METADATA

CLASS 1. DATA SET DESCRIPTORS

A. Data set identity: *TimeFISH: Long-term assessment of reef fish assemblages in a transition zone in the Southwestern Atlantic.*

B. Data set identification code:

- TimeFISH_census_data.csv
- TimeFISH_taxonomic_information.csv
- TimeFISH_location_information.csv

C. Data set description

1. Originators: Juan P. Quimbayo[1], Lucas T. Nunes[2], Fernanda C. Silva[2], Antônio B. Anderson[3], Diego R. Barneche[4,5], Angela M. Canterle[2], Isadora Cord[2], Andrea Dalben[6], Débora S. Ferrari[2], Luisa Fontoura[7], Thiago M.J. Fiuza[8], Ana M.R. Liedke[2], Guilherme O. Longo[9], Renato A. Morais[10], Alexandre C. Siqueira[11], Sergio Ricardo Floeter[2]

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2. Abstract: The TimeFish database provides the first public time-series dataset on reef fish assemblages in the Southwestern Atlantic (SWA), comprising 15 years of data (2007-2022) based on standardized Underwater Visual Censuses (UVCs). The rocky reefs covered by our dataset are influenced by pronounced seasonal cycles of ocean temperatures with warm tropical waters from the Brazil Current in the summer (~27°C) and colder waters from the La Plata River Plume discharge and upwelling from the South Atlantic Central Water in the winter (~18°C). These oceanographic conditions characterize this area as the southernmost tropical-subtropical climatic transition zone in the Atlantic Ocean. As a result, reef fish assemblages comprise both tropical and subtropical species. All records included in TimeFish were collected using UVCs, a non-destructive method that allows the estimation of fish species richness, abundance, and body size distributions. UVCs were performed through 40 m^2 belt transects by scuba diving in nine locations along the southern Brazilian coast (25°S – 29°S). Four of these locations lie within the boundaries of the no-entry Arvoredo Marine Biological Reserve, where fishing and recreational activities are forbidden,

and the remaining locations are unprotected from these activities. During each belt transect, a diver swam at a constant depth above and parallel to the reef, identifying fish species, counting the number of individuals, and estimating the total body length (Lt in cm) of all detected individuals. All fish individuals in the water column (up to 2 m above the substratum) and at the bottom were targeted. A total of 202,965 individuals belonging to 163 reef fish species and 53 families were recorded across 1,857 UVCs. All survey campaigns were funded by either public or mixed capital (private-public) sources, including seven grants from the Brazilian federal and Santa Catarina state government. Part of the data have already been used in multiple MSc and PhD theses and scientific articles. TimeFISH represents an important contribution for future studies aiming to examine temporal and spatial variations of reef fish assemblages in transition zones. No copyright restrictions apply to the use of this data set, other than citing this publication.

D. Keywords: Abundance, fish body size, fish richness, rocky reefs, temporal series.

CLASS II. RESEARCH ORIGIN DESCRIPTORS

A. Overall project description

1. Identity: *TimeFISH*: Long-term assessment of reef fish assemblages in a transition zone in the Southwestern Atlantic.

2. Originators: Juan P. Quimbayo, Lucas T. Nunes, Fernanda C. Silva, Antônio B. Anderson, Diego R. Barneche, Angela M. Canterle, Isadora Cord, Andrea Dalben, Débora S. Ferrari, Luisa Fontoura, Thiago M.J. Fiuza, Ana M.R. Liedke, Guilherme O. Longo, Renato A. Morais, Alexandre C. Siqueira, Sergio Ricardo Floeter.

3. Period of study: Underwater visual censuses started in 2007 and were performed in all austral summers since. The data collection is still ongoing and presented here until the 2022 campaign.

4. Objectives: (1) To record reef fish species richness, abundance, and body size in nine locations over time in the southern transition zone in the Southwestern Atlantic Ocean. (2) To provide an open dataset supporting future investigations of temporal trends in reef fish assemblages in transition zones.

