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Eleventh Meeting of the Scientific and Technical
Advisory Committee (STAC) of the Protocol
Concerning Specially Protected Areas and
Wildlife (SPAW) in the Wider Caribbean Region

Panama City, Panama
30 June – 3 July 2025

**REPORT ON THE CONSERVATION OF NASSAU GROUPER
(EPINEPHELUS STRIATUS)
A REPORT OF THE SPAW SPECIES WORKING GROUP**

This meeting is being convened hybrid. Delegates are kindly requested to access all meeting documents electronically for download as necessary.



ACRONYMS

CRFM	Caribbean Regional Fisheries Mechanism
COP	Conference of the Parties
FSA	Fish Spawning Aggregation
MPA	Marine Protected Area
NGO	Non-Governmental Organization
PA	Protected Area
RAC	Regional Activity Center
RAN	Regional Activity Network
RFSAMP	Regional Fish Spawning Aggregation Management Plan
SPA	Specially Protected Areas and Wildlife
SPA RAC	Regional Activity Centre for the Protocol Concerning Specially Protected Areas and Wildlife for the Wider Caribbean Region
SAWG	Spawning Aggregations Working Group
STAC	Scientific and Technical Advisory Committee
UNEP	United Nations Environment Programme
WECAFC	Western Central Atlantic Fisheries Commission
WCR	Wider Caribbean Region
WG	Working Group

PROTECTED AREA & SPECIES WORKING GROUP

Mandate

The SPAW STAC Working group on Protected Areas and the SPAW STAC Working Group on species (see list of experts in appendix IV and V) had the following tasks assigned by the STAC10:

- **Specific tasks**

Undertake the joint task in UNEP(DEPI)CAR WG.43/INF.26, paragraph 15, for the conservation of Nassau Grouper (*Epinephelus striatus*), and report progress and make recommendations, as appropriate, to STAC 11 (“Task 4” for the purposes of this report).

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Main recommendations

Habitat Mapping: SPAW Parties should map key Nassau grouper habitats, including FSAs, migration routes, and critical life stages, incorporating local ecological knowledge. These areas should be promoted for new or expanded MPAs.

Regulation Review: Evaluate existing protections for Nassau grouper and FSAs, updating regulations and management plans as needed, with attention to spawning seasons (Dec-Mar) and migration routes.

Indicators & Monitoring: Incorporate Nassau grouper-specific indicators into MPA management plans, using diverse datasets (fishery, socioeconomic) to monitor stock health, life history, and enforcement effectiveness.

National Working Groups: Form national working groups including government, NGOs, and resource users, with annual work plans and benchmarks for monitoring and management over 5-10 years.

Standardized Protocols: Adopt harmonized protocols for monitoring, evaluation, and reporting on Nassau grouper and FSAs, aligning national and regional processes.

Management Effectiveness: Include FSA management indicators in SPAW-listed MPA reports and establish a formal mechanism to share data with WECAFC and SAWG for regional planning.

Chair of the working group: SPAW RAC

Background

1. The Nassau grouper was listed in Annex III of the SPAW Protocol in 2017 (Class Teleostei, Order Perciformes, Species *Epinephelus striatus*). This species is a reef-associated piscivore known to form spawning aggregations during the months of December-March in association with the full moon. Before the 1970s, these spawning aggregations were known to be as large as 30,000 fish on average, with especially large aggregations of 100,000 fish reported in Belize and the Bahamas (Burns Perez & Tewfik, 2016; Craig, 1969).
2. Site fidelity and temporal predictability made these spawning aggregations favourable targets for commercial fishing efforts for many decades. Unfortunately, high fishing pressure has led to region-wide population declines, including local extirpation and commercial extinction of this species in many countries (Donaldson et al., 2002; Sadovy & Domeier, 2005; Sadovy & Eklund, 1999; Sala et al., 2001). This species has been listed as Critically Endangered by the IUCN Red List on the basis of a regional decline in population size of over 95% over a projected 50-year period (Sadovy et al., 2018).
3. Regional management efforts by the Western Central Atlantic Fisheries Commission (WECAFC) began with the convening of a regional workshop in 2008 and the establishment of a formal Spawning Aggregations Working Group (SAWG) in 2012. In 2020, a formal collaborative framework was established between the SPAW-STAC and the SAWG.
4. In 2022, SAWG presented a Regional Fish Spawning Aggregation Management Plan (RFSAMP) to WECAFC for endorsement. The RFSAMP was endorsed, and implementation began in three pilot countries in 2023.
5. The significance, history of management efforts and recommendations of the SPAW-STAC for conserving this species are presented in: UNEP(DEPI)/CAR WG 43/INF 26 - Priority: Protection and conservation of the Nassau Grouper (*Epinephelus striatus*) in the Wider Caribbean Region (2022) and was adopted by the SPAW COP 12 in 2023. Paragraphs 12-13 of the aforementioned document include recommendations for SPAW Contracting Parties to promote a harmonized regional closed season from December-March, to apply the precautionary principle in their management of *E. striatus* and to implement national management plans. Paragraph 14 recommends collaboration of the SPAW Secretariat and SPAW-RAC with other regional fisheries organisations, including WECAFC and Caribbean Regional Fisheries Mechanism (CRFM).
6. Paragraph 15 is the recommendation fulfilled by this document, and reads as follows: “The STAC should request the SPAW Species Working Group and Protected Areas Working Group to undertake a joint task for submission to the next STAC meeting to consider opportunities to improve MPA management and protection for Nassau grouper, including in SPAW-listed MPAs, which are known to protect important spawning aggregation sites, taking into account proposed action #16 in the RFSAMP¹.”

