

# Supporting information

## **Historical changes of the Mediterranean Sea ecosystem: modelling the role and impact of primary productivity and fisheries changes over time**

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**S1. List of functional groups and fisheries and their abbreviations included in the Ecopath food web model and time series data sources used in the Ecosim dynamic modelling. Functional groups and fisheries categories are the same in each Marine Strategy Framework Directive (MSFD) area but their composition differ per area. This is not the case for highly migratory species (2. 'other cetaceans'; 5. 'sea turtles' and 6. 'large pelagic fish') that are common for all areas and they are allowed to move and feed in all the four sub-models <sup>1</sup>. NA, not available**

#	Functional groups/fisheries	Source of biomass time series	Source of catch time series
1	<b>Piscivorous cetaceans (PC):</b> <i>Delphinus delphis</i> , <i>Stenella coeruleoalba</i> , <i>Tursiops truncatus</i>	NA	
2	<b>Others cetaceans (OC):</b> <i>Balaenoptera physalus</i> , <i>Globicephala melas</i> , <i>Grampus griseus</i> , <i>Physeter macrocephalus</i> , <i>Ziphius cavirostris</i>	NA	
3	<b>Pinnipeds (PI):</b> <i>Monachus monachus</i>	2-13	
4	<b>Seabirds (SB):</b> <i>Calonectris diomedea</i> , <i>Hydrobates pelagicus melitensis</i> , <i>Larus michahellis</i> , <i>Larus audouinii</i> , <i>Larus genei</i> , <i>Larus melanocephalus</i> , <i>Phalacrocorax carbo</i> , <i>Puffinus yelkouan</i> , <i>Puffinus mauretanicus</i> , <i>Sterna nilotica</i> , <i>Sterna sandvicensis</i> , <i>Sterna caspia</i> , <i>Sterna hirundo</i> , <i>Sterna albifrons</i> , <i>Sterna bengalensis</i>	NA	
5	<b>Sea turtles (ST):</b> <i>Caretta caretta</i> , <i>Chelonia mydas</i>	14-26	
6	<b>Large Pelagics (LP):</b> <i>Coryphaena hippurus</i> , <i>Tetrapturus belone</i> , <i>Thunnus alalunga</i> , <i>Thunnus thynnus</i> , <i>Xiphias gladius</i>	27	FishSTAT (FAO); ICCAT
7	<b>Medium pelagics (MP):</b> <i>Acanthocybium solandri</i> , <i>Alepes djedaba</i> , <i>Auxis rochei rochei</i> , <i>Auxis thazard thazard</i> , <i>Belone belone</i> , <i>Dicentrarchus punctatus</i> , <i>Euthynnus alletteratus</i> , <i>Katsuwonus pelamis</i> , <i>Lichia amia</i> , <i>Liza aurata</i> , <i>Orcynopsis unicolor</i> , <i>Pomatomus saltatrix</i> , <i>Sarda sarda</i> , <i>Scomber japonicus</i> , <i>Scomber scombrus</i> , <i>Scomberesox saurus saurus</i> , <i>Scomberomorus commerson</i> , <i>Seriola dumerili</i> , <i>Sphyraena sphyraena</i>	NA	FishSTAT (FAO)
8	<b>European pilchard (EP):</b> <i>Sardina pilchardus</i>	28-44	FishSTAT (FAO)
9	<b>European anchovy /EA):</b> <i>Engraulis encrasicolus</i>	28,29,33-45	FishSTAT (FAO)
10	<b>Other small pelagics (SP):</b> <i>Aphia minuta</i> , <i>Atherina hepsetus</i> , <i>Etrumeus sadina</i> , <i>Sardinella aurita</i> , <i>Spicara maena</i> , <i>Spicara smaris</i> , <i>Sprattus sprattus</i> , <i>Trachurus trachurus</i> , <i>Trachurus mediterraneus</i>	NA	FishSTAT (FAO)
11	<b>Large demersals (LD):</b> <i>Conger conger</i> , <i>Epinephelus aeneus</i> , <i>Epinephelus caninus</i> , <i>Epinephelus marginatus</i> , <i>Lophius piscatorius</i> , <i>Molva dypterygia</i> , <i>Muraena helena</i> , <i>Polyprion americanus</i>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)
12	<b>European hake (HK):</b> <i>Merluccius merluccius</i>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)

13	<p><b>Medium demersals (MD):</b> <i>Argyrosomus regius, Balistes capriscus, Campogramma glaycos, Cepola macrophthalmia, Chelidonichthys lucerna, Chelon labrosus, Dactylopterus volitans, Dentex dentex, Dentex macrophthalmus, Dicentrarchus labrax, Epigonus telescopus, Eutrigla gurnardus, Labrus Merula, Lagocephalus sceleratus, Lepidopus caudatus, Lithognathus mormyrus, Lophius budegassa, Mugil cephalus, Naucrates ductor, Pagellus bogaraveo, Pagrus pagrus, Phycis blennoides, Platichthys flesus, Plectorhinchus mediterraneus, Sarpa salpa, Saurida undosquamis, Sciaena umbra, Scopthalmus maximus, Scopthalmus rhombus, Scorpaena scrofa, Solea solea, Sparisoma cretense, Sparus aurata, Spondyliosoma cantharus, Trisopterus luscus, Umbrina canariensis, Umbrina cirrosa, Zeus faber</i></p>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)
14	<p><b>Small demersals (SD):</b> <i>Atherina boyeri, Boops boops, Chelidonichthys cuculus, Dicologlossa cuneata, Diplodus annularis, Diplodus sargus sargus, Diplodus vulgaris, Gobius niger, Helicolenus dactylopterus, Lepidorhombus whiffiagonis, Merlangius merlangus, Mullus barbatus barbatus, Mullus surmuletus, Nemipterus randalli, Oblada melanura, Pagellus acarne, Pagellus erythrinus, Phycis phycis, Scorpaena porcus, Serranus cabrilla, Serranus scriba, Synodus saurus, Trachinus draco, Trisopterus minutes, Uranoscopus scaber, Xyrichtys novacula</i></p>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)
15	<p><b>Deep sea fish (DF):</b> <i>Alepocephalus rostratus, Argyropelecus hemigymnus, Bathypterois mediterraneus, Benthocometes robustus, Benthosema glaciale, Brama brama, Caelorhynchus caelorhynchus, Caelorhynchus mediterraneus, Cataetys laticeps, Ceratoscopelus maderensis, Chalinura mediterranea, Chauliodus sloani, Chlorophthalmus agassizii, Coryphaenoides guentheri, Cyclothone braueri, Diaphus metopoclampus, Epigonus constanciae, Epigonus denticulatus, Epigonus telescopus, Halosaurus ovenii, Helicolenus dactylopterus, Hoplostethus mediterraneus, Hygophum benoiti, Hymenocephalus italicus, Lampanyctus crocodilus, Lepidion lepidion, Lepidopus caudatus, Lepidorhombus whiffiagonis, Micromesistius poutassou, Mora moro, Nettastoma melanorum, Nezumia aequalis, Nezumia sclerorhynchus, Notacanthus bonapartei, Notolepis rissoi, Paralepis speciosa, Polyacanthonotus rissoanus, Stomias boa, Trachyrhynchus trachyrhynchus, Trachyscorpia cristulata echinata</i></p>	<sup>46</sup>	
16	<p><b>Sharks (SK):</b> <i>Alopias superciliosus, Alopias vulpinus, Carcharias taurus, Carcharodon carcharias, Centrophorus granulosus, Centrophorus granulosus, Centroscyminus coelolepis, Cetorhinus maximus, Chimaera monstrosa, Dalatias licha, Etmopterus spinax, Galeorhinus galeus, Galeus melastomus, Heptranchias perlo, Hexanchus griseus, Isurus oxyrinchus, Lamna nasus, Mustelus mustelus, Oxinotus centrina, Prionace glauca, Scyliorhinus canicula, Sharks nei, Somniosus rostratus, Squalus acanthias, Squalus blainville</i></p>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)

