Stock assessment prioritization in the Azores: procedures, current challenges and recommendations

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To implement the Marine Strategy Framework Directive (MSFD) of the European Union (EU) in order to achieve the Sustainable Development Goals (SDGs) of the United Nations (UN) regarding the biological sustainability of marine fisheries, it is fundamental to apply a framework for prioritizing stocks. This process helps the regional managers to make the best use of data and resources for management. The present study describes and applies a standard framework for prioritization of stock assessment in the Azores. The current state of the selected stocks is identified and the main issues and gaps for assessment are presented and discussed. A total of 138 species were landed in the region during the period 2009-2019. Twenty-two (18 fishes, 2 molluscs and 2 crustaceans) were selected as priority stocks according to the Food and Agriculture Organization of the United Nations (FAO) and International Council for the Exploration of the Sea (ICES) criteria. Most of these showed a decreasing trend in their abundances. Only four stocks are currently assessed using data-limited approaches: *Pagellus bogaraveo*, *Aphanopus carbo*, *Raja clavata*, and *Trachurus picturatus*. No biological reference points are defined and stock and exploitation status relative to Maximum sustainable yield (MSY) are not assessed. The main issues identified were the lack of information regarding catches and population structure and validated analytical methods. Future studies should evaluate which methods for assessment may be suitable for each stock and identify what additional data are needed to improve the analyses.

Key words: Sustainable Development Goals; Marine Strategy Framework Directive; fishery resources, management; Azores archipelago

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INTRODUCTION

Member States of the European Union (EU) are committed, through the implementation of the Common Fisheries Policy (CFP), the Marine Strategy Framework Directive (MSFD) and the United Nations (UN) 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs), to keep exploitable marine stocks at biomass levels above those required to produce the maximum sustainable yield (MSY) as determined by their biological characteristics, at the latest by 2030.

Stock assessment involves the application of various statistical and mathematical calculations to estimate current and historical status and trends of a fish stock, including abundance, mortality and productivity (Hilborn & Walters 1992). Full assessments utilize information on life history, fishery-dependent data and stock abundance from

fishery-independent surveys. These data feed statistical models that fit available information to provide simplified representations of population and fishery dynamics (Cadrin & Dickey-Collas 2015). Therefore, if an assessment is based on weak, inaccurate or outdated data, it might provide guidance that leads to overfishing or reduces available fishing opportunities.

Resources for providing accurate and timely assessment for all stocks on a regional or national scale are insufficient. The International Council for the Exploration of the Sea (ICES) and the Food and Agriculture Organization of the United Nations (FAO) have discussed and proposed criteria for selecting exploitable stocks to be assessed according to environmental status descriptors and sustainable development indicators, namely the MSFD Descriptor 3 "Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock" and the SDG Indicator 14.4.1 "Proportion of fish stocks within biologically sustainable levels" (ICES 2011; FAO 2018).

Identification of stocks that are important for small-scale/local fisheries should be conducted at a regional level and EU Member States should add them to their national list of commercial stocks to be assessed and monitored (ICES 2011). In this context, this study aims to apply a standard framework for prioritization of stock assessment in the Portuguese Autonomous Region of the Azores (ICES Subdivision 27.10.a.2) aligned with the ICES and FAO recommendations, collecting information on each stock from available databases and identifying the current stock status. Case studies like this are of major importance for the purpose of clearly describing the process of stock prioritization adopted by the region to respond with international commitments, and for identifying gaps in data and knowledge.

MATERIAL AND METHODS

A taxonomic list of commercially exploited marine stocks in the Azores was constructed based on the official landings obtained from the Azores Auction Service - Lotaçor S.A. online database (https://lotacor.pt/pescado-descarregado) for the period 2009-2019. For each species, taxonomic classification (Fricke et al. 2020; WoRMS 2020), common name in Portuguese and English (Froese & Pauly 2019; Palomares & Pauly 2019), FAO stock code (http://www.fao.org/fishery/collection/asfis/en), and landings in weight (t) and commercial value (€) were provided. Habitat information (habitat zone and depth range) was extracted from FishBase (Froese & Pauly 2019), SeaLifeBase (Palomares & Pauly 2019) and Santos et al. (2019a, 2020). Technical sheets of commercial marine species from the Azores (Lotaçor 2019) were used to classify the main fishing gear associated with capture of each species. Fishing gear codification was based on FAO's International Standard Statistical Classification of Fishing Gear (ISSCFG) by adding a category for fishing without gear (i.e. HPD: hand picking and diving). Stocks were ranked based on landing value.

The selection of priority stocks for regional assessment was in line with the procedures proposed by FAO (FAO 2018) and ICES (ICES 2011). This stock selection was based on the ranking of landings by commercial value excluding stocks that migrate through, or occur in, more than one Exclusive Economic Zone (EEZ) (i.e. straddling stocks). These straddling stocks should be assessed under international agencies, as is the case of tuna and tuna-like species, which are assessed under the International Commission for the Conservation of Atlantic Tunas (ICCAT). When clearly defined stock units were not known, we used species and/or group as units in order to report the information at the regional level. The reference list includes stocks that represent 90% of total landing value during the period 2009-2019 and stocks of major importance in terms of ecosystem role and social/cultural considerations. The latter evaluation was performed based on available information and regional expert opinion (Fig. 1).

For each selected stock, information was provided on jurisdictional distribution (fishing areas; ICES 2020), stock category (ICES classification of stocks into six main categories based on the available knowledge; ICES 2019a) and assessment (if the species is assessed or not, biological reference points and current stock status), including MSFD capacity of the stock and D3C3 - population age Descriptor

3 (D3) criteria (D3C1 – pressure level of fishing - activity, D3C2 - reproductive

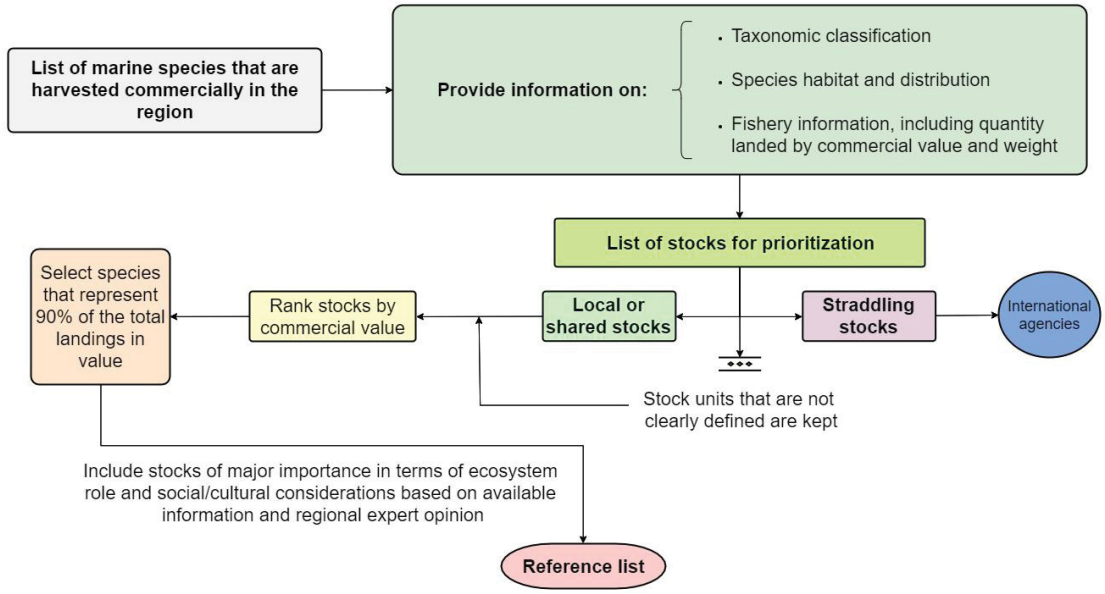

Fig. 1. Overview of the stock assessment prioritization process in the Azores.

and size distribution) of Good Environmental Status (GES) (EU 2017). When stock status could not be determined, trend analyses of the Azorean annual spring bottom longline survey-derived abundance indices for the recent period (2017-2019) were used to estimate the current stock size. The analyses were performed only for stocks which had data based on research surveys reliable for management advice (Santos et al. 2019b; Pinho et al. 2020). For species assessed under ICES working groups, the stock size information from ICES Advice sheet was used (ICES 2018a, b; 2019b, c).