¹ Action 16: Increase Nassau Grouper and Mutton Snapper Fish Spawning Aggregation (FSA) protection by improving management of current MPAs or establishment of new MPAs where the conservation of FSAs is included in the objectives.

7. This recommendation is in alignment with RFSAMP Objective 6: “To integrate FSA protection into broader planning and ecosystem scale management initiatives.”
8. Articles 4-9 of the SPAW Protocol pertain to the establishment and management of protected areas in the Wider Caribbean Region.
9. Toward this end, marine protected areas across the Caribbean have been listed under the SPAW Protocol in an effort to establish an interconnected network of expertise which promotes mutual enhancement of conservation outcomes. Further, SPAW-RAC engages the wider group of MPAs which comprises the SPAW protected area manager network.
10. Following the expected outcomes of RFSAMP Action 16, this document aims to:
Provide recommendations for implementing Nassau grouper protections in existing MPAs, and prioritisation of their spawning aggregations and ontogenetic movements in the design and establishment of new MPAs.
Present key resources to inform the implementation of assessments of status, management effectiveness and gaps in governance of Nassau grouper and their FSAs in MPAs across the Wider Caribbean

Recommendations

11. SPAW Contracting Parties should **map key habitats for Nassau grouper**, including confirmed and unconfirmed Nassau grouper FSAs, migration routes and areas of ontogenetic significance. Local ecological knowledge should be considered essential to this exercise. The existence of these areas should be promoted by the UNEP Cartagena Convention Secretariat and SPAW-STAC as significant enough to justify establishment of new MPAs and prioritisation and/or expansion of existing MPAs to protect them.
12. SPAW Contracting Parties should implement RFSAMP priority action #10² through **evaluation of protections conferred upon Nassau grouper and its FSAs by existing fisheries regulations and management plans**. New regulations and management plans should be proposed and implemented where necessary. MPA regulations, rules and boundaries should be designed/modified to better protect Nassau grouper within MPA boundaries throughout their life history, with temporal consideration for their spawning season from December-March and spatial consideration for their seasonal migration routes and FSA locations where possible.
13. SPAW Contracting Parties should implement RFSAMP priority action #3³ by incorporating the use of objectives and indicators which specifically evaluate the status of Nassau grouper FSAs into MPA management planning, monitoring and evaluation processes. Data streams for these indicators should include fishery dependent, fishery independent and socioeconomic datasets to characterise and evaluate the fishery, landings, abundance, life history, ecology, ontogenetic/annual/seasonal movement patterns, effectiveness of enforcement and outreach.
14. SPAW Contracting Parties should **form national working groups** on Nassau grouper and fish spawning aggregations to promote exchange of information, capacity and expertise. These national working groups should include representatives of government, NGO and resource user groups, as appropriate, and operate based on annual work plans which prompt monitoring, evaluation and reporting on known Nassau grouper FSAs and management effectiveness. National working groups should also establish benchmarks against which to measure success over 5- and 10-year periods.
15. SPAW Contracting Parties should adopt **harmonised protocols** for monitoring, evaluation, reporting and archival of information on Nassau grouper & FSAs. Where possible, national and regional monitoring and evaluation processes should be aligned.
16. SPAW Contracting Parties should prioritise and prompt for FSA management effectiveness indicators to be included in reports from SPAW-listed MPAs. Further, a formal mechanism should be initiated to funnel this information to WECAFC and the SAWG for regional planning purposes.

² RFSAMP Action #10: Evaluate the effectiveness, applicability and benefits of current Nassau Grouper and Mutton Snapper fisheries management and the degree of protection their FSAs are receiving.

³ RFSAMP Action #3: Define criteria to determine sites/countries at high risk of losing their NG and MS FSAs by considering ecosystem, biological, ecological and socio-economic elements and considering current known status of the species. Where no information is available, approach should be precautionary.

Key resources

[Big Fish Initiative](#) – The online presence of the WECAFC-SAWG. This website acts as a hub and resource library containing scientific papers, targeted communications and outreach materials, methodologies and news from around the Caribbean regarding fish spawning aggregations.

[Regional FSA Management Plan](#)

[Reef Fish Spawning Aggregation Monitoring Protocol for the Meso-American Reef and the Wider Caribbean](#)

[Manual for the Study and Conservation of Reef Fish Spawning Aggregations – Big Fish Initiative](#)

[Fish Spawning Aggregation Monitoring in the MARFish Network](#)

[Cooperative Research and Monitoring Protocols for Fish Spawning Aggregations in the Wider Gulf of Mexico](#)

[Emerging Science and Technology to Improve Monitoring and Assessment of Fish Spawning Aggregations to Report from the 2019 Gulf and Caribbean Fisheries Institute Workshop](#)

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APPENDIX I:

Table S1. Known/probable number of and additional information on Nassau grouper spawning aggregation sites.
From DeMitcheson et al 2020.

