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Data Article

Dataset and species aggregation method applied to food-web models in the Northern Ionian Sea (Central Mediterranean Sea)

P. Ricci[a,b], L. Sion[a,b,*], F. Capezzuto[a,b], G. Cipriano[a,b], G. D'Onghia[a,b], S. Libralato[c], P. Maiorano[a,b], A. Tursi[a,b], R. Carlucci[a,b]

[a] *Department of Biology, University of Bari Aldo Moro, Via Orabona, 4, 70125 Bari, Italy*
[b] *CoNISMa, Piazzale Flaminio, 9, 00196 Roma, Italy*
[c] *National Institute of Oceanography and Applied Geophysics – OGS, Borgo Grotta Gigante 42/c, 34010 Sgonico, Trieste, Italy*

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ABSTRACT

The ecological roles of the species in the food web are studied through the Ecopath with Ecosim modelling approach. In this modelling approach, the food web is described by means of functional groups, each representing a species, a life stage of a species, or a group of species with similar trophic, ecological and physiological features. Links between the groups are formally described by a set of linear equations, informed with ecological and fishing data. Here, the data input collected to implement 3 Ecopath models in the Northern Ionian Sea (Central Mediterranean Sea) from 1995 to 2015 are reported. This dataset applied to study the ecological roles of the demersal Chondrichthyes in the study area could be useful to explore different fishing management scenarios. A large dataset of over 300 taxa is shown detailing the ecological inputs, such as Biomass (kg km^{-2}), Production and Consumption rates (y^{-1}), Diet information (weight in %), and fishing data represented by Landings and Discards (t km^{-2} y^{-1}). In particular, the fishery data described the catches of trawls, longlines, passive nets, other gears and purse seine. In

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* Corresponding author at: Department of Biology, University of Bari Aldo Moro, Via Orabona, 4, 70125 Bari, Italy.
E-mail address: letizia.sion@uniba.it (L. Sion).

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addition, a description of the aggregation method of the species is shown.

Specifications Table

Subject	Ecological Modelling
Specific subject area	Food-web modelling applied to marine biodiversity to explore the ecological traits and fishery interactions according Ecopath approach.
Type of data	Table
How data were acquired	Digitalization of data collected from scientific literature, online databases and technical reports.
Data format	Data are in Mixed (raw and pre-processed) format. Excel files with data have been uploaded.
Parameters for data collection	Data input were collected from multiple sources, such as experimental surveys, online database and grey and scientific literature. The selection criteria of data collection were based on the proximity of data source to the study area. Thus, local data were preferred to those from neighbouring Mediterranean areas. Similar approach was adopted for the temporal scale searching the higher overlap among the data time series.
Description of data collection	Data collection concerns the input parameters for each taxa considered in the food web model. The parameters are Biomass, Diet, Production and Consumption rates, Fishery Landings and Discard (detailed in the fishing gears selected in the model).
Data source location	Calabrian Ionian area from Punta Alice (Crotone) to Capo Spartivento (Reggio Calabria) within the Geographical Sub Area (GSA) 19, Northern Ionian Sea (Central Mediterranean Sea). Coordinates: Punta Alice, 39°24′04.1″N 17°09′20.57″E; Capo Spartivento, 37°55′05″N 16°03′07″E. Sample/data: Biomass and traits of taxa extracted by experimental surveys (MEDITS) Data extracted from FishBase https://www.fishbase.in/search.php Data: Diet, Production and Consumption rates Data extracted from OBIS-SEAMAP https://seamap.env.duke.edu/ Data: abundances of Marine mammals and Sea Turtles
Data accessibility	With the article
Related research article	P. Ricci, L. Sion, F. Capezzuto, G. Cipriano, G. D'Onghia, S. Libralato, P. Maiorano, A. Tursi, R. Carlucci, Modelling the trophic roles of the demersal Chondrichthyes in the Northern Ionian Sea (Central Mediterranean Sea). *Ecological Modelling* 444,109,468 (2021). https://doi.org/10.1016/j.ecolmodel.2021.109468.