RESULTS

Landings composition

A total of 138 species of algae, molluscs, crustaceans, echinoderms and fishes (teleost and elasmobranch species) have been landed annually in the Azores during the period 2009-2019 (Table 1 and Table 2). Total landings have varied between 6,203 t and 19,029 t and 25.9 M € and 39.6 M € per year considering the studied period (Fig. 2).

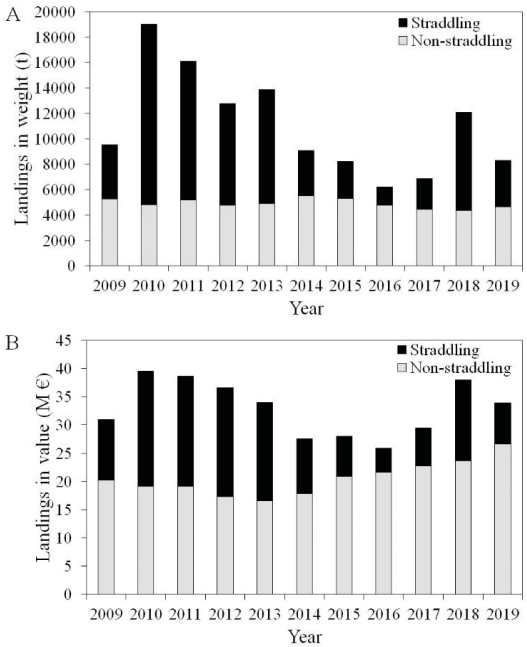

Fig. 2. Annual landings by (A) weight and (B) commercial value for all straddling and non-straddling stocks in the Azores during 2009-2019. Table 1 and Table 2 detail which species belong to each category.

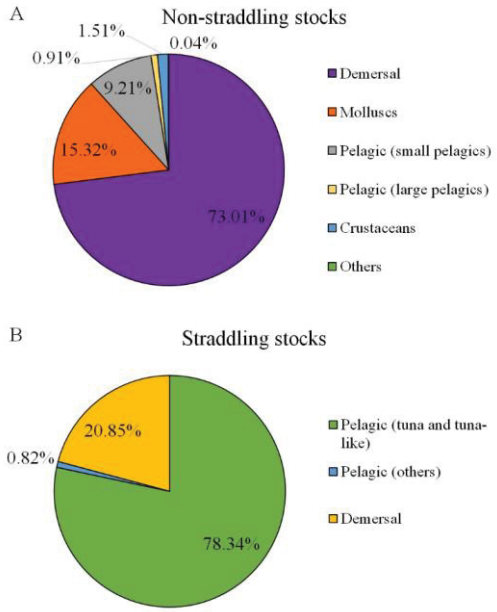

Fig. 3. Proportion of landings by commercial value for (A) non-straddling and (B) straddling stocks pooled by the main species categories in the Azores for the period 2009-2019. Table 1 and Table 2 detail which species belong to each category.

Non-straddling species represented on average 64% of these landings in value (50% in weight) and were mainly represented by demersal fishes (Fig. 3). The main gear used to capture these species were mechanized lines and pole-and-lines, and set longlines (Table 1). Straddling species represented on average 36% of the total landings in value. Overall, the main species caught were tuna and tuna-like species (Fig. 3) by the hand-operated pole-and-line fishery (Table 2).

Priority stocks

Twenty-two stocks were selected as priorities for local assessment and monitoring (Table 3). The reference list is composed of 18 fish species (*Pagellus bogaraveo* (Brünnich, 1768); *Trachurus picturatus* (Bowdich, 1825); *Helicolenus dactylopterus* (Delaroche, 1809); *Pagrus pagrus* (Linnaeus, 1758); *Phycis phycis* (Linnaeus, 1766); *Conger conger* (Linnaeus, 1758); *Beryx decadactylus* Cuvier, 1829; *B. splendens* Lowe, 1834; *Sparisoma cretense* (Linnaeus, 1758); *Lepidopus caudatus* (Euphrasen, 1788); *Scorpaena scrofa* Linnaeus, 1758; *Scomber colias* Gmelin, 1789; *Serranus atricauda* Günther, 1874; *Pontinus kuhlii* (Bowdich, 1825); *Seriola* spp. Cuvier, 1816; *Mora moro* (Risso, 1810); *Aphanopus carbo* Lowe, 1839; and *Raja clavata* Linnaeus, 1758), 2 molluscs (*Loligo forbesii* Steenstrup, 1856 and *Patella aspera* Röding, 1798) and 2 crustaceans (*Palinurus elephas* (Fabricius, 1787) and *Scyllarides latus* (Latreille, 1803)).

According to available scientific evidence, half of the selected stocks have their distribution inside the Azores EEZ (ICES Subdivision 27.10.a.2) but the other half has no clearly defined distribution (Table 3).

Assessment information and stock status

Twelve stocks were classified as ICES category 5, i.e. stocks for which only landings or a short series of catches are available, and 10 stocks were classified as ICES category 3, i.e. stocks for which survey-based assessments or exploratory assessments indicate trends (Table 3). Among all these, only four stocks are assessed using data-limited approaches: *P. bogaraveo*, *A. carbo*, and *R. clavata* (category 3) and *T. picturatus* (category 5). However, no biological reference points are defined and stock status relative to maximum sustainable yield (MSY) are not assessed for any of these stocks (Table 3).

Since the reference points for all selected stocks are not known, the MSFD D3 criteria of GES has not been possible to estimate (Table 3).

The current stock size was available for 11 stocks, and most of them (*P. bogaraveo*, *H. dactylopterus*, *P. pagrus*, *C. conger*, *B. splendens*, and *R. clavata*) showed decreasing abundance trend (Table 3).

DISCUSSION

Prioritizing stock assessment is important in order to provide a transparent and objective process for determining which are the appropriate assessment targets and how to best achieve them (Methot Jr. 2015). The reference list of priority stocks (Table 3) should remain unchanged for a number of years to allow for comparability and monitoring the effectiveness of the adopted management measures (FAO 2018). Therefore, it is essential to

Table 1. Checklist of the species officially landed in the ports of the Azores during the period 2009-2019 excluding straddling stocks. Main fishing gear: LHM - Mechanized lines and pole-and-lines, LLS - Set longlines, LHP - Handlines and hand-operated pole-and-lines, LLD - Drifting longlines, FPO – Pots, PS - Purse seines, GNS - Set gillnets (anchored), GEN - Gillnets and entangling nets (nei), LNP - Portable lift nets, LNB - Boat-operated lift nets, LN - Lift nets (nei), HPD - Hand picking and diving. MAL: mean annual landing. Species are listed in descending order of landed commercial value. Species representing 90% of the landings by value and species of major importance in terms of ecosystem role and social/cultural considerations are highlighted with a flag.