Country	Number of sites known	Peak spawning months*	Aggregation status (numbers of fish in aggregations) from UVC or catches	FSA Management	References
Colombia	2	December - February	10's to 100s of individuals seen during full moon at FSAs within Old Providence and Santa Catalina, Seaflower Biosphere	● 1	Bent, 2012
The Bahamas	30	December-February	Mostly of unknown status but many sites anecdotally indicated. Two with thousands of fish, three with fish in hundreds and many tens of fish, or FSAs known or reported but of unknown sizes. Declines across many FSAs and some no longer form. One site estimated to have between 30,000 and 100,000 fish has disappeared.	1,2	Smith, 1972; Colin, 1992; Sadovy, 1999; Cushion et al. 2008; Erisman et al., 2013; Sherman et al., 2016
Belize	15	December-January	Aggregations fished since at least 1940s. Two FSAs had 30,000 and 15,000 fish each (1960s/1970s). Historically, one aggregation yielded 200 t in a single season and up to 300 boats with a single experienced crew catching from 1,200 to 1,800 fish during a single reproductive season and estimated catches reached 90 t per season. FSAs surveyed 2003-2012 each contained < 100 to a few thousand fish.	1,2	Thompson, 1945; Craig, 1966; 1968; Carter et al., 1994; Sala et al., 2001; Heyman and Requena, 2002; Gibson et al. 2007; Paz and Truly, 2007 ; Gongora 2013; Burns Perez and Tewfik, 2016
Bermuda	4	May-July	FSAs fished at least since late 1970s. All sites now gone.	1,2	Luckhurst, 1996
British Virgin Islands	At least one		Early 1990s low fishing pressure on the species.	?	Beets and Friedlander, 1992
Cayman Islands	5-7	December - March	Exploited from early 1900s. Declines by 1980s. One FSA discovered had 7,000 fish but declined from fishing in two years. Two remaining FSAs recovering, one to 7,000 fish. From one aggregation, 2,000 fish caught in a 10 day fishing period.	● 1,2	Whaylen et al., 2004, 2007; Bush et al. 2006; Semmens et al., 2007, 2012; Shouse et al., 2018, Waterhouse et al., 2020 ; Stock et al., 2021
Cuba	> 20	December - March	Unknown status of all FSAs today; fished since 1880s. Fish also extensively fished on pre-spawning migrations.	1,2	Vilaro Diaz 1884; Claro and Lindeman 2003; Claro et al., 2009; Claro and Valle 2013; Claro et al., 2019
Dominican Republic	1	?	Possibly disappeared.	?	Sadovy 1999; Sadovy de Mitcheson et al., 2012; P. C. Colin, pers. comm.,

Honduras	5 - 12	December-March	Mostly unknown, but possibly gone, one decreasing. One site dropped from approx. 10,000 fish in early 1990s to 500 two years later. One recently validated.	1,2	Craig 1968; Fine 1990, 1992; Box and Bonilla-Mejia 2008; Canty and Box 2014
Jamaica	At least 1	February	No recent record	?	Thompson and Munro 1983
Mexico	28 sites reported	December-March	FSAs fished since early 1900s - very productive 30-35 years ago. Mahahual site gone; this site once yielded 24 t in a season. Status of many other FSAs unknown. 15,000 fish at one site in early 1990s, collapsed by 1996. Second site with 4,100 fish in 2004-5. Xcalak with 3,000 groupers in 2002. Sian Kaan biosphere reserve with two aggregations (1,000 in 2010 and the second one with 150 in 2015).	1	Aguilar-Perera, 1994, 2006, 2013, pers. comm.; Aguilar-Perera and Tuz-Sulub 2012; Aguilar-Perera et al. 2009; Medina-Quej et al., 2004; Sosa-Cordero et al., 2009; Heyman et al., 2014; Fulton et al. 2016, 2017, 2018;
Puerto Rico	2	December-April	Anecdotal, several aggregations are known from past accounts in south and southwest Puerto Rico and Mona Is.. One small one today of about 100 fish regularly forms. Once the southwest site produced enough to fill fishing boats with multiple tons during the aggregation period.	1,2	Sadovy 1999; Ojeda-Serrano et al., 2007; Schärer -Umpierre et al. 2012, 2014; Olson et al., 2018; Tuohy et al., 2016
Turks & Caicos	1	December - March	Status unknown but probably good given relatively low focus on ,aggregation. Trap boat fishers targeted but few free-divers. Trap CPUE was 85 kg/person/day ranging from 4 to 425 kg and spear fishers CPUE was 30 kg/person/day ranging from 0 to 76 kg. Over the spawning season trap boats caught 8 to 22 metric tons of Nassau grouper.	1,2	Rudd 2003, National Parks Ordinance and Subsidiary Legislation CAP. 80 of 1988; Vo et al., 2008; Landsman et al., 2009; Calosso and Claydon, 2016
U.S., Florida Keys	Anecdotal	?	No information.	1,2	Sadovy and Eklund 1999; Hill and Sadovy de Mitcheson 2013
U.S. Virgin Islands	2	December – April	Fished at least since 1960s. One site with 2,000-3,000 fish present; late 1970s collapsed. Peak landings at St. Thomas aggregations 2.3 t per day. One FSA possibly recovering with c. 200 fish.	1,2	Olsen and LaPlace 1979; Munro and Blok 2005; Nemeth et al., 2009; Kadison et al., 2010; Sharer-Umpierre et al., 2014; Rowell et al., 2015, Chérubin et al., 2020
Venezuela	Anecdotal	January	No information.	1	Boomhower et al. 2010

Notes: Level of management is indicated by '0' for little to none; '1' for general measures (such as MPAs that could benefit the species but are not specifically focused on Nassau grouper or their aggregations), and '2' for species-specific measures (temporal/spatial protection of aggregations, minimum size, etc.).

**= All full moon*

UVC=Underwater Visual Census.

