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SPECIES WORKING GROUP (SWG)

PROPOSAL FOR THE INCLUSION OF ALL PARROTFISHES (Perciformes: Scaridae) IN ANNEXES OF THE PROTOCOL ON SPECIALLY PROTECTED AREAS AND WILDLIFE IN THE WIDER CARIBBEAN REGION OF THE CONVENTION FOR THE PROTECTION AND DEVELOPMENT OF THE MARINE ENVIRONMENT IN THE WIDER CARIBBEAN REGION (SPAW PROTOCOL)

Proposal for the inclusion of all parrotfishes (Perciformes: Scaridae) in Annexes of the Protocol on Specially Protected Areas and Wildlife in the Wider Caribbean Region of the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (SPAW Protocol)

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Acronyms

AGRRA: Atlantic and Gulf Rapid Reef Assessment Program
CERMES: Centre for Resource Management and Environmental Studies
GCRMN : Global Coral Reef Monitoring Network
ICRI : International Coral Reef Initiative
IPBES : Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC : Intergovernmental Panel on Climate Change
IUCN: International Union for Conservation of Nature

MMAs: Marine managed areas
NCRMP: National Coral Reef Monitoring Program
NOAA: National Oceanic and Atmospheric Administration
SPAW : Specially Protected Areas and Wildlife
SocMon: Global Socioeconomic Monitoring Initiative for Coastal Management

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I. Nomination Requirements

1. Requirements regarding species nomination are set forth in Specially Protected Areas and Wildlife (SPAW) Protocol Articles 11, 19, and guidelines and criteria adopted by the Parties pursuant to Article 21. The procedures to amend the annexes, contained in Article 11(4), state that "any Party may nominate an endangered or threatened species of flora or fauna for inclusion in or deletion from these annexes," and that, after review and evaluation by the Scientific and Technical Advisory Committee, the Parties shall review the nominations, supporting documentation and the reports of the Scientific and Technical Advisory Committee and shall consider the species for listing. Such a nomination is to be made in accordance with guidelines and criteria adopted by the Parties pursuant to Article 21. As such, this nomination addresses the 2014 "Revised criteria for the listing of species in the Annexes of the Protocol Concerning SPAW and Procedure for the submission and approval of nominations of species for inclusion in, or deletion from Annexes I, II and III." Finally, Article 19(3) lists the type of information that should be included, to the extent possible, in reports relevant to protected species.

2. Article 1 of the SPAW Protocol defines Annex II as "the annex to the Protocol containing the agreed list of species of marine and coastal fauna that fall within the category defined in Article 1 and that require the protection measures indicated in Article 11(1)(b). Annex III is"the annex to the Protocol containing the agreed list of species of marine and coastal flora and fauna that may be utilized on a rational and sustainable basis and that require the protection measures indicated in Article 11(1)(c)." Further, Article 11 of the Protocol specifies that "each Party shall, in cooperation with other Parties, formulate, adopt and implement plans for the management and use of such species…"

3. In addition, and according to the Revised Criteria for the Nomination and Procedure for listing species, the criteria 1 and 10 are of particular relevance because herbivorous fish, such as parrotfish, should be considered as a key group of species for vulnerable ecosystems, including coral reefs, because of the ecological functions they provide.

- *"…Criterion #1. For the purpose of the species proposed for all three annexes, the scientific evaluation of the threatened or endangered status of the proposed species is to be based on the following factors: size of populations, evidence of decline, restrictions on its range of distribution, degree of population fragmentation, biology and behavior of the species, as well as other aspects of population dynamics, other conditions clearly increasing the vulnerability of the species, <u>and the importance of the species to the maintenance of fragile or vulnerable ecosystems and habitats</u>"*

- *"…Criterion #10. Although ecosystems are best protected by measures focused on the system as a whole, <u>species essential to the maintenance of such fragile and vulnerable ecosystems/habitats</u>, as mangrove ecosystems, seagrass beds, and **coral reefs**, may be listed if the listing of such species is felt to be an "appropriate measure to ensure the protection and recovery" of such ecosystems/habitats where they occur, according to the terms of Article 11 (1) (c) of the Protocol…"*

4. The full list of criteria can be found in the Revised criteria for the listing of species in the Annexes of the SPAW Protocol (ref).

II. Nomination Statement

5. In accordance with these requirements, the working group proposes to nominate all parrotfishes (Family Scaridae) for inclusion in Annex III of the SPAW Protocol and some species in Annex II. We believe that the key ecological role of this family of herbivorous fish in maintaining the health of coral reefs in combination with the life histories of its members, requires a cooperative regional approach to conservation, as called for in Article 11(1).

A. Importance of the Species to the Maintenance of Fragile or Vulnerable Ecosystems and Habitats

6. The Global Coral Reef Monitoring Network (GCRMN) report entitled: *Status and Trends of Caribbean Coral Reefs: 1970-2012* (Jackson *et al*. 2014) documented quantitative trends on coral reef health over 43 years in the wider Caribbean. The report emphasized that one of the major drivers of coral reef decline in the Caribbean is the overfishing of herbivores, particularly parrotfish. The main results from the report were:

• Coral reef health requires an ecological balance of corals and algae in which herbivory is a key element;

• Populations of parrotfish are a critical component of that herbivory, particularly since the decline of *Diadema* sea urchins in the early 1980s;

• The main causes of mortality of parrotfish are the use of fishing techniques such as spearfishing and, particularly, the use of fish traps.

7. The primary recommendation of the report concluded management actions were urgently needed to reduce overfishing, especially of parrotfish, at the national and local levels which can have significant, direct positive benefits on coral reef condition.

8. The need for protecting key herbivores, especially parrotfish, is even **more urgent now** given the unprecedented, pandemic coral disease outbreak currently occurring throughout the Caribbean. Stony coral tissue loss disease (SCTLD) is likely the most devastating disease to impact the Caribbean, with now 17 countries/territories being affected. Unlike previous coral diseases, SCTLD infects many coral species (25+ spp., not *Acropora*), causes rapid coral colony tissue mortality (weeks to months), results in high colony death (60-100% of susceptible corals die), has high transmission rates (spreads rapidly, possible bacterial pathogen), affects large geographic range (scale 10-100 kms) and has a long duration of outbreak (active year-round, multiple years) (www.agrra.org/coral-disease-outbreak/). With the significant loss of coral, the quality of the reef habitat that parrotfish rely on will be affected. Concurrently, the ability for corals to recover, regrow and have open space for corals to recruit on will depend upon, in large part, the ability of sufficient populations of herbivores to graze and keep macroalgae in check.

9. Herbivorous fish help maintain healthy coral reefs by controlling the abundance of macroalgae, transfering energy to intermediate carnivorous fish, and supporting coral recruitment. They are natural bioeroders, producing sediments - while grazing on rocks, calcareous algae and living corals (less than 10% of their food) - like the white sand we see on beaches, and through this process they help recycle nutrients and contribute to the reef carbonate budget (Heenan. *et al*., 2013; Edwards *et al.,* 2014; Hermelin, 2006). Bioerosion is an important ecological process to consider in the context of the accelerated erosion that our coasts are facing.

10. Herbivores also help avoid algal phase shifts, whereby live corals are replaced by algae through competition for space (Arias-Gonzalez *et al*., 2017, Fig. 1). In terms of richness, four families (Scaridae, Kyphosidae, Pomacentridae, and Acanthuridae) with 41 species in ten genera have been recorded in the Western Atlantic (Robertson D.R. & Van Tassel J., 2018). Of these families, members of Scaridae are the most diverse, ubiquitous and abundant in the tropical and subtropical shallow waters of the Wider Caribbean (Kramer, 2003, Mumby et al 2006).

11. A study conducted in the Caribbean (Cramer *et al*., 2017) has shown that coral accretion rates are driven by parrotfish abundance and highlighted the critical role of this group of herbivores for maintaining coral-dominated habitats in Caribbean coral reefs. A more recent paper (Steneck. *et al*., 2019) documented the high recovery resilience capability of coral reefs in Bonaire were driven by high densities of parrotfishes that limit macroalgae and improve conditions for coral regrowth and new coral recruitment.

12. How do parrotfishes contribute to the maintenance of healthy coral reefs? Parrotfishes are a large part of the guild of herbivores that control algal populations on coral reefs via grazing. Without such top-down control of algae, the superior competitive advantages of fleshy algae, relative to Scleractinian reef-building corals, result in algal dominance in the race to occupy and maintain hard substrate. Un-grazed algae enjoys a competitive advantage over stony coral due to both direct overgrowth and via exclusion of newly settling coral polyps. Evidence for the competitive inhibition of Scleractinian coral larvae settlement and metamorphosis into coral polyps is strong (McCook *et al*., 2001). There is no doubt that Caribbean coral cover has declined precipitously throughout the Caribbean (Gardner *et al*., 2003, Jackson et al 2014). To the extent that this decline has resulted from punctuated mortality events due to external drivers, such as hurricanes (Shinn *et al*., 2000), followed by algal exclusion of coral recruitment, there is every reason to believe such declines will continue to accelerate as climate change continues to strengthen such drivers (Gardner *et al*., 2005). It is thus increasingly important that nations work to maintain or increase the abundance and diversity of herbivores, such as parrotfishes and the long-spined sea urchin (*Diadema antillarum)*, that suppress the competitive advantage of algae.

13. Caribbean parrotfish species, as a guild, provide critical ecosystem services in the form of herbivory and bioerosion. However, the specific functional role of each species is largely distinct, such that both the diversity and abundance of parrotfishes on Caribbean coral reefs are positively related to the strength of algal control. For instance, in controlled experiments, multi-species grazing reduced macroalgae by >50% and increased crustose coralline algae (the preferred recruitment substrate for corals) by >50%, relative to single species grazing (Burkepile & Hay, 2008). The distinction of species-specific functional roles in algal control comes both from diet specialization and habitat preference (Muñoz & Motta, 2000). Fishes in the genus Scarus largely feed on filamentous algal turf assemblages, crustose coralline algae, and endolithic algae, while fishes in the genus *Sparisoma* preferentially feed on macroalgae. A recent study observed that parrotfishes also consume cyanobacteria (Clements *et al.,* 2017). Within these genera, however, species exhibit separation in habitat preferences (Adam *et al*., 2015). As such, the functional role of herbivory across coral reef habitats and algal taxa is most complete when both the diversity and abundance of parrotfishes is high.

14. Aside from dietary components and their related impacts to coral reefs, certain parrotfish species are also important bioeroders responsible for transporting sediment and adding to the reef carbonate budget. In fact, parrotfishes have been observed to reintroduce 58% of sediments back to the reef framework (Hubbard *et al.,* 1990). This functional role was thought to be limited to the largest species - *Scarus guacamaia, Scarus coeruleus* and *Scarus coelestinus* - however *Sparisoma viride* is now thought to be the only parrotfish that significantly contributes to this process. Bioerosion rates have already declined with reductions in this species (Bonaldo *et al.,* 2014). In that case, it is critical and timely that this commonly harvested parrotfish species be utilized on a rational and sustainable basis to help maintain this functional role.

B. Socio-economic importance of the taxonomic group

15. Parrotfishes play a critical role in the economies and ecosystem function of Caribbean nations. Burke *et al*. (2011) estimated Caribbean fisheries yield US $400 million in annual benefit. Parrotfishes support these fisheries benefits via direct harvest in many locations, and support of targeted species region-wide via prey resources and habitat maintenance. Parrotfishes are a staple food source in many Caribbean countries, particularly in areas where larger commercially important fish (e.g., snappers and groupers) have been overharvested. In a recent review of the importance of parrotfishes to the Caribbean region, Harms-Tuohy (2020) found that *S. viride* was the most abundantly harvested parrotfish. Of the 24 nations that responded to the survey used to develop the review, seven indicated that parrotfishes were a staple food source. Of those seven, only four nations had some level of protection already in place to assist in maintaining sustainability of the parrotfish fishery.

16. However, the functional role of herbivory, which benefits coral recruitment and maintenance of coral cover, also benefits the tourism industry that relies on healthy Caribbean coral reefs. The Caribbean tourism economy now dwarfs the fisheries economy, with estimated annual benefits of more than US $2.7 billion (Burke *et al*., 2011). If reef-associated tourism continues to broaden economic benefits to Caribbean nations, the value of real and perceived coral reef health - and the functional roles that promote it - demand appropriate management and protection. Healthy parrotfish populations support SCUBA tourism. Reefs covered in algae are disappointing for SCUBA divers and parrotfishes are popular fishes to observe.

III. Substantiated Nomination Requirements to Support Inclusion in Annex II or III

17. The following section presents a review of information on Parrotfishes (Scaridae) to substantiate the nomination requirements presented in the **I. Nomination Requirements** section of this document. This review supports the inclusion of all Parrotfishes in Annex III of the SPAW Protocol.

A. Article 19(3) – Information to be included in reports relevant to protected species, to the extent possible

a. Article 19(3)(a) – Scientific and Common Names of the Species

Scientific Names: Family *Scaridae*

Table 1. Scientific and common names of the species.

Species	English common Names	Spanish common names	French common names
1. *Cryptotomus roseus*	Bluelip parrotfish	Loro chimuelo, Loro dientón, Loro barba azul	Perroquet à lèvre bleue
2. *Nicholsina usta*	Emerald parrotfish	Loro esmeralda	Perroquet émeraude
3. *Scarus coelestinus*	Midnight parrotfish	Loro medianoche	Perroquet noir
4. *Scarus coeruleus*	Blue parrotfish	Loro azul	Perroquet bleu
5. *Scarus guacamaia*	Rainbow parrotfish	Loro guacamayo	Perroquet arc-en-ciel
6. *Scarus iseri*	Striped parrotfish	Loro listado	Perroquet rayé
7. *Scarus taeniopterus*	Princess parrotfish	Loro princesa	Perroquet princesse
8. *Scarus vetula*	Queen parrotfish	Loro reina	Perroquet royal
9. *Sparisoma atomarium*	Greenblotch parrotfish	Loro mancha verde	Perroquet à une tâche
10. *Sparisoma aurofrenatum*	Redband parrotfish	Loro manchado	Perroquet à bride
11. *Sparisoma axillare*	Redeye parrotfish	Loro ojo rojo	Perroquet à oeil rouge

12. Sparisoma chrysopterum	Redtail parrotfish	Loro colirrojo, Loro verde	Perroquet vert
13. Sparisoma griseorubrum	Grey parrotfish	Loro gris	Perroquet gris
14. Sparisoma radians	Bucktooth parrotfish	Loro dientuso	Perroquet aile-noire
15. Sparisoma rubripinne	Yellowtail parrotfish	Loro coliamarilla	Perroquet queue jaune
16. Sparisoma viride	Stoplight parrotfish	Loro semáforo, Loro brilloso	Perroquet feu

b. Article 19(3)(b) - Estimated Populations of Species and their Geographic Ranges

b.1. Size of Populations

18. In **Antigua**, the 2016 Coral Reef Report Card reported herbivorous fish biomass ranged 1818-9967 g/100m^2, while in **Barbuda** parrotfish biomass was low (680 g/100m^2) and surgeonfish biomass was also low (640 g/100m^2) (Kramer *et. al.* 2016, also see Steneck *et al*. 2018, Brandt *et al*. 2005, Table 3). In an island wide survey of Barbuda, Ruttenberg *et a*l. (2018) found parrotfish biomass was 7.1 ± 0.62 g m^2 and surgeonfish biomass was 6.4 ± 0.57 g m^2. **They reported large parrotfish were nearly absent with *Scarus guacamaia* only observed at two sites, while Sc. *coelestinus* and *Sc. coeruleus* were not observed at any sites.** Other parrotfish species such as Sc. *taeniopterus*, *Sc. vetula*, *Sparisoma rubripinne* and *Sp. viride* were present at only 25–35% of sites. *Sparisoma aurofrenatum* was more abundant (90% of sites), while *Sp. chrysopterum* was rare (6% of sites).

19. In **The Bahamas**, Dahlgren *et al*. (2020) reported in the Bahamas 2020 Coral Reef Report Card that parrotfish were found on all reefs surveyed, but the size and abundance varied among sites due in part to natural variations in coral reef structure, but also due to increasing fishing pressure, especially of large-bodied species. They found *Sp. chrysopterum, Sp. aurofrenatum, Sc. hypselopterus and Sp. viride* were the most abundant of the important algal grazers. They further reported parrotfish populations have decreased around some islands over the past five years. For example, in New Providence & Rose Island, biomass values of key grazing parrotfish decreased 40% from 1,715 g/100 m^2 in 2011 to only 685 grams/m^2. They recommended parrotfish species should be managed to ensure their sustainability, including better compliance with existing regulations, improved enforcement, eliminating illegal foreign fishing, and ensuring all fishers understand fishing regulations. (Dahlgren *et al*. 2020, Dahlgren *et. al.* 2016, see also Table 3, Fig. 2-5).

20. CERMES (2018) compared the biomass of Scaridae on **Barbados** fringing, patch and bank reefs between 2012 and 2017. Biomass was lowest on the shallow fringing reefs and highest on the deep bank reefs. Although biomass was poor on fringing and patch reefs in 2012, there was a significant increase between 2012 and 2017 (223.5g/100m^2 to 779.9g/m^2 on fringing reefs and 320.8g/100m^2 to 1208.4g/m^2 on patch reefs). Biomass of Scaridae on bank reefs increased from 1498.7 g/100m^2 to 3335.7g/100m^2 between 2012 and 2017. The mean size of Scaridae has also tended to increase, but only significantly on bank reefs.

21. In **Belize**, the 2020 HRI Coral Reef Report Card found herbivorous fish biomass increased from 2384 g/100m^2 reported in 2018 to 2744 g/100m^2 (McField *et al*., 2020). The southern barrier reef had the highest biomass nationwide, which increased from 4194 to 4685 g/100m^2. However, in the northern barrier reef, herbivorous fish biomass decreased from 3104 to 990 g/100m^2. *Sparisoma viride* (724 g/100m^2) had the highest biomass, followed by *Sp. aurofrenatum* (386 g/100m^2), *Sc. iseri* (316 g/100m^2), *Sc. taeniopterus* (279 g/100m^2), and *Sp. rubripinne* (266 g/100m^2). **Belize has some of the higher biomass of Sc. *guacamaia* (23 g/100m^2) in the Caribbean. Low biomass was observed for *Scarus coelestinus* (7 g/100m^2) and *Sc. coeruleus* (2 g/100m^2)** (Table 3, Fig. 2-5). A ban on harvesting parrotfish was established in 2009 and there was about a 5 year lag before parrotfish populations started to increase nationwide (McField *et al*, 2020, Fig. 6). Numerous studies have been conducted on parrotfish in Belize including research on the ecology (e.g., Mumby *et al*. 2012), protection strategies (e.g., Cox 2014, Mumby *et al*. 2014, Cox *et al*. 2017), and long-term data from Glover's Reef Atoll (e.g., McClanahan and Muthiga, 2020).