Category	Scientific name	Common name (EN)	Common name (PT)	FAO code	Habitat	Depth range (m)	Main fishing gear	MAL (t)	% Total* (t)	Ranking in Weight	MAL (M €)	% Total* (€)	Ranking in Value	
Teleost	*Pagellus bogaraveo* (Brünnich, 1768)	Blackspot seabream	Carapau / Goraz / Peixão	SBR	Demersal	150 - 700	LHM, LLS	631.54	12.47	2	6.40	31.13	1	
Mollusc	*Loligo forbesii* Steenstrup, 1856	Veined squid	Lula	SQF	Demersal	68 - 431	LHP	462.64	9.13	3	2.85	13.85	2	
Teleost	*Trachurus picturatus* (Bowdich, 1825)	Blue jack mackerel	Chicharro / Chicharro-do-alto	JAA	Pelagic	305 - 370	PS, LNB, LNP, LHM, LLS	845.82	16.70	1	1.37	6.65	3	
Teleost	*Helicolenus dactylopterus* (Delaroche, 1809)	Blackbelly rosefish	Boca-negra	BRF	Demersal	50 - 1100	LLS	245.39	4.85	6	1.25	6.07	4	
Teleost	*Pagrus pagrus* (Linnaeus, 1758)	Red porgy	Pargo / Parguete	RPG	Demersal	0 - 250	LHM, LLS	85.63	1.69	15	0.87	4.23	5	
Teleost	*Phycis phycis* (Linnaeus, 1766)	Forkbeard	Abrótea	FOR	Demersal	13 - 614	LHM, LLS	226.80	4.48	8	0.80	3.91	6	
Teleost	*Conger conger* (Linnaeus, 1758)	European conger	Congro / Safio	COE	Demersal	0 - 1171	LHM, LLS	407.56	8.05	4	0.72	3.52	7	
Teleost	*Beryx decadactylus* Cuvier, 1829	Alfonsino	Imperador	BXD	Demersal	110 - 1000	LHM, LLS	39.96	0.79	21	0.63	3.05	8	
Teleost	*Beryx splendens* Lowe, 1834	Splendid alfonsino	Alfonsim	BYS	Demersal	25 - 1300	LHM, LLS	145.36	2.87	11	0.51	2.46	9	
Teleost	*Sparisoma cretense* (Linnaeus, 1758)	Parrotfish	Veja	PRR	Demersal	20 - 50	GNS	209.48	4.14	10	0.46	2.24	10	
Teleost	*Lepidopus caudatus* (Euphrasen, 1788)	Silver scabbardfish	Peixe-espada-branco	SFS	Demersal	42 - 620	LLS	216.27	4.27	9	0.45	2.21	11	

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Teleost	*Scorpaena scrofa* Linnaeus, 1758	Red scorpionfish	Rocaz	SER	Demersal	20 - 500	LLS	28.03	0.55	25	0.39	1.88	12	
Teleost	*Scomber colias* Gmelin, 1789	Atlantic chub mackerel	Cavala	MAZ	Pelagic	0 - 300	LNB, LHM, LLS	306.73	6.06	5	0.36	1.76	13	
Teleost	*Serranus atricauda* Günther, 1874	Blacktail comber	Garoupa	WSA	Demersal	0 - 150	GNS, LHM, LLS	56.74	1.12	17	0.29	1.39	14	
Teleost	*Pontinus kuhlii* (Bowdich, 1825)	Offshore rockfish	Cântaro / Bagre	POI	Demersal	100 - 600	LHM, LLS	54.10	1.07	18	0.27	1.33	15	
Teleost	*Seriola* spp. Cuvier, 1816	Amberjacks nei	Írio / Lírio	AMX	Demersal	1 - 360	LHM, LLD	40.31	0.80	20	0.26	1.25	16	
Teleost	*Mora moro* (Risso, 1810)	Common mora	Melga / Escamuda-branca	RIB	Demersal	450 - 2500	LHM, LLS	92.52	1.83	14	0.25	1.21	17	
Crustacean	*Palinurus elephas* (Fabricius, 1787)	Common spiny lobster	Lagosta	SLO	Benthic	5 - 200	HPD, FPO	8.94	0.18	39	0.24	1.18	18	
Teleost	*Aphanopus carbo* Lowe, 1839	Black scabbardfish	Peixe-espada-preto	BSF	Demersal	200 - 2300	LLS	94.45	1.86	13	0.24	1.14	19	
Teleost	*Epinephelus marginatus* (Lowe, 1834)	Dusky grouper	Mero	GPD	Demersal	8 - 300	LHM, LLS	25.58	0.50	26	0.22	1.07	20	
Teleost	*Pseudocaranx dentex* (Bloch & Schneider, 1801)	White trevally	Encharéu	TRZ	Demersal	10 - 238	LHM, LLS	35.31	0.70	23	0.18	0.86	21	
Teleost†	*Sphyraena viridensis* Cuvier, 1829	Yellowmouth barracuda	Bicuda	YRU	Pelagic	0 - 100	LHM, LLS	66.74	1.32	16	0.16	0.80	22	
Mollusc	*Patella aspera* Röding, 1798	Azorean limpet	Lapa-brava	LQY	Benthic	0 - 10	HPD	21.20	0.42	29	0.13	0.65	23	
Teleost	*Zeus faber* Linnaeus, 1758	John dory	Peixe-galo	JOD	Demersal	5 - 400	LHM, LLS	12.21	0.24	33	0.13	0.64	24	
Teleost	*Diplodus sargus* (Linnaeus, 1758)	White seabream	Sargo / Sarguete	SWA	Demersal	0 - 50	LHM, GNS	39.60	0.78	22	0.13	0.63	25	
Elasmobranch	*Raja clavata* Linnaeus, 1758	Thornback ray	Raia	RJC	Demersal	5 - 1020	LHM, LLS	98.96	1.95	12	0.11	0.54	26	
Teleost	*Mullus surmuletus* Linnaeus, 1758	Surmullet	Salmonete	MUR	Demersal	5 - 409	GNS, FPO	11.66	0.23	36	0.11	0.53	27	