5. Abstract: Same as above

6. Sources of funding:

- Projeto Ilhas do Sul. PI: Sergio R. Floeter (Conselho Nacional de Desenvolvimento Científico e Tecnológico, CNPq: 475367/2006-5).
- MCT-Jovens Pesquisadores. PI: Sergio R. Floeter (Conselho Nacional de Desenvolvimento Científico e Tecnológico, CNPq: 571295/2008-8).
- Rede Nacional de Pesquisa em Biodiversidade Marinha (SISBIOTA-Mar). PI: Sergio R. Floeter (Conselho Nacional de Desenvolvimento Científico e Tecnológico, CNPq: 563276/2010-0).
- Fundação de Amparo à Pesquisa e Inovação do Estado de Santa Catarina. PI: Sergio R. Floeter (FAPESC: 6308/2011-8).
- Project MAArE – Monitoramento Ambiental da Reserva Biológica Marinha do Arvoredo e Entorno. PI: Barbara Segal (PETROBRAS).
- Projeto Biodiversidade Marinha do Estado de Santa Catarina. PI: Alberto Lindner (FAPESP 4302/2010-8)
- Programa de monitoramento de ambientes recifais na Reserva Biológica Marinha do Arvoredo. Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio).

B. Specific subproject description

1. Site description

Data assembled in the TimeFISH database were collected in nine locations on the coast of Santa Catarina State (Figure 1). This area represents approximately 7% of the Brazilian coast (Diehl and Horn Filho 1996). The region is under the influence of two main marine water systems: the Brazil current, which carries warm tropical waters from the north, and the La Plata River plume discharge, which transports cold waters from the south. Additionally, the waters beyond the coast are influenced by the South Atlantic Central Water, also a cold-water system. Due to these specific oceanographic conditions, this region is recognized as a transition zone (i.e., where both tropical and temperate species distributions overlap and changes in sea surface temperature are most pronounced, Ferro and Morrone 2014). The southernmost limit of distribution of tropical reef fish fauna in the Southwester Atlantic is located along the coast of Santa Catarina State (Anderson et al. 2015, 2020, Pinheiro et al. 2018). Four sampled locations are situated within the limits of the No-entry Arvoredo Marine Biological Reserve, whereas the remaining locations lie in unprotected areas (Figure 1). The Arvoredo Marine Biological Reserve was established in 1990, and encompasses an area of 17,800 ha, characterizing the only nearshore no-take and no-entry Brazilian MPA (Magris et al. 2020). It comprises three islands: Arvoredo (-27.17 | -48.36), Deserta (-27.16 | -48.19), and Galé Island (-27.10 | -48.24; Figure 1). Part of Arvoredo Islands is located within the MPA (-27.17 | -48.36), and other part outside the MPA (-27.28 | -48.37). The surveyed locations outside of the marine reserve include one continental location in Porto Belo (-27.7 | -48.31), and four in coastal islands, Aranhas (-27.29 | -48.21), Campeche (-27.41| -48.27), Moleques do Sul (-27.50 | -48.25) and Xavier Island (-27.36 | -48.23; Figure 1).

The benthic communities include a diverse assemblage of algal turfs, macroalgae and zoanthids that are common across the sampled locations (Horta et al. 2008, Pascelli et al. 2013, Aued et al. 2018). At Galé Island, we also find free-living colonies of *Madracis decactis* that occur in sandy substratum (Capel et al. 2012). One location in the northern part of Arvoredo Island (inside MPA) contain a relatively extensive rhodolith bed occurs (Horta et al. 2008, Pascelli et al. 2013). The most recent and comprehensive local fish species checklist published for the Santa Catarina State reported 278 reef fish species belonging to 170 genera and 74 families (Anderson et al. 2015). Approximately 8.3% of these species are classified as threatened by the International Union for Conservation of Nature (IUCN), comprising mostly top predators and large Brazilian endemic herbivores (Anderson et al. 2015).