22. Historically, **Bonaire** had some of the highest parrotfish biomass (6264 g/100m^2) in the Caribbean (Kramer 2003, Table 3). *Sparisoma viride* (2189 g/100m^2) had the highest biomass, followed by *Sc. vetula* (1983 g/100m^2), *Sc. taeniopterus* (1558 g/100m^2), and Sp. *aurofrenatum* (202 g/100m^2). **Bonaire also had some of the highest biomass of *Scarus coelestinus* (126 g/100m^2) and *Sc. coeruleus* (166 g/100m^2), although no *Sc. guacamaia* were observed** (Table 3). Since then, long-term studies by Steneck *et al*. (2019) found Bonaire's parrotfish population densities and biomass declined between 2003 to 2009. However, both abundance and biomass stabilized until 2017 when parrotfish densities then increased dramatically. Parrotfish biomass recorded in 2017 was twice that recorded in the Eastern Caribbean, including no-take reserves (Steneck *et al*. 2018). **The three largest parrotfishes were very rare, with just one *S. coelestinus* and two *S. guacamaia* seen in more than 300 visual censuses among 2011 - 2017** (Steneck *et al*., 2019, Supp Table 2). For more information on the Dutch Caribbean, see the Dutch Caribbean Biodiversity Database at: https://www.dcbd.nl/document/status-dutch-caribbean-reefs).

23. In **Cuba**, a baseline AGRRA assessment in 1998 of the Archipiélago Jardines de la Reina along the southwest of Cuba showed parrotfish biomass average was 2345 g/100m^2. *Sparisoma viride* had the highest biomass (1020 g/100m^2), followed by *Sc. iseri* (381 g/100m^2) and *Sp. aurofrenatum* (298 g/100m^2) (Table 3, Fig. 2-5, Alcolado *et al*. 2014). In María la Gorda, herbivore biomass was 37% lower than that found in 1996 in the marine reserve at the Archipiélago Jardines de la Reina, where larger-sized species were more abundant (Claro and Cantelar Ramos, 2003). **On the northwest shelf, Gonzalez-Sanson et al. (2009) found only two individuals of *Scarus coelestinus* and no *Sc. coeruleus* or *Sc. guacamaia* were observed**. More recent information on parrotfish may be available. According to Gonzalez *et al*. (2018), some Cuban reefs are well preserved, however several others are being impacted by fisheries and pollution and strong conservation management measures are needed.

24. In **Dominica**, herbivorous fish biomass reported in 2005 averaged 1,200 g/100m^2. Most fish were small in size (11-21cm), although more large parrotfish were found in the protected area of Soufriere-Scott's Head Marine Reserve. Harvesting of parrotfish was reported (Steiner 2015, Kramer *et. al.* 2016, Table 3, Fig. 2-5).

25. According to Steneck and Torres (2019), the overall long-term trend of parrotfish biomass in the **Dominican Republic** is not promising. In 2015 and 2017 between four and seven sites out of a total of 12, had parrotfish biomass exceeding 1000 g/120 m^2. However, in the 2019 fish surveys none of the site averages were at or above the 1000 g/120 m^2 mark.

26. In **Grenada**, the 2016 Coral Reef Report Card reported herbivorous fish biomass was 1004 g/100m^2 (Kramer *et al*. 2016, also see Anderson *et al*. 2014, Phillips *et al*. 2016). Herbivorous fish were abundant but small in size so biomass estimates were low. Based on 2018-2019 surveys, parrotfish biomass was 1959 g /100 m^2) (O. Harvey *per*s. *comm*., Table 3). *Sparisoma viride* (659 g/100m^2) had the highest biomass, followed by *Sc. taeniopterus* (492 g/100m^2), *Sp. aurofrenatum* (389 g/100m^2) and *Sc. iseri* (189 g/100m^2). **Biomass of *Sc. guacamaia* was low (9 g/100m^2) and no individuals of *Sc. coelestinus or Sc. coeruleus* were observed** (O. Harvey *pers*. *comm*., Table 3, Fig. 2-5.)

27. In **Guatemala**, the 2020 HRI Coral Reef Report Card found herbivorous fish biomass increased slightly from 2018 but remains in critical condition (873 g/100m^2) (McField *et al*. 2020). *Sparisoma viride* had the highest biomass (407 g/100m2), followed by *Sc. iseri* (145 g/100m^2) (Table 3, Fig. 2-5, Fig 6.). **No individuals of *Scarus coelestinus*, *Sc. coeruleus* or *Sc. guacamaia* were observed.** In 2015, the government established a ban on harvesting herbivorous fish with the support of fishers and local communities. In 2020, they extended the ban for another 5 years, which should help continue to protect these populations and allow them to increase.

28. In **Haiti**, a baseline report in Three Bays National Park found parrotfish were the most abundant group of reef fish, but the majority of parrotfish were small in size (Kramer *et al*. 2016). Parrotfish biomass ranged from 933g/100m^2 to 2,897g/100m^2. *Scarus iseri* (striped parrotfish) was the most frequently observed parrotfish species, followed by stoplight parrotfish (*Sparisoma viride*) and redband parrotfish (*Sparisoma aurofrenatum*). In a subsequent study in the same area, there was a decrease in parrotfishes from 1,970 g/100m^2 observed in 2015 to 358 g/100m^2 in 2018 (Lang and Roth 2019). (Table 3, Fig. 2-5)

29. The HRI 2018 Report Card found **Honduras** had the highest herbivorous fish biomass (4,493 g/100 m^2) in the Mesoamerican Reef Region (Mexico, Belize, Guatemala, Honduras), with higher biomass in the Bay Islands, Cayos Cochinos and Swan Islands (McField et al 2020). Nearly every survey site had large parrotfish present. However, the 2020 HRI Coral Reef Report Card found a significant decline (>50%) in herbivorous fish biomass to 1981g/100m2 due to increases in fishing pressure and illegal fishing, even within no-take zones. *Sparisoma viride* (686 g/100m^2) had the highest biomass, followed by *Sp. rubripinne* (202 g/100m^2), *Sp. aurofrenatum* (187 g/100m^2), *Sc. taeniopterus* (150 g/100m^2), and *Sc. iseri* (130 g/100m^2). **Very low biomass was observed of *Scarus coelestinus* (8 g/100m^2), *Sc. coeruleus* (9 g/100m^2), and *Sc. guacamaia* (3 g/100m^2)** (Table 3, Fig. 2-5, Fig 6.).

30. In **Jamaica**, a national island-wide survey reported herbivorous fish biomass was 1,185 g/100m^2. Parrotfish biomass was 939.6 g/100m^2, with densities of 37.9 fish/100m^2. Surgeon fish biomass was 245.7 g/100m^2, with density averaging 9.3 fish/100m^2 (NEPA 2014). In Portland Bight Protected Area, herbivorous fish biomass averaged 2,488g/100m^2 (Palmer 2014). Most fish were small in size (avg 8 cm in length), and large-bodied parrotfish were rare (2% of all fish seen). In Bluefields Bay Special Fishery Conservation Area, parrotfish biomass increased from 865 g/100m^2 observed in 2015 to 1,550 g/100m^2 in 2018 (Lang and Roth 2019, Table 3, Fig. 2-5).

31. In **Mexico**, the Healthy Reefs Initiative 2020 Coral Reef Report Card reported herbivorous fish biomass (2470 g/100m^2 in 2020) increased since the 2018 Report Card due to abundant surgeonfish and small parrotfish (McField et al. 2020). Parrotfish biomass was 1598 g/100m^2, *Sp. viride* had the highest biomass (557 g/100m^2), followed by Sp. *rubripinne* (302) g/100m^2, *Sp. aurofrenatum* (292 g/100m^2), *Sc. guacamaia* (123 g/100m^2) and *Sc. taeniopterus* (115 g/100m^2) (Table 3, Fig. 2-5, Fig 6.). Only 7% of parrotfish had reached large enough sizes to reproduce or be effective grazers. In 2019, 10 species of parrotfish were protected by Mexico which should help continue to improve their parrotfish populations.

32. In **Nicaragua** (2003), parrotfish biomass was low (394 g/100m2). *Scarus coelestinus* had the greatest biomass (178 g/100m2), followed by *Sp. aurofrenatum* (67 g/100m2), *Sp. viride* 53 g/100m2) (Table 3, Fig. 2-5).

33. In **Saint Lucia**, the 2016 Coral Reef Report Card reported herbivorous fish biomass ranged from 918-4017 g/100 m^2, with an average of 1987 g/100 m^2 (Kramer *et al*. 2016). In a study of the effects of protected areas, Steneck *et al*. (2018) found more parrotfish in protected no-take zones (2001 g/100 m^2) than on unprotected reefs (316 g/100 m^2).

34. In **St. Eustatius**, the parrotfish populations appear to be in a stable state with low fishing pressure, where the average size of parrotfishes are observed to be greater than the average length reported for the species on Fishbase (Kitson-Walters, 2017).

35. In **St. Kitts and Nevis**, a comprehensive island-wide survey found herbivorous fish biomass averaged 2538 g/100 m^2 (Bruckner and Williams 2012, Kramer *et al.* 2016, Table 3, Fig 2-5). Parrotfish were small in size (6-10 cm), with only 10 parrotfish seen larger than >40 cm in size. Parrotfish were observed being harvested and caught in abandoned traps. The high abundance of juveniles suggests populations could increase if protected measures were implemented.

36. In **St. Vincent and the Grenadines**, the 2016 Coral Reef Report Card reported herbivorous fish biomass ranged from 331- 6219 g/100 m2 (Kramer *et al*. 2016, also see Phillips *et al*. 2016). In a study of several of the islands, Steneck *et al*. (2018) found parrotfish were often higher in protected zones with biomass ranging from 723 g/100 m^2 in Canoan (a fished area) to 1697 g/100 m^2 in Mustique (has protection measures).

37. According to the **United States of America**'s NOAA-NCRMP surveys (conducted using the Reef Visual Census protocol), total parrotfish biomass when scaled to the region in **Puerto Rico** is 375 g/100m^2, **St. John/ St. Thomas, USVI** is 439 g/100m^2, **St. Croix, USVI** is 379 g/100m^2 , in **Florida** is 211 g/100m^2 and specifically in the **Dry Tortugas** is 474 g/100m^2. However, it is important to note that not all parrotfish species contribute evenly to these biomass estimates and given the difference in survey methodology, the estimates cannot be directly compared with estimates from other countries. The three large parrotfish are rarely sighted on NOAA NCRMP surveys in the US Caribbean, while *S. aurofrenatum* and *S. iseri* are the most abundant. See Table 4 (Appendix 3) for individual parrotfish species density and biomass estimates per region (J. Blondeau, pers comm).

38. In **Venezuela**, historically (1998), Los Roques had some of the highest scarid densities reported in the Caribbean (Kramer 2003, Posada *et al*. 2003). Of all fish families surveyed (1998), density was highest for scarids (41.0 ind./100 m^2) and acanthurids (22.5 ind./100 m^2). Most fish were small in size (11-20 cm size class). Similar to other areas in the Caribbean, *Scarus iseri* (formerly *S. croicensis*, striped parrotfish) was the most abundant of the parrotfish species (Posada *et al*. 2003). In a subsequent study of four sites in the Caribbean comparing large parrotfishes in areas of varying protection levels and fishing intensities, Debrot *et al*. 2008, found Los Roques Archipelago and Las Aves Archipelago had the highest abundances of larger species of parrotfishes. *Sparisoma viride* average densities of initial and terminal phases were 10.84-4.60 ind/1,000 m^2 in Los Roques and 13.79-8.58 ind/1,000 m^2 in Las Aves. **Los Roques had the highest densities of *Scarus guacamaia* (9.30 ind/1,000 m^2), S. *coelestinus* (10.73 ind/1,000 m^2), and *S. coreuleus* (5.23 ind/1,000 m^2). Las Aves had high densities of *S. coelestinus* (7.35 ind/1,000 m^2) and *S. coreuleus* (4.32 ind/1,000 m^2).** Parrotfish were also reported as one of the more abundant fish families in Morrocoy National Park (Lopez-Ordaz and Rodriguez-Quintal, 2010).

b.2. Evidence of Decline and Data Deficiency

39. Coral reef fish have been heavily harvested in the Caribbean since before the middle of the 20th century (Jackson, 1997). While parrotfish were not historically a preferred fin-fishery species, with the loss of large predatory fish species, fishers began targeting other fish including parrotfishes. Parrotfishes, particularly large ones, are vulnerable to all types of fishing gear especially traps and spearfishing (Hawkins *et al*., 2007).

40. In the first large-scale, region-wide survey in the Caribbean (Kramer, 2003), parrotfishes were found to be the most abundant fish family on both shallow (<5 m) and deep (>5 m) reefs. Parrotfish density averaged 13.7/100 m^2 and were most abundant in the eastern and southern Caribbean survey sites. Parrotfish species composition was similar across the region except for Abrolhos which contained a Brazilian endemic, *Scarus trispinosus* (greenlip parrotfish). *Scarus croicensis* (striped), *Sparisoma aurofrenatum* (redband), *Scarus taeniopterus* (princess), *Sparisoma viride* (stoplight) and *Scarus vetula* (queen) were the five most abundant parrotfish species overall, with mean densities of 3.8/100 m^2, 3.6/100 m^2, 3.1/100 m^2, 2.8/100 m^2 , and 1.1/100 m^2, respectively. **Large-sized parrotfishes, including *Scarus guacamaia* (rainbow), *Scarus coelestinus* (midnight), and *Scarus coeruleus* (blue), were observed only occasionally and were more common in the southern Caribbean than in other subregions** (Kramer, 2003, Table 3, Fig 2-5).

41. Since then, continued declines in parrotfish abundance have been documented in several locations, especially on unprotected reefs, and large-bodied parrotfish have disappeared from many reefs (Mumby *et al*., 2012, Jackson *et al*., 2014, see **Country status summaries above**). Most parrotfishes throughout the Caribbean are small in size (Valles, 2014, Shantz *et al*. 2020, McField *et al*., 2020, Dahlgren *et al*., 2020), often smaller than sufficient reproductive size or effective algal grazing sizes. Caribbean-wide, small-sized fish (<11cm) comprised 70% of all fish on heavily fished reefs versus ~25% on minimally fished reefs (Shantz *et al*., 2020). However, the implementation of measures to protect parrotfishes have contributed to the increase in both the abundance and size of parrotfishes (Mumby and Harborne, 2010, Steneck *et al*., 2019). Continued biological monitoring of parrotfish populations (species richness and species-specific abundance, size, and biomass) are needed regionwide.

42. There is a lack of records of landing information of herbivorous fish species for the majority of the sites and countries of the region. Thirty-seven Caribbean countries recently reported that they harvest parrotfishes by trap fishing and spearfishing with catch intention for personal consumption and commercial use (Harms-Tuohy, 2020). Ten species of parrotfishes were either targeted directly by these fishing methods or caught incidentally as bycatch from other fisheries (Harms-Tuohy, 2020). However, 27 of the 37 countries reviewed also reported that they either do not record landing data, do not record it to the species taxonomic level and/or have a harvesting ban with no previous record of parrotfishes prior to the ban.

43. Some limited information is available regarding parrotfish landings. In **St. Lucia**, parrotfish landings were recorded as 13,000 lbs in 2019 (M. Felix, pers comm).

44. In **St. Eustatius**, parrotfish only make up 3% of the recorded landings. Four species are harvested (*S. aurofrenatum, S. chrysopterum, S. viride, S. taeniopterus)* by traps but only *S. viride* was reported by spearfishing. Landed parrotfish were all over 20cm (Kitson-Walters, 2017).

45. The **United States of America** does record parrotfish catch by commercial and recreational fishers. In **Puerto Rico**, parrotfishes are not a staple food source but are considered part of the fishery and data is available from 2004 to 2017. Upwards of 50,000 lbs of parrotfishes were landed in 2004, with a steady decline in that number until 2012 when 60,000 lbs were reported. Thereafter, the landings have remained relatively consistent around 45,000-50,000 lbs until 2017 (M. Gonzalez, pers comm). Stoplight parrotfish (*S. viride)* is the most abundant parrotfish reported in recreational catch (Gonzalez, 2020). **In Florida**, parrotfishes are reported as bycatch of hook-and-line and trap fishing, with landings from 2009 to 2019 varying from <500 to 2,200 lbs (C. Sweetman, pers comm).

46. In **Nicaragua**, parrotfish landings have been recorded since 2010 with total pounds landed per year varying from 100 - 1,500 pounds (R. Barnuty, pers comm).

47. In **Venezuela**, the parrotfish *S. coelestinus, S. coeruleus, S. guacamaia, S. vetula, S. aurofrenatum, S. chrysopterum* and *S. viride* are reported in catch data, with *S. viride* being the most commonly harvested at 22,372 kg in 2019. The country reports an increasing trend of parrotfish landings from 2015 until present, with values rising from 5,000 kg (2015) to 30,000 kg (2017, 2019) (L.W. González Cabellos, pers comm).

b.3. Restrictions on Parrotfish Range of Distribution

48. Parrotfishes are widely distributed throughout the Wider Caribbean Region, from Bermuda and Gulf of Mexico to Brazil and the current range is similar to the historic range. There are no known restrictions to its historic range.

b.4 Degree of Population Fragmentation

49. There is no indication that population fragmentation is an operative threat. However population functions to the vulnerable ecosystems of coral reefs could be compromised because of the depletion of large parrotfish in general.

b.5 Summary table

Table 2. Summary table ; IUCN category, threats and geographic range[1] IUCN Status from the *The IUCN Red List of Threatened Species,* 2012 (IUCN, 2020)

Species:	IUCN Category	Population severely fragmented	Threats	Geographic range
1. Cryptotomus roseus	LC	No	No major threats	From Bermuda, South Carolina to southern Florida (USA), Bahamas, Antilles to Santa Catarina, Brazil
2. Nicholsina usta	LC	No	No major threats	Caribbean sea (from New Jersey, USA and northern Gulf of Mexico to southeastern Brazil)

1 Source : *The IUCN Red List of Threatened Species,* 2012 (IUCN, 2020, Bertoncini, A.A., 2012, Padovani-Ferreira, B. et al., 2012, Rocha, L.A et al., 2012)

3. Scarus coelestinus	**DD**	**No**	**Fishing & harvesting aquatic resources**	**Caribbean sea (from Bermuda and South Florida to Venezuela)**
4. Scarus coeruleus	**LC**	**No**	**Fishing & harvesting aquatic resources**	**Caribbean sea (from Bermuda and Maryland (USA) to Venezuela)**
5. Scarus guacamaia	**NT**	**Yes**	**Residential & commercial development, Fishing & harvesting aquatic resources, ecosystem and species stresses**	**Caribbean sea (from Bermuda through south Florida, the Bahamas and the Caribbean to Venezuela)**
6. Scarus iseri	LC	No	No major threats	Caribbean sea
7. Scarus taeniopterus	LC	No	No major threats	Caribbean sea
8. Scarus vetula	LC	No	Fishing & harvesting aquatic resources	Caribbean sea
9. Sparisoma atomarium	LC	No	No major threats	Caribbean sea and Gulf of Mexico
10. Sparisoma aurofrenatum	LC	No	No major threats	Caribbean sea
11. Sparisoma axillare	DD	No	Fishing & harvesting aquatic resources	Endemic to Brazil ??
12. Sparisoma chrysopterum	LC	No	Fishing & harvesting aquatic resources	Caribbean sea
13. Sparisoma griseorubrum	DD	No	Not known	Only known from northern Venezuela
14. Sparisoma radians	LC	No	No major threats	From Florida, Bermuda, Bahamas, eastern Gulf of Mexico, including the Antilles, and Central America to Santa Catarina, Brazil
15. Sparisoma rubripinne	LC	No	Fishing & harvesting aquatic resources	From Massachusetts (USA) and Bermuda to Venezuela. It is also found in the eastern Atlantic.