Value of the Data

- These data represent a detailed collection of ecological information related to over 300 marine taxa distributed in the Northern Ionian Sea, an area poorly investigated at the ecosystem scale.
- Marine research institutions involved in the management and conservation of biodiversity can benefit from this information to develop quantitative approaches for the analysis of marine ecosystem impacts and management.
- This data collection is a basal dataset useful to build time- and space-explicit simulations required for producing scenarios of ecosystem change induced by environmental and anthropogenic pressures.
- The data could be used to explore the trophic role of the top-predators in other Mediterranean areas, in order to identify their ecological importance and develop a shared strategy of conservation of biodiversity and fishing management.

- The data could be used to investigate and compare the trophic structures of different Mediterranean areas, in order to deepen the ecological knowledge of the functioning of marine ecosystems.

1. Data Description

The data collection concerns the ecological traits of the demersal, benthic, pelagic and planktonic taxa as well as the fishing activities operating in the south-western Calabrian area of the Northern Ionian Sea (Central Mediterranean Sea) that covers an area of 3469 km^2 in a 10–800 m depth range. The information was used to implement 3 food web models by means the Ecopath with Ecosim approach [1], in order to investigate the ecological roles of the demersal Chondrichthyes and their interactions with fishing activities. The data collection covers a time span from 1995 to 2015 [2]. The taxa included in the food web models are aggregated in 57 functional groups (Table 1).

The data related to the ecological traits of the functional groups are represented by the Biomass, Production and Consumption rates and by the diets information (when available) of each taxa considered in the food web model (Appendix A, Table A1). Biomass data of demersal taxa were collected by the “MEDiterranean International Trawl Survey” (MEDITS) program [3] conducted in the Northern Ionian Sea (GSA 19) [4,5]. The fishing data were obtained from the Fisheries and Aquaculture Economic Research for the Ministry of Agricultural Food and Forestry Policies (MIPAAF), and consist of landing and discard data for each functional group in each investigated time periods (Tables 2 and 3). These data are detailed by 5 fishing gears: Trawl, Longline, Passive Nets, Other gears and Purse Seine.

The diet matrices (predator x preys) adopted in each investigated period are reported in Table A2÷A4 (see Appendix A, Excel files). The entire dataset has been realized using Excel 2010 Plus.

2. Experimental Design, Materials and Methods

The data collection were used to implement three different Ecopath models describing the condition of the ecosystem trophic structure in the Calabrian area during the periods 1995–1997, 2003–2005 and 2013–2015. Food webs are described by means of Functional Groups (FGs), each representing a species, a life stage of a species, or a group of species with similar trophic, ecological and physiological features. Links between FGs are formally described by a set of linear equations [6]. In the first one, the biological production of a functional group is equal to the sum of fishing mortality, predation mortality, net migration, biomass accumulation, and other unexplained mortality (Eq. (1)):

$$\left(\frac{P}{B}\right) B_i = Y_i + \sum_j B_j \left(\frac{Q}{B}\right) DC_{ji} + E_i + BA_i + \left(\frac{P}{B}\right) B_i \ (1 - EE_i) \tag{1}$$

where (P/B) is the production to biomass ratio for a certain functional group (i), B_i is the biomass of a group (i), Y_i the total fishery catch rate of group (i), $(Q/B)_j$ is the consumption to biomass ratio for each predator (j), DC_{ji} is the proportion of the group (i) in the diet of predator (j), E_i is the net migration rate (emigration–immigration), BA_i is the biomass accumulation rate for the group (i), EE_i is the ecotrophic efficiency, and $(1-EE_i)$ represents mortality other than predation and fishing.

In the second equation (see Eq. (2)), the consumption of a functional group is equal to the sum of production, respiration and unassimilated food.

$$\text{Consumption} = \text{production} + \text{respiration} + \text{unassimilated food} \tag{2}$$

The assumption of this modelling approach is that the production and consumption in the food web are mass-balanced, thus Ecopath uses and solves a system of linear equations (one for

Table 1
Functional groups (FGs) in the Ecopath Calabrian food web model. The mean Centre Of Gravity values (COG, a bathymetric position index expressed in metres) are reported for several FGs. For the species aggregated in the FGs see Table A1 in Appendix A.