APPENDIX II

Table S2. Regulations, knowledge and enforcement related to Nassau Groupers

Country	Regulations	NG specific PAs	Knowledge	Enforcement
Bahamas	<p>Fisheries Resources (Jurisdiction and Conservation) Act CH.244-11, Part V Fisheries Act amended to prohibit fishing Nassau grouper during the months of December– February, which coincide with peak reproduction in The Bahamas. All marine resources within the park’s boundaries are protected. Regulations include:</p> <ul style="list-style-type: none"> - Minimum Size Limit - Closed Season Dec-Feb 	<p>Limitations placed on catching marine resources (including Nassau grouper) within the 456 km² Exuma Cays Land and Sea Park</p>	<p>Many spawning sites, various environmental conditions, but close to drop-off. Bahamas has the largest number (ca. 30 sites) of known viable (reproductively active) Nassau grouper spawning aggregations (Sadovy & Eklund 1999, Cheung et al. 2013), but with significant declines apparent at many of the historic aggregation sites.</p> <p>Between 1994 and 2014, a total of 4716 tonnes (t) of Nassau grouper were landed in The Bahamas, averaging 236 t yr⁻¹ (Fig. 2). Landings in The Bahamas declined to 70 t in 2012 from a peak of 514 t in 1997, with an overall decline of 86% over the past 2 decades. The most recent studies from The Bahamas indicate abundances of Nassau grouper have declined over the past 2 decades between 70 and 90% in several historical locations (e.g. High Cay), and only 2 of 6 documented spawning aggregation sites in Long Island are still active.</p>	<p>At present, the remaining stocks in The Bahamas experience high rates of poaching from local fishers, with up to 25 to 35% of fish removed from spawning aggregation sites annually.</p>
Belize	<p>Fisheries (Nassau Grouper & Species Protection) Regulations (2009) (SI 2009/49). Belize.</p> <p>Fisheries (Nassau Grouper Protection)</p>	<p>Belize has established year-round no-take zones around 13 known spawning aggregation sites for Nassau grouper. Two of these sites exist as features of the</p>	<p>A considerable knowledge base exists in Belize regarding spawning aggregations of Nassau grouper. Some aggregations (e.g. Northeast Point, Gladden</p>	<p>Local infractions considered rare. Locals are aware of penalties and fines, which have been increased under new Fisheries Regulations (2020). Up</p>

	<p>Regulations (2003) (SI 2003/162). Belize. Fisheries (Spawning Aggregation Site Reserves) Order (2003) (SI 2003/161). Belize. Regulations include:</p> <ul style="list-style-type: none"> - Closure of 13 FSA sites - Closed season Dec-Mar - Minimum Size Limit - Maximum Size Limit - NG must be landed whole - All fish landed as filets must include a skin patch 	<p>following SPAW Protected Areas.</p> <ul style="list-style-type: none"> - Northeast Point FSA, Glovers Reef Marine Reserve - Rocky Point FSA, Hol Chan Marine Reserve <p>Spatial design of PAs does not specifically account for Nassau groupers in other ways, though they experience protection in zones which prohibit commercial fishing.</p> <p>A national closed season for Nassau grouper extends from December-March, coinciding with the known spawning season of this species in Belize.</p>	<p>Spit) have been monitored continuously for over two decades. Traditional knowledge was summarized in Paz & Truly (2007). Stakeholders have organized into a Spawning Aggregation Working Group which maintains national impetus for monitoring and management.</p> <p>FSAs generally exhibit a downward trend in abundance, except for Sandbore FSA at Lighthouse Reef which remains at ~4,000 individuals.</p>	<p>to \$2500USD/fish for illegal catch. Presence of enforcement officers is typically considered an adequate deterrent. Special patrols are conducted at protected FSA sites during the NG closed season.</p> <p>IUU fishing by foreign vessels from Guatemala, Honduras is known to occur at night.</p> <p>Resources (e.g fuel) limit enforcement capacity, especially at distant FSAs.</p>
Cayman Islands	<p>In 1985 the Cayman Islands government restricted fishing FSAs to only residents using hook-and-line gear.</p> <p>In 2003, the Cayman Islands Marine Conservation Board banned fishing on the aggregation site off the west coast of Little Cayman.</p> <p>The Cayman Islands government renewed the initial FSA fishing bans and subsequently enacted comprehensive Nassau Grouper management via legislation (no take during spawning months, bag and slot limits away from FSAs in the rest of the year).</p>		<p>Nassau Grouper FSAs historically formed at five known locations. Fishermen have targeted Cayman FSAs with small boats and handlines around the full moons in January and February since the early 1900s. Intense fishing by local fishermen using handlines removed around 4000 fish in two consecutive 1-week spawning seasons (ca. 2000 in 2001 and 1934 in 2002).</p> <p>Acoustically tagged adult fish on Little Cayman and Cayman Brac do not cross deep water to other islands and the vast majority of reproductive fish attend the one FSA on their island to spawn</p>	<p>Since 2003, the Grouper Moon Project, a collaboration between the CI-DoE, Reef Environmental Education Foundation (REEF), and academic scientists, has published several findings relevant to FSA assessment: (i) a decrease in mean length coupled with an increase in size range from 2004 to 2010 suggests that recruitment occurred on Little Cayman (Heppell et al., 2012); and (iii) since protection, fish numbers have increased substantially on Little Cayman, tentatively on Cayman Brac, and not at all on Grand Cayman.</p> <p>Over the last 15 y the Nassau grouper population on Little Cayman has more than tripled in response to</p>