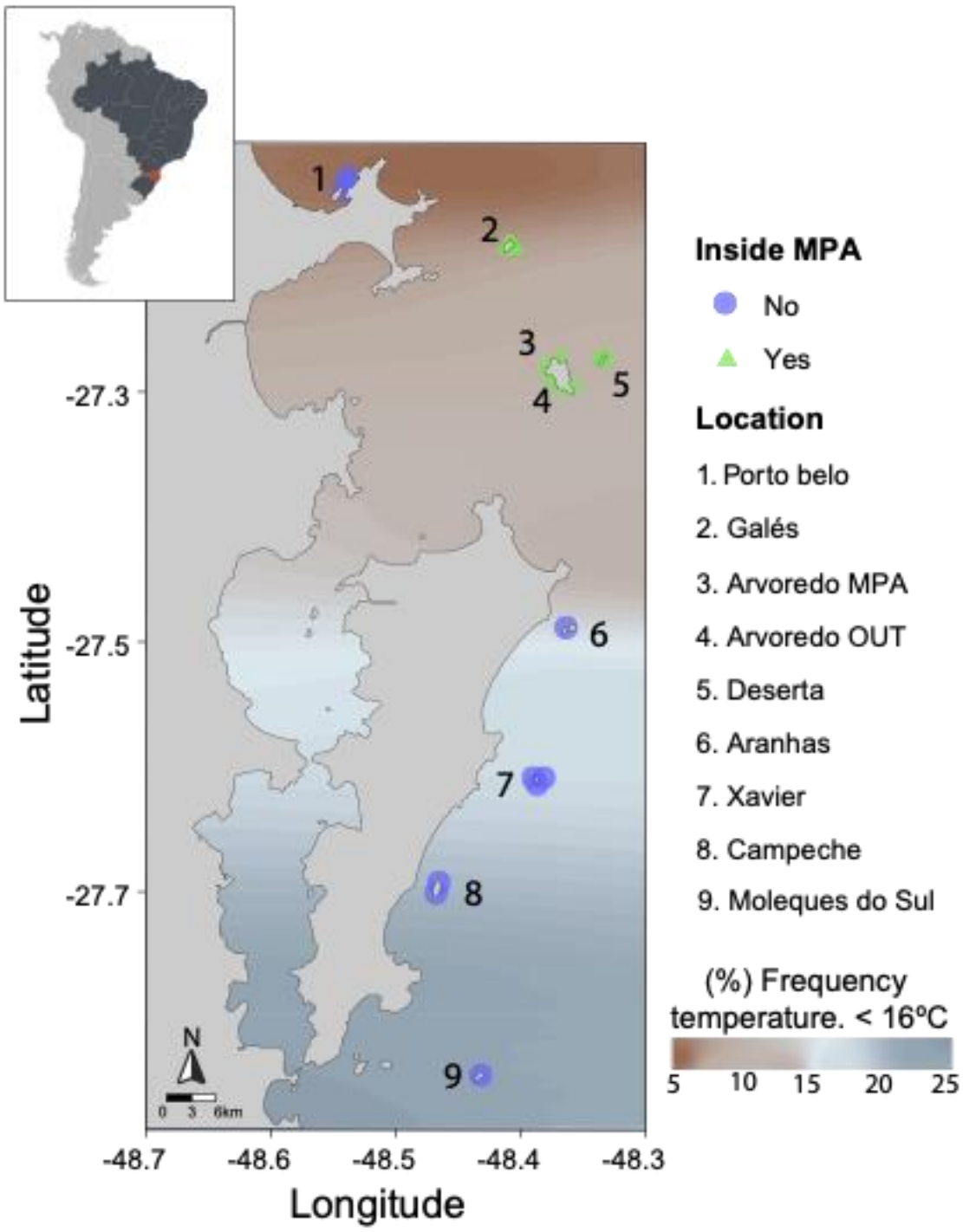

Figure 1. Geographical position of the nine locations sampled over 15 years in the Southwestern Atlantic. Sea surface temperature data were extracted from Faria-Junior and Lindner (2019).

2. Experimental or sampling design

Underwater visual censuses

Reef fish assemblages were sampled using Underwater Visual Censuses (UVCs), a non-destructive technique that provides estimates of species richness, abundance, and body size with minimal habitat impacts (Brock 1954, Kulbicki 1998). During the UVCs (20 X 2m = 40m^2), all fish species observed in the water column and at or near the bottom were identified, counted, and had their individual body size estimated. To perform such activity, a diver first swam horizontally and parallel to the rocky shore while simultaneously laying out a 20 m measuring tape and writing down all information assessed from the species observed in the water column. Then, the diver swam back retrieving the measuring tape and writing down information on all detected species associated with the benthos. Such technique has been repeatedly and successfully used along the Brazilian coastal and oceanic reefs (Floeter et al. 2007, Krajewski and Floeter 2011, Pinheiro et al. 2011, Longo et al. 2014, 2015, Luiz et al. 2015, Morais et al. 2017, Quimbayo et al. 2019), in other regions in the Atlantic Ocean (Maia et al. 2018, Freitas et al. 2019), and for regional or global assessments of reef fish assemblages (Barneche et al. 2019, Inagaki et al. 2020, Quimbayo et al. 2021a). A total of 1,857 UVCs were performed throughout the last 15 years across the nine locations sampled in Santa Catarina (Figure 2).