N.	FG	COG (m)	COG Variance
1	Odontocetes	–	–
2	Fin whales	–	–
3	Turtles	–	–
4	Seabirds	–	–
5	Large pelagic fishes	–	–
6	Slope Sharks, Rays Chimeras benthic-feeders	552	101
7	Shelf-Break Elasmobranchs	171	28
8	Shelf Elasmobranchs	29	47
9	Slope Elasmobranchs fish-feeders	570	58
10	Kitefin shark	644	78
11	Velvet belly lanternshark	544	125
12	Blackmouth catshark	546	135
13	Demersal opportunistic fishes	597	154
14	Slope Demersal fishes generalist-feeders	204	179
15	Shelf-Break Demersal fishes generalist-feeders	64	47
16	Shelf-Break Demersal fishes fish-feeders	86	57
17	Slope Bathypelagic fishes fish-feeders	520	104
18	Slope Demersal fishes Decapods-feeders	388	121
19	Slope Fishes crustaceans-feeders	488	137
20	Shelf-Break Fishes crustaceans-feeders	229	100
21	Shelf Demersal fishes benthic crustaceans-feeders	77	40
22	Shelf Demersal fishes benthic invertebrates-feeders	65	40
23	Slope Fishes planktivorous	556	107
24	Shelf-Break Fishes planktivorous	90	60
25	Small pelagic fishes	48	29
26	Medium pelagic fishes	92	76
27	Macrourids	519	119
28	Myctophids	431	123
29	Red mullet	38	49
30	Hake	131	176
31	Anglers	232	196
32	Slope Squids	545	85
33	Shelf-Break Squids	121	85
34	Shelf Cephalopods	77	64
35	Slope Cephalopods	430	133
36	Shelf-Break Bobtail Squids	232	98
37	Benthopelagic Shrimps	446	93
38	Slope Decapods scavengers	433	104
39	Slope Crabs	295	87
40	Shelf Crabs	60	55
41	Deep-water Rose Shrimp	252	96
42	Red Giant shrimp	436	152
43	Red and Blue shrimp	545	126
44	Polychaetes	–	–
45	Macrobenthic invertebrates	–	–
46	Gelatinous plankton	–	–
47	Supbentcrustacenas	–	–
48	Macrozooplankton	–	–
49	Mesozooplankton	–	–
50	Microzooplankton	–	–
51	Bacterioplankton	–	–
52	Seagrasses and algae	–	–
53	Large phytoplankton	–	–
54	Small phytoplankton	–	–
55	Marine Snow	–	–
56	Discards	–	–
57	Benthic Detritus	–	–

Table 2
Landings (t km^{-2} y^{-1}) in 1995, 2005 and 2015 by the trawl (OTB), long line (LL), passive nets (GND), other gears (MIX) and purse seine (PS).

	OTB			LL			GND			MIX			PS		
FG	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015
3															
4															
5			0.0015	0.002		0.0027	0.0058			0.0073		0.01441	0.0010		0.0002
6															
7	0.0006														
8	0.0005		0.001	0.0001		0.0001	0.0005					0.0015			
9															
10															
11															
12															
13	0.0002	0.004	0.0032	0.004		0.0021			0.0003						
14	0.0204		0.005	0.0008	0.028	0.005	0.0000	0.0002	0.02						
15	0.0079	0.002	0.008			0.0017			0.0229						
16	0.1008	0.0460	0.01			0.0049	0.0000		0.0148						
17															
18	0.0002	0.001	0.0008			0.001	0.0008								
19															
20	0.03	0.026	0.0082	0.0060	0.0368	0.0052	0.0001	0.0011	0.0001	0.0008	0.0006	0.0002			
21	0.0205	0.026	0.0321			0.002	0.0443	0.0677	0.0311	0.0032	0.0111	0.0007	0.0043	0.0154	0.0077
22	0.0088	0.002	0.0057				0.0027	0.0004	0.042	0.0007	0.0019				
23															
24															
25	0.0063	0.002	0.0151				0.0004	0.0111	0.0004	0.0009	0.017	0.0073	0.0265	0.0322	0.0622
26	0.0516	0.0695	0.04	0.0002		0.0025	0.0008		0.04	0.0117	0.0076	0.0278	0.0059	0.0336	0.032
27															
28															
29	0.0273	0.026	0.0444				0.0007	0.025	0.0296	0.0002	0.001				
30	0.0243	0.0186	0.01	0.0019	0.0027	0.001	0.0005	0.0008	0.0071						
31	0.0057	0.0161	0.0031				0.0003	0.0001	0.001						