16. Sparisoma viride	LC	No	Fishing & harvesting aquatic resources	Caribbean sea (from Bermuda and Florida (USA) to Venezuela)

c. Article 19(3)(c) - Status of Legal Protection, with Reference to Relevant National Legislation or Regulation

50. There are 26 nations and territories that either endorse or are observers of the SPAW Protocol. Of these, 20 nations and territories have some kind of legal protection in place to manage parrotfishes. The regulations vary from complete harvesting bans of all parrotfishes to minimum size requirements, prohibition of harvesting the largest three parrotfish or other specific parrotfishes, gear restrictions and requirements, bag limits, annual catch limits (ACLs) and seasonal closures. However, in terms of those countries without total harvesting bans, no single country included all the above mentioned types of regulations (Harms-Tuohy, 2020).

SPAW Contracting Parties in the Wider Caribbean Region with legal protection (non exhaustive list)

c.1 The Bahamas

51. The Bahamas Protected Areas Fund Act – 2014 and the Marine Protection Plan – 2018 are the main regulations for large parrotfish across zoning. The species are protected from fishing in no-take zones within marine protected areas. At least 20% of the nearshore waters of the Island Territories are conserved under the protected areas and fisheries regulations (Dahlgren *et al.* 2016; The Bahamas National Trust, 2018).

c.2. Belize

52. **The Legislation Statutory Instrument (SI) No. 49 of 2009 sets out the rules of law for grazer species (any fish of the *scaridae* family, including the genus *Scarus* and S*parisoma*; any fish of the *acanthuridae* family) in coral reefs, stating that no person shall take, buy, sell, or hold any species of grazing fish.** The regulation specified that, in cases of non-compliance with the measure, people might be fined up to five hundred dollars, imprisoned, or both.

c.3. Colombia

53. At the national level, the list of threatened wild species of Colombia's biological continental diversity, marine and coastal, better known as the Red Book of Marine Fish of Colombia - Resolution 1912 of 2017, **states that three species of parrotfish are classified as endangered species (*Scarus coelestinus, Scarus coeruleus, Scarus guacamaia*)** and two species as almost threatened (*Scarus vetula, Sparisoma viride*).

54. At a national level in 2017, The National Environmental Authority (Minambiente) and the National Marine Investigation Institute (INVEMAR) assessed the population status of some hydrobiological resources associated with the marine, coastal and insular ecosystems of Colombia (emphasis on parrotfishes). According to this study, the main threats or risk factors to which parrotfish species are exposed in the Colombian Caribbean are:

• Overfishing (due to the reduction of commercially important species such as snappers, horse mackerel and groupers).

• The most commonly used fishing gear to extract *S. chrysopterum* is the caritera (a type of gillnet or "transparent" net). In the case of *S. viride* and parrotfish species larger than 40 cm, fishermen use a harpoon.

• Additionally, given that parrotfish inhabit coral reefs, the deterioration of these ecosystems can seriously affect their survival.

55. At the local level, the Corporation for the Sustainable Development of the Archipelago of San Andres, Providencia and Santa Catalina (CORALINA) created specific measures for the protection of 14 species of herbivorous fish[2] (Resolution No. 369). These taxonomic species are recognized as hydrobiological resources and some protection measures include the prohibition of artisanal, commercial, industrial, and sport fishing of the species with any gear or method, as well as the commercialization at a national and international level. The regulation also includes the ban of spearguns and sanctions for non-compliance, such as the confiscation of products and fishing gear (Resolution No. 369 of CORALINA).

c.4. Cuba

56. The Resolution 160/2011 related to *Regulations for the control and protection of species of special significance for biological diversity in Cuba* has parrotfish and herbivorous fish recognized as a species of high environmental significance.[3] Special significance refers to species that require control of their use to be sustainable because they are representative of the ecosystems or because they provide high ecological, economic, or other values.

c.5. Dominican Republic

57. In 2017, Resolution 23 regulated fishing for herbivorous fish - such as parrotfish, doctorfish, and urchins - by banning (for two years) any kind of fishing for these species in Dominican Republic marine waters. The ban was renewed for one additional year and currently, organizations and authorities are promotinge ecosystem-based management that includes regulations for herbivorous fish.

c.6. Kingdom of the Netherlands

58. According to the Nature Management Bonaire Decree from 2010 and the National Decree for the protection of native flora and fauna from 2017, **all parrotfishes are protected species in the Island's Territories of Bonaire and Aruba. It is prohibited to catch, kill, wound, or disturb them.** There are no regulations in Saba, St. Eustatius, Curaçao, and St. Maarten.

c.7. Panama

59. In June 1994, Executive Decree number 29 entered into force in Panama completely banning the commercialization and extraction of reef fish in the Economic Exclusive Zones of the Atlantic and Pacific Oceans (Ministry of Commerce and Industry). Currently, it is being revised by the Coral Reef Working Group to strengthen its implementation.

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2 *Cryptotomus roseus, Nicholsina usta, Scarus coelestinus, Scarus coeruleus, Scarus guacamaia, Scarus iseri, Scarus taeniopterus, Scarus vetula, Sparisoma atomarium, Sparisoma aurofrenatum, Sparisoma chrysopterum, Sparisoma radians, Sparisoma rubripinne, Sparisoma viride.*

3 Recognized species are *Cryptotomus roseus* (Blue-bellied Parrot), *Nicholsina usta* (Emerald Parrot), *Scarus coelestinus* (Midnight Parrot), *Scarus coeruleus* (Blue Parrot), *Scarus iserti* (Striped Parrot), *Scarus guacamaia* (Macaw Parrot), *Scarus taeniopterus* (Princess Parrot), *Scarus vetula* (Queen Parrot), *Sparisoma atomarium* (Green Mole Parrot), *Sparisoma aurofrenatum* (Old Parrot), *Sparisoma chrysopterum* (Red-tailed Parrot), *Sparisoma radians* (Dentusian Parrot), *Sparisoma rubripinne* (Red-footed Parrot) *Sparisoma viride* (Parrot) and *Acanthuridae* (Barbers).

c.8. Republic of France

60. The Island Territories of France have different regulations depending on the species and the territories.

61. In the Islands of Saint Barthelemy and La Martinique, **the capture of the following species *(Scarus coelestinus, Scarus coeruleus, Scarus guacamaia),* is totally forbidden**, with others (*Cryptotomus roseus, Nicholsina usta, Scarus iseri, Scarus taeniopterus, Scarus vetula, Sparisoma atomarium, Sparisoma aurofrenatum, Sparisoma axillare, Sparisoma chrysopterum, Sparisoma griseorubrum, Sparisoma radians, Sparisoma rubripinne, Sparisoma viride)* forbidden for recreational fishermen[4].

62. According to Order No. 971-2019-08-20-003 S25C-919082015150 Regulation of recreational sea fishing in Guadeloupe and Saint-Martin from August 20, 2019, the capture of the following species (*Scarus coelestinus, Scarus coeruleus, Scarus guacamaia)* is forbidden for recreational fishermen.

c.9. Saint Vincent and the Grenadines

63. In December 2019, the fisheries regulations for parrotfish came into effect. The measure 18A states that no person shall harm, take, hold, sell, or purchase a parrotfish, its fry, or its eggs (Fisheries (Amendment) Regulations, 2019).

c.10. United States of America

64. The reef fish fishery of the Caribbean EEZ includes wrasses and parrotfishes, and is managed under the Fishery Management Plan for the Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (Reef Fish FMP). The Reef Fish FMP was prepared by the Caribbean Fishery Management Council (Council) and is implemented by the National Marine Fisheries Service under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) by regulations at 50 CFR part 622

65. In accordance with regulations at 50 CFR 622.12(a), if landings from a Caribbean island management area are estimated to have exceeded the applicable Annual Catch Limit (ACL), the Assistant Administrator for NOAA Fisheries (AA) will file a notification with the Office of the Federal Register to reduce the length of the fishing season for the applicable species or species group the following fishing year by the amount necessary to ensure landings do not exceed the applicable ACL. NMFS evaluates landings relative to the applicable ACL based on a moving 3-year average of landings, as described in the Reef Fish FMP.

66. In St. Croix specifically, where parrotfishes are considered a staple food, there are size limits on particular parrotfish species.

Other countries in the Wider Caribbean Region with legal protection

4.Regulations on the exercise of inshore fishing in the waters of Saint-Barthelemy, created by the decision of the Territorial Council No 2015-035 TC of 27 July 2005 and amended by the decision of the Territorial Council No 2016-037 TC of 27 June 2016 & Order No. R02-2019-04-25-003 regulating professional sea fishing in Martinique of 25 April 2019.

c.11. Bermuda

67. Under the Fisheries Order of 1978, the Caribbean Island State of Bermuda bans the extraction of any fish or Parrotfish species anywhere within its exclusive economic zone.[5]

c.12. Costa Rica

68. In Costa Rica, Executive Decree No. 41774 - MINAE states that coral ecosystems are recognized as areas threatened by human activities and climate change. Also, species associated with coral reefs are legally protected. Protected coral reef communities include those within or outside natural protected areas. Additionally, there is a working group for decision-making with representatives of government institutions, academia, and non-governmental organizations. The group recognizes the need to mitigate the effects of climate change, addresses the problems of ocean acidification, and focuses on initiatives to restore coral reefs.

c.12. Guatemala

69. In Guatemala, the Ministerial Decree 23-2020 bans the capture of herbivorous fish, including the families Scaridae (Parrotfish), Chaetodontidae (Butterflyfish), Pomacanthidae (Angelfish), and Acanthuridae (Surgeonfish). The ban is framed by the argument that by prohibiting the capture of herbivorous fish, the direct benefit is to the coral reef ecosystems, home to other commercial species important for artisanal fisheries and local livelihoods. Non-compliance with the ban leads to sanctions (General Fisheries and Aquaculture Act).

c.13. Mexico

70. México has a specific prohibition on capturing fish of the Scaridae family or parrotfish in the Mexican Caribbean Biosphere Reserve (Administrative Rule 88 Management Program of the Mexican Caribbean Biosphere Reserve). The regulation seeks to protect these fish which limit the proliferation of macroalgae, known to have negative effects on the settlement of larvae, growth, and survival of reef-building corals. More recently, Mexico added ten parrotfish[6] species to the list of species at risk in the special protection category Official Mexican Standard NOM-059-SEMARNAT-2010 (Amendment, January 2020). México also bans the use of nets, marshaling techniques, spearguns, longlines, and shoring in the reefs of the Caribbean region (Mexican Official Norm NOM-064-SAG/PESC/SEMARNAT-2013).

Other Initiatives that promote the regulation of fishing to protect parrotfish and herbivorous fish

71. At its 28th International Coral Reef Initiative (ICRI) General Meeting on 17 October 2013, ICRI, in response to the report of the Global Coral Reef Monitoring Network (GCRMN), entitled: "*Status and Trends of Caribbean Coral Reefs: 1970-2012,*" issued a recommendation (Appendix A) regarding the decline in coral reef health throughout the Wider Caribbean Region and the taking of parrotfish and similar herbivorous fish, urging all nations in the Caribbean to adopt conservation and fisheries management strategies aimed at the restoration of parrotfish populations and consider listing parrotfishes on the SPAW annexes.

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5 Made under section 5 of the Fisheries Act 1972 and brought into operation on 1 April 1978.

6 The parrotfish species that they included are the traffic light parrotfish *(Sparisoma viride*), Macaw or rainbow (*Scarus guacamaia*), Blue (*Scarus coeruleus*), Middle night (*Scarus coelestinus*), Queen (*Scarus vetula*), Princess (*Scarus taeniopterus*), Scratched (*Scarus iseri*), Red Band (*Sparisoma aurofrenatum*), Red Fin (*Sparisoma rubripinne*), Yellow Tail (*Sparisoma chrysopterum*).

72. At the 34th ICRI General Meeting in Australia on December 2019, in response to the decline of herbivorous fish populations, ICRI developed a new recommendation on addressing the decline of herbivorous fish populations for improved coral reef community health throughout the Tropical Eastern Pacific, the Eastern and Western Atlantic, and the Greater Caribbean Region. This recommendation encourages governments in the Latin American region to coordinate strategies, priorities, and programs leading to ecosystem-based management and sustainable management of fisheries and coastal areas to support the recovery of herbivorous fish. Some of the specific recommendations emphasize closures, fishing quotas, catch sizes, and control of fishing gear, such as spearguns and traps (ICRI, 2019). Some countries in the Wider Caribbean Region that have established several regulations that include arguments from this recommendation include México and Archipelago de San Andrés, Providencia y Santa Catalina, in Colombia.

73. France and the US are cosponsors, with different organizations, of Motion 23[7] of the 2020-2021's IUCN'S Congress on the "Protection of herbivorous fish for improved coral community" which has been approved by electronic votes in October 2020. and "REQUESTS, for the Caribbean region, the assessment of the parrotfish species *Scarus coeruleus*, *S. coelestinus* and *S. guacamaia* for inclusion in Annex II of the Specially Protected Areas and Wildlife (SPAW) Protocol to the Cartagena Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region, and of all other herbivorous Scaridae and Acanthuridae fish species in Annex III of the Protocol."

74.

In the countries of Mexico, Belize, Honduras, and Guatemala, the organizations Healthy Reefs for Healthy People Initiative and AIDA Americas were instrumental in promoting the concept of restricting parrotfish harvesting which led to enacting harvesting bans that eventually became congruent among these Mesoamerican countries. These initiatives are evidence of the ability to find unified sub regional collaboration working for the same goal in managing and protecting parrotfishes (McField *et al*., 2020). It is also worthy to note that these non-profit or non-governmental organizations successfully campaigned for governmental protection of parrotfishes.

75. In 2018, the non-profit organization The Nature Conservancy in the Caribbean led a social media campaign called "Pass on Parrotfish"[8] which developed targeted messaging on social media platforms and a public service announcement video that promoted "keeping parrotfish on the reef and off our plates". The campaign was made available region wide but was initially targeted at Jamaica, Haiti, Dominican Republic, St. Vincent and the Grenadines and Grenada.

d. Article 19(3)(d) - Ecological Interactions with Other Species and Specific Habitat Requirements

76. Predators of parrotfishes (e.g. snappers, groupers, jacks, sharks) have been overfished. Bans on harvest of parrotfishes may result in increased abundance and therefore increased corallivory (live coral consumption) and bioerosion on degraded reefs, i.e. erosion may exceed accretion. Lionfish are predators on smaller size classes of parrotfishes (and may be partially filling the depleted predator niche). Unique stalking and hovering tactics may mean that lionfish are perceived as less of a threat and parrotfish are frequently found in lionfish stomachs (Green *et al*., 2011, Morris & Akins, 2009). Lionfish may not only reduce recruitment, but alter foraging behaviour and reduce bite rates (Eaton *et al*., 2016, Kindinger & Albins, 2017). It has been suggested that there has been a lionfish-driven phase shift from coral to algal domination on mesophotic corals reefs (Lesser & Slattery 2011). Increased lionfish harvest is another tool for Parties to consider as a parrotfish conservation measure.

7 023 - Protection of herbivorous fish for improved coral community

8 Pass On Parrotfish

e. Article 19(3)(e) - Management and Recovery Plans for Endangered and Threatened Species

e.1. Belize

77. Fisheries investigators and managers in Belize have encouraged the growth of Caribbean reefs through monitoring, marine reserves and fisheries regulations (McField *et al*, 2020, Cox et al. 2013, 2017).

e.2. Colombia

78. No management measures of parrotfishes exist currently in Colombia, but fishing is forbidden since 2019 in the Seaflower Biosphere Reserve, which encompasses around 80% of coral reefs from Colombia.

e.3. Dominican Republic

79. Currently the Dominican Republic does not have any management measure for parrotfishes, since the conclusion of the two-year fishing ban that was implemented from 2017-2019. Herbivores such as parrotfishes and surgeonfishes have continued to decline in the Dominican Republic despite the ban that was implemented at the national level from 2017-2019, which is why it is considered that new and better conservation measures are needed, especially those that result from a consensus between stakeholders in the fisheries and environment sectors (Steneck R.S. and Torres R., 2019).

e.4.Republic of France

80. The Action Plan for the coral reefs include two sub-actions related to herbivorous fish: Action 1.1 (p.10)[9] : "Protection réglementaire des espèces de poissons herbivores, concourant au "broutage des algues colonisant et asphyxiant les coraux" which should be adopted in 2021.

81. France is a cosponsor of Motion 23 of the IUCN'S Congress "Protection of herbivorous fish for improved coral community" which has been approved by electronic votes in October and "REQUESTS, for the Caribbean region, the assessment of the parrotfish species *Scarus coeruleus, S. coelestinus* and *S. guacamaia* for inclusion in Annex II of the Specially Protected Areas and Wildlife (SPAW) Protocol to the Cartagena Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region, and of all other herbivorous Scaridae and Acanthuridae fish species in Annex III of the Protocol."

e.5. United States of America

82. At the regional level, in the Atlantic Ocean, the Caribbean Fishery Management Council is the body that sets policy for fisheries in the waters of the U.S. Caribbean. In early 2019, this body promoted the creation and application of fisheries management instruments in the Island Territories of Puerto Rico and the US Virgin Islands that regulate corals and associated fish[10]. Also, the Caribbean Coral Reef Association protects coral reefs, mangroves, estuaries, and coastal wetlands through water quality standards, an aspect that is linked to algae growth.