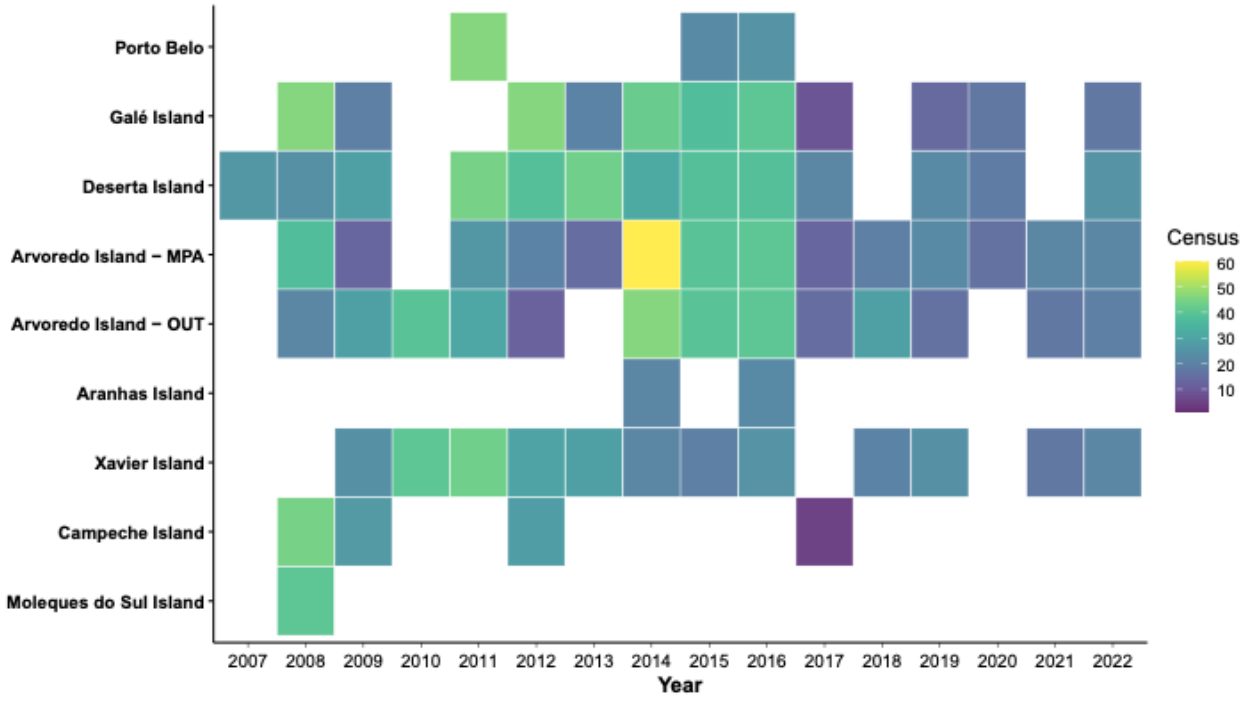

Figure 2. Number of underwater visual censuses performed over 15 years in nine locations in the Southwestern Atlantic. The warmer colors depict a higher sampling effort. This uneven sampling effort is associated with the lack of consistent funding to sample all locations over time.

A total of 202,965 individuals from 163 reef fish species were recorded across all surveys included in the TimeFISH database. This set of species represents 58% of the reef fish fauna reported for the whole Santa Catarina state (Anderson et al. 2015). Parts of the dataset have supported over 20 international and national publications or reports, highlighting the importance of evaluating temporal and spatial patterns of reef fish in transition zones. As an example, the detection and assessment of the population density patterns of the invasive *Chromis limbata* in the study area emphasizes the benefits of such long-term monitoring programs (Anderson et al. 2017, 2020).

3. Research methods

Taxonomic and systematics

The taxonomic classification followed the Eschmeyer's Catalog of Fishes (Fricke et al. 2020).