(*continued on next page*)

Table 2 (*continued*)

	OTB			LL			GND			MIX			PS		
FG	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015
32															
33	0.0040	0.002	0.0168				0.0000	0.0005	0.0115			0.0002			
34	0.0857	0.11	0.0224				0.0209	0.04	0.0343	0.0009	0.005	0.0066			
35															
36															
37	0.01														
38	0.0263	0.003	0.002												
39															
40	0.0691	0.008	0.0156				0.0010	0.0003	0.0115	0.0000	0.0000	0.001			
41	0.1734	0.2359	0.1096												
42	0.0435	0.0847	0.104												
43	0.0592	0.0286	0.033												
45															

Table 3
Discard (t km^{-2} y^{-1}) in 1995, 2005 and 2015 by the trawl (OTB), long line (LL), passive nets (GND), other gears (MIX) and purse seine (PS).

	OTB			LL			GND			MIX			PS		
FG	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015
3				0.0001	0.0001					0.0009		0.0002			
4										0.0000					
5				0.0000						0.0005					
6	0.0001	0.0002	0.0003	0.0000	0.0001										
7	0.0005	0.0001	0.0001	0.0000											
8	0.036	0.0016	0.0022	0.0006	0.0003		0.0009	0.0009		0.0004					
9	0.0011	0.0003	0.0001	0.0000											
10	0.0021	0.0025	0.0012												
11	0.0041	0.0059	0.0043												
12	0.0086	0.013	0.0156	0.0000											
13	0.0035	0.001	0.0024	0.0000	0.0001					0.0006		0.0002			
14	0.0024	0.0008	0.0011	0.0001	0.0001		0.0048	0.005	0.0002	0.0002		0.0001			
15	0.0129	0.0029	0.0031	0.0002	0.0001		0.0045	0.0042	0.0002						
16	0.0001	0.0073	0.0005	0.0000	0.0001		0.0003	0.0007							
17	0.0331	0.005	0.001												
18	0.0713	0.0161	0.0289	0.0000	0.0001										
19	0.0061	0.0006	0.0001												
20	0.0500	0.12	0.0923							0.0000					
21	0.0609	0.0401	0.01	0.0000	0.0001		0.0030	0.003	0.0001	0.0003		0.0001	0.0007		
22	0.0023	0.0023	0.0007	0.0003	0.0003	0.0001	0.0012	0.0012	0.0001						
23															
24	0.0439	0.0112	0.01				0.0047	0.0048	0.0001						
25	0.0063	0.005	0.0089				0.0016	0.0016	0.0001	0.0001			0.0013	0.0001	
26	0.0007	0.0075	0.008				0.0000			0.0006			0.0001	0.0000	0.001
27	0.0250	0.0201	0.01												
28	0.0003	0.003	0.0001												
29							0.0000								
30															

(*continued on next page*)

Table 3 (*continued*)

	OTB			LL			GND			MIX			PS		
FG	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015
31															
32	0.0040	0.003	0.0015												
33	0.0014	0.0018	0.0013										0.0001	0.0001	
34	0.0007	0.0006	0.0005												
35	0.0011	0.002	0.0016												
36	0.0000	0.0001	0.0001												
37	0.0415	0.0138	0.0144												
38	0.029	0.0079	0.0045							0.0000					
39							0.0006	0.0006							
40	0.0278	0.0107	0.013				0.003	0.0032	0.0001	0.0000		0.0001			
41															
42															
43															
45							0.0127	0.0132	0.0001	0.0007					

each functional group present in the system) estimating missing parameters [7]. Therefore, the input parameters (B, P/B, Q/B, and DC) are entered first, and then the mass-balance in the model is ensured.