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9 PLAN D'ACTIONS POUR LA PROTECTION DES RÉCIFS CORALLIENS DES OUTRE-MER FRANÇAIS

10 PEW, 2019. Un nuevo enfoque se adapta a los planes para los recursos oceánicos de Puerto Rico y las Islas Vírgenes de EE. UU. El Consejo de Administración de Pesca del Caribe entrega un gran premio para corales, peces y personas. The Pew Charitable Trusts. Disponible en: Caribbean Fishery Council Delivers Big Win for Corals Fish and People

f. Article 19(3)(f) - Research Programs and Available Scientific and Technical Publications Relevant to the Species

83. Please refer to Appendices for a list of publications/references by particular researchers and research programmes. Data tables, figures and maps are in Appendix 3.

g. Article 19(3)(g) - Threats to the Protected Species, their Habitats and their Associated Ecosystems, Especially Threats which Originate Outside the Jurisdiction of the Party

g.1. Overfishing

84. The main threat to parrotfishes is overfishing, mainly indiscriminate catch with fish traps or selective spearfishing. It is exacerbated by depletion of other target fish stocks such as groupers.

85. In the Caribbean region, fishing communities that depend on this activity for their livelihood have overexploited several commercial fish species. The decline in these more desirable food fish species has led to targeting parrotfishes, whose populations have dramatically diminished in certain areas within the Caribbean region (AIDA, 2019). The lack of herbivorous fish, particularly parrotfishes, has contributed to the increase in macroalgal cover on Caribbean coral reefs, posing a severe threat to their survival.

86. According to the commercialization platform for manufacturers, suppliers, and exporters, called Alibaba.com, frozen parrotfish is sold from several countries including those in the Americas, Europe, and Asia (Alibaba.com, 2020). Venezuela also reports exporting their parrotfishes to countries of the Lesser Antilles, in particular Martinique and Grenada (Leo Walter González Cabellos, pers comm).

g.2. Habitat destruction and fragmentation

87. Deforestation of mangroves, along with the dredging of seagrasses, has greatly affected the life cycle of various species of parrotfishes. Associated with this loss, coral cover has suffered a drastic reduction in the last 20 years. It should be noted that habitat degradation also increases sedimentation and nutrient concentration, resulting in increased macroalgal cover. Examples include the growing tourism industry and the demand for coastal infrastructure, where poor or unregulated coastal development destroys mangroves, seagrasses, wetlands, and coastal dunes (AIDA, 2019). In particular, coastal development that results in direct habitat loss is threatening populations of *Scarus guacamaia* which depend on mangroves for first life stages development.

g.3. Pollution

88. Studies of water quality in the Caribbean show high concentrations of pollutants from the expansion of agriculture and coastal development. Sedimentation has decreased the transparency of the water, particularly in Belize, Guatemala, and Honduras. In these countries, there are high amounts of agricultural pollutants due to the increase in agriculture and inadequate wastewater management in coastal areas, including chemicals transported from upper and middle basins to the sea. High levels of contamination are linked to increased coral disease and algae growth

(AIDA, 2019). Improving water quality and reducing contaminants will benefit the condition and quality for coral reef habitat for parrotfish and other reef organisms.

g.4. Climate change

89. Climate change is a growing threat to coral reefs and associated ecosystems (Bruno *et al*. 2019). Among the main risks involved are rising temperatures, sea levels, and acidification of the oceans. According to experts, the reduced presence of herbivorous fish in coral reef systems affects their resilience, reducing their ability to recover from natural phenomena like hurricanes, which are increasingly intense due to changes in weather patterns. Studies in Bermuda show that healthy reefs protected from overfishing have survived four hurricanes since 1984, without losing their coral cover. In contrast, on reefs in Belize, where fish populations have declined due to overfishing, coral cover has declined by 49% after three hurricanes (Jackson, *et. al,* 2014). These results highlight the need to protect these herbivorous fishes which have a direct positive benefit to coral reefs by helping to create reef resilience.

90. The Intergovernmental Panel on Climate Change (IPCC) notes, in the Special Report on the Ocean and Cryosphere, that 30% of the world's reefs have been degraded (IPCC, 2019). This degradation is reported to be more significant in the Caribbean, with 50% of reefs in poor condition (Jackson *et al.* 2014), and in the Mesoamerican Reef System, where coral reefs have further degraded by 90% (McField *et al.* 2020). The IPCC also states that if the global temperature rises 1.5°C it would result in the loss of 70% to 90% of coral reefs. With a 2°C increase in temperature, the world's coral communities would collapse by 99% (IPCC, 2018). Additionally, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) also noted that one-third of reef-building corals are under threat of extinction (IPBES, 2018).

g.5. Other Conditions Clearly Increasing the Vulnerability of the Species

91. Parrotfishes have a complex life history, where some species rely on the existence of several marine habitats (mangroves and coral reefs) to complete their life cycle. They are protogynous (or sequential) hermaphrodites. Females can change sex to become male (known as the 'terminal phase') based on social cues of the population (Munoz and Warner, 2003) often driven by the reduction of the largest individuals. Removing large parrotfishes from the population drives smaller parrotfish to reach sexual maturity faster than normal, which results in smaller sized individuals. As evident with other fish species, smaller parrotfish are not able to contribute as significantly to the population (i.e. lower egg size and quality) as larger individuals. This makes them particularly vulnerable in unmanaged fisheries (Hawkins & Roberts, 2003), but at the same time provides a way to effectively manage their fisheries (Pavlowich, T. *et al*., 2018) by introducing regulations that protect both the smallest and largest size classes.

g.6 Harmful Fishery Subsidies

92. Parrotfishes are a group of species that suffer from overfishing, lack of adequate monitoring of capture and bycatch, and illegal fishing outside national jurisdictions or the Economic Exclusive Zone (EEZ) in WCR. An example is the illegal fishing that happens in the Archipelago de San Andrés, Colombia from vessels using Jamaican flags that illegally catch 6 tons[11] of parrotfishes at the end of October 2020. This illegal fishing could be related to **harmful subsidies** such as the subvention of non-specific fuel subsidies and vessel modernization that make it possible to cross EEZ.

11 El Isleño, October 2020. Armada incautó 8.075 kilos de pesca ilegal en Serrana, Thursday, October 22, 2020. Available at: http://www.elisleño.com/index.php?option=com_content&view=article&id=20617:armada-incauto-8075-kilos-de-pesca-ilegal-en-serrana&catid=42:otros&Itemid=84

93. Fisheries subsidies are defined as financial contributions, direct or indirect, from public entities to the fishing sector, providing "benefits" to make more profit than it would otherwise[12]. These include grants, loans, and equity infusions; foregone government revenue from tax exemptions; indirect support through government payments into funding mechanisms; or any other form of income or price support. The problem is that many of these subsidies are pervasive and have influenced fish stock depletion. Subsidies are classified by their effects and impacts[13]. **Good or beneficial subsidies** encourage the growth of fish stocks through the promotion of fishery resource conservation and management. Some examples include fishery management programs and services, research and development, and marine protected areas. **Harmful or capacity-enhancing subsidies** include programs that encourage more fishing capacity, resulting in overfishing[14].

94. Governments[15] must fulfill their commitment to stop investing public money in activities that fund overfishing[16], produce illegal, unreported, and unregulated (IUU) fishing, and degrade the ocean and aim to implement United Nations Sustainable Development Goal (SDA) 14. To implement SDA 14 on the conservation and sustainable use of oceans, seas, and marine resources, to ensure prosperity, food security and sustainable development for all:

a. Target 14.6: By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation.

b. Target 14.4: By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics.

B. Article 21 – Establishment of Common Guidelines or Criteria

95. The 2014 "Revised criteria for the listing of species in the Annexes of the Protocol Concerning Specially Protected Areas and Wildlife and Procedure for the submission and approval of nominations of species for inclusion in, or deletion from Annexes I, II and III" enumerated specific factors to be included in the threats analysis of a scientific evaluation of the threatened or endangered status of the nominated species. Factors for the purpose of the scientific evaluation of threatened or endangered status, specifically outlined in the criteria, are reviewed here.

12 Sumaila, U.R., Ebrahim, N., Schuhbauer, A., Skerritt, D., Li, Y., Kim, H.S., Mallory, T.G., Lam, V.W. and Pauly, D., 2019. "Updated estimates and analysis of global fisheries subsidies" Marine Policy, 109 (2019), p.103695.

13 Sumaila, U. Rashid, Ahmed S. Khan, Andrew J. Dyck, Reg Watson, Gordon Munro, Peter Tydemers, and Daniel Pauly. "A bottom-up re-estimation of global fisheries subsidies." Journal of Bioeconomics 12, no. 3 (2010): 201-225.

14 Bayramoglu, Basak, Brian R Copeland, and Jean-Francois Jacques. "Trade and Fisheries Subsidies." Journal of International Economics 112 (2018): 13–32. 13-32.

15 WTO, 2020. Negotiations on fisheries subsidies, Available at: https://www.wto.org/english/news_e/news20_e/fish_14dec20_e.htm

16 Stop Funding Overfishing Campaign 2020. 174 leading organizations have signed the statement #StopFundingOverfishing to support the signing of the global agreement that will protect our ocean from harmful fisheries subsidies before the World Trade Organization. Available at: https://stopfundingoverfishing.com/es/statement/

a. Article 21 criterion #1 - The importance of the species to the maintenance of fragile or vulnerable ecosystems and habitats.

96. *"...1. For the purpose of the species proposed for all three annexes, the scientific evaluation of the threatened or endangered status of the proposed species is to be based on the following factors: size of populations, evidence of decline, restrictions on its range of distribution, degree of population fragmentation, biology and behaviour of the species, as well as other aspects of* ***population dynamics, other conditions clearly increasing the vulnerability of the species, and the importance of the species to the maintenance of fragile or vulnerable ecosystems and habitats****…"*

b. Article 21 criterion #3 - levels and patterns of use and the success of national management programmes

97. *"...3. With particular reference to listing in Annex III, the levels and patterns of use and the success of national management programmes should be taken into account…"*

c. Article 21 criterion #5 - local or international trade

98. *"...5. The evaluation of a species is also to be based on whether it is, or is likely to be, the subject of local or international trade, and whether the international trade of the species under consideration is regulated under CITES or other instruments…"*

99. Parrotfishes play a critical role in the economies and ecosystem function of Caribbean nations. Burke *et al*. (2011) estimated Caribbean fisheries yield US $400 million in annual benefit; Parrotfishes support these fisheries benefits via direct harvest in some locations, and support of targeted species region-wide via prey resources and habitat maintenance.

d. Article 21 criterion #6 - Usefulness of Regional Cooperative Efforts

100. The regulatory measures that Island Territories and States have are critical experiences that can be used as lessons for regional cooperation. These measures present experiences of regulation and sustainable management that can help decision-makers, governments, fishers, and social organizations to recognize the importance of herbivorous fish species and the creation of effective policies. This aspect is supported by criterion six (6) of the Revised Criteria for the Nomination and Procedure for listing species that states:

101. *"…6. The evaluation of the desirability of listing a species in one of the annexes should be based on the importance and usefulness of regional cooperative efforts on the protection and recovery of the species…"*

102. Though very little work has been done on the genetics of parrotfish in the Caribbean, there is evidence of a high level of genetic connectivity between sub-regional populations of parrotfishes, indicating a high level of long-distance larval dispersion (Geertjes *et al*. 2004.; Cox 2014). This makes it imperative that parrotfish conservation is addressed cooperatively at a regional level. In other words, healthy local populations of large adult spawners will increase the potential for recruitment (arrival of new fish) both locally and regionally.

e. Article 21 criterion #10 - appropriate measure to ensure the protection and recovery

103. *"... 10. Although ecosystems are best protected by measures focused on the system as a whole, species essential to the maintenance of such* ***fragile and vulnerable ecosystems/habitats, as*** *mangrove ecosystems, seagrass beds and* ***coral reefs, may be listed if the listing of such species is felt to be an "appropriate measure to ensure the protection and recovery" of such ecosystems/habitats*** *where they occur, according to the terms of Article 11 (1) (c) of the Protocol..."*

104. Considering the above, some believe it is necessary to add all parrotfishes to Annex III to ensure regional cooperative management to keep their populations at levels necessary for the conservation of coral reefs in the region.

IV. Discussion points and recommendations

A. Harvesting measures

105. The implementation of fisheries management measures that have a direct impact on parrotfish species (especially within Marine Protected Areas) is considered most useful to avoid the effects of overfishing on the population dynamics of parrotfishes that are currently an important part of artisanal fisheries on coral reefs (Hawkins & Roberts, 2003; O´Farrel *et al*., 2016; Roos *et al*., 2020).

106. Parrotfishes are an important commercial species and food source in some Contracting Parties. For instance, in Grenada they are the "fisher's choice" and are usually retained for the fishers' own consumption or special clients, while in other countries the flesh is considered too soft for good eating, but in the absence of alternative fish they are still widely consumed. Parrotfishes are typically caught in traps, seine nets and by spearfishers and often make up the majority of the catch in traps. Bans on harvest of parrotfishes are therefore unlikely to be socio-politically feasible in countries where parrotfishes are considered a staple food source. Size restrictions or closed seasons may allow for authorized but regulated exploitation which may have the support of fishers (e.g. Lovell and Spencer 2017). SocMon reports of interviews with fishers adjacent to Marine Management Areas in Dominica (Cabritts), St. Kitts (Narrows) and Grenada (Grand Anse) found that the majority recognize the problem of overfishing parrotfish and support temporary measures to recover parrotfish populations, including size restrictions, closed seasons and no take zones. Shantz *et al.* (2020) recommend minimum and maximum size restrictions, because medium and large size classes are better at controlling algal growth together than large size classes alone. With regard to no take zones, MMAs that are large enough to incorporate diurnal movements between feeding and resting sites are considered sufficient to incorporate spawning sites of most species (Harborne & Mumby, 2018).

107. Steneck & Torres' (2019) report on their study in the Dominican Republic concluded that the two-year ban had not been successful and that "new, improved measures" were needed "especially ones that are the result of consensus from most, if not all, fisheries and environmental stakeholders". This is true for many SPAW Contracting Parties. Listing is likely to fail in its objectives unless there is consensus from fishers, and other stakeholders, to abide by the regulations. This observation was also supported in the regional review of parrotfishes in the Caribbean, where some countries indicated that a lack of compliance with harvesting bans is directly related to fishers not being included in the decision-making process (Harms-Tuohy, 2020). In contrast, in Antigua where fishers are part of the discussion and provided with a fisher education program, compliance with the parrotfish harvesting ban is observed to occur (Harms-Tuohy, 2020).

B. *Diadema* protection and recovery

108. In the past, one of the most prolific algal grazers was the long spined sea urchin (*Diadema antillarum)* but an epizootic disease in the 1980s significantly reduced their populations (Lessios, 1988). Unfortunately, they have yet to recover (Mumby *et al*., 2006). This example illustrates the profound need for diversity and redundancy in the ecological role filled by *Diadema*. How much macroalgal growth is typical (baseline) on Caribbean reefs (Bruno *et al*. 2014)? Hawkins and Roberts (2004) have shown that since the *Diadema* die-off, herbivorous fishes have controlled algal overgrowth of corals in lightly fished areas but not in heavily fished areas. Ongoing restoration of *Diadema* is warranted and is currently underway in various areas throughout the Caribbean (Healthy Reefs Initiative, 2020). Efforts should be placed on further protecting these herbivores to prevent any further decline. In the current state, *Diadema* populations are not in a uniform level of abundance throughout the Wider Caribbean (Appendix 3, Fig. 11). Restoration can reintroduce *Diadema* to its natural habitats, but it must be understood that even a total replenishment of their populations is not a panacea for addressing macroalgal overgrowth on Caribbean coral reefs. It is necessary to ensure both the abundance and diversity of herbivores, which includes parrotfishes. Although herbivores perform similar roles, parrotfishes are targeting different types of algae and substrates and occupying different habitats - as with *Diadema* - which underscores the importance of maintaining both types of herbivores on coral reefs.

C. Parrotfish habitat protection

109. Protecting parrotfishes alone is not enough to ensure coral reef resilience because the negative impacts of overfishing are exacerbated by pollution, coastal development and resulting terrigenous run-off and climate change related stressors like rising seawater temperatures and diseases on corals (Bruno *et al.* 2019). Protecting the habitat parrotfish rely on is also important, especially reducing the impacts of the current Stony Coral Tissue Loss Disease Outbreak (SCTD) on coral reefs. Additionally, the protection afforded to parrotfishes should extend beyond simply reducing or eliminating harvest. Parrotfishes occupy a variety of marine habitats including seagrass beds, mangroves and coral reefs. Some species need specific habitats to complete their life history stages, such as *S. guacamaia* that requires mangroves for its juvenile phase before migrating to coral reefs. Furthermore, some parrotfishes spend their entire lives in seagrass beds and never migrate to coral reefs. To this point, it is necessary to consider protecting these habitats as an essential step to ensure parrotfish population stability and resilience. Mangroves habitats can be protected from coastal development by ensuring they are not removed or destroyed in these processes. Seagrass beds can be protected from pollution, sewage and terrigenous run-off that overloads the system with nutrients and reduces water quality. Coral reefs can be protected by preventing the spread of diseases (i.e. maintaining good water quality and removing sources of land-based pollution), preventing anchoring and ensuring responsible tourism (i.e. no walking on the reefs or kicking with snorkel fins). There are many other ways to protect these habitats that are essential to parrotfishes. Regardless, in order to ensure the largest benefits to parrotfishes, and complement the proposed management of parrotfish harvesting, there needs to be a subsequent level of protection afforded to their essential habitats.

D. Water quality issues

110. Zaneveld *et al.* (2016) suggest that restoration of parrotfishes *without* efforts to simultaneously combat water quality issues could have negative consequences for corals. Parrotfish consumption of corals on shallow reef flats and shallow parts of fore reefs can be profound, especially on *Porites porites* (Littler *et al*., 1989), however corallivory is not the main feeding strategy or food preference of parrotfishes as a whole. However, Burkepile (2012) found that the frequency and intensity of corallivory increased at sites with low coral cover. The evidence for "positive effects of parrotfishes on coral resilience is substantial for fore reef environments but impacts might be absent in environments where algal growth is strongly influenced by high light and/or high nutrients such as shallow patch reefs". Thus, water quality should be measured and addressed in order to avoid compounding impacts to these delicate coral reef ecosystems that can be severely impaired in eutrophic (nutrient rich) systems. Improving water quality (by reducing runoff, pollution, sedimentation) will complement the role of parrotfishes by improving coral reef health in a more holistic manner. Ways to improve water quality include :

1) improving sanitation and waste management to prevent it from entering the ocean

2) reducing land-based runoff and sedimentation resulting from development and erosion (i.e. prevent coastal development and/or use appropriate construction barriers)

3) prevent dumping of chemicals and industrial waste

4) maintaining clean beaches and waterways further upstream from the ocean

5) establishing a water monitoring program to actively check bacteria levels, among many other options

111. Improving water quality on coral reefs will not only help corals survive by providing them with the oligotrophic system that they require but will also complement the positive benefits that parrotfishes provide to the system, such as reducing algal overgrowth.

