

Short Communication

Unusual high fish biomass suggests healthy conditions in a Mexican reef on the southern Gulf of Mexico

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ABSTRACT. Reef health can be assessed from the fish biomass (roving herbivorous and predatory commercial species). In this preliminary note, the biomass of fish indicators of a healthy reef of Blake Reef, Veracruz, is estimated and compared with that recorded in other systems in the southern Gulf of Mexico. The size and abundance of fish observed in Blake Reef determine a remarkable biomass that exceeds the estimates of other reefs. The health of this reef makes it an important reservoir of regional diversity.

Keywords: reef health; roving herbivorous fishes; predatory commercial fishes; fish biomass; coral reefs; Mexico

The biomass of roving herbivorous (RH) and predatory fishes (PF) in the coral reefs are used as health indicators in the Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocol (AGRRA 2022) and Healthy Reefs for healthy people (Healthy Reefs 2022) between others because large-sized herbivorous fishes (>20 cm) remove more algae than small-sized, and because large-sized groupers (~50 cm) produce more offspring (AGRAA 2022). Recently published data on the health of coral reefs from the southern Gulf of Mexico, based on fish biomass data (herbivorous and predatory), indicate reef health status range from a critical (Alacranes: ~1300 g 100 m⁻² of RH and ~2400 g 100 m⁻² of PF, Pérez-Cervantes et al. 2017) to a very good condition (Bajos del Norte: ~5000 g 100 m⁻² of RH, and ~2500 g 100 m⁻² of PF, Favoreto et al. 2020; and Arenas: ~3600 g 100 m⁻² of RH and 1700 g 100 m⁻² of PF, Pérez-Cervantes et al. 2017). In 2013, biologists from the University of Veracruz carried out research funded by the National Commission for the Knowledge and Use of Biodiversity (CONABIO, by its Spanish acronym) in order to update the fish inventory of coral reefs at locations north and south of Veracruz,

including Blake Reef (20°45'45"N, 96°59'20"W). One hundred twenty-two fish species were recorded (González-Gándara 2014). In addition, a high frequency and large sizes of roving herbivorous and predatory fishes were observed (Fig. 1). In this note, based on the sighting rate observed during fish censuses in 2013, the biomass of reef health indicator fish on Blake Reef was estimated (2017) to assess its health status and compare it with other systems in the southern Gulf of Mexico.

One hundred and sixteen visual censuses using the roving diver technique for 30 min were done in 2013. In each census, the roving herbivorous, as well as predatory-commercially important fishes, were identified using their morphological characteristics and coloration patterns that distinguish them (Humann & Deloach 2014) and the sighting rate of the fish species (defined by the number of sightings/numbers of census × 100) was estimated. To estimate the fish biomass, in June 2017, 12 visual censuses using a transect belt (25×2 m) were made in three separate sites (north, south, and mid reef) with different depths (10.6 ± 0.6, 16.2 ± 0.8, and 22.4 ± 1.4 m) at Blake Reef. During the