17	<b>Rays and skates (RS):</b> <i>Dasyatis pastinaca</i> , <i>Leucoraja naevus</i> , <i>Gymnura altavela</i> , <i>Mobula mobular</i> , <i>Myliobatis aquila</i> , <i>Rays and Skates nei</i> , <i>Raja asterias</i> , <i>Raja clavata</i> , <i>Raja montagui</i> , <i>Rhinobatos rhinobatos</i> , <i>Rostroraja alba</i>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)
18	<b>Benthopelagic cephalopods (BPC):</b> <i>Alloteuthis media</i> , <i>Ancistroteuthis lichtensteini</i> , <i>Illex coindetii</i> , <i>Loligo vulgaris</i> , <i>Marine molluscs nei</i> , <i>Ostrea edulis</i> , <i>Sepia officinalis</i> , <i>Todarodes sagittatus</i>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)
19	<b>Benthic cephalopods (BC):</b> <i>Eledone cirrhosa</i> , <i>Eledone moschata</i> , <i>Marine molluscs nei</i> , <i>Octopus vulgaris</i>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)
20	<b>Bivalves_gastropods (BG):</b> <i>Callista chione</i> , <i>Cerastoderma edule</i> , <i>Chamelea gallina</i> , <i>Crassostrea gigas</i> , <i>Donax vittatus</i> , <i>Littorina littorea</i> , <i>Marine molluscs nei</i> , <i>Mytilus galloprovincialis</i> , <i>Ostrea edulis</i> , <i>Pecten jacobaeus</i> , <i>Pecten maximus</i> , <i>Ruditapes decussatus</i> , <i>Venerupis pullastra</i> , <i>Venus verrucosa</i>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)
21	<b>Crustaceans (CR):</b> <i>Aristaeomorpha foliacea</i> , <i>Aristeus antennatus</i> , <i>Carcinus aestuarii</i> , <i>Crangon crangon</i> , <i>Erugosquilla massavensis</i> , <i>Homarus gammarus</i> , <i>Maja squinado</i> , <i>Marine crustaceans nei</i> , <i>Marsupenaeus japonicus</i> , <i>Melicerus kerathurus</i> , <i>Metapenaeus monoceros</i> , <i>Nephrops norvegicus</i> , <i>Palaemon serratus</i> , <i>Palinurus elephas</i> , <i>Palinurus mauritanicus</i> , <i>Parapenaeus longirostris</i> , <i>Plesionika martia</i> , <i>Portunus pelagicus</i> , <i>Scyllarides latus</i> , <i>Squilla mantis</i>	International Bottom Trawl Survey in the Mediterranean (Medit database)	FishSTAT (FAO)
22	<b>Jellyfish (JF):</b> <i>Aequorea forskalea</i> , <i>Aurelia aurita</i> , <i>Pelagia noctiluca</i> , <i>Chrysaora hysoscella</i> , <i>Cotylorhiza tuberculata</i> , <i>Liriope tetraphylla</i> , <i>Mnemiopsis leidyi</i> , <i>Pleurobrachia rhodopis</i> , <i>Physalia physalis</i> , <i>Rhizostoma pulmo</i>	NA	
23	<b>Benthos (BE):</b> nematodes, copepods (and naupliar stages), polychaetes, oligochaetes, isopods, cumaceans, amphipods, acarians, ostracods, oligochaetes, tanaidaceans, cnidarians, kinorhynchs, turbellarians, gastrotriches, nemerteans, bivalves, priapulids (including larvae), cladocerans, decapods (larvae) and echinoderms	<sup>46</sup>	
24	<b>Zooplankton (ZO):</b> meso and macro zooplankton (amphipods, copepods, cladocerans, euphasids, mysids, pteropods)	NA	
25	<b>Phytoplankton (PH):</b> diatoms, dinoflagellates	NA	
26	<b>Seagrass (SE):</b> <i>Cymodocea nodosa</i> , <i>Posidonia oceanica</i> , <i>Zoostera marina</i> , <i>Zoostera noltii</i>	NA	
27	<b>Detritus (DE)</b>		
28	<b>Discards (DI)</b>		
29	<b>Trawlers (TR)</b>		
30	<b>Purse seiners (PS)</b>		
31	<b>Long liners (LL)</b>		
32	<b>Artisanal fisheries (AR)</b>		
33	<b>Recreational fisheries (RC)</b>		

**S2. Input (light grey cells) and output (white cells) parameters of the Mediterranean marine ecosystem model for the 1950s period. Functional groups/species of the model are separated following the four Marine Strategy Framework Directive (MSFD) areas: Western (W); Adriatic (A); Ionian and Central Mediterranean (I); Aegean and Levantine (E).**

#	Group name	Trophic level	Habitat area (fraction)	Biomass in habitat area (t/km <sup>2</sup> )	Biomass (t/km <sup>2</sup> )	Production / biomass (/year)	Consumption / biomass (/year)	Ecotrophic efficiency	Production / consumption
1	Piscivores cetaceans W	4.19	0.33	0.01	0.00	0.08	25.84	0.97	0.00
2	Others cetaceans	3.53	1.00	0.07	0.07	0.05	8.29	0.07	0.01
3	Pinnipeds W	4.20	0.33	0.00	0.00	0.08	13.15	0.90	0.01
4	Seabirds W	3.09	0.33	0.00	0.00	5.33	73.09	0.01	0.07
5	Sea turtles	2.68	1.00	0.02	0.02	0.19	2.78	0.14	0.07
6	Large Pelagics	3.94	1.00	0.44	0.44	0.35	2.50	0.04	0.14
7	Medium pelagics W	3.28	0.33	0.56	0.18	0.75	4.94	0.85	0.15
8	European pilchard W	3.13	0.33	0.55	0.18	0.99	8.45	1.00	0.12
9	European anchovy W	3.25	0.33	0.67	0.22	0.87	7.95	0.90	0.11
10	Other small pelagics W	3.14	0.33	0.36	0.12	0.75	6.63	0.90	0.11
11	Large demersals W	3.68	0.33	0.24	0.08	0.87	3.06	0.87	0.28
12	European hake W	3.81	0.33	0.28	0.09	0.60	2.80	0.91	0.21
13	Medium demersals W	2.94	0.33	0.79	0.26	0.70	6.40	0.92	0.11
14	Small demersals W	3.03	0.33	0.38	0.13	1.57	6.87	0.98	0.23
15	Deep sea fish W	2.97	0.33	0.85	0.28	0.70	3.50	0.99	0.20
16	Sharks W	3.85	0.33	0.36	0.12	0.42	3.48	0.10	0.12
17	Rays and skates W	3.34	0.33	0.28	0.09	0.80	3.67	0.83	0.22
18	Benthopelagic cephalopods W	3.69	0.33	0.32	0.11	2.00	9.00	0.96	0.22
19	Benthic cephalopods W	3.44	0.33	0.56	0.18	2.10	7.00	0.86	0.30
20	Bivalves_gastropods W	2.01	0.33	1.00	0.33	1.30	5.00	0.94	0.26
21	Crustaceans W	2.79	0.33	0.99	0.33	3.50	12.00	0.97	0.29
22	Jellyfish W	3.08	0.33	0.33	0.11	13.87	50.48	0.42	0.27
23	Benthos W	2.02	0.33	16.22	5.39	2.50	9.04	0.33	0.28
24	Zooplankton W	2.25	0.33	7.76	2.58	30.60	102.00	0.81	0.30
25	Phytoplankton W	1.00	0.33	18.40	6.11	197.00	--	0.18	--
26	Seagrass W	1.00	0.33	16.70	5.55	5.94	--	0.16	--
27	Piscivores cetaceans A	4.16	0.05	0.00	0.00	0.08	25.84	0.90	0.00
28	Pinnipeds A	4.19	0.05	0.00	0.00	0.08	13.15	0.55	0.01
29	Seabirds A	3.03	0.05	0.00	0.00	4.61	69.34	0.16	0.07
30	Medium Pelagics A	3.26	0.05	0.88	0.05	0.92	6.76	0.89	0.14
31	European pilchard A	3.00	0.05	4.32	0.23	0.80	9.19	0.31	0.09
32	European anchovy A	3.11	0.05	2.60	0.14	0.85	11.02	0.75	0.08
33	Other small pelagics A	3.02	0.05	0.53	0.03	1.00	11.29	0.48	0.09

34	Large demersals A	3.63	0.05	0.20	0.01	0.90	5.14	0.72	0.18
35	European hake A	3.86	0.05	0.28	0.01	0.40	1.85	0.79	0.22
36	Medium demersals A	2.96	0.05	0.39	0.02	1.10	5.57	0.99	0.20
37	Small demersals A	2.96	0.05	0.32	0.02	1.50	8.02	0.97	0.19
38	Deep sea fish A	2.88	0.05	0.61	0.03	0.70	3.50	0.98	0.20
39	Sharks A	3.79	0.05	0.10	0.01	0.50	4.00	0.26	0.13
40	Rays and skates A	3.41	0.05	0.12	0.01	0.64	4.10	0.77	0.16
41	Benthopelagic cephalopods A	3.58	0.05	0.22	0.01	2.70	9.00	0.88	0.30
42	Benthic cephalopods A	3.45	0.05	0.33	0.02	2.10	7.00	0.85	0.30
43	Bivalves_gastropods A	2.05	0.05	0.95	0.05	1.30	5.00	0.99	0.26
44	Crustaceans A	2.76	0.05	0.80	0.04	3.50	12.00	0.99	0.29
45	Jellyfish A	3.14	0.05	2.27	0.12	14.60	50.48	0.94	0.29
46	Benthos A	2.02	0.05	68.24	3.64	1.31	6.71	0.18	0.20
47	Zooplankton A	2.11	0.05	5.79	0.31	37.85	126.17	0.97	0.30
48	Phytoplankton A	1.00	0.05	15.00	0.80	140.00	--	0.33	--
49	Seagrass A	1.00	0.05	2.68	0.14	4.02	--	0.50	--