E. Nomination for Annex II or Annex III

112. In the review paper by Adam *et al*. (2015), one of the conclusions / recommendations states that "Different species of parrotfishes have different life-history traits and different impacts on benthic communities. Therefore, they should not be managed as a single species complex. In particular, the largest parrotfishes in the Caribbean, *Scarus guacamaia*, *S. coelestinus*, and *S. coeruleus*, are highly susceptible to overexploitation and are not functionally equivalent to smaller species, and thus should be fully protected from fishing." On the other hand, the population dynamics of intermediate and small parrotfish species tend to be correlated at the local (reef-scale) level, suggesting that generic actions (e.g. gear restrictions) aimed at population management and restoration of these species will likely yield benefits across this guild (see Appendix 1-3).

113. The three large parrotfishes of the Caribbean (*Scarus coeruleus*, *S. guacamaia*, *S. coelestinus*) are species whose sighting frequency (and abundance) is currently very low in most of their distribution, which is believed to be due to a considerable reduction in their populations due to strong fishing pressure (in fact, there are no good historical data on the abundance of these species, but in the memory of researchers who travelled the coral reefs in Colombia since the 1980s, such reduction seems clear). In many areas where fishing is not prohibited (such as in the Colombian continental Caribbean) they are still the target of spearfishing. As a result, the three species are currently considered as threatened species in Colombia, although globally they are not (Chasqui V., L., A. et al., 2017). Regarding the global extinction risk category of the three great parrotfishes in the Caribbean (Rocha, L.A. et al., 2012 (a and b), Choat, J.H., 2012), the three evaluations are outdated (2012) and from the justification it is obvious that their threat status is not well established due to the lack of data/sightings throughout their distribution (Appendix 3).There is consensus among the contributors to this document that the lack of information is not due to a lack of observational effort; rather, the paucity of data on these species reflects critically low population levels for these species throughout most of the Tropical Western Atlantic.

114. **All parrotfish species should be considered for inclusion in Annex III, regardless of their size.** Listing all species would resolve any confusion in the individual interpretation of size-specific classifications of parrotfishes (i.e. small-bodied versus medium-bodied parrotfishes), especially considering that parrotfishes serve important ecological roles within these various sizes and it would be disadvantegous to restrict inclusion in Annex III based on this metric.

115. **According to the experts having contributed to this document, there are several threats that provide strong support to suggest inclusion of the three large parrotfish *Scarus guacamaia*, *Scarus coeruleus* and *Scarus coelestinus* in Annex II.** First, given the lack of historical data and resulting inability to statistically compare historical abundance and biomass (e.g. abundance in the last century) to modern data, it is difficult to ascertain exact changes in population structure of these three species over time. Gaining access to this information is not currently possible, although archaeological surveys and modern survey tools (e.g., sediment cores and microscopy) may ultimately shed light on long-term status and trends. However, anecdotal evidence from scientists, fishers and the dive industry suggests that these three parrotfish species were in much greater abundance in past decades than they are now. Available data indicates the persistent rarity of these three species throughout the region (Table 3, Figs. 2-5). **In particular, *Scarus coelestinus* is exceptionally rare throughout the Caribbean, and appears to be decreasing in abundance over the last three decades. Second, there is evidence to suggest that at least *S. guacamaia* has been driven to local extinction within some countries in the Caribbean (Mumby et al., 2004).** This factor alone should encourage stricter harvesting regulations on this species and stronger management of its critical habitats (i.e. mangroves) that are necessary to support its full life history. **Third, it is important to note that several SPAW member countries have already banned the harvest of these three parrotfish species.** These existing bans support the notion that despite the limited evidence of regional declines over the last century, the precautionary principle is a valid and useful means of placing protection on species with such great ecological importance. To that point, these three species contribute to the critical ecological process of bioerosion and their large body sizes should also suggest a greater contribution to herbivory, yet their scarcity places significant pressure on the remaining fish bioeroder, *S. viride,* to fill this role. As evidenced with the *Diadema* dieoff in the 1980s, and their subsequent lack of recovery, it is vital that we bolster the diversity and abundance of the remaining bioeroders/algal grazers and avoid relying on one species to serve the role. **Therefore, given these factors described, all authorssupport the inclusion of *S. guacamaia*, *S. coeruleus* and *S. coelestinus* in Annex II.**

V. Conclusion

116. This work highlights that parrotfishes are fundamental to the maintenance of healthy coral reefs, a threatened ecosystem that has seen dramatic decline throughout the Wider Caribbean region. Furthermore, the information presented in this report supports the notion that parrotfishes meet the criteria for listing stated in article 19 of the SPAW protocol. In particular, there is clear evidence that fishing-induced declines in parrotfish populations weaken the resilience of corals, and thus the suite of ecosystem services they provide. In addition to fishing, climate change, pollution and habitat destruction enhance the vulnerability of parrotfishes and associated reef communities. Thus, according to criteria 1 and 10 of the Revised Criteria for the Nomination and Procedure for listing species, **all experts agreed that including all parrotfishes in Annex III seems consistent with 'the importance of the species to the maintenance of fragile or vulnerable ecosystems and habitats'** and 'the scientific evaluation of the threatened or endangered status of the proposed species'.

117. Furthermore, according to all authors, there is sufficient evidence to consider **the three largest parrotfish species (*Scarus guacamaia*, *Scarus coeruleus* and *Scarus coelestinus*) for Annex II listing**. At present, these species are ecologically absent throughout most of the Caribbean, and have remained at persistently low levels in the region for most of the last three decades (Kramer 2003, Jackson *et al*. 2014, Donovan and Ruttenberg, to be published; also see Appendix 3-Table 3, figures 2-5 and 7-10). Collectively, these species represent the largest class of Caribbean bioeroders, and undoubtedly played a critical role in maintaining coral reef health in a historical context. There is good reason to believe their absence throughout the Caribbean has ultimately compromised reef resilience. As mounting threats from climate change and regional human population growth act synergistically to compromise the vital ecosystem services of Carribean reefs, the importance of herbivory in maintaining reef resilience demands action to restore these giants.

118. Finally, this report suggests several possible management scenarios and recommendations that could improve protection of parrotfishes. These suggestions are designed to address a wide array of parameters that should be considered when developing a management strategy for parrotfishes. They address incorporation of critical data collection of biological and socioeconomic factors, regional collaboration options to enhance continuity in management, outreach criteria, among others. These recommendations are not an exhaustive list of possibilities, but were designed to provide concrete guidance with examples to assist in developing complementary local and regional protection for parrotfishes. In many cases, the examples suggested have already been administered by some SPAW countries which can serve as a framework to guide other nations.

1. **Develop a specific task/subgroup dedicated to Parrotfish in the Species Working Group and work towards developing a Caribbean Parrotfish Management Plan**
    a. Establish a Parrotfish Advisory Working Group
        i. Convene periodic meetings to share and review Parrotfish status updates
        ii. Develop regional management objectives and track progress of management planning and actions
    b. Share experiences and expertise developed through the Working Group to develop a collaborative Caribbean Parrotfish Management Plan.
    c. Develop cooperative management agreements with other countries and territories
        i. Coordinate with other countries to harmonize parrotfish management planning between or among countries due to the transboundary nature of the species and need to maintain connectivity among populations.
    d. Develop an annual progress report for the status of parrotfish in the Caribbean and implementation of management plan.
    e. Coordinate recovery activities, monitor and evaluate progress, and update/revise the Management Plan regularly.

2. **Protect and enhance existing populations by reducing negative effects from overharvesting and unsustainable fishing methods.**
    a. Improve implementation and enforcement of existing regulations to protect or manage parrotfish populations.
    b. Evaluate fisheries and landing data to consider developing size and catch limits.
        i. Implement a maximum size limit for some species such as *Sp. viride*
        ii. Ban the harvest of the three large parrotfish species (*Scarus coeruleus*, *Sc. guacamaia*, *Sc. coelestinus*)
        iii. Consider setting an annual catch limit of less than 10% of the fishable population (Bozec et al. 2016) for all parrotfishes across the region with other species-specific regulations as options.

        iv. Consider a minimum catch size limit for other vulnerable parrotfish species based on their life histories.
    c. Discuss and consider regulations to be applied to fishing activities that target parrotfishes directly and indirectly.
        i. Prohibit harvest at night when parrotfishes are more vulnerable to spearfishing.
        ii. Regulate spearfishing by imposing size limits, bag limits, species restrictions (especially for the large-bodied parrotfish species), licensing of fishers, or banning spearfishing of all parrotfishes where possible. Consider restricting import of spearguns.
        iii. Restrict use of traps and nets by imposing soak times, construction types, mesh sizes and size opening. Limiting trap opening sizes and mesh size protects the smallest (pre-reproductive) and largest (reproductive, fecund) individuals.
        iv. Ban use of traps in countries where spearfishing and hook-and-line fishing has enough traction to provide income to fishers who can transition to these gears.
        v. Implement seasonal closures of all parrotfishes
    d. Protect known spawning sites for parrotfishes, including multi-species spawning sites attended by the largest three parrotfish species (alongside spawning Nassau grouper, yellowfin grouper, tiger grouper, black grouper).
    e. Ban the export of parrotfishes.
    f. If a total harvesting ban is not already in place, conduct an assessment to determine if banning the harvest of all parrotfishes would be agreeable to all stakeholders. Communicate and involve key audiences such as fishers, conservationists, fishery managers, independent biologists, restaurant owners, fish market owners and other interested stakeholders.
    g. Collaborate and share information and lessons learned with nations that have successfully implemented and enforced full harvest bans of parrotfish (e.g., Belize, Mexico, Bonaire) or other parrotfish protection regulations and measures.
    h. Remove predation threats caused by exotic lionfish by supporting lionfish control and removal programs such as lionfish derbies.
    i. Establish a program to evaluate the effectiveness of regulations and management actions (include factors such as enforcement, compliance, fishery dependent and independent monitoring). Work with local or regional NGOs to assist with this if financial means do not exist to conduct independently.

3. **Improve the condition of marine habitats that parrotfish depend upon and prevent further habitat degradation.**
    a. Support the designation, management, and maintenance of strategic marine managed areas that protect essential fish and coral reef habitat and nursery areas (i.e. mangroves, seagrasses) that parrotfish depend upon.
    b. Improve coral reef habitat by maintaining and restoring water quality, including reducing untreated sewage or pollutants.
    c. Improve coral reef habitat by supporting efforts to reduce the impacts of the Stony Coral Tissue Loss Disease (SCTLD) outbreak.
    d. Restore and improve coral reef habitat through coral population enhancement efforts.
    e. Support the re-introduction and population enhancement of *Diadema antillarum* to help restore these important herbivores to reefs.
    f. Protect and promote regeneration of seagrass beds and mangroves.
        i. Minimize loss caused by unregulated coastal development
        ii. Increase the habitat spatial area by replanting native mangrove plant species

    iii. Improving water quality and restore or enhance natural flow
    iv. Removing exotic tree species in mangrove forests

4. **Improve the understanding of parrotfish status by supporting fisheries-independent research on the physiology, life history, and ecology of parrotfishes.**
    a. Establish a fishery-independent monitoring program (at least annual) to survey distribution and status of parrotfish populations including data on species richness, size, density, and biomass.
    b. Coordinate with national and regional programs to support monitoring and sharing of information on the distribution and status of parrotfish populations throughout the Caribbean. Utilize collective information to update regional status reports.
    c. Develop and maintain a regional Caribbean Parrotfish Database that includes population data (size, density, biomass, species richness), fisheries-dependent data (e.g., landings, gear type) and socioeconomic information. Visualize and integrate information using GIS data platforms.
    d. Support research on parrotfish life history, coral reef habitat use, connectivity of populations and condition of coral reef habitats.
        i. Monitor effects of the SCTLD disease event on coral reef condition and subsequent impacts of habitat value, use or loss to parrotfish.
    e. Evaluate life history information compared to landing/catch data to determine relative impact on parrotfishes in your nation.
    f. Work with a local or regional NGO or entities to assist with this effort if financial means do not exist to establish an independent program.

5. **Establish 'fisheries-dependent' data collection program to better record fisheries and landing data to determine the effects of fishing on parrotfish populations.**
    a. Establish a 'fisheries-dependent' data collection program to collect species-specific data on the following parameters. Collect data from commercial, recreational and personal fishers.
        i. Total parrotfish removed (landings and discarded dead)
        ii. Level of fishing participation (catch rates, catch per unit effort (CPUE))
        iii. Fishing methods (gear type, trip length)
        iv. Targeted (or incidentally caught) parrotfish species
        v. Seasonality and locations fished for parrotfishes
        vi. Related economic information (the cost of fishing trips, the value of fish sold)
        vii. Fish biological information (species, age, length, weight, maturity)
    b. Provide assistance from local or regional experts in training on fish identification and data collection methods, if necessary.
    c. Partner with a nation who has a well-established port sampling/landing data recording strategy to better understand how this was implemented.
    d. Incorporate fisheries and landing data into the Caribbean Parrotfish Database.

6. **Conduct socioeconomic evaluations to understand role of parrotfish**
    a. Conduct socioeconomic evaluations to assess knowledge, attitudes, perceptions and understanding of the ecological importance of parrotfish in maintaining coral reef ecological health.
    b. Record community information and socioeconomic characteristics such as human use patterns, management support/opposition for protecting parrotfish, and knowledge, attitudes, and perceptions of coral reefs/coral reef management.

c. Evaluate the economic contribution of marine-related activities either through fishing or tourism-related activities that directly or indirectly depend on parrotfish populations. Include age and gender factors in participation of parrotfish-related economic opportunities.
d. Conduct an evaluation of the relevance of particular parrotfish species in the fishery, such as *Sp. viride*, to determine if certain species are preferentially targeted by fishers.
    i. Use this information to suggest management scenarios offered in #2
    ii. Use this information to determine the relative importance of parrotfish compared to other fisheries, and to evaluate perceptions of parrotfish as a food fish.
e. Incorporate socioeconomic information into the development of management actions, outreach efforts, and evaluation of these actions.
f. Assess and evaluate the impact of COVID-19 on small-scale fishing communities, tourism, and commercial fisheries to determine its impact on local parrotfish harvest.

7. **Increase outreach, communication and public awareness.**
    a. Develop parrotfish education and outreach campaigns specific for different demographic groups (i.e., restaurant owners, consumers, fishers, children).
    b. Work with a local or regional NGOs to assist with the development and implementation of materials or request access to previously prepared materials that could serve your purpose.
        i. Focus your campaign based on your specific need/interest.
        ii. Promote parrotfish harvesting regulations that already exist and educate fishers, restaurant owners, and fish markets.
        iii. Encourage consumers to choose a different, more sustainable fish choice to eat.
        iv. Teach children the ecological importance of parrotfishes.
    c. Evaluate your outreach campaign to determine if your desired outcome was achieved.
    d. Develop a regional platform to share educational and outreach materials in various languages. Numerous resources currently exist and can be collated and made available for wider use. Translate existing materials as needed.
    e. Support and incorporate scientific and citizen science data into outreach efforts.

8. **Support programs to assist the transition of fishers to alternative livelihoods & strengthen education.**
    a. Identify what resources are needed to support programs that assist the transition of fishers to alternative livelihoods and determine how regional organizations could assist further (i.e., microfunds for alternative livelihood feasibility studies).
    b. Review where alternative livelihoods have worked in the Caribbean (i.e., seaweed farming in Belize, ecotourism in Honduras) and explore ways to implement.
    c. Assist with fisher integration into other existing fisheries and/or strengthen education regarding existing fishery regulations and environmental importance of all fisheries of that nation. Suggestions include:
        i. Trap buy-back program to provide fishers with monetary gain for leaving trap fishing.
        ii. Provide means for fishers to access other fisheries (i.e., funds, shared use of vessels, gear).
        iii. Fisher training program that educates fishers of the regulations and ecological importance of the species involved in each fishery. (i.e. Antigua)

APPENDICES

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Appendix 1: Criteria Evaluation

		Concerns Annexes I, II and III						
Criteria evaluation for the Parrotfish under the Annex III as a group listing and for *S. guacamaia*, *S. coeruleus* and *S. coelestinus* in Annex II.								
SPAW Article	**Criterion Number**	**Criterion**	**Criterion details**	**Presence of information in the proposal report**	**Information quotes**	**Literature**	**1 is the criterion relevant for this species R/NR 2 is it possible to obtain the information O/NO)**	**If relevant Criteri validation Yes/ No**
21	#1	The scientific evaluation of the threatened or endangered status of the species is to be based on these factors :	Size of population	Y	Based on the information available from NGOs and some local and national governmental biological monitoring, there is a general estimate of the parrotfish population size for much of the Caribbean	Kramer et al. 2016, 2020 Semmens 2020 McField et al. 2020	R	Y
			Evidence of decline	Y	The biomass data presented herein do show declines in parrotfish biomass in various regions throughout the Caribbean.	Jackson et al. 2014	R	Y
			Restriction on its range	N	There is no evidence of range restriction	N/A	NR?	

			of distribution		of parrotfishes in the Wider Caribbean region with the exception of two species that have only been reported in the southern Caribbean/Brazil			
			Degree of population fragmentation	N	There is no evidence of population fragmentation of parrotfishes in the Wider Caribbean region	N/A	R?	?
			Biology and behavior	Y	There is a wide breadth of literature that illustrates the biology and ecology of parrotfishes Much is known about their roles on coral reefs. The behavior of parrotfishes, as it relates to their ecological roles and interaction with each other is relatively well known	Adam et al. 2015 Bonaldo et al. 2014 Burkepile & Hay 2008 Munos & Motta 2000	R	Y
			Other population dynamics	Y	Much is known about their social structure, sex change and impact of fishing on these aspects	Pavlowich et al. 2018 O'Farrell et al. 2016 Munoz &	R	Y

						Warner 2003		
			Conditions increasing the vulnerability of the species	Y	There is strong evidence to suggest that overfishing, habitat degradation,invasive species and poor quality are impacting parrotfishes	Jackson et al. 2014 Hawkins & Roberts 2003	R	Y
			Importance of the species to the maintenance of fragile or vulnerable ecosystems and habitats	Y	Strong scientific supports the roles of parrotfishes as algal grazers, assisting in coral recruitment, bioerosion,and sediment transport. These processes are critical to maintaining healthy coral reefs	Adam et al. 2015 Bonaldo et al. 2014 Burkepile & Hay 2008	R	Y
	#2	Precautionary principle (when criterion 1 gives indication that the species is threatened or endangered, the lack of full scientific certainty about the exact status of the species is not to prevent the listing of the species on the appropriate annex)		N/A	N/A	N/A		
	#3	Only for Annex III:		see	N/A	N/A		

		levels and patterns of use and the success of national management programmes		criterion 6				
	#4	Application of the IUCN criteria in a regional (Caribbean) context will be helpful if sufficient data are available	IUCN category for the Caribbean	Y	Varies by parrotfish species, but some such as S. guacamaia isare listed as Near Threatened	IUCN	R	Y
21	#5	Is the species the subject of local or international trade AND is the international trade regulated under CITES or other instruments ?		N	N/A	N/A		
21	#6	Importance and usefulness of regional and cooperative efforts on the protection and recovery for species	Importance of efforts	Y	Subregional collaboration has been successful at managing parrotfishes in the Mesoamerican coral reef system.	AIDA 2019	R	Y
			Efforts mentioned	Y	NGO efforts to promote governmental protection of parrotfishes along the continuous Mesoamerican	AIDA 2019	R	Y

					coral reef system			
			Usefulness of efforts	Y	Successfully campaigned to spread outreach regarding regulations and promoted importance of establishing regulations with the governments	AIDA 2019	R	Y
21	#7	Endemism of the species (and importance of regional cooperation for its recovery)		Y	Two parrotfish species listed are only reported in the southern Caribbean/Brazil	Robertson & Van Tassell 2018	R	Y
21	#8	Listing as a taxonomic unit . Higher taxa (than species) can be utilized in listing when there are reasonable indications that the lower taxa are similarly justified in being listed, or to address problems of misidentification caused by species of similar appearance. In the case of Annex III, higher taxa can also be used to simplify the list.		Y	Very relevant for inclusion of all parrotfishes (Perciformes: Scaridae) in Annex III. Justify by the fact the he lower taxa are similarly justified in being listed, and also for the ecological fonctionality as a group.		R	Y
21	#10	Importance of the species		Y	Parrotfishes are diverse and perform	Adam et al.	R	Y

		regarding the maintenance of fragile and vulnerable ecosystems/habitats (as Rhizophora for mangroves ecosystems)			an array of ecological roles that are vital for maintaining healthy coral reef ecosystems. Coral reefs have been shown to withstand abiotic influences and resist algal dominance on reefs with intact and diverse parrotfish populations (i.e. Bonaire).	2015 Bonaldo et al. 2014 Burkepile & Hay 2008		
11 (4,a) – 19 (3)	**	information demonstrating the applicability of the appropriate SPAW listing criteria		Y	There is strong supporting evidence to list all parrotfishes under Annex III and there is evidence to list the three largest parrotfishes under Annex II	see Conclusions	R	Y
	***	Does the species benefis from another protection tool ?		Y	There are some SPAW Parties that have already adopted complete harvesting bans on parrotfishes, or have certain regulations in place to protect the group in some way	Harms-Tuohy 2020	R	Y

Appendix 2. Overview characteristics Parrotfish (Scaridae)

Table 1: Descriptive characteristics of each of the Caribbean parrotfish species considered for Annex III.