CLASS III. DATA SET STATUS AND ACCESSIBILITY

A. Status

1. Latest update: 2022

2. Latest archive data: 2022

3. Metadata status: Metadata are complete

4. Data verification: All data were reviewed according to CLASS V section B and checked for any input errors.

B. Accessibility

1. Storage location and medium: All data and metadata are stored with this publication in the journal *Ecology*.

2. Contact persons:

- Juan Pablo Quimbayo, Center for Marine Biology, University of São Paulo, São Sebastião, Brazil. Email: quimbayo.j.p@gmail.com
- Sergio Ricardo Floeter, Marine Macroecology and Biogeography Laboratory, Federal University of Santa Catarina, Florianópolis, Brazil. Email: sergio.floeter@ufsc.br

3. Copyright or propriety restrictions: There are no copyright or proprietary restrictions for research or teaching proposes.

4. Proprietary restrictions: None.

5. Citation: This paper.

CLASS IV. DATA STRUCTURAL DESCRIPTORS

A. Data set files

1. Identity

- TimeFISH_census_data.csv
- TimeFISH_taxonomic_information.csv
- TimeFISH_location_information.csv

2. Size

- TimeFISH_census_data: [27,377 rows + header, 5 columns; (1.3MB)]
- TimeFISH_taxonomic_information: [163 rows + header, 9 columns; (14KB)]
- TimeFISH_location_information: [1,958 rows + header, 23 columns; (363KB)]

3. Format and storage: Digital data file in *.csv

4. Header information: See column description in section B.

5. Alphanumeric information: Mixed.

B. Variable information

Each row of the data files represents a unique value, i.e., one species observed in one location and one year (Table 1).

Table 1. List of column names found in TimeFISH

Variable name	Variable definition	Nature	Units
Province	Marine biogeographic province defined by Spalding et al. (2007)	Categorical (nominal)	
State	Brazilian political federation unit	Categorical (nominal)	
Location	Marine location where the belt transects were performed	Categorical (nominal)	
Site	Sites where the belt transects were performed (smallest-scale unit within the location)	Categorical (nominal)	
Thermal_category	Classification of locations according to the water thermal regime, estimated from the mean summer sea surface temperature (warm locations are those with a mean temperature higher than 24°C, and cool locations are those with a mean temperature lower than 24°C)	Categorical (nominal)	
No_take_zone	Whether or not inside a No-take area	Categorical (nominal)	
Longitude	Longitude for the sampling site in decimals (Western: -180 to 0, Eastern: 0 to 180)	Continuous	Degrees
Latitude	Latitude for the sampling position in decimals (Southern: -90 to 0, Northern: 0 to 90)	Continuous	Degrees
ntransect	Number tag of the belt transect in the year sampled	Discrete	
transect_id	Transect identification following the combination: year + ntransect	Categorical	

		(nominal)	
Observer	Observer name	Categorical	
		(nominal)	
Sampling_method	Sampling method used (UVC)	Categorical	
		(nominal)	
Sampling_area_m2	Transect area of 20x2 (40m^2)	Continuous	Square meters
Day	The day when sampling occurred	Discrete	
Month	The month when sampling occurred	Discrete	
Year	The year when sampling occurred	Discrete	
Sampling_season	Season during which the sampling occurred. We considered the climatic classification of the southern hemisphere	Categorical (nominal)	
Depth	Depth at which the belt transect was performed. Expressed in meters	Continuous	Meter
Temperature	Water temperature recorded from dive computer, for each belt transect	Continuous	Degrees Celsius
Complexity	Substratum complexity visually estimated in each belt transect in three levels (Figure 3): 1=low complexity (Flat large boulders with very few crevices, which have low coverage and diversity of benthic organisms); 2=medium complexity (Rounded large boulders with some crevices and high coverage and diversity of benthic organisms); 3=high complexity (A mix of large and small boulders with many crevices and holes associated with high	Discrete	

	coverage and diversity of benthic organisms).		
Visibility	The horizontal visibility estimated in each belt transect and expressed in meters	Continuous	
Start_time	Exact starting time of the belt transect	Continuous	Hour
End_time	Exact finishing time of the belt transect	Continuous	Hour
Biotop	Biotope on the reef where the belt transect was performed. Slope (all rock reef that contain boulders, crevices, holds and benthic communities associate), rhodolith (bottom cover 100% rhodolite), interface (intercept between rocky reef and sand bottom), and sand (bottom cover more than 80% sand)	Categorical (nominal)	
Trophic_group_1	Trophic group based on diet data available in the literature (see Quimbayo et al. 2021b) Levels: hd = herbivore detritivore hm = macroalgivore im = mobile invertebrate feeder is = sessile invertebrate feeder pk = planktivore om = omnivore fc = fish & cephalopods	Categorical (nominal)	
Trophic_group_2	Trophic group based on local diet analyses Levels: herb_detri = herbivore detritivore macroalgivore = herbivore macroalgivore minv = mobile invertebrate feeder sinv = sessile invertebrate feeder plank = planktivore mcar = macrocarnivore (fish and Brachyura) omni = omnivore	Categorical (nominal)	