50	Piscivores cetaceans I	4.13	0.30	0.00	0.00	0.08	25.84	0.77	0.00
51	Pinnipeds I	4.16	0.30	0.00	0.00	0.08	13.15	0.35	0.01
52	Seabirds I	3.11	0.30	0.00	0.00	4.60	105.43	0.07	0.04
53	Medium Pelagics I	3.20	0.30	0.38	0.11	0.70	7.70	0.96	0.09
54	European pilchard I	3.02	0.30	0.48	0.14	0.94	8.68	0.97	0.11
55	European anchovy I	3.14	0.30	0.53	0.16	0.91	12.30	0.86	0.07
56	Other small pelagics I	3.04	0.30	0.28	0.08	0.86	8.36	0.95	0.10
57	Large demersals I	3.66	0.30	0.20	0.06	0.65	2.85	0.93	0.23
58	European hake I	3.86	0.30	0.13	0.04	0.65	3.40	0.96	0.19
59	Medium demersals I	2.89	0.30	0.65	0.20	0.90	8.13	0.82	0.11
60	Small demersals I	2.93	0.30	0.34	0.10	1.10	6.38	0.98	0.17
61	Deep sea fish I	2.80	0.30	0.59	0.18	0.70	3.50	0.81	0.20
62	Sharks I	3.72	0.30	0.24	0.07	0.41	4.33	0.10	0.09
63	Rays and skates I	3.27	0.30	0.24	0.07	0.60	3.00	0.76	0.20
64	Benthopelagic cephalopods I	3.53	0.30	0.17	0.05	2.70	9.00	0.93	0.30
65	Benthic cephalopods I	3.42	0.30	0.33	0.10	2.10	7.00	0.95	0.30
66	Bivalves_gastropods I	2.01	0.30	0.70	0.21	1.30	5.00	0.95	0.26
67	Crustaceans I	2.63	0.30	0.63	0.19	3.45	12.00	0.97	0.29
68	Jellyfish I	3.10	0.30	0.17	0.05	11.10	35.90	0.87	0.31
69	Benthos I	2.01	0.30	11.74	3.52	2.75	22.00	0.29	0.13
70	Zooplankton I	2.14	0.30	3.63	1.09	38.44	128.12	0.57	0.30
71	Phytoplankton I	1.00	0.30	7.60	2.28	61.80	--	0.88	--
72	Seagrass I	1.00	0.30	16.00	4.79	2.59	--	0.64	--

73	Piscivores cetaceans E	4.12	0.31	0.00	0.00	0.08	25.84	0.76	0.00
74	Pinnipeds E	4.11	0.31	0.00	0.00	0.08	13.15	0.31	0.01
75	Seabirds E	3.12	0.31	0.00	0.00	4.78	111.61	0.00	0.04
76	Medium Pelagics E	3.23	0.31	0.61	0.19	0.80	4.79	0.92	0.17
77	European pilchard E	3.02	0.31	0.48	0.15	0.95	9.49	0.99	0.10

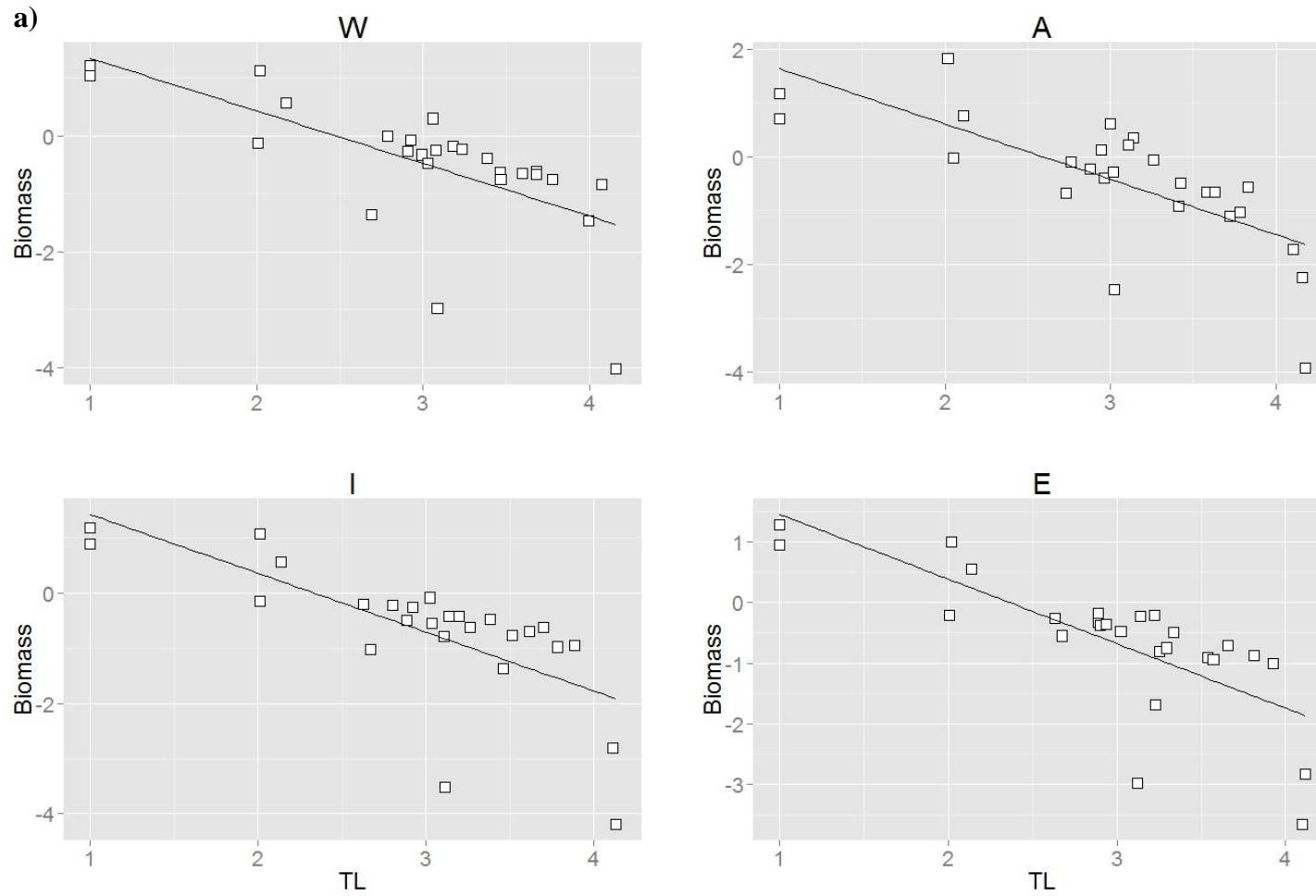
78	European anchovy E	3.14	0.31	0.87	0.27	0.90	5.20	0.92	0.17
79	Other small pelagics E	2.89	0.31	0.48	0.15	0.95	8.23	0.91	0.12
80	Large demersals E	3.57	0.31	0.18	0.06	0.70	4.35	0.94	0.16
81	European hake E	3.79	0.31	0.28	0.09	0.60	5.26	0.92	0.11
82	Medium demersals E	2.87	0.31	0.40	0.12	1.00	9.09	0.91	0.11
83	Small demersals E	2.95	0.31	0.36	0.11	1.10	7.64	0.99	0.14
84	Deep sea fish E	2.90	0.31	0.42	0.13	0.70	3.50	0.94	0.20
85	Skarks E	3.70	0.31	0.20	0.06	0.50	5.16	0.10	0.10
86	Rays and skates E	3.38	0.31	0.18	0.06	0.70	4.07	0.93	0.17
87	Benthopelagic cephalopods E	3.55	0.31	0.13	0.04	2.70	9.00	0.92	0.30
88	Benthic cephalopods E	3.36	0.31	0.32	0.10	2.10	7.00	0.96	0.30
89	Bivalves_gastropods E	2.01	0.31	0.62	0.19	1.30	5.00	0.98	0.26
90	Crustaceans E	2.64	0.31	0.56	0.17	3.50	12.00	0.98	0.29
91	Jellyfish E	3.25	0.31	0.16	0.05	4.84	15.00	0.75	0.32
92	Benthos E	2.02	0.31	9.83	3.10	2.64	16.13	0.32	0.16
93	Zooplankton E	2.14	0.31	3.59	1.13	38.80	129.33	0.55	0.30
94	Phytoplankton E	1.00	0.31	8.83	2.78	70.00	--	0.66	--
95	Seagrass E	1.00	0.31	15.00	4.72	2.69	--	0.40	--
96	Discards W	1.00	0.33	0.02	0.01	--	--	0.02	--
97	Detritus W	1.00	0.33	32.01	10.63	--	--	0.04	--
98	Discards A	1.00	0.05	0.01	0.00	--	--	0.11	--
99	Detritus A	1.00	0.05	19.73	1.05	--	--	0.25	--
100	Discards I	1.00	0.30	0.01	0.00	--	--	0.27	--
101	Detritus I	1.00	0.30	14.78	4.43	--	--	0.59	--
102	Discards E	1.00	0.31	0.01	0.00	--	--	0.13	--
103	Detritus E	1.00	0.31	14.74	4.64	--	--	0.29	--