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Mollusc	*Octopus vulgaris* Cuvier, 1797	Common octopus	Polvo	OCC	Demersal	0 - 347	HPD	12.04	0.24	34	0.09	0.42	28
Teleost	*Muraena helena* Linnaeus, 1758	Mediterranean moray	Moreia-pintada	MMH	Demersal	1 - 801	LHM, LLS, FPO	49.35	0.97	19	0.07	0.34	29
Mollusc	*Patella* spp. Linnaeus, 1758	Limpets nei	Lapa	LPZ	Benthic	0 - 10	HPD	9.77	0.19	38	0.07	0.34	30
Teleost	*Sarda sarda* (Bloch, 1793)	Atlantic bonito	Serra	BON	Pelagic	80 - 200	LHM	14.46	0.29	32	0.07	0.32	31
Teleost	*Pagellus acarne* (Risso, 1827)	Axillary seabream	Besugo	SBA	Demersal	0 - 500	LHM, LLS	16.93	0.33	30	0.06	0.31	32
Teleost	*Chelon labrosus* (Risso, 1827)	Thicklip grey mullet	Tainha / Muja	MLR	Pelagic	0 - 50	GNS	24.61	0.49	27	0.05	0.24	33
Teleost	*Molva macrophthalma* (Rafinesque, 1810)	Spanish ling	Pescada-dos-açores	SLI	Demersal	30 - 1000	LLS	15.97	0.32	31	0.05	0.22	34
Teleost	*Sardina pilchardus* (Walbaum, 1792)	European pilchard	Sardinha / Petinga	PIL	Pelagic	10 - 100	PS	23.89	0.47	28	0.04	0.19	35
Crustacean	*Scyllarides latus* (Latreille, 1802)	Mediterranean slipper lobster	Cavaco	YLL	Benthic	4 - 100	HPD, FPO	1.37	0.03	62	0.04	0.17	36
Teleost	*Labrus bergylta* Ascanius, 1767	Ballan wrasse	Bodião-vermelho	USB	Demersal	1 - 50	GNS, LHM	10.65	0.21	37	0.03	0.17	37
Teleost	*Schedophilus ovalis* (Cuvier, 1833)	Imperial blackfish	Choupa	HDV	Demersal	70 - 700	LHM, LLS	3.38	0.07	52	0.03	0.13	38
Elasmobranch†	*Isurus oxyrinchus* Rafinesque, 1810	Shortfin mako	Rinquim/Anequim	SMA	Pelagic	0 - 750	LLS	8.22	0.16	40	0.02	0.10	39
Teleost	*Boops boops* (Linnaeus, 1758)	Bogue	Boga	BOG	Demersal	0 - 350	LN	30.24	0.60	24	0.02	0.08	40
Crustacean	*Megabalanus azoricus* (Pilsbry, 1916)	Azorean barnacle	Craca	?	Benthic	0 - 20	HPD	5.51	0.11	44	0.02	0.08	41
Teleost	*Epigonus telescopus* (Risso, 1810)	Black cardinal fish	Escamuda / Escamuda-preta	EPI	Demersal	75 -1200	LHM, LLS	4.98	0.10	46	0.01	0.07	42
Teleost	*Diplodus vulgaris* (Geoffroy Saint-Hilaire, 1817)	Common two-banded seabream	Safia	CTB	Demersal	0 - 160	LHM, GNS	6.71	0.13	41	0.01	0.07	43

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Teleost	Not idendified	Several fish	Diversos Peixes	?	?	?	?	5.51	0.11	43	0.01	0.06	44
Crustacean	*Cancer bellianus* Johnston, 1861	Toothed rock crab	Sapateira	KCB	Benthic	37 - 750	FPO	6.21	0.12	42	0.01	0.05	45
Mollusc	*Ruditapes decussatus* (Linnaeus, 1758)	Grooved carpet shell	Amêijoa	CTG	Benthic	0 - 1	HPD	0.55	0.01	74	0.01	0.05	46
Teleost	*Lophius piscatorius* Linnaeus, 1758	Angler (= Monk)	Tamboril	MON	Demersal	20 - 1000	LHM, LLS	4.16	0.08	49	0.01	0.04	47
Teleost	*Bodianus scrofa* (Valenciennes, 1839)	Barred hogfish	Peixe-cão / Gaio	IVD	Demersal	20 - 200	LHM, LLS	2.25	0.04	59	0.01	0.03	48
Teleost	*Mycteroperca fusca* (Lowe, 1838)	Island grouper	Badejo	MKF	Demersal	1 - 200	LHM, LLS	1.23	0.02	64	0.01	0.03	49
Teleost	*Ruvettus pretiosus* Cocco, 1833	Oilfish	Escolar / Chocolate / Peixe-chocolate	OIL	Demersal	100 - 800	LHM, LLS	2.66	0.05	57	0.01	0.03	50
Teleost	*Labrus mixtus* Linnaeus, 1758	Cuckoo wrasse	Peixe-rei-do-alto	USI	Demersal	2 - 200	LHM, LLS, GNS	1.70	0.03	60	0.00	0.02	51
Teleost	*Clupea harengus* Linnaeus, 1758	Atlantic herring	Arenque	HER	Pelagic	0 - 364	?	3.96	0.08	50	0.00	0.02	52
Teleost	*Sarpa salpa* (Linnaeus, 1758)	Salema	Salema	SLM	Demersal	5 - 70	GNS	4.48	0.09	48	0.00	0.02	53
Teleost	*Kyphosus incisor* (Cuvier, 1831)	Yellow sea chub	Patruça / Preguiçosa	KYI	Demersal	1 - 15	LHM, LLS, GNS	3.46	0.07	51	0.00	0.02	54
Elasmobranch	*Centrophorus lusitanicus* Barbosa du Bocage & de Brito Capello, 1864	Lowfin gulper shark	Tubarão-lusitano	CPL	Demersal	300 - 1400	LLS	2.29	0.05	58	0.00	0.02	55
Algae	*Sargassum* spp. Agardh, 1820	Sargassum	Sargaço	QWX	?	?	HDP	11.86	0.23	35	0.00	0.02	56
Teleost	*Trachinotus ovatus*	Pompano	Prombeta / Pombeta	POP	Pelagic	50 - 200	LHM, PS	5.22	0.10	45	0.00	0.02	57
Teleost	*Gymnothorax unicolor* (Delaroche, 1809)	Brown moray	Moreão	AGK	Demersal	0 - 20	LHM, LLS, FPO	2.96	0.06	55	0.00	0.01	58