Family	**Species name**	**IUCN Status**	**Vulnerability***	**Price Category***	**Resilience****	**Trophic group**

Scaridae	*Cryptotomus roseus*	Least concern (LC)	Low (10/100)		High	Herbivorous
Scaridae	*Nicholsina usta*	Least concern (LC)	Low (23/100)	High	High	Herbivorous
Scaridae	*Scarus coelestinus*	Data deficient (DD)	Moderate (38/100)	High	Medium	Herbivorous
Scaridae	*Scarus coeruleus*	Least concern (LC)	Moderate (42/100)	High	Medium	Herbivorous
Scaridae	*Scarus guacamaia*	Near threatened (NT)	Moderate (42/100)	High	Medium	Herbivorous
Scaridae	*Scarus iseri*	Least concern (LC)	Low (17/100)	High	High	Herbivorous
Scaridae	*Scarus taeniopterus*	Least concern (LC)	Low (25/100)	High	High	Herbivorous
Scaridae	*Scarus vetula*	Least concern (LC)	Moderate (28/100)	High	High	Herbivorous
Scaridae	*Sparisoma atomarium*	Least concern (LC)	Low (12/100)		High	Herbivorous
Scaridae	*Sparisoma aurofrenatum*	Least concern (LC)	Low (22/100)	High	Medium	Herbivorous

Scaridae	*Sparisoma axillare*	Data deficient (DD)	Moderate (38/100)		Medium	Herbivorous
Scaridae	*Sparisoma chrysopterum*	Least concern (LC)	Low (23/100)	High	High	Herbivorous
Scaridae	*Sparisoma griseorubrum*	Data deficient (DD)	Moderate (34/100)		High	Herbivorous
Scaridae	*Sparisoma radians*	Least concern (LC)	Low (14/100)	High	High	Herbivorous
Scaridae	*Sparisoma rubripinne*	Least concern (LC)	Moderate (26/100)	High	High	Herbivorous
Scaridae	*Sparisoma viride*	Least concern (LC)	Moderate (31/100)	High	Medium	Herbivorous

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Table 2: Ecological roles and description of impact to the benthos for each of the Caribbean parrotfish species considered for Annex III.

Species name	**Foraging role+**	**Algae+ (main)**	**Trophic level**	**K**	**Length-weight (a)**	**Length-weight (b)**

Cryptotomus roseus			2		0.01175	3.13
Nicholsina usta			2			
Scarus coelestinus		Turf algae, coralline algae, endolithic alage	2	1.4-4.4	0.01622	3.06
Scarus coeruleus		Turf algae, coralline algae, endolithic alage	2	1.4-4.4	0.01288	3.05
Scarus guacamaia	Excavator	Turf algae, coralline algae, endolithic alage	2	1.4-4.4	0.01349	3.03
Scarus iseri	Scraper	Turf algae, coralline algae, endolithic alage	2	0.2	0.01096	3.02
Scarus taeniopterus	Scraper	Turf algae, coralline algae, endolithic alage	2	0.2	0.01350	3.00
Scarus vetula	Scraper	Turf algae, coralline algae, endolithic alage	2	0.6	0.01000	3.04
Sparisoma atomarium		Macroalgae	2	0.6		
Sparisoma aurofrenatum	Grazer/Scraper (including live coral)	Macroalgae	2	1.4-4.4	0.01072	3.13

Sparisoma axillare		Macroalgae	2	1.4-4.4	0.01318	3.09
Sparisoma chrysopterum	Grazer	Macroalgae	2	0.7	0.01072	3.10
Sparisoma griseorubrum		Macroalgae	2		0.01047	3.06
Sparisoma radians		Macroalgae	2		0.00977	3.06
Sparisoma rubripinne	Grazer	Macroalgae	2	0.5	0.01413	3.09
Sparisoma viride	Excavator (including live coral)	Macroalgae	2	1.4-4.4	0.01380	3.05

Appendix 3: Figures and Tables

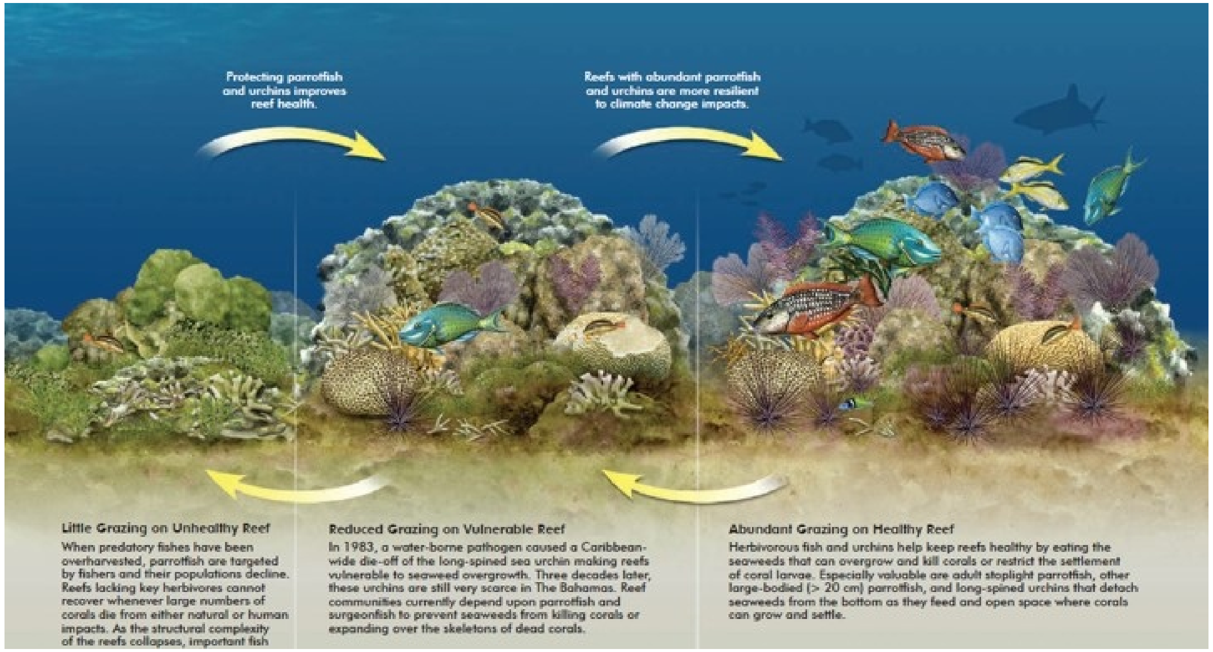

Figure 1. Parrotfish are key grazers on coral reefs by preventing algae from overgrowing and killing coral and keeping reef surfaces clear for juvenile corals to recruit. Large-sized parrotfish (>20cm) are especially important as they are able to remove more algae while grazing. (Dahlgren, Kramer, Lang, and Sherman, 2014).

Table 3: AGRRA data on parrotfish biomass by species for Caribbean countries (AGRRA 2020). Data-Year indicates different "batches" of AGRRA data that were included in calculations. Biomass is calculated in g/100m². For full explanation on how biomass was calculated, refer to AGRRA Standard Product Metadata document. Asterisk(*) indicates countries that signed but not yet ratified SPAW. Guyana, Republic of Trinidad-Tobago, and Saint Lucia did not have AGRRA data available.

SPAW Countries	Data Year	Total Biomass	*Scarus*						*Sparisoma*				
			coelestinus	*coeruleus*	*guacamaia*	*iseri*	*taeniopterus*	*vetula*	*atomarium*	*aurofrenatum*	*chrysopterum*	*rubripinne*	*viride*
Antigua and Barbuda*	2005, 2017-18	2414	0	0	0	592	45	314	5	353	58	87	960
Bahamas	2001, 2013, 2015, 2017-19	2253	76	17	70	105	372	362	2	292	107	105	744
Belize	2018	2213	7	2	23	316	279	31	11	386	168	266	724
Bonaire	1999	6264	126	166	0	28	1558	1983	0	202	12	0	2189
Cayman Islands	1999-2000	2476	1	0	0	264	450	83	0	424	133	188	933
Colombia	2012	1624	0	0	0	195	359	86	3	549	64	25	343
Costa Rica	1999	4166	302	0	0	265	6	0	0	99	349	2813	333
Cuba	2001	2345	46	1	139	381	73	88	3	298	65	232	1020
Curacao	1998	2835	0	0	127	164	791	104	0	120	0	135	1396
Dominica	2005	655	0	0	3	155	80	60	0	250	0	0	106
Dominican Republic	2003-2004, 2018	665	1	0	0	234	44	2	1	147	20	81	136
Grenada	2018-2019	1959	0	0	9	189	492	58	1	389	73	87	659
Guatemala*	2018	735	0	0	0	145	94	5	0	70	2	12	407
Haiti	2015, 2018, 2020	1182	0	0	1	528	103	8	17	223	14	49	238
Honduras	2018	1540	8	9	3	130	150	55	22	187	89	202	686
Jamaica*	2000, 2005, 2012, 2014-15, 2018	1317	1	1	6	368	113	10	10	455	14	71	267
Mexico*	2018	1598	0	2	11	123	115	85	1	292	111	302	557
Navassa	2012	3177	0	0	0	94	1314	101	2	891	0	39	735
Nicaragua	2003	394	178	9	0	22	13	10	0	67	0	43	53
Panama	2002	1897	10	1	0	650	4	22	2	257	53	296	602
Saba	1999	2055	0	0	0	365	146	99	0	656	27	64	699
St Vincent and the Grenadines	2018, 2019	1378	0	0	17	245	417	95	5	123	15	9	452
St. Eustatius	1999	3118	0	0	0	276	1226	30	0	786	14	20	766
St. Kitts	2011	1560	9	0	40	474	349	81	4	362	7	5	229
St. Maarten	1999	2118	0	0	0	11	180	0	0	843	0	73	1011
Turks & Caicos	1999, 2018	2169	0	0	0	93	278	573	0	286	21	172	747
United States	2003, 2004, 2006	1617	72	40	117	119	14	253	1	189	23	108	682
United States, Puerto Rico	2003	2897	0	0	3	639	151	152	1	778	28	70	1075
United States, USVI	1998-2000	2515	0	0	0	287	461	146	23	418	23	329	829
Venezuela	1999	9125	993	564	160	538	396	2839	0	231	131	461	2811

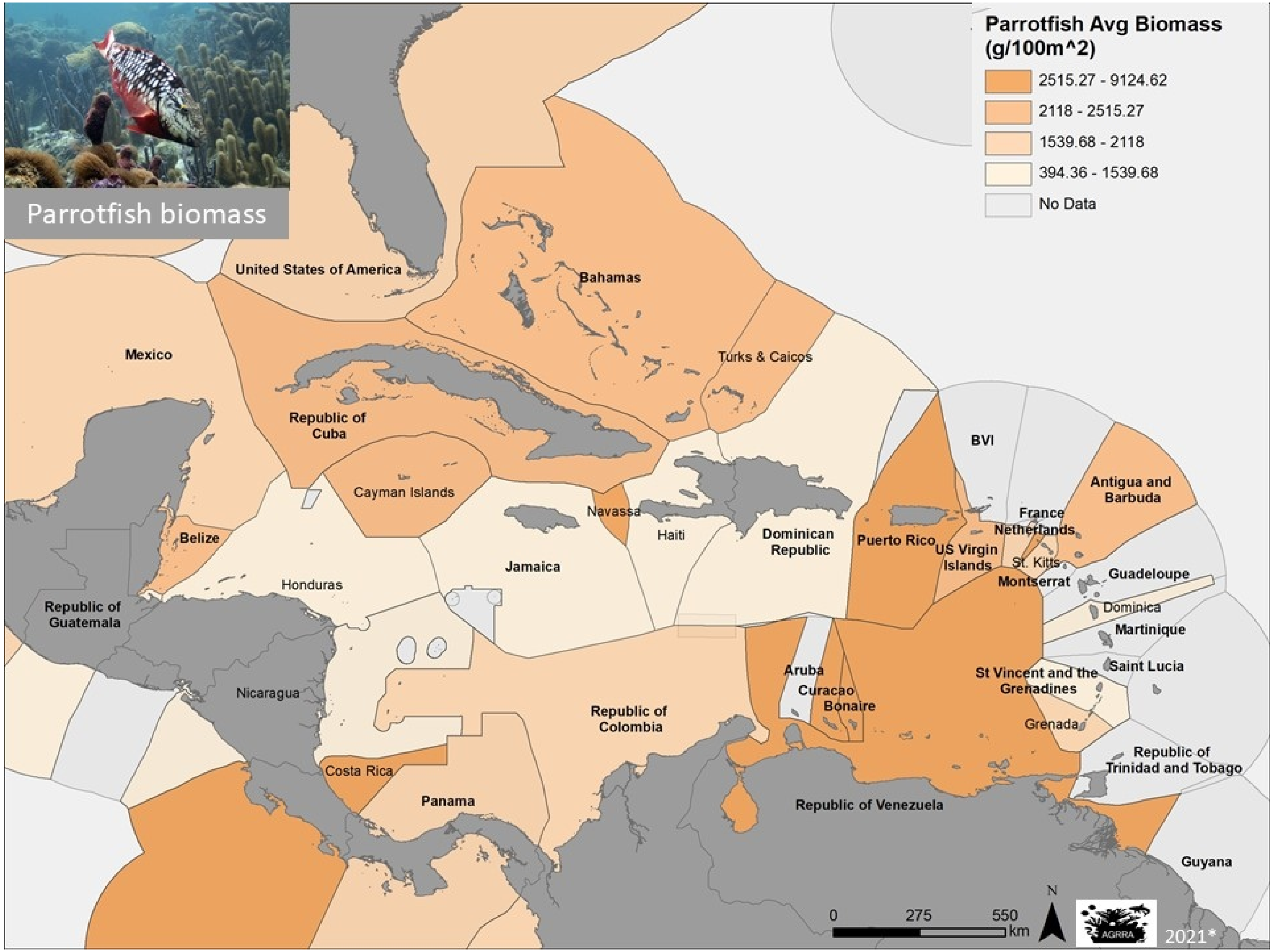

Figure 2. Map of total parrotfish biomass (all species combined) for countries with available AGRRA data (shown in above table) (AGRRA 2020). Note the year data was collected varies by country and recent data from other sources may be available. Biomass is calculated as g/100m^2.

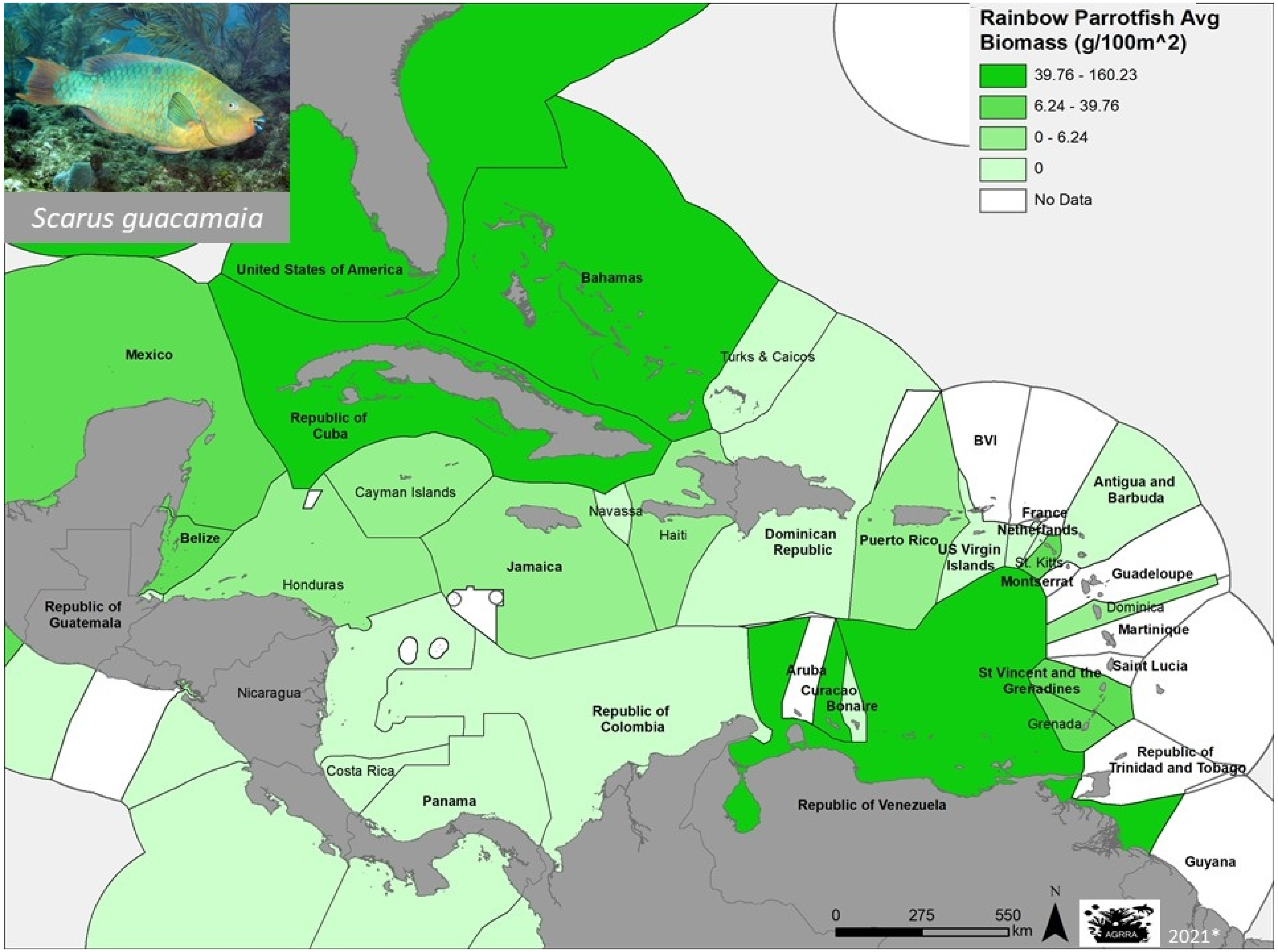

Figure 3. Map of rainbow parrotfish (*Scarus guacamaia*) biomass for countries with available AGRRA data (shown in above table) (AGRRA 2020). Note the year data was collected varies by country and recent data from other sources may be available. Biomass is calculated as g/100m^2.