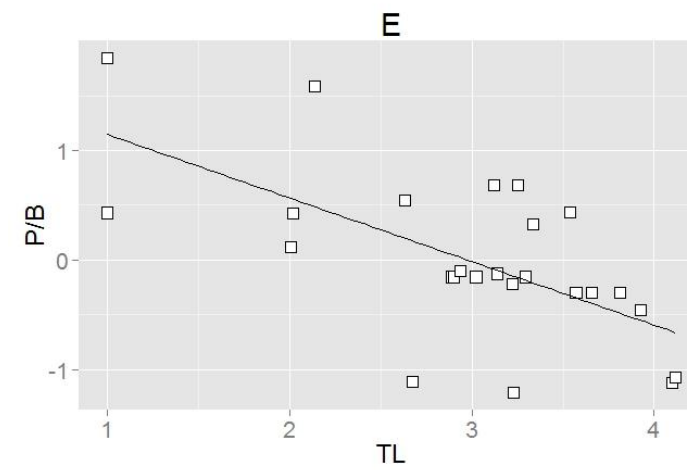
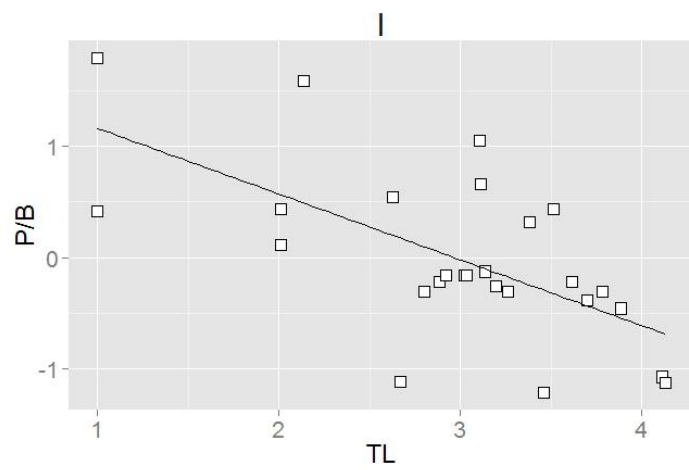
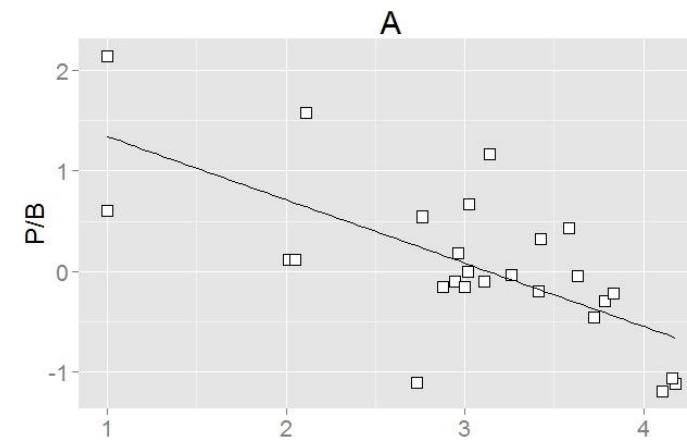
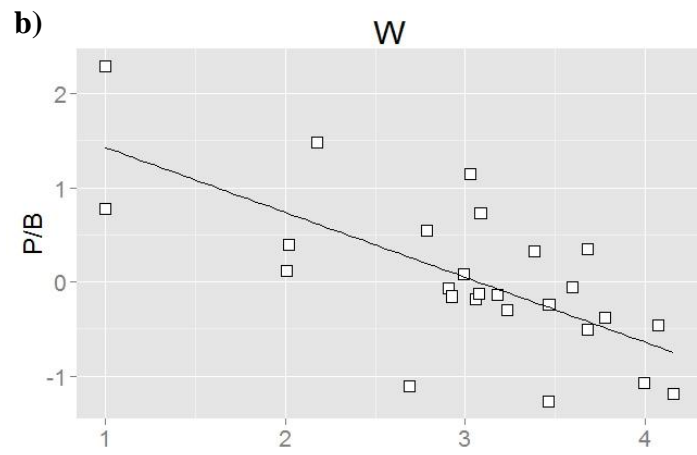
**S3. Diet composition matrix for the Mediterranean marine ecosystem model for the 1950s period. Prey groups are indicated by rows and predators by columns. Functional group codes are reported according to Table S2.**



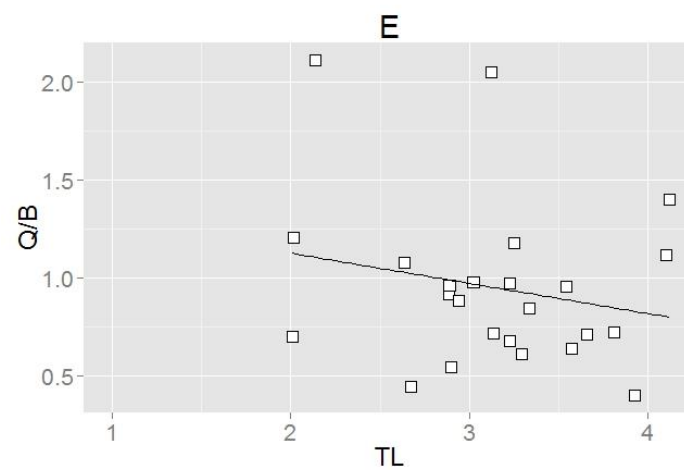
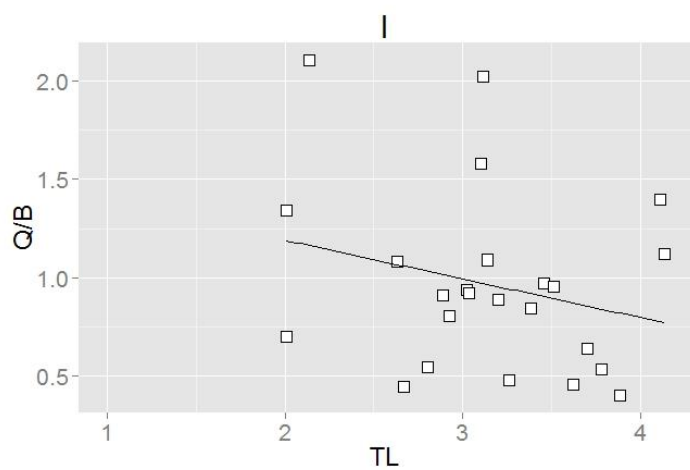
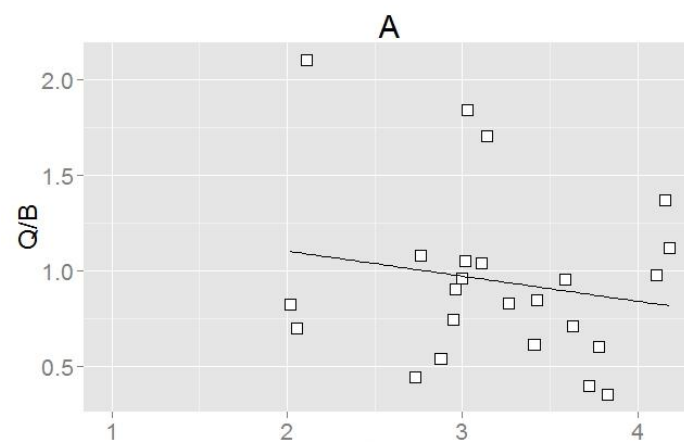
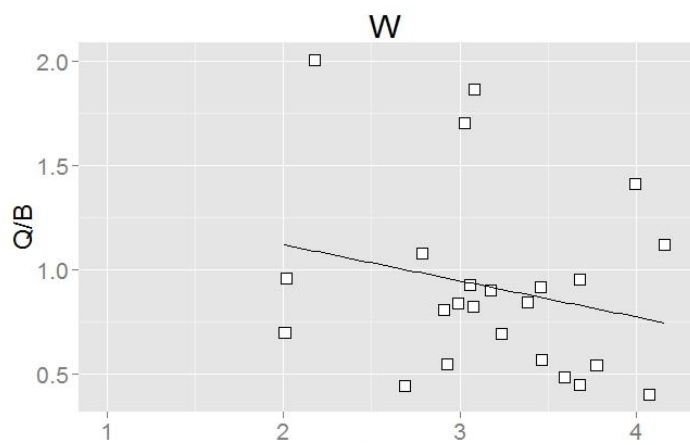


**S4. PREBAL for each Mediterranean sub-area (Western [W]; Adriatic [A]; Ionian [I]; Eastern and Levantine [E]) plotting (a) biomass estimates ( $t/km^2$ ), (b) production/biomass ratio (per year), and (c) consumption/biomass (per year) on a log scale vs trophic level, from lowest to highest trophic level, of each species/functional group.**