Category	Scientific name	Common name (EN)	Common name (PT)	FAO code	Habitat	Depth range (m)	Main fishing gear	MAL (t)	% Total* (t)	Ranking in Weight	MAL (M €)	% Total* (€)	Ranking in Value
Crustacean	*Chaceon affinis* (Milne-Edwards & Bouvier, 1894)	Deep-sea red crab	Caranguejo-real	KEF	Benthic	130 - 2047	FPO	1.21	0.02	65	0.00	0.01	59
Crustacean	*Maja brachydactyla* Balss, 1922	Atlantic spinous spider crab	Santola	JDV	Benthic	0 - 80	FPO	0.77	0.02	68	0.00	0.01	60
Teleost	*Caranx crysos* (Mitchill, 1815)	Blue runner	Írio-de-serra	RUB	Pelagic	0 - 100	LHM, LLD	0.60	0.01	73	0.00	0.01	61
Echinoderm	*Holothuria* spp. Linnaeus, 1767	Sea Cucumber	Pepino-do-mar	WBX	Benthic	?	HPD	3.30	0.07	53	0.00	0.01	62
Echinoderm	*Sphaerechinus granularis* (Lamarck, 1816)	Violet sea urchin	Ouriço-do-mar	FKG	Benthic	2 - 130	HPD	0.75	0.01	69	0.00	0.01	63
Teleost	*Chromis limbata* (Valenciennes, 1833)	Azores chromis	Castanheta-amarela	HZL	Demersal	5 - 45	LHM, GNS	0.50	0.01	75	0.00	0.01	64
Algae	*Porphyra* spp. Agardh, 1824	Nori nei	Erva-patinha	FYS	Benthic	?	HPD	0.12	<0.01	88	0.00	0.01	65
Teleost	*Lepidorhombus whiffiagonis* (Walbaum, 1792)	Megrim	Areeiro	MEG	Demersal	100 - 700	LLS	0.19	<0.01	83	0.00	0.01	66
Teleost	*Zenopsis conchifer* (Lowe, 1852)	Silvery John dory	Galo-branco	JOS	Demersal	50 - 600	LHM, LLS	0.39	0.01	76	0.00	0.01	67
Teleost	*Serranus cabrilla* (Linnaeus, 1758)	Comber	Garoupa-do-alto	CBR	Demersal	5 - 500	LHM, LLS	0.63	0.01	71	0.00	0.01	68
Mollusc	*Hexaplex trunculus* (Linnaeus, 1758)	Banded dye-murex	Búzio	FNT	Benthic	1 - 100	HPD, FPO	0.75	0.01	70	0.00	0.01	69
Mollusc	*Patella candei* d'Orbigny, 1839	Limpet	Lapa-mansa	?	Benthic	0 - 3	HPD	0.12	<0.01	87	0.00	0.01	70
Teleost	*Chelidonichthys cuculus* (Linnaeus, 1758)	Red gurnard	Cabra / Ruivo	GUR	Demersal	15 - 400	LLS	1.26	0.02	63	0.00	<0.01	71
Elasmobranch	*Dalatias licha (Bonnaterre, 1788)*	Kitefin shark	Gata-lixa	SCK	Demersal	37 - 1800	LHM, LLS	2.72	0.05	56	0.00	<0.01	72
Teleost	*Polymixia nobilis* Lowe, 1836	Stout beardfish	Salmonete-do-alto	PXV	Demersal	100 -770	LHM, LLS	0.14	<0.01	85	0.00	<0.01	73
Teleost	*Brama brama* (Bonnaterre, 1788)	Atlantic pomfret	Xaputa	POA	Pelagic	0 - 1000	LHM, LLS	0.31	0.01	79	0.00	<0.01	74
Teleost	*Centracanthus cirrus* Rafinesque, 1810	Curled picarel	Boqueirão	EHI	Demersal	0 - 464	LLS, GNS	0.82	0.02	67	0.00	<0.01	75

Category	Scientific name	Common name (EN)	Common name (PT)	FAO code	Habitat	Depth range (m)	Main fishing gear	MAL (t)	% Total* (t)	Ranking in Weight	MAL (M €)	% Total* (€)	Ranking in Value
Teleost	*Thalassoma pavo* (Linnaeus, 1758)	Ornate wrasse	Rainha	TMP	Demersal	1 - 150	LHM, GNS	0.32	0.01	78	0.00	<0.01	76
Algae	*Pterocladiella capillacea* (S.G.Gmelin) Santelices & Hommersand, 1997	Spanish agar	Agar	OKQ	Benthic	0 - 15	HPD	230.73	4.56	7	0.00	<0.01	77
Teleost	*Muraena augusti* (Kaup, 1856)	Mediterranean moray	Moreia-preta	MWK	Demersal	0 - 250	LHM, LLS, FPO	1.68	0.03	61	0.00	<0.01	78
Elasmobranch	*Dasyatis pastinaca* (Linnaeus, 1758)	Common stingray	Ratão / Uge	JDP	Demersal	5 - 200	LHM, GNS	0.60	0.01	72	0.00	<0.01	79
Crustacean	*Plesionika* spp. Spence Bate, 1888	Plesionika shrimps nei	Camarão	XKX	Benthic	4 - 910	FPO	0.07	<0.01	90	0.00	<0.01	80
Elasmobranch	*Centrophorus granulosus* (Bloch & Schneider, 1801)	Gulper shark	Barroso / Xara-Branca	GUP	Demersal	50 - 1440	LHM, LLS	0.84	0.02	66	0.00	<0.01	81
Crustacean	*Grapsus grapsus* (Linnaeus, 1758)	Lightfoot crab	Caranguejo-fidalgo	GSQ	Benthic	0 - 5	HPD	0.04	<0.01	95	0.00	<0.01	82
Teleost	*Symphodus trutta* (Lowe, 1834)	Emerald wrasse	Bodião-verde / Bodião-azul	JCN	Demersal	5 - 15	LHM, GNS	0.19	<0.01	82	0.00	<0.01	83
Mollusc	*Charonia lampas* (Linnaeus, 1758)	Trumpet shell	Buzina	?	Benthic	0 - 200	HPD, FPO	0.17	<0.01	84	0.00	<0.01	84
Mollusc	*Haliotis tuberculata* Linnaeus, 1758	Tuberculate abalone	Lapa-burra / Abalone	HLT	Benthic	0 - 200	HPD	0.02	<0.01	102	0.00	<0.01	85
Teleost	*Bothus podas* (Delaroche, 1809)	Wide-eyed flounder	Carta	OUB	Demersal	15 - 400	LHM, LLS	0.03	<0.01	98	0.00	<0.01	86
Echinoderm	*Centrostephanus longispinus* (Philippi, 1845)	Needle spined urchin	Ouriço-castanho-de-espinhos-longos	?	Benthic	40 - 363	HPD	0.05	<0.01	92	0.00	<0.01	87
Echinoderm	*Arbacia lixula* (Linnaeus, 1758)	Black sea urchin	Ouriço-do-mar-negro	UKB	Benthic	0 - 50	HPD	0.02	<0.01	105	0.00	<0.01	88
Mollusc	*Callista chione* (Linnaeus, 1758)	Smooth callista	Ameijola	KLK	Benthic	10 - 180	HPD	0.03	<0.01	99	0.00	<0.01	89
Teleost	*Gaidropsaurus guttatus* (Collett, 1890)	Spotted rockling	Viúva	?	Demersal	5 - 10	LHM, LLS	0.04	<0.01	96	0.00	<0.01	90
Elasmobranch	*Deania profundorum* (Smith	Arrowhead dogfish	Sapata	SDU	Demersal	205 - 1800	LLS	0.38	0.01	77	0.00	<0.01	91