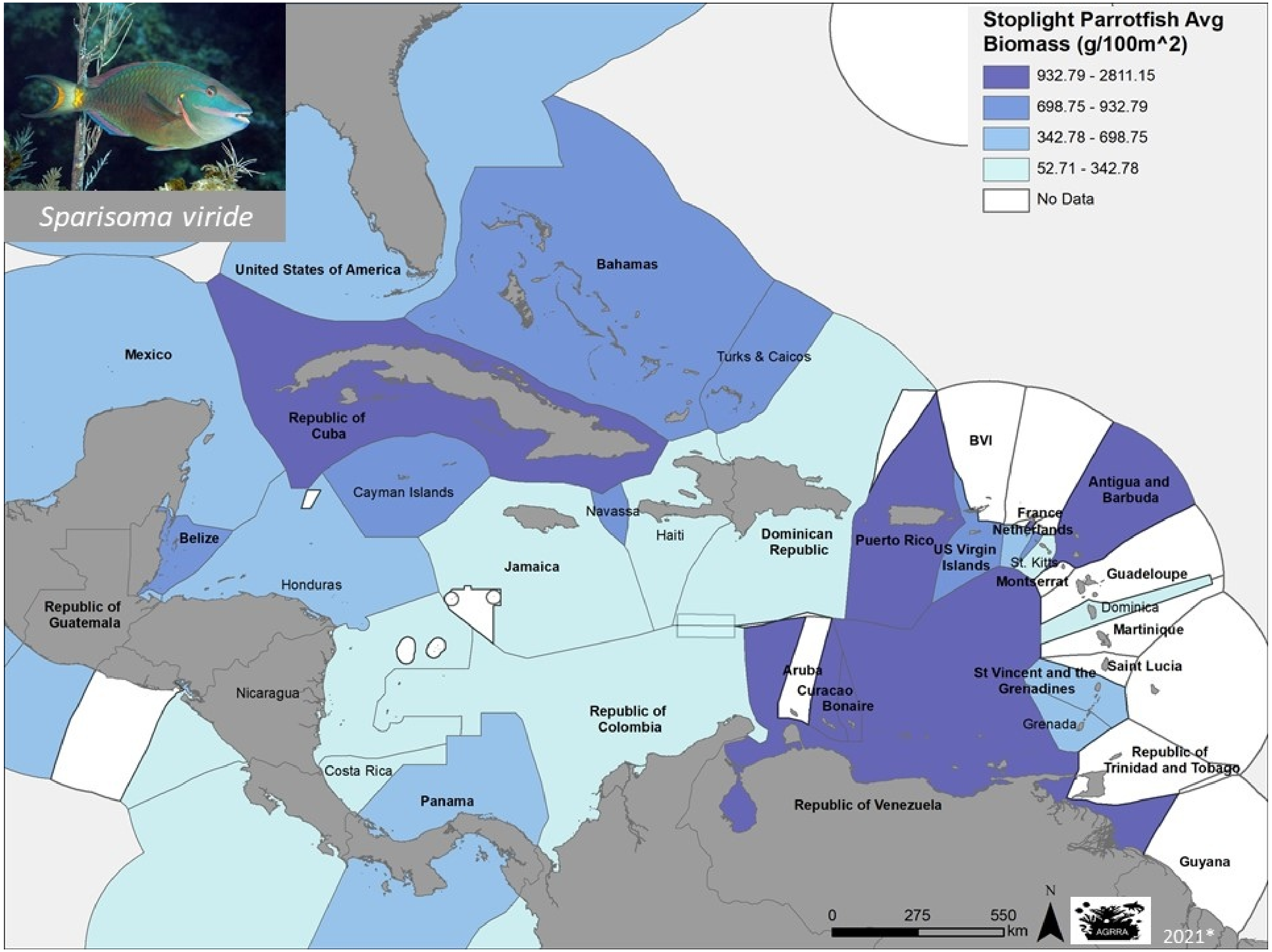

Figure 4. Map of stoplight parrotfish (*Sparisoma viride*) biomass for countries with available AGRRA data (shown in above table) (AGRRA 2020). Note the year data was collected varies by and recent data from other sources may be available. Biomass is calculated as g/100m^2.

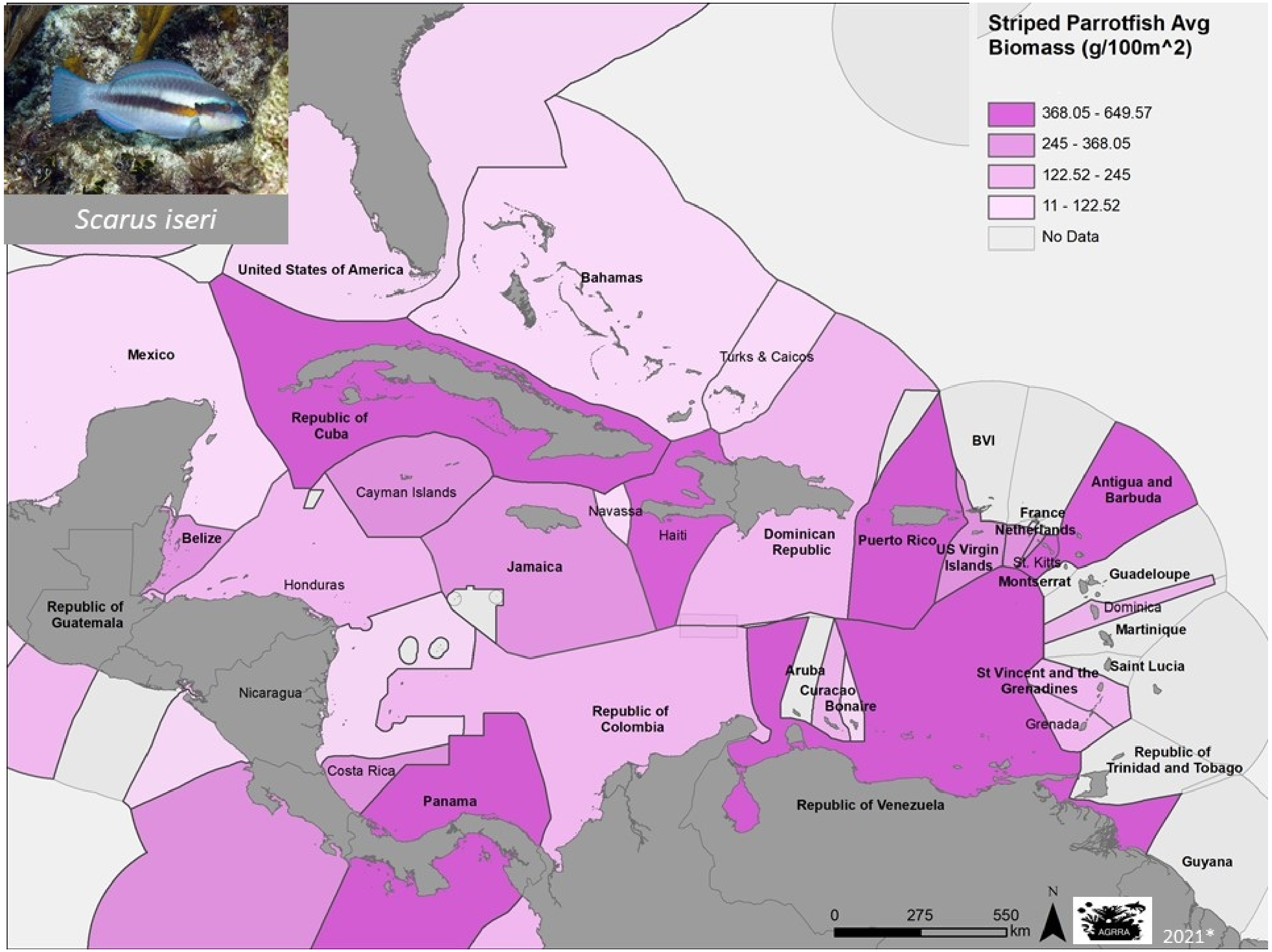

Figure 5. Map of striped parrotfish (*Scarus iseri*) biomass for countries with available AGRRA data (shown in above table) (AGRRA 2020). Note the year data was collected varies by country and recent data from other sources may be available. Biomass is calculated as g/100m^2.

Table 4. The densities and biomass estimates for parrotfishes in the US Caribbean, Florida and the Dry Tortugas (USA). Density and biomass is estimated as fish/177m^2 and kg/177m^2 based on the size of the RVC survey cylinder. The US Caribbean data is from 2019 while Florida and the Dry Tortugas is from 2018. *Source: NOAA NCRMP database, as retrieved by J. Blondeau (2021).*

	St. Thomas/St. John, USVI		**St. Croix, USVI**		**Puerto Rico, USA**		**Florida Keys, USA**		**Dry Tortugas, USA**	
Species	**Density**	**Biomass**	**Density**	**Biomass**	**Density**	**Biomass**	**Density**	**Biomass**	**Density**	**Biomass**
Cryptotomus roseus	0.3972	0.0053	0.2771	0.0034	0.5145	0.0061	0.2398	0.0020	0.6078	0.0063
Scarus coelestinus	0	0	0.0002	0.0001	0	0	0.0515	0.0507	0.0074	0.0229
Scarus coeruleus	0	0	0	0	0	0	0.2282	0.1649	0.0459	0.0546
Scarus guacamaia	0.0005	0.0008	0.0010	0.0001	0.0020	0.0014	0.1324	0.1689	0.0067	0.0126
Scarus iseri	6.0971	0.1318	1.1929	0.0547	2.0768	0.0635	7.3570	0.0575	10.6935	0.0728
Scarus taeniopterus	3.1955	0.1794	2.1611	0.1919	1.9642	0.1194	0.6638	0.0339	0.3596	0.0085
Scarus vetula	0.1223	0.0258	0.1137	0.0358	0.0590	0.0197	0.0563	0.0243	0.0041	0.0013
Sparisoma atomarium	0.8223	0.0022	0.8191	0.0023	1.2444	0.0039	0.9661	0.0024	2.9902	0.0101
Sparisoma aurofrenatum	4.9277	0.1573	3.5276	0.1944	3.0944	0.1614	3.7389	0.1004	3.1936	0.1062
Sparisoma chrysopterum	0.0413	0.0058	0.2154	0.0402	0.1614	0.0320	0.4376	0.0856	0.1633	0.0562
Sparisoma radians	0.0773	0.0003	0.2175	0.0012	0.3901	0.0009	0.2671	0.0008	0.2020	0.0012
Sparisoma rubripinne	0.1619	0.0375	0.1353	0.0283	0.1889	0.0281	0.4806	0.0802	0.1041	0.0477
Sparisoma viride	1.5727	0.2294	0.6109	0.1174	1.2264	0.2263	1.2632	0.2271	0.9257	0.2454

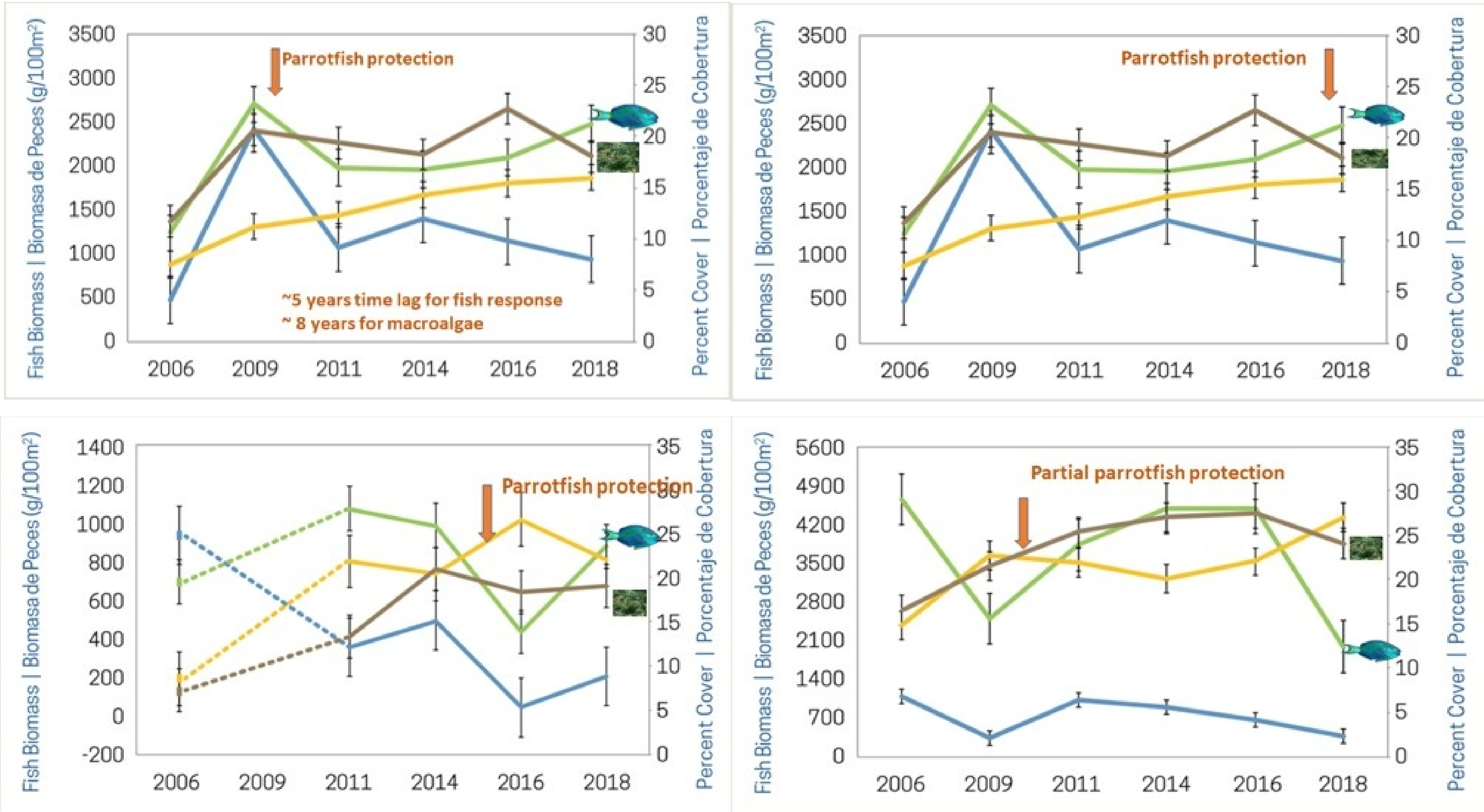

Figure 6. Herbivorous fish (parrotfish and surgeonfish) biomass over time for four countries of the Mesoamerican Reef Region. All four countries have implemented parrotfish protection measures (Orange arrow shows date of implementation). Parrotfish abundance increased in all four countries after protection measures. For Belize, there was about a five year time lag after the ban on parrotfish harvest before significant increases in biomass were measured. Fleshy macroalgae decreased over time with increasing herbivorous fish biomass, although as seen for Belize, there is also a time lag (~8 years). (note - the sudden decrease in fish biomass in Honduras is believed to be due to a lack of enforcement and illegal fishing). (Green lines - Herbivorous fish biomass, Brown line - Fleshy macroalgal cover, Yellow line - coral cover, Blue line - Commercial fish biomass). Mcfield et al. 2020.

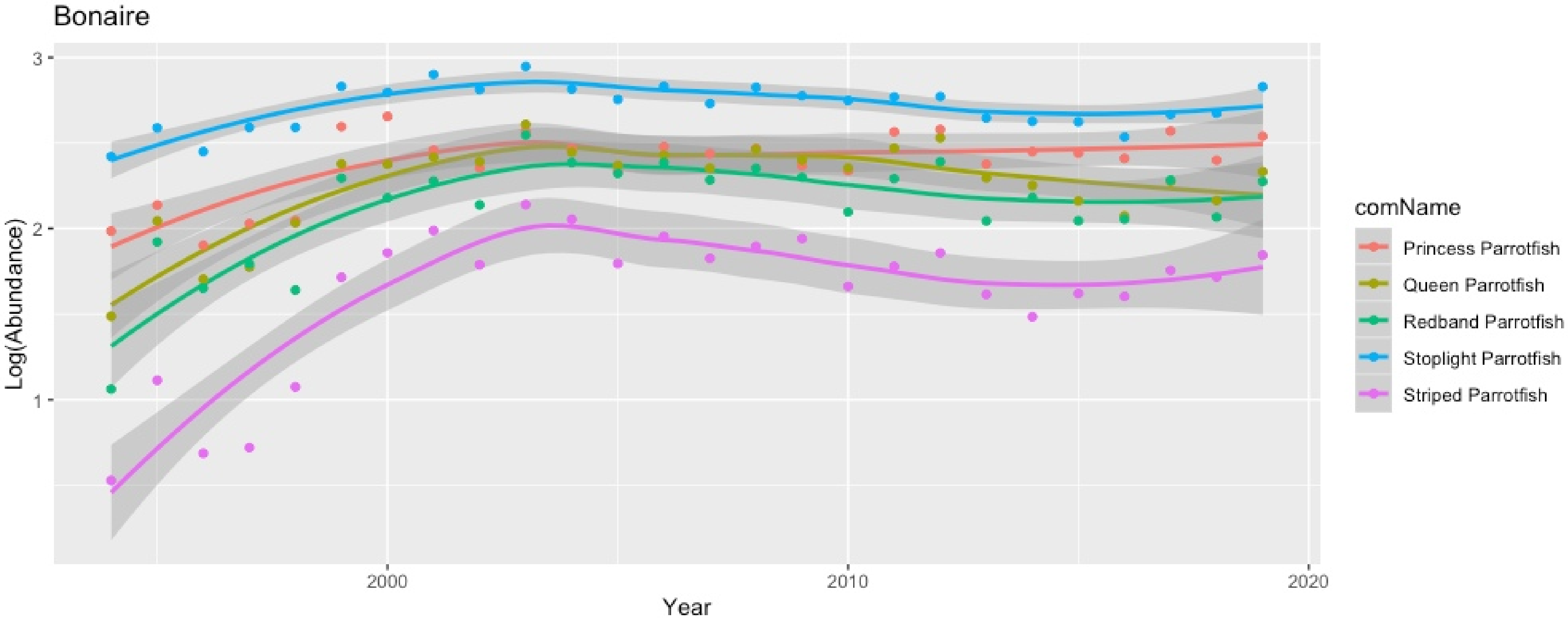

Figure 7. Abundance trends in common small- and medium-bodied parrotfish species on dive sites in Bonaire over the last 30 years. Data come from the Reef Environmental Education Foundation (REEF) Fish Survey Project, and citizen science project that enlists recreational divers to record and report the presence and relative abundance of fishes seen while diving. Note that the abundance trends of these species are tightly correlated, suggesting all species respond synchronously to environmental and anthropogenic drivers (and presumably, management actions).