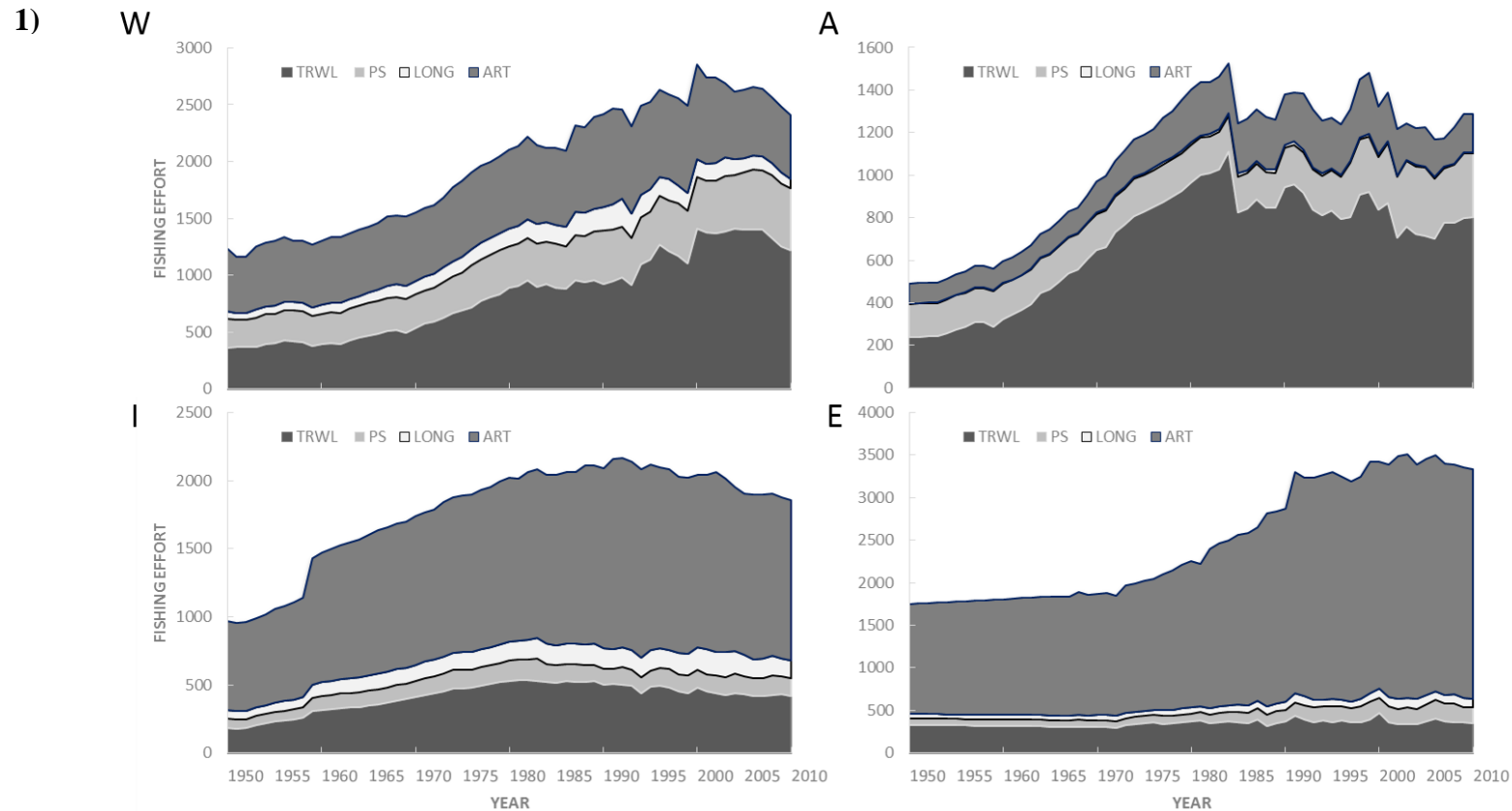




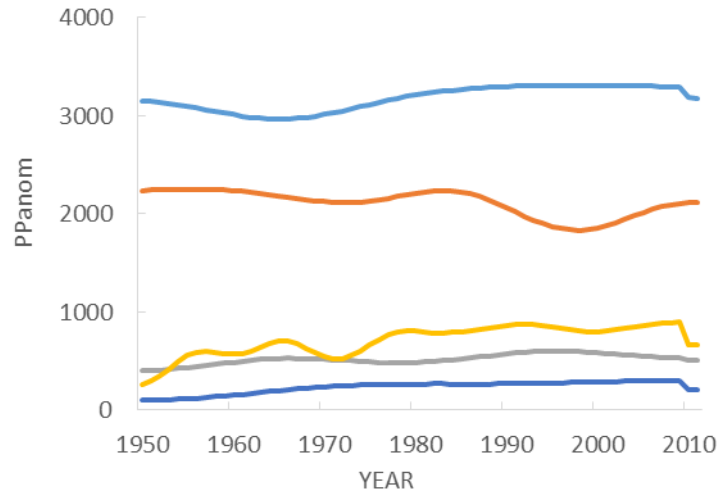
c)



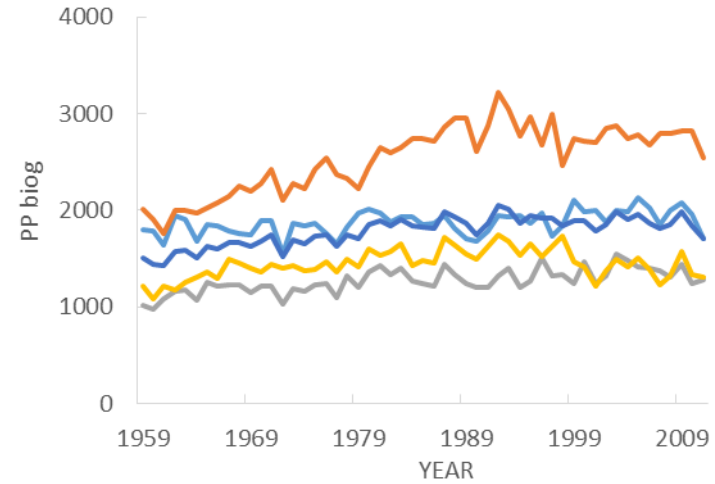
**S5. The main drivers used in the fitting procedure: 1) reconstructed fishing effort ( $\text{kW}\cdot\text{days}^{-1}$ ) for the main fishing fleets (trawlers: TRWL; purse seiners: PS; long liners: LONG; artisanals: ART) of the four Mediterranean sub-areas (Western: W; Adriatic: A; Ionian: I; Eastern and Levantine: E); 2a) primary production anomaly (PP anom;  $\text{t}\cdot\text{Km}^{-2}\cdot\text{year}^{-1}$ ) estimated by the model and 2b) primary production from the biogeochemical model (PPbiog;  $\text{t}\cdot\text{Km}^{-2}\cdot\text{year}^{-1}$ ) for the four Mediterranean sub-areas and the whole Mediterranean Sea.**



2a)



2b)