The aggregation of the species in the FGs was performed by means of a Reiterative Aggregation Method based on the trophic similarity and the bathymetric distribution of species [8]. In particular, the bathymetric distribution indicator of the species biomass was the Centre Of Gravity (COG) [9], a synthetic measure that indicates the depth to which a species shows the highest biomass concentration with a value of variance indicating the displacement of biomass species between bathymetric layers (Table 1). It is expressed as:

$$\mathrm{COG} = (\mathrm{X} - 1 + 2\mathrm{X}_2 + 3\mathrm{X}_3 + 4\mathrm{X}_4 + \ldots + \mathrm{nX}_\mathrm{n}) / \sum X\_i$$

where X represents the value of the average biomass of the species in the layer *i*. In particular, 8 bathymetric layers of 100 m were identified between 10 and 800 m depth.

The quantitative information on diet preferences (in weight) was collected for 129 species out of a total of 276 species sampled in the benthopelagic and demersal assemblages of study areas, through the scientific published and grey literature of both local and nearby geographical areas. In particular, the data were obtained from the literature and the Fishbase dataset (www.fishbase.org) [10]. The analysis of diet data was carried out by implementing a bi-clustering on the matrix of prey-predator relationships, also using the vector of weighting factor [COG], implemented by means of a Microsoft Visual Basic routine. Species lacking in diet information were successively grouped according to the life-history traits and habitat preferences [5]. Biomass data (kg km^{-1}) of demersal and benthopelagic species were collected during MEDITS surveys carried out annually on the soft bottoms of the Northern Ionian Sea (GSA 19), in the depth range 10−800 m according to a random stratified sampling design [3]. The MEDITS data collection covers the time period 1995–2015. Biomass data of Odontocetes, Fin whale, and Loggerhead turtle were estimated by density data (N/km^{-2}) obtained from the OBIS SEAMAP [11] and by the mean individual weight used in other models [12,13]. Biomass data of Large Pelagics were estimated by the close areas of the Eastern Ionian Sea [14] and of the Strait of Sicily [15].

The Production rate (P/B) for each species was obtained from empirical equations used to estimate the total mortality (Z) or from other models. In particular, Z can be assumed equal to the production rate of a species [16]. The estimation of Z was carried out by the equations $Z = M + F$, where M is the natural mortality and F is the fishing mortality [17]. The Consumption rate (Q/B) was estimated by means empirical equations [6] or obtained from the local existing model or literature. The FG values were calculated as weighted averages of the values for the species belonging to the group, where the proportion of species biomass within the group was used as a weighting factor [18].

The diet information (DC expressed as weight percentage) were derived from several Mediterranean areas preferring the information close to the study area when available.

Data referring to annual commercial landings were provided from the Fisheries and Aquaculture Economic Research for the Ministry of Agricultural Food and Forestry Policies (MIPAAF) for the period 2006–2015 and they were processed in order to reconstruct disaggregated landings for trawls, long lines, nets, other gears, and purse seines in the period 1995–2005. Discards of the trawl fishery by species with commercial value (undersize individuals) were calculated using the discard rate estimated by [19]. The discard fraction for species or functional groups of no commercial value caught by the trawl was calculated on the basis of the proportion of commercial and no commercial discard in MEDITS data and local references [20]. Discard for others gears was obtained from the scientific literature relative to neighbouring Mediterranean areas [21] eventually correcting discard rate on the basis of the knowledge and experience of local experts.

Ethics Statement

Not applicable.

CRediT Author Statement

R. Carlucci, S. Libralato, P. Ricci, and **L. Sion:** Conceptualization, Supervision and Validation; **F. Capezzuto, R. Carlucci, G. Cipriano, G. D'Onghia, S.Libralato, P. Maiorano, P. Ricci, L. Sion,** and **A. Tursi:** Data curation, Methodology, Visualization, Writing-Original draft preparation and Writing-Review & Editing; **P. Ricci:** formal analysis.

Declaration of Competing Interest

The Authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.106964.

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