Category	Scientific name	Common name (EN)	Common name (PT)	FAO code	Habitat	Depth range (m)	Main fishing gear	MAL (t)	% Total* (t)	Ranking in Weight	MAL (M €)	% Total* (€)	Ranking in Value
	& Radcliffe, 1912)												
Teleost	*Gephyroberyx darwinii* (Johnson, 1866)	Darwin's slimehead	Peixe-vidro	GXW	Pelagic	9 - 1210	?	0.01	<0.01	110	0.00	<0.01	92
Teleost	*Similiparma lurida* (Cuvier, 1830)	Canary damsel	Castanheta-azul	AUU	Demersal	0 - 25	LHM, GNS	0.02	<0.01	103	0.00	<0.01	93
Teleost	*Promethichthys prometheus* (Cuvier, 1832)	Roudi escolar	Peixe-coelho	PRP	Demersal	80 - 800	LLS	0.05	<0.01	94	0.00	<0.01	94
Teleost	*Synodus saurus* (Linnaeus, 1758)	Atlantic lizardfish	Lagarto-da-costa	SDR	Demersal	1 - 400	LHM, GNS	0.24	<0.01	81	0.00	<0.01	95
Crustacean	*Dardanus calidus* (Risso, 1827)	Great red hermit crab	Caranguejo-eremita	?	Benthic	3 - 30	FPO	0.06	<0.01	91	0.00	<0.01	96
Teleost	*Macroramphosus scolopax* (Linnaeus, 1758)	Longspine snipefish	Trombeteiro	SNS	Demersal	25 - 600	PS, LNB	0.01	<0.01	108	0.00	<0.01	97
Teleost	*Pomadasys* spp. Lacepède, 1802	Grunts	Roncador	BGX	?	?	?	0.02	<0.01	101	0.00	<0.01	98
Elasmobranch	*Etmopterus* spp. Rafinesque, 1810	Lanternsharks nei	Lixinha-da-fundura	SHL	Demersal	100 - 1200	LHM, LLS	0.01	<0.01	109	0.00	<0.01	99
Teleost	*Belone belone* (Linnaeus, 1760)	Garfish	Peixe-Agulha	GAR	Pelagic	0 - 20	LLD, GNS	0.03	<0.01	97	0.00	<0.01	100
Teleost	*Apogon imberbis* (Linnaeus, 1758)	Cardinal fish	Folião	OGT	Demersal	10 - 200	LHM, GEN	0.02	<0.01	107	0.00	<0.01	101
Teleost	*Alepocephalus rostratus* Risso, 1820	Risso's smooth-head	Celindra	PHO	Demersal	300 - 2250	LLS	0.05	<0.01	93	0.00	<0.01	102
Teleost	*Enchelycore anatina* (Lowe, 1838)	Fangtooth moray	Víbora	AWM	Demersal	3 - 60	LHM, LLS	0.02	<0.01	104	0.00	<0.01	103
Teleost	*Anthias anthias* (Linnaeus, 1758)	Swallowtail seaperch	Canário-do-mar	AHN	Demersal	0 - 300	LHM, GNS	0.02	<0.01	100	0.00	<0.01	104
Elasmobranch	*Deania calcea* (Lowe, 1839)	Birdbeak dogfish	Sapata-áspera	DCA	Demersal	60 - 1490	LLS	0.14	<0.01	86	0.00	<0.01	105
Crustacean	*Pachygrapsus marmoratus* (Fabricius, 1787)	Marbled rock crab	Moura	YGM	Benthic	0 - 5	HPD	0.00	<0.01	111	0.00	<0.01	106
Teleost	*Coryphaenoides rupestris* Gunnerus, 1765	Roundnose grenadier	Peixe-rato	RNG	Demersal	180 - 2600	LLS	0.02	<0.01	106	0.00	<0.01	107

Category	Scientific name	Common name (EN)	Common name (PT)	FAO code	Habitat	Depth range (m)	Main fishing gear	MAL (t)	% Total* (t)	Ranking in Weight	MAL (M €)	% Total* (€)	Ranking in Value
Teleost	*Acantholabrus palloni* (Risso, 1810)	Scale-rayed wrasse	Bodião-vidrão	AKL	Demersal	30 - 500	?	0.00	<0.01	112	0.00	<0.01	108
Teleost	*Capros aper* (Linnaeus, 1758)	Boarfish	Pimpim	BOC	Demersal	40 - 700	GNS	0.07	<0.01	89	0.00	<0.01	109
Algae	*Asparagopsis* spp. Montagne, 1840	Harpoon seaweeds	-	ASR	Benthic	?	HPD	4.60	0.09	47	0.00	<0.01	110
Algae	*Gelidium spinosum* (S.G.Gmelin) P.C.Silva, 1996	Spiny straggle weed	-	?	Benthic	?	HPD	3.20	0.06	54	0.00	<0.01	111
Algae	*Halopteris scoparia* (Linnaeus) Sauvageau, 1904	Sea flax weed	-	?	Benthic	?	HPD	0.26	0.01	80	0.00	<0.01	112

Note: * Total landings excluding straddling stocks. † Classified as large pelagic fish.

Table 2. List of the species officially landed in the ports of the Azores during the period 2009-2019 considered as straddling stocks. Main fishing gear: LHM - Mechanized lines and pole-and-lines, LLS - Set longlines, LHP - Handlines and hand-operated pole-and-lines, LLD - Drifting longlines, GNS - Set gillnets (anchored). MAL: mean annual landing. Species are listed in descending order of landed commercial value.

Category	Scientific name	Common name (EN)	Common name (PT)	FAO code	Habitat	Depth range (m)	Main fishing gear	MAL (t)	MAL (M €)
Teleost†	*Thunnus obesus* (Lowe, 1839)	Bigeye tuna	Atum-patudo	BET	Pelagic	0 - 1500	LHP, LHM, LLD	2429.83	5.19
Teleost†	*Katsuwonus pelamis* (Linnaeus, 1758)	Skipjack tuna	Bonito / Gaiado	SKJ	Pelagic	0 - 260	LHP	2901.41	3.38
Teleost	*Polyprion americanus* (Bloch & Schneider, 1801)	Wreckfish	Cherne	WRF	Demersal	40 - 600	LLS	177.70	2.32
Teleost†	*Thunnus alalunga* (Bonnaterre, 1788)	Albacore	Atum-voador	ALB	Pelagic	0 - 600	LHP, LHM, LLD	331.70	0.68
Teleost†	*Xiphias gladius* Linnaeus, 1758	Swordfish	Espadarte / Agulhão	SWO	Pelagic	0 - 2878	LHM, LLS	91.19	0.43
Teleost	*Balistes capriscus* Gmelin, 1789	Grey triggerfish	Peixe-porco	TRG	Demersal	0 - 55	LHM, GNS	77.05	0.11
Elasmobranch	*Galeorhinus galeus* (Linnaeus, 1758)	Tope shark	Cação	GAG	Demersal	0 - 1100	LHM, LLS	52.30	0.10
Teleost	*Pomatomus saltatrix* (Linnaeus, 1766)	Bluefish	Anchova	BLU	Pelagic	0 - 200	LHM	17.89	0.05
Teleost†	*Thunnus albacares* (Bonnaterre, 1788)	Yellowfin tuna	Atum-Albacora / Galha-à-ré	YFT	Pelagic	1 - 250	LHP, LHM, LLD	21.99	0.05
Teleost	*Phycis blennoides* (Brünnich, 1768)	Greater forkbeard	Juliana / Abrótea-do-alto	GFB	Demersal	10 - 1200	LLS	11.96	0.04
Elasmobranch	*Prionace glauca* (Linnaeus, 1758)	Blue shark	Tintureira	BSH	Pelagic	1 - 1000	LHM, LLS	66.94	0.03
Teleost	*Coris julis* (Linnaeus, 1758)	Rainbow wrasse	Peixe-rei	COU	Demersal	0 - 120	LHM, GNS	3.23	0.02
Teleost	*Coryphaena hippurus* Linnaeus, 1758	Common dolphinfish	Dourado	DOL	Pelagic	0 - 85	LHP, LHM	6.71	0.02
Teleost†	*Thunnus thynnus* (Linnaeus, 1758)	Atlantic bluefin tuna	Atum-rabilho / Rabilo	BFT	Pelagic	0 - 985	LHP, LHM, LLD	0.76	0.01
Elasmobranch	*Sphyrna zygaena* (Linnaeus, 1758)	Smooth hammerhead	Cornuda / Tubarão-martelo	SPZ	Pelagic	0 - 200	LHM, LLS	0.85	0.00
Teleost†	*Makaira nigricans* Lacepède, 1802	Blue marlin	Espadim-azul	BUM	Pelagic	0 - 1000	LHM, LLD	0.23	0.00