			(Semmens et al., 2007, 2009).	conservation efforts. Census data from Cayman Brac, while more sparse, show a similar pattern. These findings demonstrate that spatial and seasonal closures aimed at rebuilding aggregation-based fisheries can foster conservation success
Colombia		The distribution area of the Nassau grouper is partially protected by Tayrona NP, Corales del Rosario and San Bernardo NP and Old Providence and McBean Lagoon NP, as well as by the Seaflower Biosphere Reserve of the San Andres, Providencia and Santa Catalina Archipelago.	<p>The NG was listed as Endangered (EN) in the National Red List of Fishes by Acero et al. in 2002. In 2017, a re-evaluation modified this listing to Critically Endangered A2ad (Chasqui et al. 2017), stating that <i>“the threat status was upgraded to Critically Endangered (CR) due to a considerable decrease in its presence in the Colombian oceanic territory, where it was previously considered relatively frequent.”</i></p> <p>Noted knowledge gaps include:</p> <ul style="list-style-type: none"> - Biological/ecological studies - Regular population monitoring - Fishery dependent/landings data - Species specific data collection to avoid collation with other groupers in datasets 	
Cuba		<p>Two SPAW PAs:</p> <ul style="list-style-type: none"> - Reserva de la Biosfera Península de Guanahacabibes, declining Nassau populations 	The top annual catches were traditionally obtained during the spawning period and at various spawning sites (Claro & Lindeman 2003). As a result of concentrated fishing of spawning aggregations,	

		<p>- Cayos de San Felipe. No Nassau spawning documented there.</p> <p>Punta Frances is the oldest marine reserve in Cuba, but small. Declining populations of Nassau.</p>	<p>catches decreased from more than 2,000 metric tons annually in the 1960s to less than 100 metric tons in the late 1990s.</p>	
Puerto Rico	Six-months seasonal closure	Six-months seasonal marine MPA in Bajo de Sico Seamount	<p>The only documented Nassau grouper FSA occurs on Bajo de Sico (BDS), an isolated seamount off the island's West coast that is part of a six-month seasonal marine protected area (MPA). While movements off the seamount are possible, none were explicitly detected. Outside of the spawning season, Nassau grouper occupied small home ranges territories with high site fidelity.</p>	<p>The current timing of the seasonal MPA at BDS inadequately protects the spawning population and offers limited protection for non-spawning Nassau grouper.</p>
Saint Martin (FR)	<p>Regulations from 2002 on fishing gears and net sizes. Minimum fish size of 10cm. Regulations for non-professionals updated in 2019: fishing of Nassau grouper and Goliath grouper strictly forbidden</p>	One MPA. Fishing of any kind is strictly forbidden in (at least) one part of the MPA.	<p>-Nassau grouper is strongly present in the juvenile phase and less so in the subadult and adult phases, rarely over 30cm,</p> <p>- Goliath grouper is very rare and occasionally 1 large adult individual is reported (1 to 3 times a year)</p>	<p>- the 2 species are fished opportunistically, but not targeted by professionals (too rare)</p> <p>- the biggest danger is non-professional harpoon fishing: trophy status, sought-after flesh, and the feat of fishing due to its rarity and size</p>
Turk and Caicos	In 2015, the Turks and Caicos Government implemented a ban on fishing, possession and sale of Nassau grouper during the presumed spawning months (December to February), and introduced size restrictions.		<p>Spawning grounds in South Caicos. Free-diving boats caught between 4 to 6 metric tons of Nassau groupers, while trap boats caught 8 to 22 tons. These landings were spread between four aggregation sites and appeared to be relatively low compared to historical landings from</p>	Nassau grouper is predominantly fished commercially using spears and traps.

			aggregations in other countries.	
US Virgin Islands	The current 3 mo (February through April) GB area and yellowfin grouper fishery closures do not encompass the more extensive spawning period documented for either species in this study	Seasonal Grammanik Bank (GB) and permanent Hind Bank Marine Conservation District (MCD) marine protected areas.	Nassau grouper aggregated over a 5 mo spawning season (January to May). Nassau grouper have reformed a spawning aggregation at the GB and may have mimicked yellowfin grouper site selection and seasonality.	Current protections at the MCD and GB and for Nassau and yellowfin groupers may be allowing gradual spawning population recovery

APPENDIX III

Locations of Nassau grouper spawning aggregations and protected areas in the Caribbean

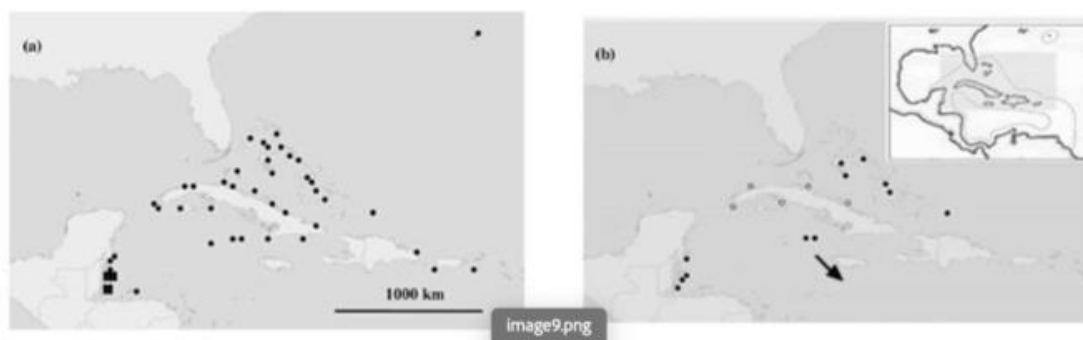


Figure 2.2. Known/reported spawning aggregations of Nassau grouper: (a) All known aggregations reported since 1884. (b) Sites believed to exist today. Each black circle represents one or several aggregations, open circles represent aggregations of unknown status. Recently noted site is indicated by arrow (Hill and Sadovy de Mitcheson, 2013). Inset shows geographic range (line) of species.

Figure S1. Known/reported spawning aggregations of Nassau grouper: (a) All known aggregations reported since 1884. (b) Sites believed to exist today. Each black circle represents one or several aggregations, open circles represent aggregations of unknown status. Recently noted site is indicated by an arrow (Hill and Sadovy de Mitcheson, 2013). Inset shows geographic range (line) of species.