Family	Family name following the Eschmeyer's Catalog of Fishes	Categorical (nominal)	
Genus	Genus name following the Eschmeyer's Catalog of Fishes	Categorical (nominal)	
Species	Species name following the Eschmeyer's Catalog of Fishes	Categorical (nominal)	
Fishbase_code	Species code following the FishBase database	Discrete	
Species_code	Code defined by the combination of the first three letters from the genus column and the three letters from the species column	Categorical (nominal)	
Total length	Visually estimated fish total length	Continuous	Centimeters
Abundance	Absolute number of individuals	Discrete	
a	Length-weight coefficient: Weight = a x Length^b	Continuous	Grams/ Centimeters^b
b	Length-weight coefficient: Weight = a x Length^b	Continuous	

Missing value code: NA

CLASS V. SUPPLEMENTAL DESCRIPTORS

A. Data acquisition: See details in the section Class II, more specifically the Data Collection.

B. Quality assurance/quality control procedures: The name of all fish species observed in the UVCs over 15 years, were reviewed and updated according to the Eschmeyer's Catalog of Fishes (Fricke et al. 2020). The fish trophic groups and species-specific length-weight conversion coefficients were extracted from Quimbayo et al. (2021b).

C. Computer programs and data processing algorithms

Data processing was performed in the R environment version 4.0.2 (R Core Team 2020) using the packages "dplyr" (Wickham et al. 2022), "ggplot2" (Wickham 2016), and "tidyr" (Wickham and Girlich 2022).

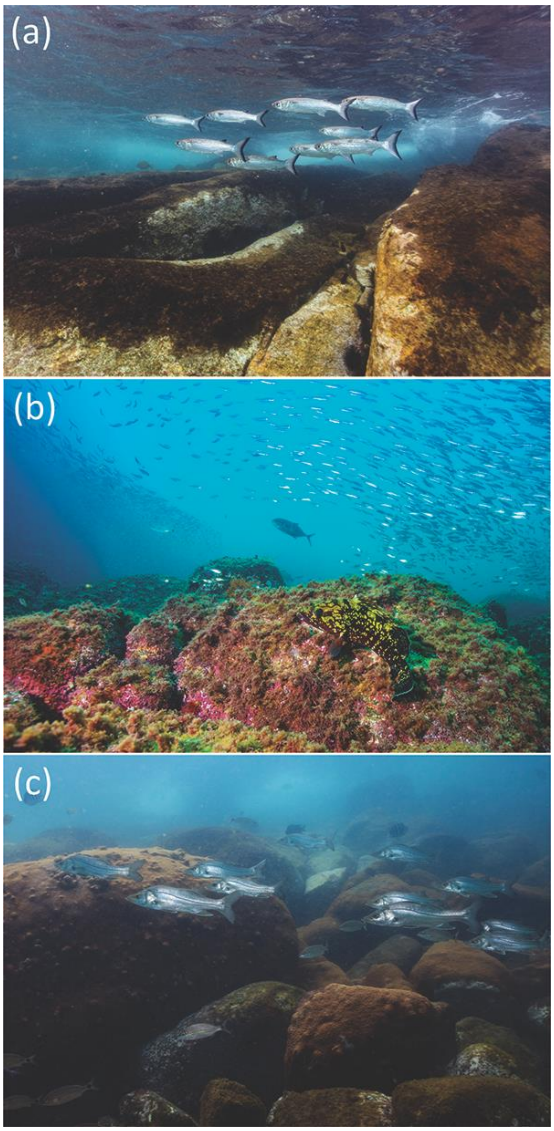

Figure 3. Types of substratum complexity estimated in each belt transect. a) Low complexity = 1 (Flat large boulders with very few crevices, which have low coverage and diversity of benthic organisms); b) medium complexity = 2 (Rounded large boulders with some crevices and high coverage and diversity of benthic organisms); and c) high complexity = 3 (A mix of large and small boulders with many crevices and holes associated with high coverage and diversity of benthic organisms). Images: J.P. Krajewski.

Acknowledgments

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