Category	Scientific name	Common name (EN)	Common name (PT)	FAO code	Habitat	Depth range (m)	Main fishing gear	MAL (t)	MAL (M €)
Teleost†	*Auxis rochei* (Risso, 1810)	Bullet tuna	Judeu	BLT	Pelagic	0 - 200	LHM	0.13	0.00
Teleost†	*Acanthocybium solandri* (Cuvier, 1832)	Wahoo	Cavala-da-índia / Uau	WAH	Pelagic	0 - 20	LHM, LLS	0.08	0.00
Elasmobranch	*Centroscymnus owstonii* Garman, 1906	Shortnose velvet dogfish	Xara-preta-de-natura	CYY	Demersal	100 - 1500	LHM, LLS	0.80	0.00
Teleost†	*Kajikia albida* (Poey, 1860)	Atlantic white marlin	Espadim-branco	WHM	Pelagic	0 - 150	LHM, LLD	0.07	0.00
Elasmobranch	*Heptranchias perlo* (Bonnaterre, 1788)	Sharpnose sevengill shark	Bico-doce	HXT	Demersal	0 - 1000	LLS	0.20	0.00
Elasmobranch	*Hexanchus griseus* (Bonnaterre, 1788)	Bluntnose sixgill shark	Tubarão-albafar	SBL	Demersal	1 - 2500	LHM, LLS	0.22	0.00
Elasmobranch	*Alopias superciliosus* Lowe, 1841	Bigeye thresher	Tubarão-raposo-olhudo	BTH	Pelagic	0 - 730	LLS	0.07	0.00
Teleost	*Hoplostethus atlanticus* Collett, 1889	Orange roughy	Peixe-relógio	ORY	Pelagic	180 - 1809	LLS	0.00	0.00
Elasmobranch	*Centroscymnus crepidater* (Barbosa du Bocage & de Brito Capello, 1864)	Longnose velvet dogfish	Sapata-preta	CYP	Demersal	230 - 1500	LLS	0.08	0.00
Elasmobranch	*Centrophorus squamosus* (Bonnaterre, 1788)	Leafscale gulper shark	Lixa / Xara	GUQ	Demersal	145 - 2400	LHM, LLS	0.00	0.00

Note: † Classified as tuna and tuna-like species.

Table 3. Reference list of the species landed in the ports of the Azores during the period 2009-2019 that represent 90% of total landings in value excluding landings from straddling stocks which were selected as priority stocks. This list also includes species of major importance in terms of ecosystem role and social/cultural considerations. Current stock status for each stock is reported based on the ICES Advice and Marine Strategy Framework Directive (MSFD) Descriptor 3 criteria. ICES data category: 3 – stocks for which survey-based assessments or exploratory assessments indicate trends. 5 – stocks for which only landings or a short series of catches are available. NA: not available. ?: Unknown or undefined. ARQDAÇO: Azorean annual bottom longline survey.

Category	Scientific name	FAO code	Stock jurisdictional distribution	ICES			MSFD			Stock status	Stock size	Source
				Data category	Assessed species	Reference point	D3C1	D3C2	D3C3			
Teleost	*Pagellus bogaraveo* (Brünnich, 1768)	SBR	27.10*	3	Yes	?	?	?	?	?	↘	ICES (2019b)
Mollusc	*Loligo forbesii* Steenstrup, 1856	SQF	?	5	No	?	?	?	?	?	?	NA
Teleost	*Trachurus picturatus* (Bowdich, 1825)	JAA	27.10.a2	5	Yes	?	?	?	?	?	?	ICES (2018a)
Teleost	*Helicolenus dactylopterus* (Delaroche, 1809)	BRF	27.10.a2	3	No	?	?	?	?	?	↘	ARQDAÇO (2017-2019)
Teleost	*Pagrus pagrus* (Linnaeus, 1758)	RPG	27.10.a2	3	No	?	?	?	?	?	↘	ARQDAÇO (2017-2019)
Teleost	*Phycis phycis* (Linnaeus, 1766)	FOR	27.10.a2	3	No	?	?	?	?	?	↗	ARQDAÇO (2017-2019)
Teleost	*Conger conger* (Linnaeus, 1758)	COE	?	3	No	?	?	?	?	?	↘	ARQDAÇO (2017-2019)
Teleost	*Beryx decadactylus* Cuvier, 1829	BXD	27†	5	No‡	?	?	?	?	?	↗	ARQDAÇO (2017-2019)
Teleost	*Beryx splendens* Lowe, 1834	BYS	27.10.a2	3	No‡	?	?	?	?	?	↘	ARQDAÇO (2017-2019)
Teleost	*Sparisoma cretense* (Linnaeus, 1758)	PRR	?	5	No	?	?	?	?	?	?	NA
Teleost	*Lepidopus caudatus* (Euphrasen, 1788)	SFS	?	5	No	?	?	?	?	?	?	NA
Teleost	*Scorpaena scrofa* Linnaeus, 1758	SER	?	5	No	?	?	?	?	?	?	NA
Teleost	*Scomber colias* Gmelin, 1789	MAZ	?	5	No	?	?	?	?	?	?	NA
Teleost	*Serranus atricauda* Günther, 1874	WSA	27.10.a2	5	No	?	?	?	?	?	?	NA
Teleost	*Pontinus kuhlii* (Bowdich, 1825)	POI	27.10.a2	3	No	?	?	?	?	?	→	ARQDAÇO (2017-2019)
Teleost	*Seriola* spp. Cuvier, 1816	AMX	?	5	No	?	?	?	?	?	?	NA

Category	Scientific name	FAO code	Stock jurisdictional distribution	ICES			MSFD			Stock status	Stock size	Source
				Data category	Assessed species	Reference point	D3C1	D3C2	D3C3			
Teleost	*Mora moro* (Risso, 1810)	RIB	?	3	No	?	?	?	?	?	↗	ARQDAÇO (2017-2019)
Crustacean	*Palinurus elephas* (Fabricius, 1787)	SLO	?	5	No	?	?	?	?	?	?	NA
Teleost	*Aphanopus carbo* Lowe, 1839	BSF	27†	3	Yes	?	?	?	?	?	→	ICES (2018b)
Mollusc	*Patella aspera* Röding, 1798	LQY	27.10.a2	5	No	?	?	?	?	?	?	NA
Elasmobranch	*Raja clavata* Linnaeus, 1758	RJC	27.10.a2	3	Yes	?	?	?	?	?	↘	ICES (2019c)
Crustacean	*Scyllarides latus* (Latreille, 1803)	YLL	?	5	No	?	?	?	?	?	?	NA

Note: * Stock is considered a management unit for Subdivision 10.a.2 but ICES advice is currently provided for Subarea 10. † Stock unit is not clearly defined. ‡ Stocks assessed by ICES as a single group (*Beryx* spp.).

include representative stocks of different categories of marine resources which are exploited locally.