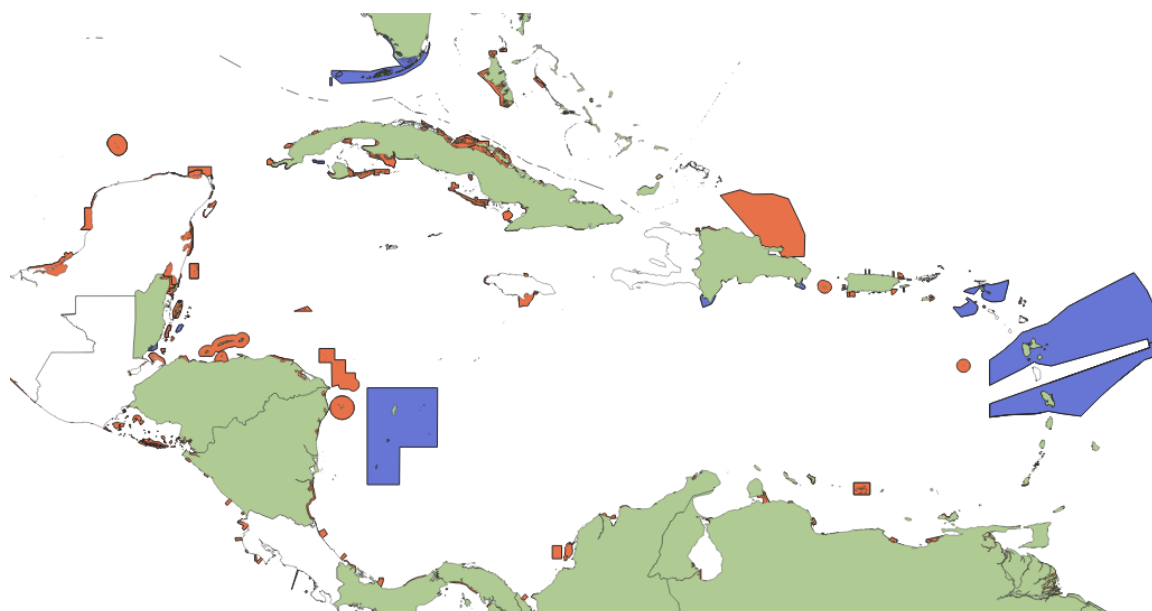


Figure S2. Marine protected areas in the Caribbean (orange), including SPAW Protected areas (purple), in contracting parties (source: SPAW and WDPA).

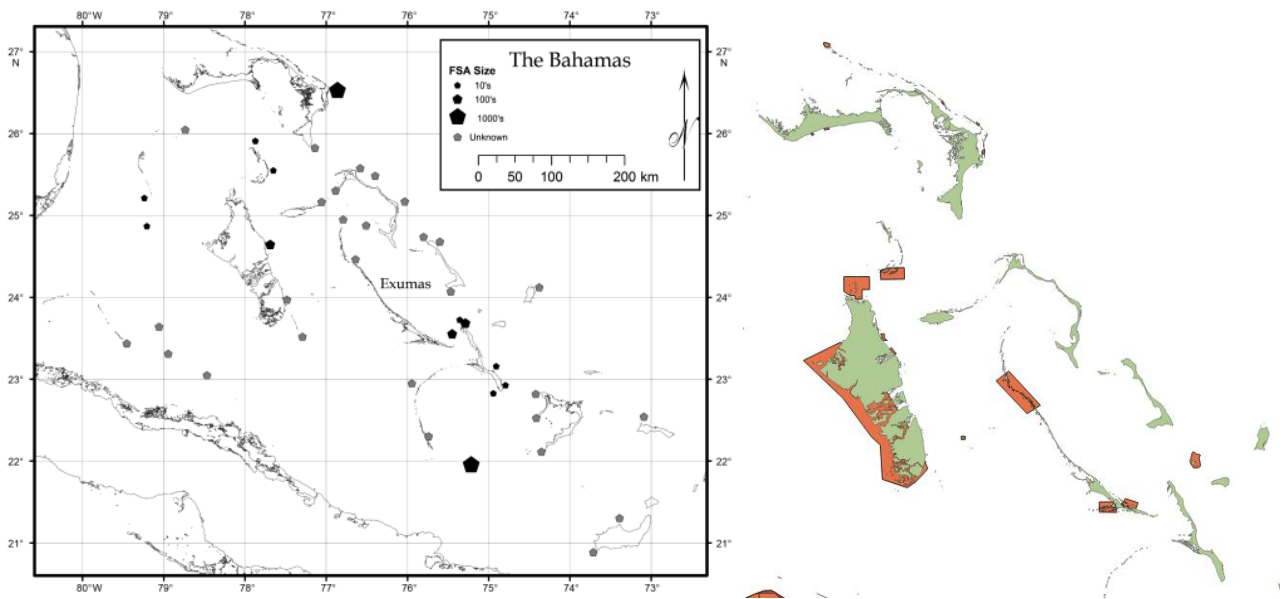


Figure S3. Location of Nassau grouper spawning aggregations in the Bahamas (Sherman et al. 2016), and marine protected areas.