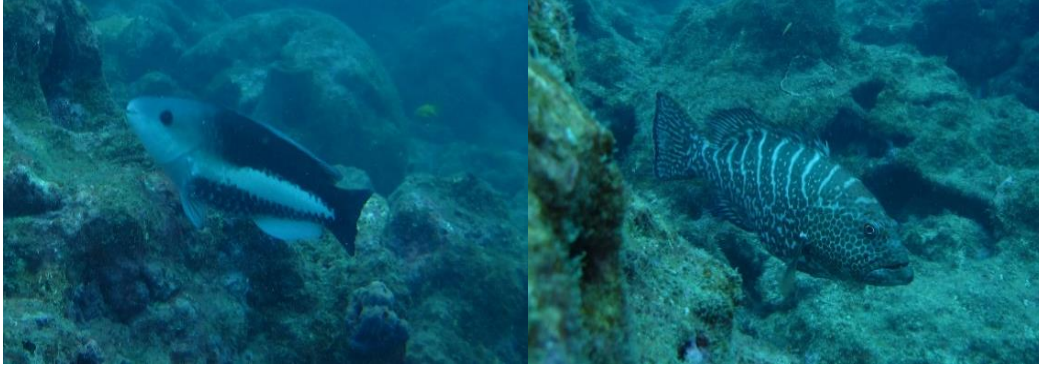


Figure 1. The common size of two frequent fish species (female of *Scarus vetula*, ~50 cm total length (TL), and *Mycteroperca tigris*, ~60 cm TL) from Blake Reef, south Gulf of Mexico (2013). Photographs: Carlos González-Gándara.

Table 1. Relative frequency (%) of roving herbivorous fishes (surgeonfishes and parrotfishes) and predatory commercial fish species (snappers and groupers) at Blake Reef, southern Gulf of Mexico, during 2013. In bold, the fish species more frequent.

Guild	Species	Relative frequency (%)
Herbivorous	<i>Acanthurus coeruleus</i>	57
	<i>Acanthurus chirurgus</i>	25
	<i>Acanthurus tractus</i>	24
	<i>Scarus iseri</i>	37
	<i>Scarus guacamaia</i>	4
	<i>Scarus taeniopterus</i>	11
	<i>Scarus vetula</i>	83
	<i>Sparisoma aurofrenatum</i>	16
	<i>Sparisoma viride</i>	47
	Predatory	<i>Lutjanus apodus</i>
<i>Lutjanus cyanopterus</i>		3
<i>Lutjanus griseus</i>		16
<i>Lutjanus jocu</i>		35
<i>Lutjanus mahogoni</i>		8
<i>Cephalopholis cruentata</i>		27
<i>Cephalopholis fulva</i>		2
<i>Epinephelus adscensionis</i>		43
<i>Mycteroperca interstitialis</i>		58
<i>Mycteroperca phenax</i>		6
<i>Mycteroperca tigris</i>		34
<i>Mycteroperca venenosa</i>	0.1	

censuses, the fish species were identified, and their abundance was estimated using the proposal of Harmelin-Vivien et al. (1985). The total length of each specimen was measured using a T rule of 100 cm in length and an accuracy of 5 cm. With data of mean size, the biomass was calculated using the exponential function: $W = a L^b$, where W = total weight (g), L = total length (cm), a and b = constants of length-weight relationship. Values of a and b constants were obtained from the database FishBase (Froese & Pauly 2022). The result was multiplied by the abundance; subsequently,

each species' average ichthyologic biomass was estimated and expressed in grams per 100 m².

Three of the fish species indicators of reef health showed a sighting rate above 50% (*Scarus vetula*, *Mycteroperca interstitialis*, and *Acanthurus coeruleus*) and five ranged from 30 to 50% (*Sparisoma viride*, *Epinephelus adscensionis*, *Scarus iseri*, *Lutjanus jocu*, and *Mycteroperca tigris*) on Blake Reef. The rest of the fish species presented a sighting rate of 0.1 to 27% (Table 1). The observed fish size could indicate that fishing pressure is directed toward other species

Table 2. Size range (cm) and total biomass (g 100 m⁻²) of roving herbivorous fishes (surgeonfishes and parrotfishes) according to depth layers in Blake Reef, southern Gulf of Mexico (2017).

Family	Fish species	Depth layer (m)					
		10-15		15-20		20-25	
		Size range	Biomass	Size range	Biomass	Size range	Biomass
Acanthuridae	<i>A. coeruleus</i>	6-20	92.97	31-40	1884.89	21-25	179.42
	<i>A. chirurgus</i>	6-10	6.28	6-15	20.60	21-30	393.61
	<i>A. tractus</i>	----	----	16-25	446.49	16-20	64.29
Scaridae	<i>S. guacamaia</i>	----	----	----	----	81-85	5853.80
	<i>S. iseri</i>	6-10	31.01	6-30	230.20	6-20	358.43
	<i>S. taeniopterus</i>	----	----	6-10	13.82	6-10	24.19
	<i>S. vetula</i>	6-50	3041.06	16-45	3613.71	31-50	5595.45
	<i>S. aurofrenatum</i>	----	----	11-20	1659.30	11-20	122.18
	<i>S. viride</i>	6-40	1474.71	6-50	2622.13	6-40	770.74
Total biomass		4646.04		10491.14		13362.10	

Table 3. Size range (cm) and total biomass (g 100 m⁻²) of predatory commercial fish species (snappers and groupers) according to depth layers in Blake Reef, southern Gulf of Mexico (2017).