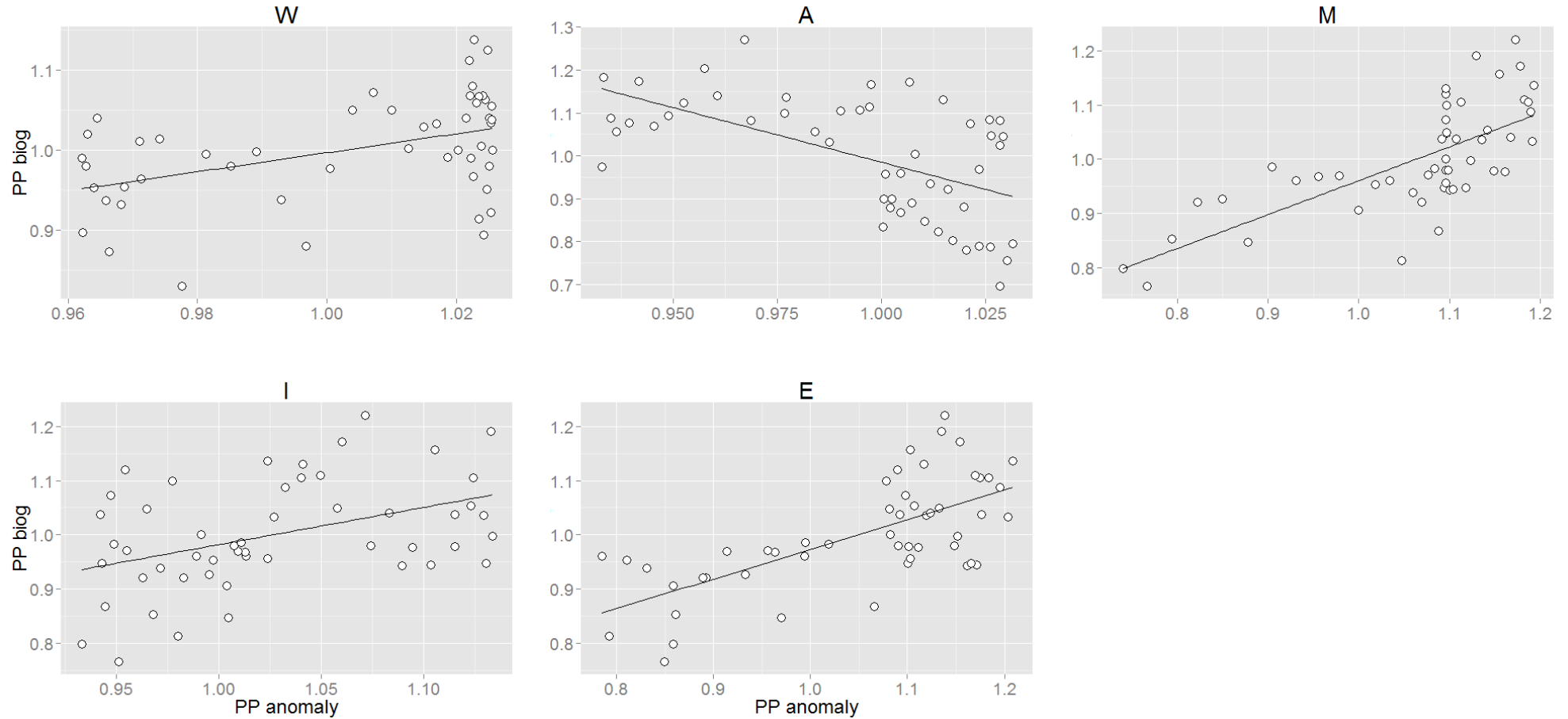


— W — A — I — E — M

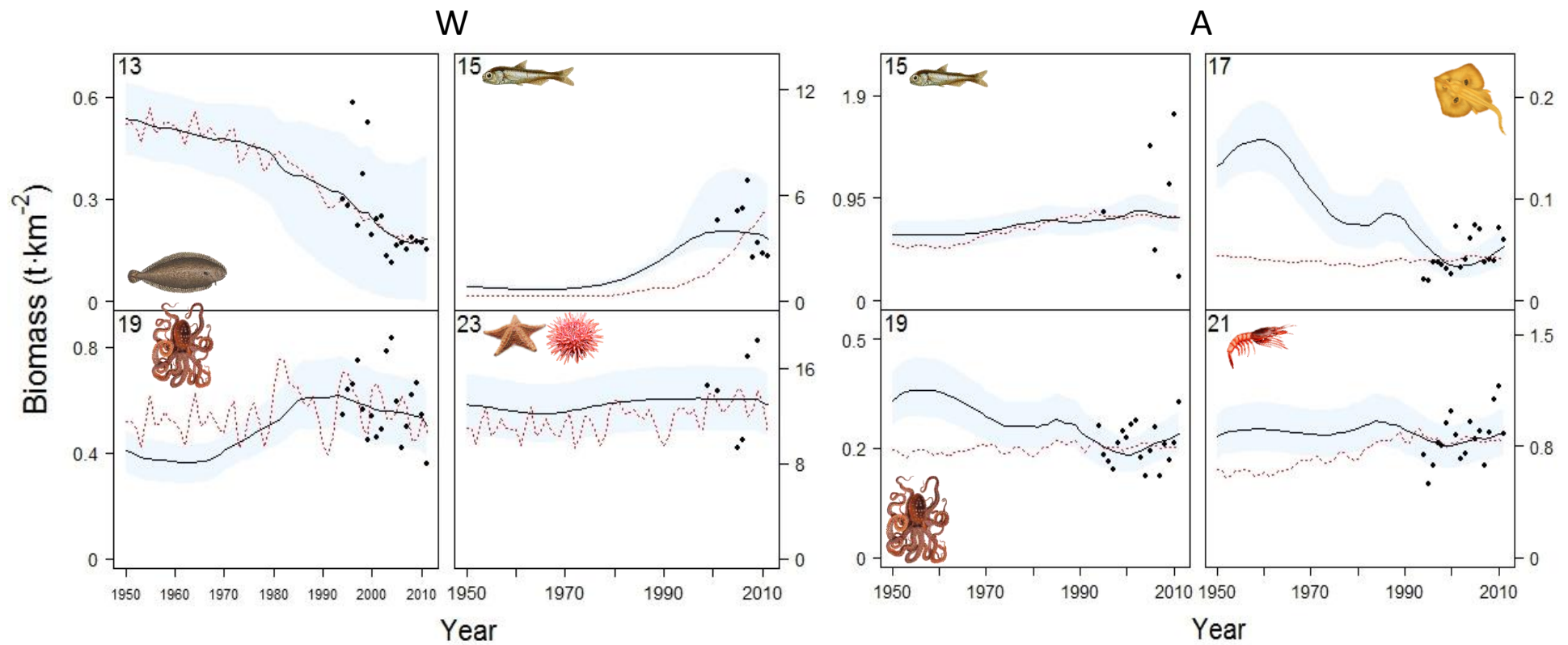
**S6. Technological coefficients of fishing vessels by gear type used in the analyses (Sources: <sup>47-49</sup>).**

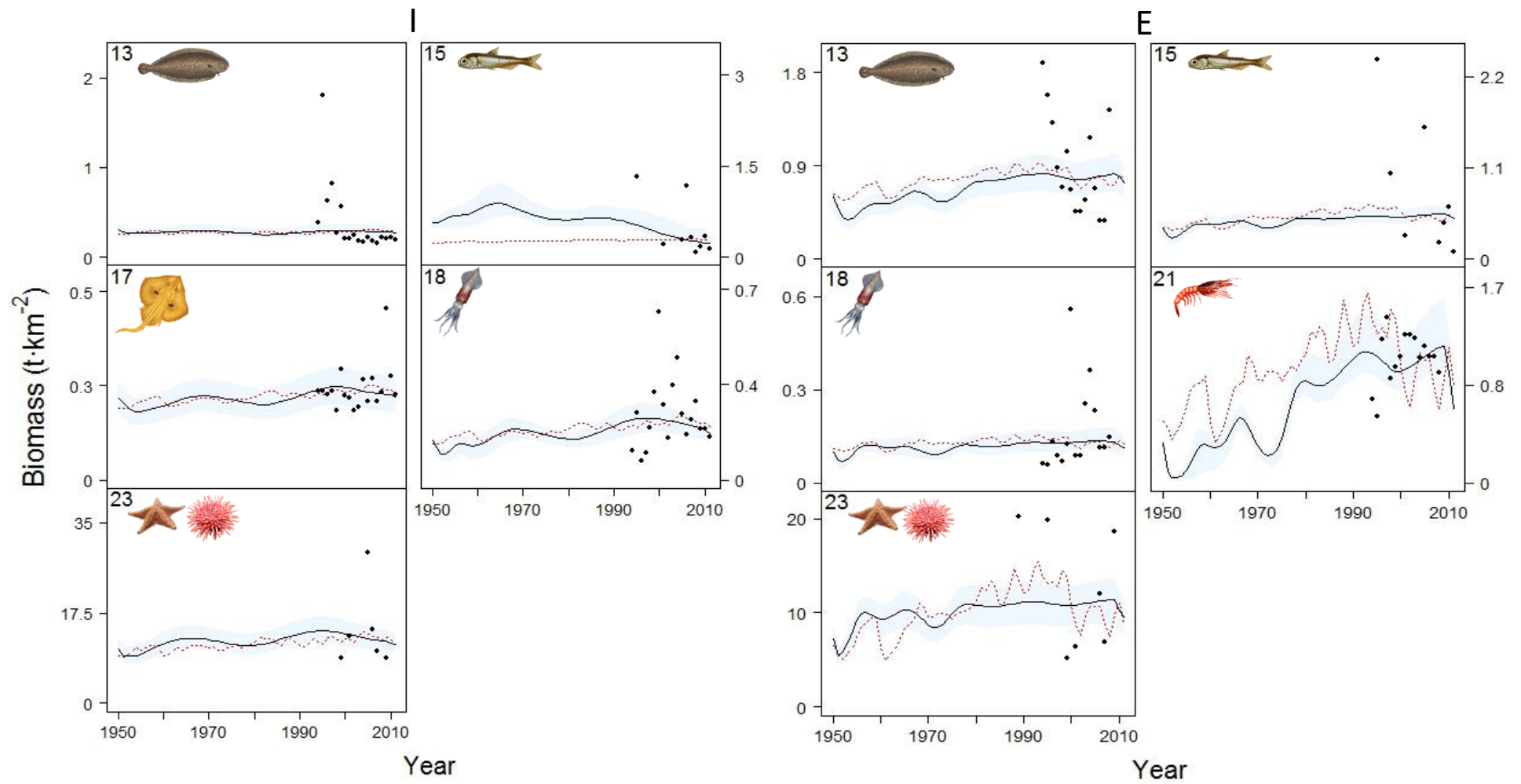
Vessel type	Technological coefficient		
	1950-1979	1980-1995	1996-2010
Trawlers	0.5	1	1.8
Purse seiners	0.5	1	1.8
Artisanal	0.5	1	1.3
Longliners	0.5	1	2.8