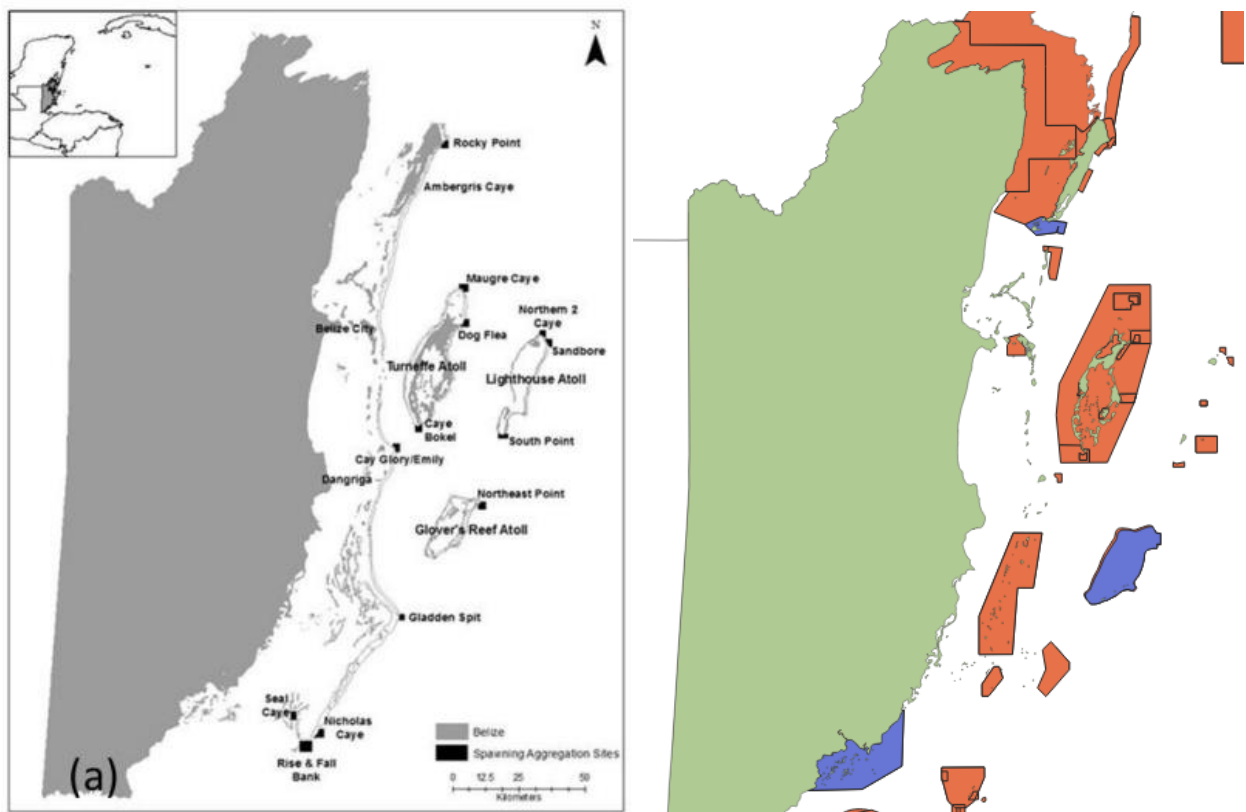


Figure S4. Location of Nassau grouper spawning aggregations in Belize (Burn Perez & Tewfik, 2016), and marine protected areas (including SPAW protected areas in purple).