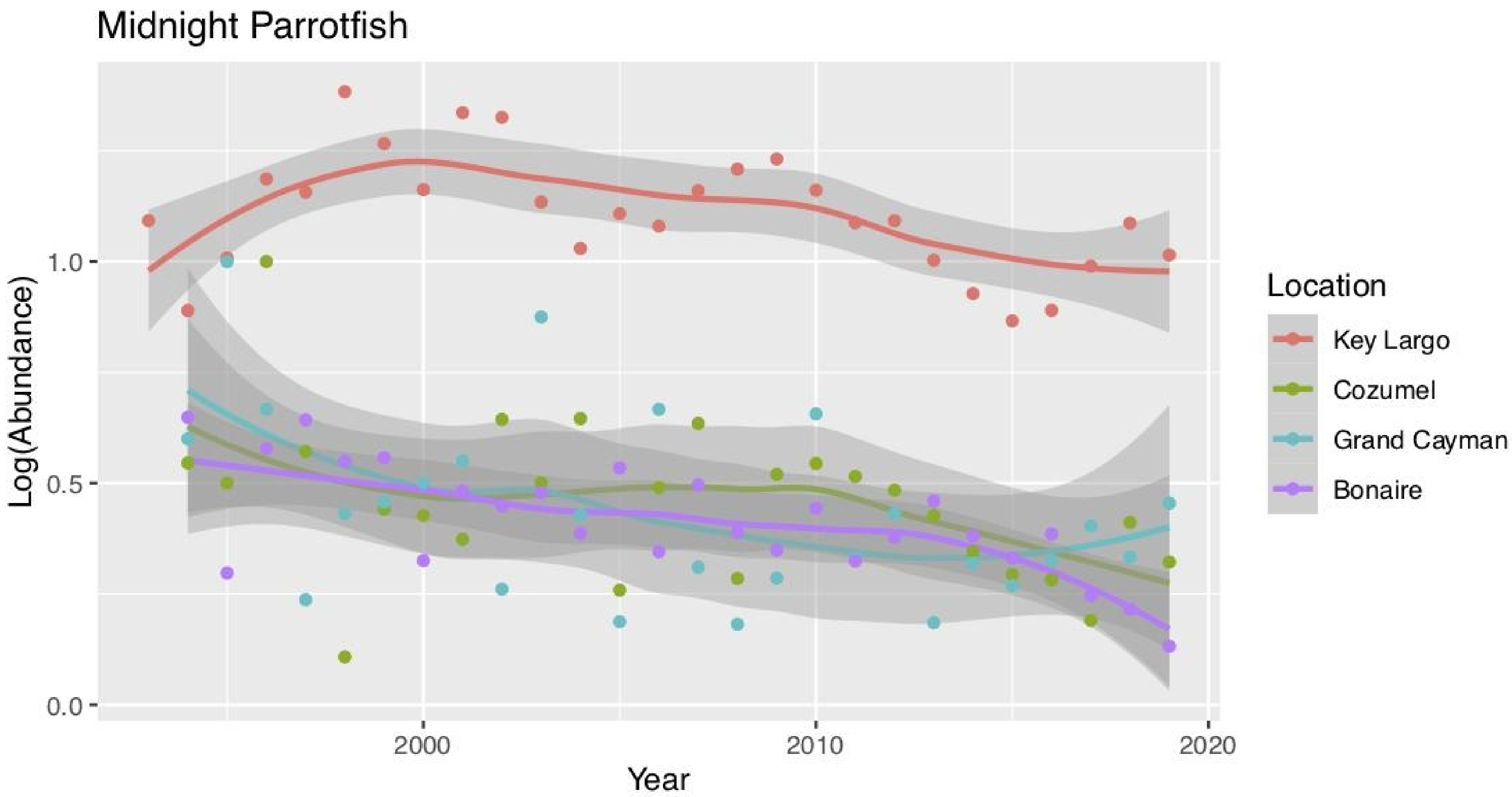

Figure 8. Abundance trends in midnight parrotfish (*Scarus coelestinus*) on dive sites over the last 30 years. Data come from the Reef Environmental Education Foundation (REEF) Fish Survey Project, and citizen science project that enlists recreational divers to record and report the presence and relative abundance of fishes seen while diving. The regions represented in the plot (Florida Keys, Cayman Islands, Cozumel and Bonaire) have some of the highest densities of surveys across years in the Fish Survey Project, and are broadly representative of the Caribbean region as a whole.

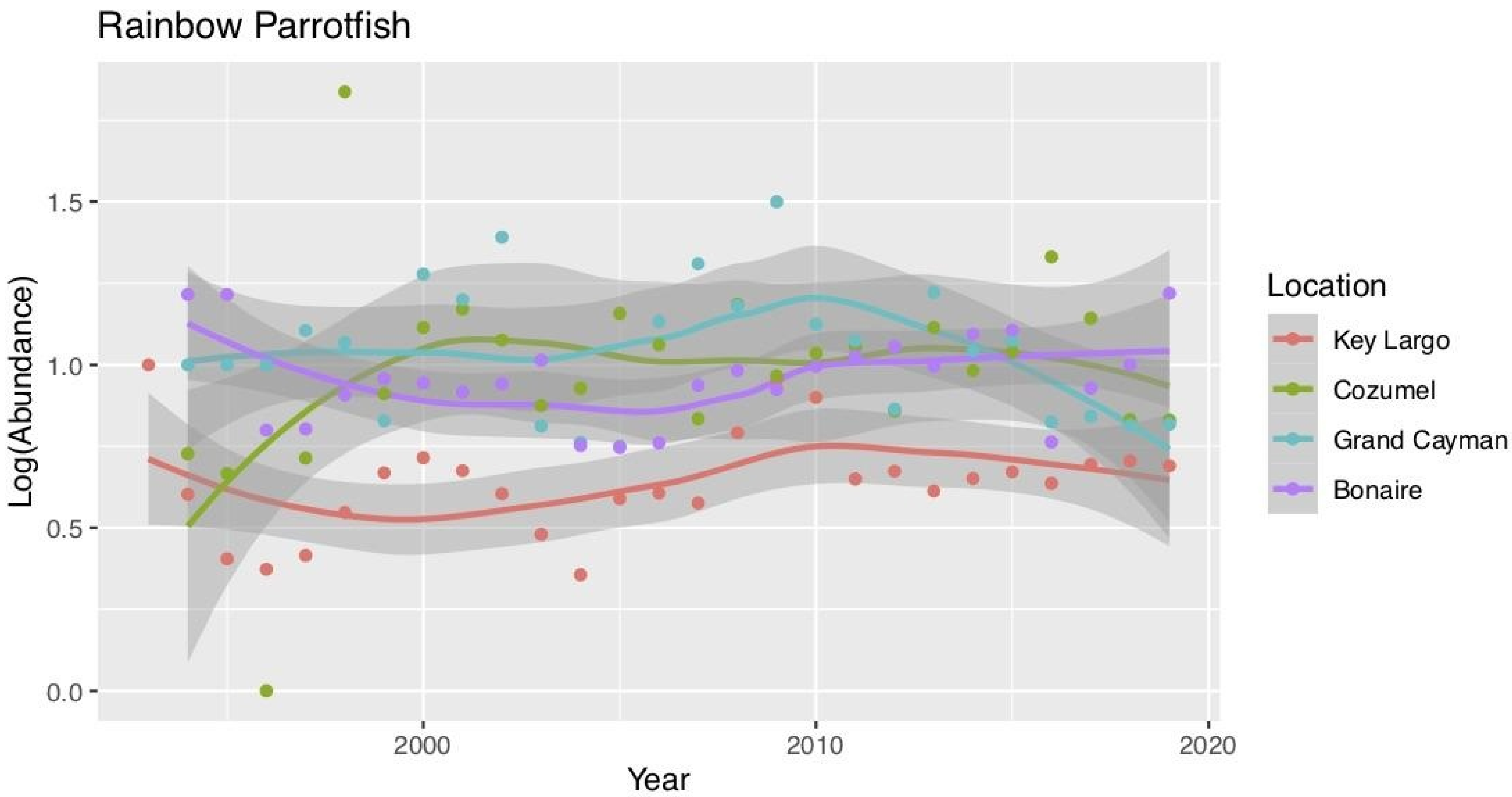

Figure 9. Abundance trends in rainbow parrotfish (*Scarus guacamaia*) on dive sites over the last 30 years. Data come from the Reef Environmental Education Foundation (REEF) Fish Survey Project, and citizen science project that enlists recreational divers to record and report the presence and relative abundance of fishes seen while diving. The regions represented in the plot (Florida Keys, Cayman Islands, Cozumel and Bonaire) have some of the highest densities of surveys across years in the Fish Survey Project, and are broadly representative of the Caribbean region as a whole.

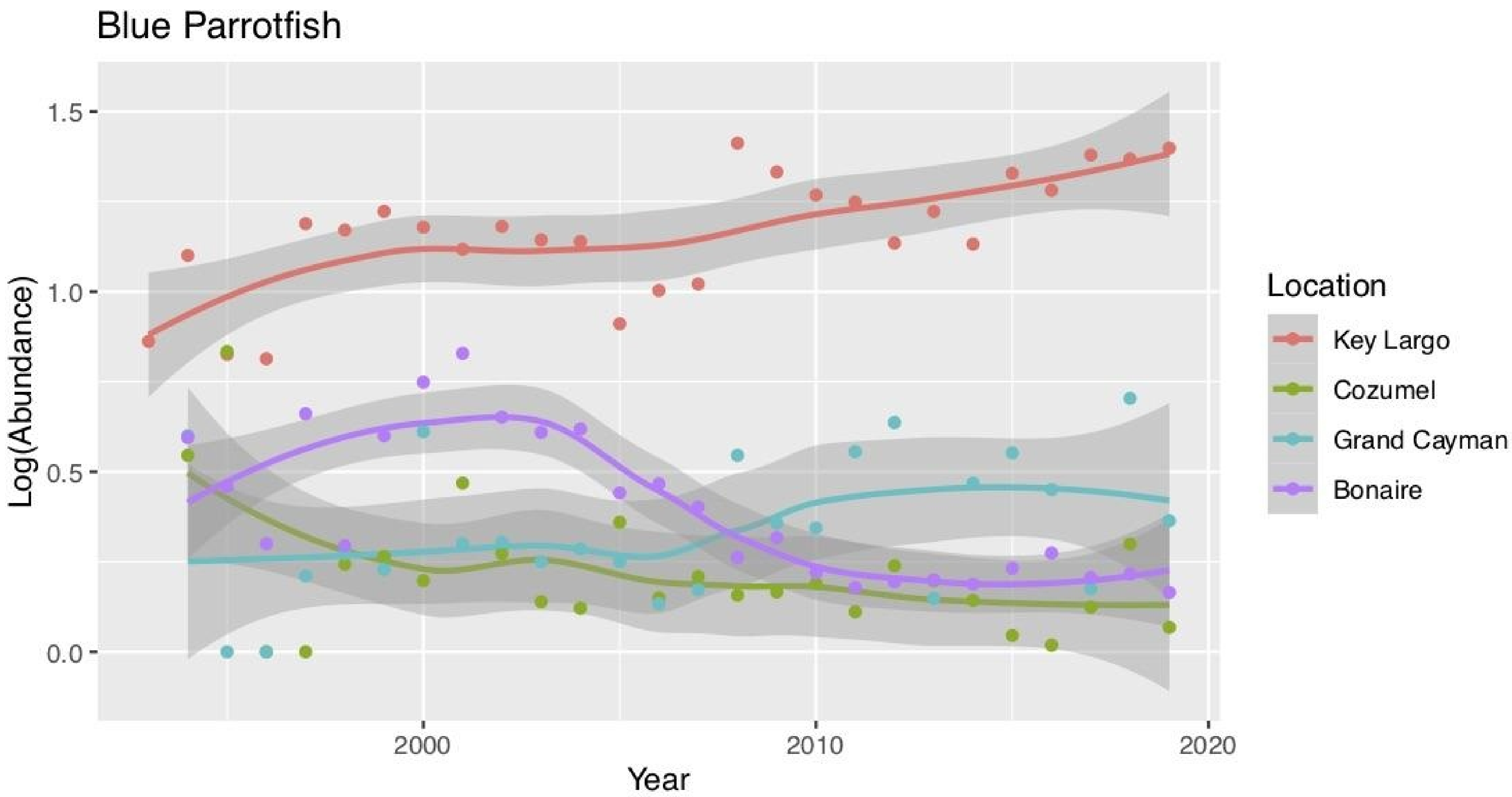

Figure 10. Abundance trends in blue parrotfish (*Scarus coeruleus*) on dive sites over the last 30 years. Data come from the Reef Environmental Education Foundation (REEF) Fish Survey Project, and citizen science project that enlists recreational divers to record and report the presence and relative abundance of fishes seen while diving. The regions represented in the plot (Florida Keys, Cayman Islands, Cozumel and Bonaire) have some of the highest densities of surveys across years in the Fish Survey Project, and are broadly representative of the Caribbean region as a whole.

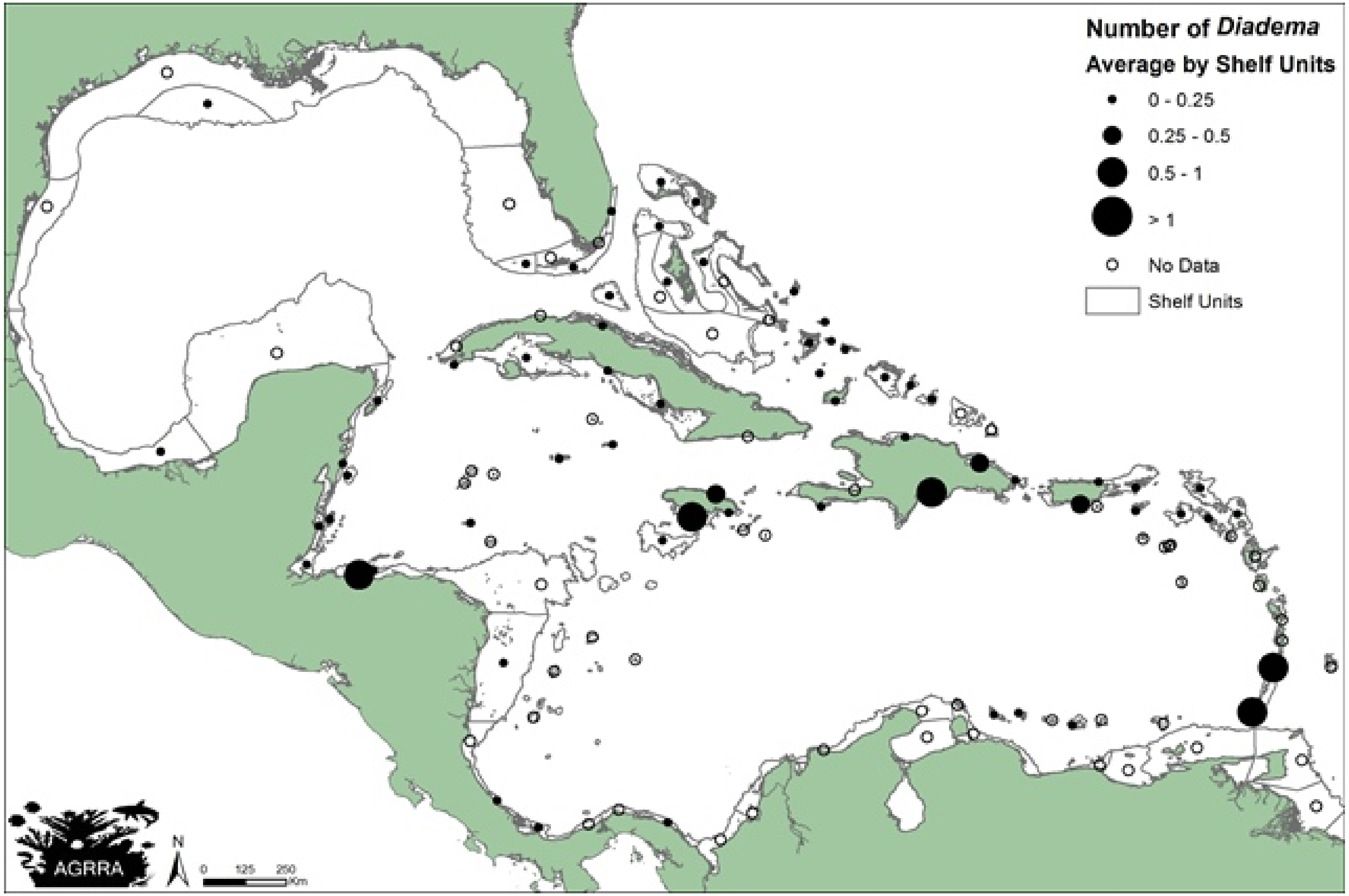

Figure 11. Number of *Diadema antillarum* (long-spined sea urchin) in the Caribbean. Most areas have low numbers of *Diadema*, although abundant populations are found in certain areas such as Tela, Honduras, parts of Jamaica and Dominican Republic, and shallow reefs in the southern Eastern Caribbean. Data combined and pooled at the Shelf unit (outlines). (AGRRA 2017).