**S7. Graphical presentation of the Spearman correlation analysis. Scatter plots show, for the four sub-areas (Western: W; Adriatic: A; Ionian: I; Eastern and Levantine: E) and for the additional Mediterranean Sea as whole (Mediterranean: M), values of PP from the biogeochemical model (PP biog) versus PP anomaly. Both time series were divided by their mean to be able to compare the two trends.**



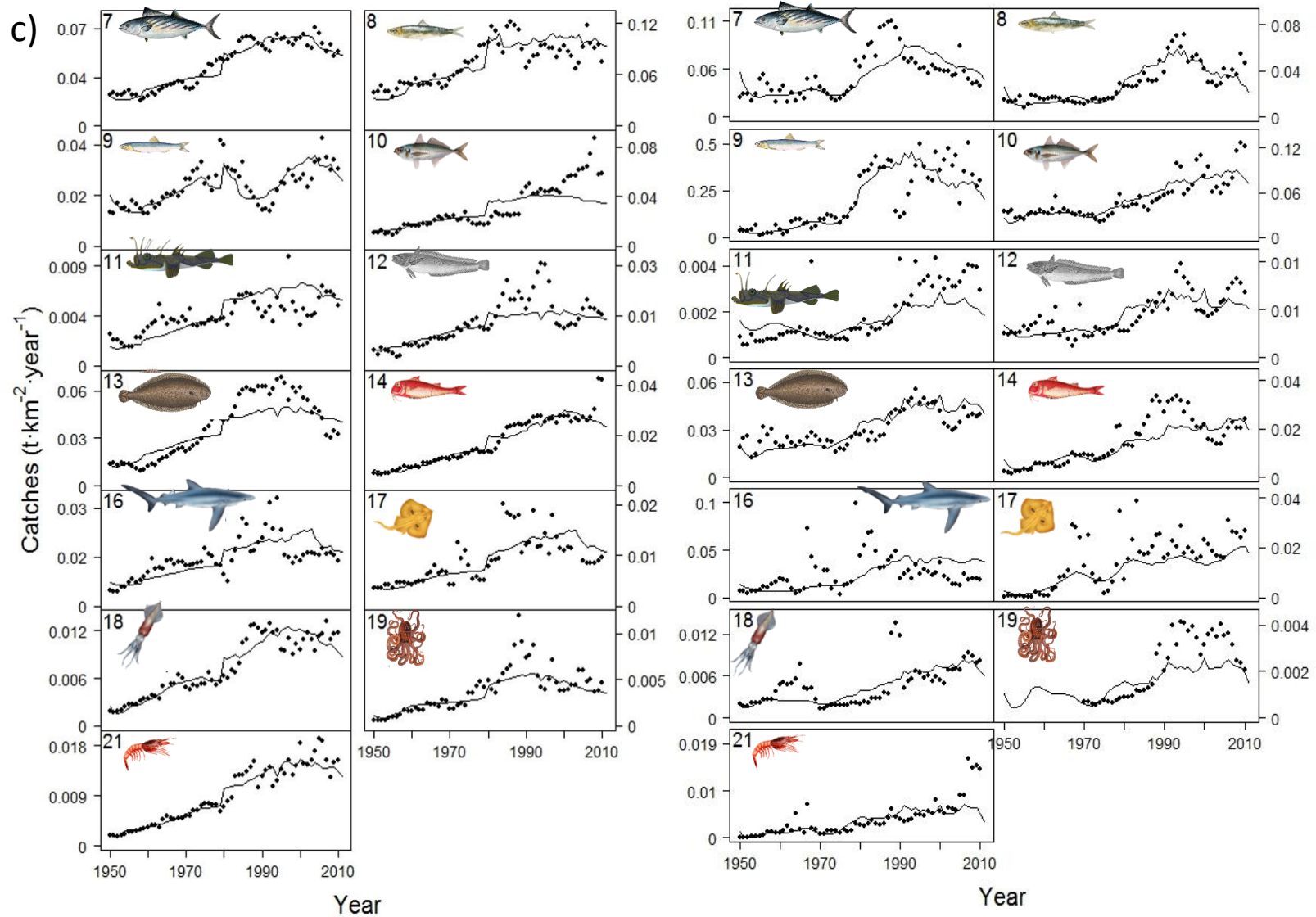
**S8. Representation of modelling fitting for the remaining functional groups occurring in the Western (W), Adriatic (A), Ionian (I) and Eastern/Levantine (E) Seas for the period 1950-2011. Predicted biomass ( $t \cdot km^{-2}$ ) is shown as solid black lines while observed data is represented as black dots. Functional groups codes correspond to those given in Fig 2. The predicted model results (dashed red line) using the modelled biogeochemical PP is also shown. Blue shadow represents the 95% percentile and 5% percentile obtained through the Monte Carlo routine.**