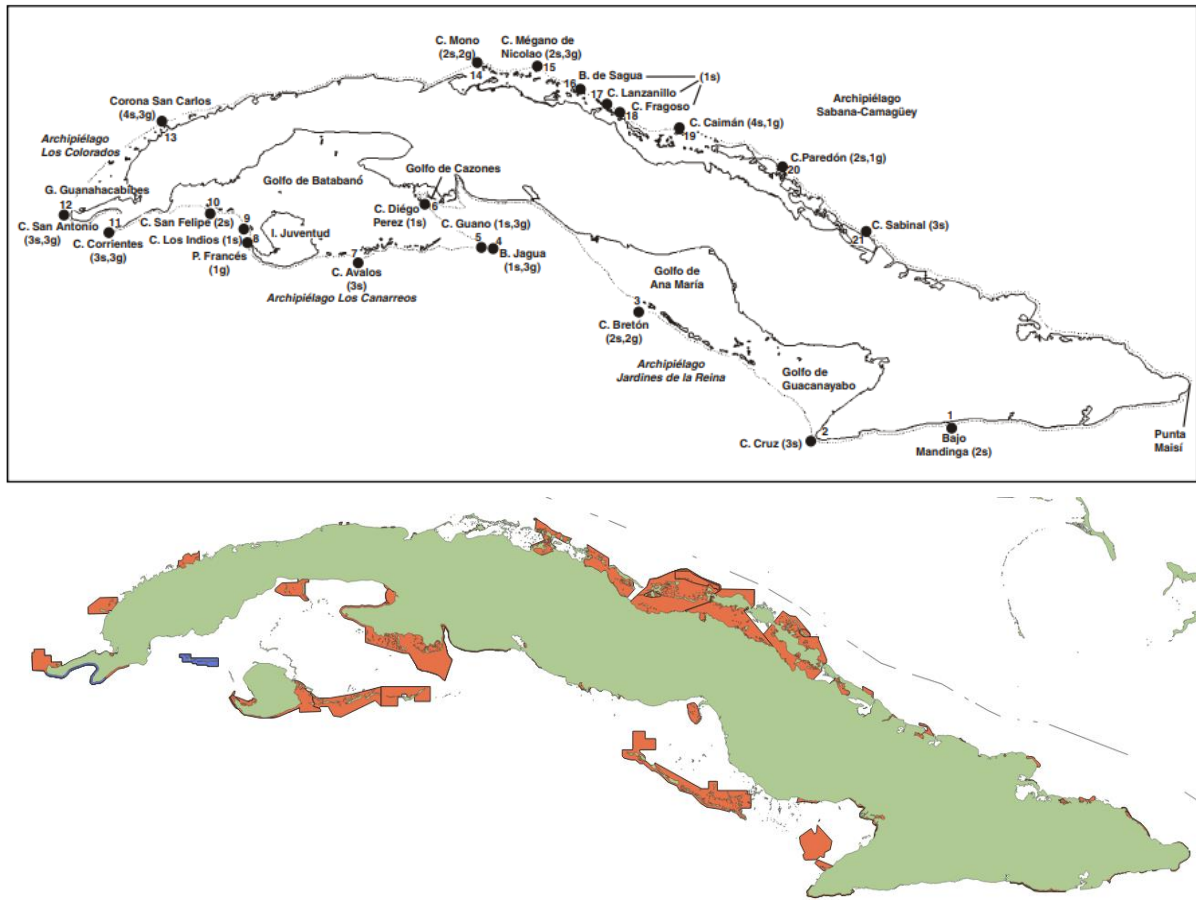


Figure S5. Location of Nassau grouper spawning aggregations in Cuba (Claro & Lindeman, 2003), and marine protected areas (including SPAW protected areas in purple).

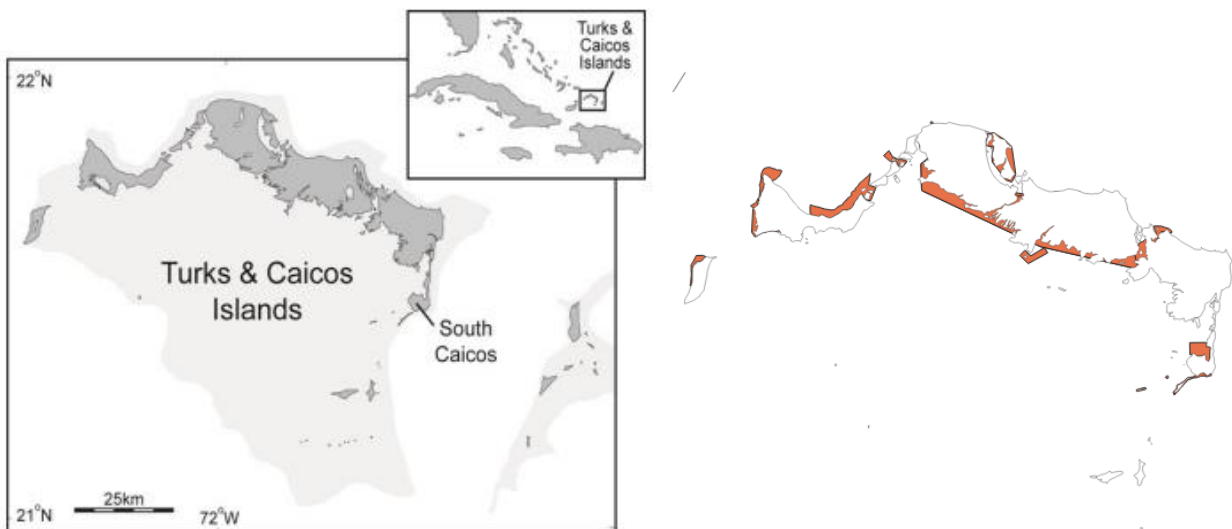


Figure S6. Location of Nassau grouper spawning aggregations in Turk and Caicos (Calosso & Claydon, 2019), and marine protected areas (including SPAW protected areas in purple).



Figure S7. Location of Nassau grouper spawning aggregations in the Cayman Islands (Bush, 2013), and marine protected areas.

APPENDIX IV: LIST OF SPAW PROTECTED AREAS WORKING GROUP EXPERTS

Name of experts	Affiliation
Milema Marrugo	Colombia
Nacor Bolaños-Cubillos	Colombia
Aylem Hernández Ávila	Cuba
Juliett González Méndez	Cuba
Jonathan Delance	Dominican Republic
Laura Díaz	Dominican Republic
Florent Merle	France
Linossi Lucie	France
Laetitia Mathon	Netherlands
Nastasha Silva	Netherlands
Marino Eugenio Abrego	Panama
Lcda Digna Barsallo	Panama
Gonzalo Cid	USA
Samantha Ebersole	USA
Alexis Alberto Zambrano Zambrano	Venezuela
Rivera Jemimah	Venezuela
Milema Marrugo	Colombia
Nacor Bolaños-Cubillos	Colombia
Lloyd Gardner	Founding Development Planning, inc.

Carlos Godoy	IUCN
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APPENDIX V: LIST OF SPAW SPECIES WORKING GROUP EXPERTS

Name of experts	Affiliation
Julia Horrocks	Barbados
Andrea Polanco	Colombia
Milena Benavides	Colombia
Dannerys Beatriz Baez Taveras	Dominican Republic
Bienvenido Marchena	Dominican Republic
Marcos Casilla Mariñez	Dominican Republic
Mr. Iván Figueroa Reyes	Cuba
Mrs. Indra Contrera Caballero	Cuba
Océane Beaufort	France
Sietske van der Wal	Netherlands
Anna Venema	Netherlands
Marino Eugenio Abrego	Panama
Dra Lissette Trejos	Panama
Kristen Koyama	USA
Angela Somma	USA
Betzabey Motta	Venezuela
Susan Millward	AWI
Monica Borobia-Hill	Monitor Caribbean
Courtney Vails	Lighthousekeepers
Jeffrey Bernus	CCS
Jaime Bolaños-Jiménez	Caribbean-Wide Orca Project (CWOP)
Lindsay Porter	IWC
Roxanne Francisca	DCNA

Olga Koubrak	SeaLife Law
Sonja Fordham	Shark Advocates International
Myles Philipps	WECAFC
Nuno Barros	Manta Trust
Susan Millward	AWI