Family	Fish species	Depth layer (m)					
		10-15		15-20		20-25	
		Size range	Biomass	Size range	Biomass	Size range	Biomass
Lutjanidae	<i>L. griseus</i>	----	----	----	1038.25	16-40	5910.95
	<i>L. jocu</i>	----	----	----	----	26-45	2185.13
	<i>L. mahogoni</i>	26-30	268.43	----	----	26-30	268.43
Serranidae	<i>C. cruentata</i>	36-40	636.22	21-40	1220.79	----	----
	<i>E. adscensionis</i>	36-40	419.77	26-30	167.93	26-30	167.93
	<i>M. interstitialis</i>	21-30	263.71	26-30	168.96	6-50	506.87
	<i>M. tigris</i>	----	----	21-25	164.05	----	----
Total biomass		1588.13		2759.98		9039.32	

Table 4. Comparison of fish biomass estimated (g 100 m⁻²) at Blake Reef with other reefs of the southern Gulf of Mexico.

Reef	Reefs health indicators			Authors
	Roving herbivorous	Predatory fishes	Year of sampling	
Alacranes	1300 ± 600	2400 ± 900	2016	Pérez-Cervantes et al. (2017)
Bajos del Norte	5000	2500	2019	Favoreto et al. (2020)
Arenas	3600 ± 1000	1700 ± 700	2016	Pérez-Cervantes et al. (2017)
Triángulos	2000 ± 500	1800 ± 300	2016	Pérez-Cervantes et al. (2017)
Tuxpan	4929 ± 412	1279 ± 363	2015	Unpublished data
Blake	9500 ± 2564	4462 ± 2313	2017	This study

(Tables 2-3), especially since harpoon fishing is little used in this reef system (Martos 2010). The estimated average biomass on Blake Reef reveals high values of roving herbivorous (9499.8 ± 2564.5 g 100 m⁻²) and predatory-commercially important fishes (4462.5 ± 2313.3 g 100 m⁻²). A gradient that increases with depth was detected (Tables 2-3), possibly associated with coral cover and the structural complexity of the substrate. These findings suggest a remarkable reef

health status of Blake Reef based mainly due to the sizes presented by: *Scarus guacamaia*, *S. vetula*, and *S. viride* (Table 2), as well as: *Lutjanus griseus*, *L. jocu*, and *M. interstitialis* (Table 3). A general comparison of these biomass data with other reefs of the Bank of Campeche (Pérez-Cervantes et al. 2017, Favoreto et al. 2020) and the north of Veracruz (data not published) reveal a remarkable contrast, exceeding that of any previously reported for regional coral reefs (Table 4),

especially the roving herbivorous fishes. Although this report is preliminary, and the comparison should be taken with caution, it is a state of conservation indicator of the Blake Reef and its importance as a reservoir of regional diversity.

ACKNOWLEDGMENTS

This study is part of the projects “Esponjas, corales escleractinios, equinodermos y peces de arrecifes coralinos del norte y sur de Veracruz” funded by the National Commission for the Knowledge and Use of Biodiversity (CONABIO) Convenio JF-124, and “Bases para el análisis y síntesis de los sistemas costeros de Veracruz”, supported by Mexican Ministry of Public Education (Secretaría de Educación Pública). The author appreciates the comments of C. González-Salas and three anonymous referees who improved the manuscript.

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Received: November 14, 2022; Accepted: February 3, 2023