considers them vulnerable and declining in the U.S., critically endangered in Brazil), in economic and enforcement capabilities, and in data availability, as well as in sociological drivers to fish [52]. It is imperative that these differences be considered.

In the U.S., for instance, Goliath Grouper remain fully protected from harvest in federal waters, while full protection in Florida’s state waters ended March 1, 2023, to allow a limited juvenile harvest. In addition to the targeted juvenile fishery inshore [38], a catch-and-release fishing operation occurs on spawning aggregation sites off Florida’s east coast [36,53], as does poaching and illegal fishing (e.g., 75 citations issued by FWC for illegal possession of Goliath Grouper from 2014 to 2022. FWC public records request, 18 January 2022). Still, the U.S. situation is better than and differs markedly from that in nations like Brazil, where fishing Goliath Grouper is banned but enforcement is virtually nonexistent in most regions, leaving the population critically endangered. It differs even more from countries on the Atlantic coasts of Central America (Mexico, Belize, Guatemala, Honduras, and Panama) [54,55], throughout the Caribbean (including Venezuela and Colombia), and the northeastern coast of South America (French Guiana, Trinidad, Suriname, Guiana) [9,56], and the west coast of Africa, where populations are unprotected, regulations are nonexistent, and population status is unknown [2]. While all countries can benefit from habitat protection and restoration, few can afford to do it properly. Yet any country could benefit from a non-consumptive ecotourism diving industry created around this iconic species while acknowledging the need for fishers in these countries to be able to continue fishing on other species.

Conservation leaders in Brazil are taking steps to change their approach through a new organization, *The Atlantic Goliath Grouper Conservation Network* which was revealed at the 2022 United Nations Ocean Conference [57]. For this organization to be successful will require considerable interaction among fishers, non-fishers, environmentalists, managers, and politicians from all nations throughout the global range of this species. It also will require support to be able to work with and learn from these different countries and sectors if anything is to be accomplished. The focus needs to be on developing and implementing actionable targets for Goliath Grouper conservation and protection that are tailored to each nation’s needs and capabilities. The goal, after all, is for each nation to implement the best practices available for their region to protect and

conserve this species and its associated habitats as determined through interactive programs that focus on overcoming implementation challenges that have heretofore hindered their ability to move forward [58].

Conclusions

Despite laws enacted in U.S. federal and Florida state waters in 1990 that increased Goliath Grouper populations, events occurring since 2010 have contributed to persistent declines.

- Juvenile decline is attributed to cold-weather and red tides that affected resident populations and mangrove habitat whereas adult decline is primarily attributed to poor recruitment from juvenile populations following the episodic events and to the damaging effects of mercury poisoning and catch-and-release fishing.
- FWC Commissioners opened a limited fishery for juveniles in south Florida, ignoring both the best available scientific information and the precautionary approach.
- The FWC Commissioners could benefit by having a more diverse body of members and considerably more training than is currently available to them before they proceed to vote on matters critical to Florida's ecosystems, native species, and residents.
- Proposed steps for FWC to support the survival and recovery of native species and habitats are: (1) to reduce eutrophication in South Florida estuaries; (2) to increase mangrove and seagrass coverage through targeted habitat restoration; and (3) to shift from consumptive fishing to a non-consumptive diving ecotourism industry based on Goliath Grouper, the economic value of which trumps consumptive harvest.
- The protective actions recommended for the U.S. will be difficult to accomplish throughout Goliath Grouper's geographic range without a multinational effort that acknowledges differences among nations in the creation of appropriate conservation and management plans.

CRedit authorship contribution statement

Felicia C. Coleman: Conceptualization, Visualization, Writing – review & editing. **José A.C.C. Nunes:** Conceptualization, Writing – original draft, Writing – review & editing. **Áthila A. Bertoncini:** Writing – review & editing. **Leonardo S. Bueno:** Writing – review & editing. **Matheus O. Freitas:** Writing – review & editing. **Máira Borgonha:** Writing – review & editing. **Jonas R. Leite:** Writing – review & editing. **Márcio J.C.A. Lima-Júnior:** Writing – review & editing. **Beatrice Ferreira:** Writing – review & editing. **Bianca Bentes:** Writing – review & editing. **Christopher C. Koenig:** Writing – review & editing. **Christopher R. Malinowski:** Writing – review & editing. **Eduardo G. Sanches:** Writing – review & editing. **Maurício Hostim-Silva:** Writing – review & editing. **Cláudio L.S. Sampaio:** Writing – review & editing.

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Footnotes

Text Footnotes

- [1]NOAA also closed the fishery in the US Caribbean in 1993.
- [2]No data were available from the Everglades National Park for 2020–2022 due to the COVID-19 pandemic and the loss of the creel survey position (ENP, personal communication 15 January 2023).