The reference list comprises the main species of small-pelagic and demersal fishes, crustaceans and molluscs targeted by the main fisheries that take place in the Azorean region. The demersal (handline and longline) fishery is one of the most important in terms of value, weight and number of vessels (Santos et al. 2019a). It is a small-scale fishery, whose vessels (mostly less than 12 m in length) operate throughout the year around the islands and in banks/seamounts targeting demersal/deep-water species such as blackspot seabream *Pagellus bogaraveo*, blackbelly rosefish *Helicolenus dactylopterus*, and alfonsinos *Beryx* spp. (Santos et al. 2019a). Part of this fleet occasionally changes its fishing activity for targeting the veined squid *Loligo forbesi* between November and February when the latter appears in large quantities in the region (cyclical resource; Martins 1982; Porteiro 1994). In the pelagic zone, a small coastal purse-seine fleet catches blue jack mackerel *Trachurus picturatus*, which is used for human consumption and as live bait in the tuna fishery. Other coastal fisheries use gillnets, pots and traps, or hand-picking to target coastal fishes (e.g. parrotfish *Sparisoma cretense,* blacktail comber *Serranus atricauda*), lobsters (e.g. common spiny lobster *Palinurus elephas* and Mediterranean slipper lobster *Scyllarides latus*), and limpets (e.g. Azorean limpet *Patella aspera*).

Most of these Azorean fishery resources are considered to be intensively exploited (ICES 2018c) and, just as the survey-derived stock sizes are decreasing (Table 3), commercial landings also exhibit a decreasing pattern for some species (Santos et al., 2019a, 2020). These results should be interpreted with caution as the observed trends may reflect a variation in the survey catch process (e.g. soak-time, gear saturation) or commercial fleet operational regime (e.g. changes in targeted species and fishing area as consequence of fisheries regulations such as introduction of restricted areas, total allowable catches and closed period) and not a variation of stock abundances caused by fishing exploitation (Santos et al. 2019a). Thus, it is through stock assessments that scientists attempt to understand the long-term dynamics of populations and their response to historical exploitation rates and to define biological reference points. Biological reference points provide guidance to decision makers in determining whether populations are too small, or fishing pressure is too high (Cooper 2006). However, for almost all priority stocks in the Azores region, the exploitation and stock status are unknown. Two main issues that may be related to these knowledge gaps are the deficiency of information regarding catches and population structure and lack of validated analytical methods for local stock assessment.

Fishery-independent data have been collected annually in the Azores over the past *c*. 25 years (Santos et al. 2019a). The Azorean spring bottom longline survey (ARQDAÇO) has as main objectives to: (i) provide annual fishery independent estimates of abundance and size composition for commercially important demersal fish species, (ii) collect information for biological studies on growth and reproduction, and (iii) obtain information for ecological studies, such as distribution and community structure (Santos et al. 2019b). This information has been used for stock assessment and advice for management of commercially exploited demersal fish species but has certain limitations. The survey is considered reliable for conducting management advice for 10 species (Santos et al. 2019b), although abundance indices better reflect populationabundance of species mainly distributed down to 800 m (i.e. *P. phycis, P. bogaraveo, P. pagrus, H. dactylopterus*, *R. clavata, B. splendens*, and *P. kuhlii*; Pinho et al. 2020). Nevertheless, the linear relationship between longline catch rate and density of these species (i.e. effect of factors such as soak time, gear saturation and competition for hooks on the longline catching process; Sigler 2000) should be assessed to reliably apply longline catch rates for management advice (Santos et al. 2019b).

Another issue is that some demersal fish stocks are not fully sampled throughout their distribution range and population dynamic aspects (e.g. reproductive and growth parameters) are not fully known. This issue is mostly related to the difficulty of defining local management units, given that most stocks have a spatial distribution that goes far beyond the Azores EEZ and detailed

data is only available for the Azorean sub-region (ICES Subdivision 10.a.2). *Beryx splendens* and *B. decadactylus*, for example, are currently assessed by the ICES working group on biology and assessment of deep-sea fisheries resources (WGDEEP) as a single stock comprising both species in the North Atlantic Ocean (ICES 2018c). Recent studies have shown, at least for *B. splendens*, that the Azorean stock can be considered a local management unit (Santos et al. 2019c). However, discrepancies in some life-history parameters indicate that its stock structure needs to be better studied.

Small pelagic fishes (e.g. blue jack mackerel *Trachurus picturatus*, Atlantic chub mackerel *Scomber colias*),veined squid *Loligo forbesii* and some coastal resources (e.g. common spiny lobster *Palinurus elephas,* Mediterranean slipper lobster *S. latus*, Azorean limpet *Patella aspera*) are not being currently assessed under directed and continued research surveys. For most of these resources only landings or a short series of catches are available and advice on that basis (when performed) needs to be applied on a precautionary basis (ICES 2012). Populations with insufficient data to conduct a conventional stock assessment are assessed using methods applicable to data-limited stocks (ICES 2012). Although a wide range (over 85) of data-limited methods have been described (Carruthers & Hordyk 2020), suitable methods to be used for specific stocks in the Azorean region need to be studied. This evaluation should be performed exploring available dataset and requires both simulation testing (e.g. Carruthers et al. 2014; Wiedenmann et al. 2019) and validation (e.g. Kokkalis et al. 2017; Sagarese et al. 2019). Besides that, analyses should be carried out on which additional data are needed to run better-performing methods and so inform future data collection priorities.

Stock assessments are often done using both fishery-independent (research surveys) and fishery-dependent data (Hilborn & Walters 1992; Cadima 2003). These two sources may provide different types of information with additional details. Fishery-dependent data (e.g. catch, effort, time, fishing area, gear, biological samples of target species landed for reproduction and growth studies) have been collected in the Azores EEZ since 1990 within the European Commission's Data Collection Framework (DCF; EU 2008). The structured interviews of captains of the local fleet have been carried out in the main ports of the Azores during landings. Differently from the research surveys, fishing data have been collected on a monthly basis, which allows a more robust assessment of the exploitable populations. On the other hand, degradation in data quality can occur when fishermen do not trust stock assessments and believe that these interviews (inquiries) are responsible for increasingly restricted quotas and reduced fishing opportunities. This degradation can cause serious errors in stock assessments, as a reduction in fishing pressure and Red-Listing of healthy and commercially important stocks (Helle et al. 2015). Therefore, even with legal requirements, reported fishing data cannot necessarily be assumed to be accurate (NRC 1998). Thus, in addition to application of techniques and diagnostics to standardize fishing data to minimize confounding effects (Maunder & Punt 2004), it is essential to promote perception and understanding of fishermen about the management mechanisms and procedures for stock assessment (Mauser et al. 2013), seeking to resolve conflicts and improve their participation and involvement in these processes.

The main contribution of this study is to help ensure effective and transparent decision-making related to stock assessment planning within the Azorean region. Once the reference list of priority stocks is defined, the next step should involve first-time assessments for previously not assessed stocks, updating existing assessments using established methods and data, and upgrading assessments using new types of data and methods. For this, it is necessary to catalogue and document available information for assessment on life history, fishery monitoring and stock abundance data for each of the selected stocks and propose new studies to collect them when necessary. All information should be validated, and adequate analytical methods for stock assessment should be defined based on the data quality. Exploratory analyses should be performed to improve the assessments. Some of these analyses involves, for example, standardization of fishery abundance indices and effort unit, analyses of the effects of competition,

gear saturation and soak time on the survey data to better understand the reliability of abundance indices for assessment, and analyses of the reproductive biology and spatial distribution of the species.

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