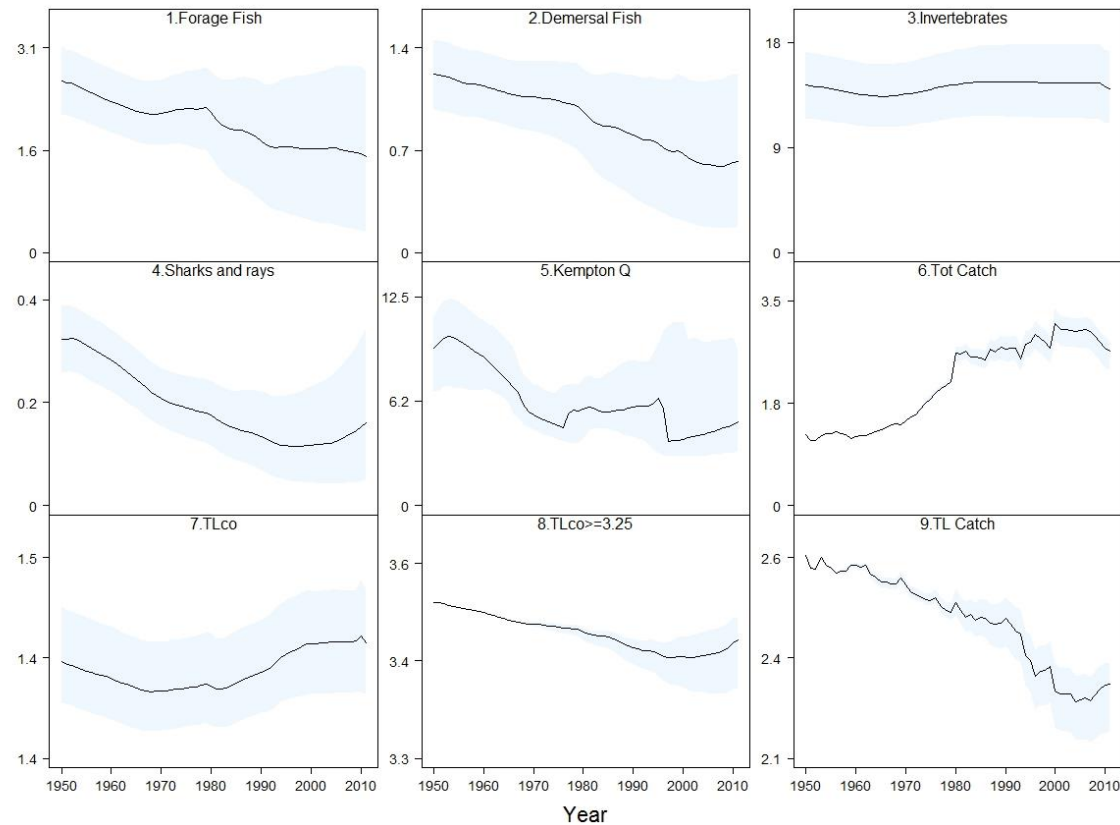




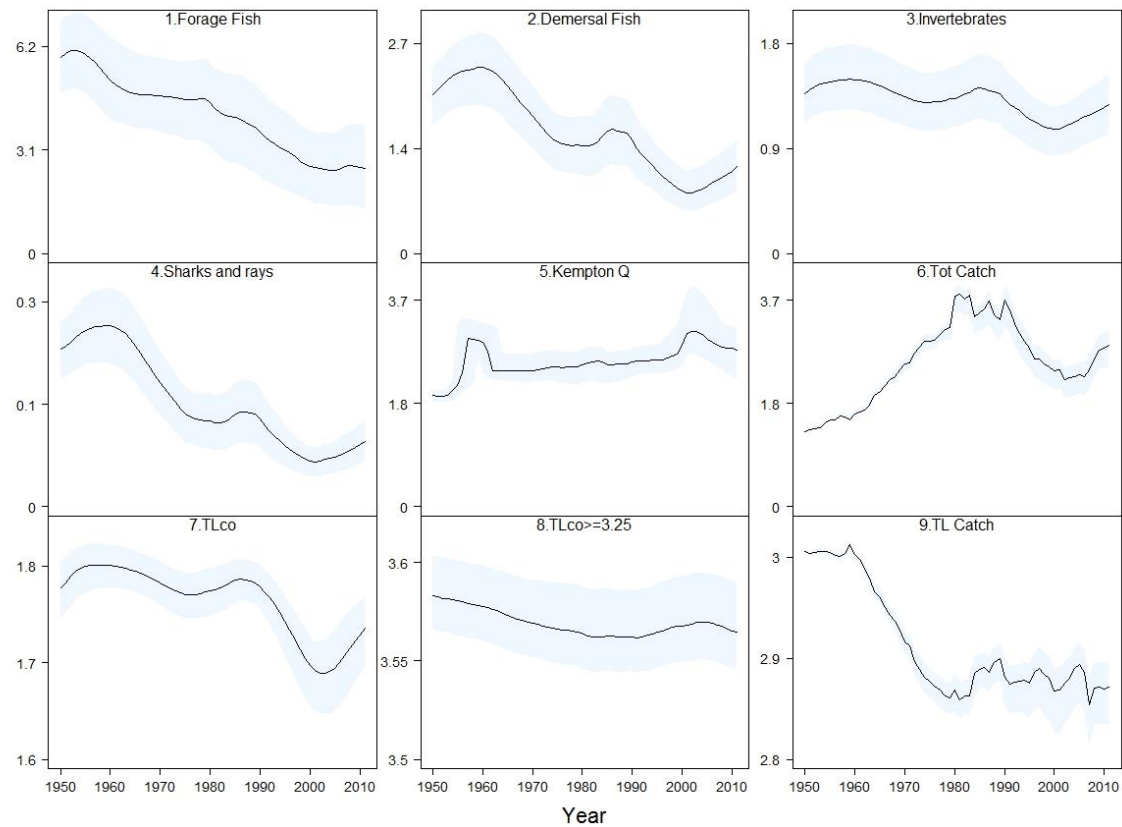
S9. Predicted (solid lines) *versus* observed (dots) catches ( $t \cdot km^{-2} \cdot year^{-1}$ ) for main commercially important functional groups of the Ionian (c) and Eastern (d) Mediterranean ecosystems (1950-2011). Drawings for species/functional groups 1-3, 5-6 and 8 are by Massimo Demma - <http://www.massimodemma.it/>.



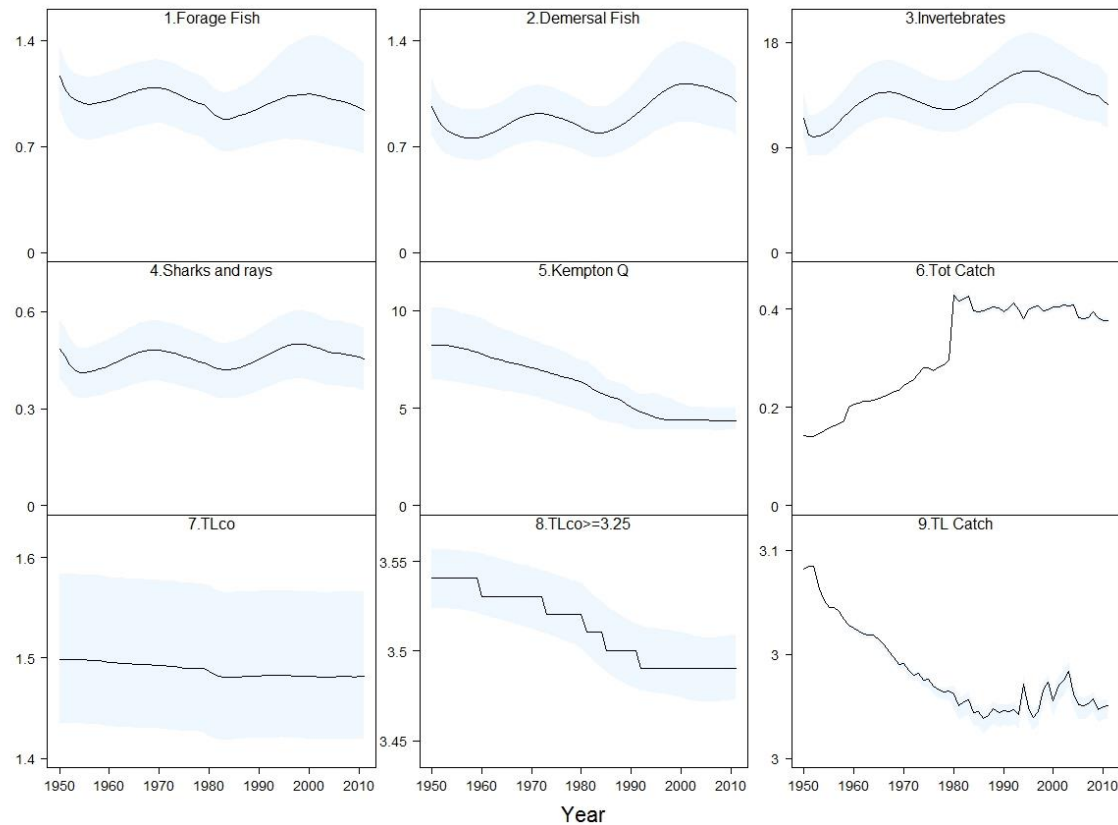
**S10. Ecological indicators (1. Forage fish biomass ( $t \cdot km^{-2}$ ); 2. Demersal fish biomass ( $t \cdot km^{-2}$ ); 3. Invertebrates biomass ( $t \cdot km^{-2}$ ); 4. Sharks/rays and skate biomass ( $t \cdot km^{-2}$ ); 5. Kempton's index of biodiversity; 6. Tot Catch: Total Catch ( $t \cdot km^{-2} \cdot year^{-1}$ ); 7. mTLco: Mean trophic level of the community; 8. mTL>3.25: Mean trophic levels of groups having trophic level >3.25 (excluding marine mammals, sea turtles and seabirds); 9 mTLC: Mean trophic level of the catches) estimated from results of the Ecosim model for the period 1950-2011 for the Western Mediterranean Sea. Blue shadow represents the 95% percentile and 5% percentile obtained through the Monte Carlo routine.**



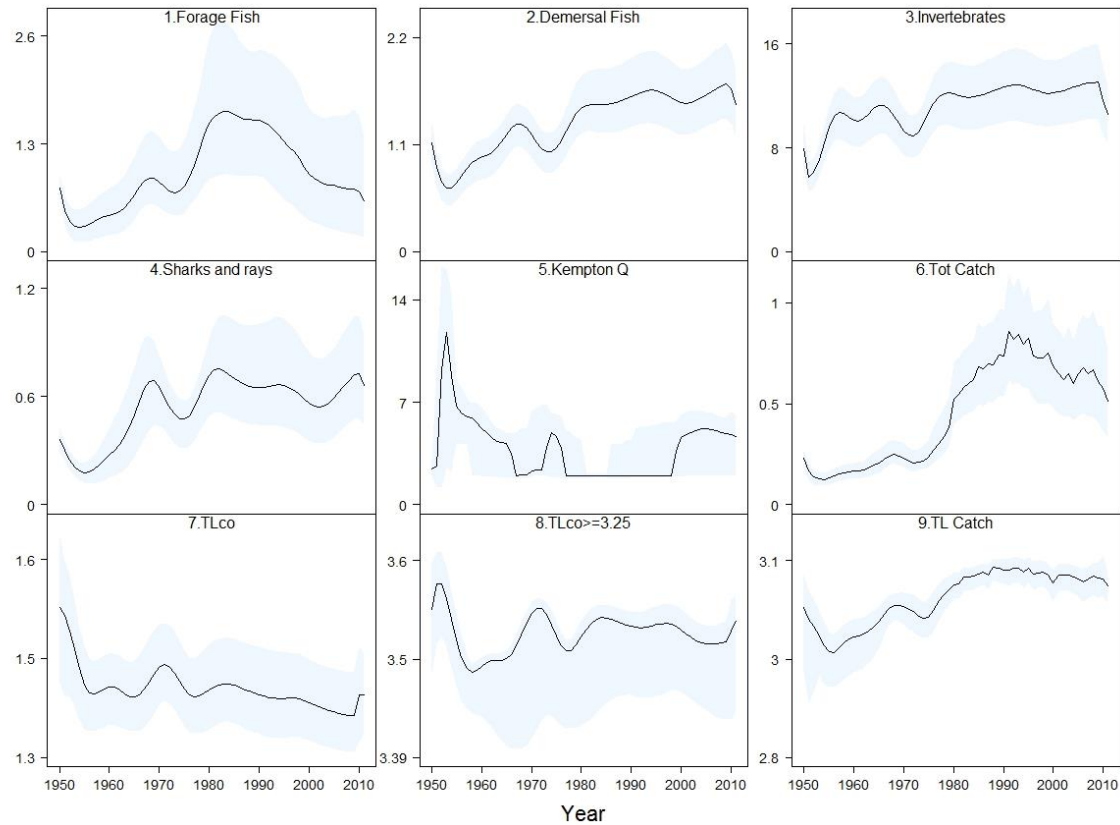
**S11. Ecological indicators (1. Forage fish biomass ( $t \cdot km^{-2}$ ); 2. Demersal fish biomass ( $t \cdot km^{-2}$ ); 3. Invertebrates biomass ( $t \cdot km^{-2}$ ); 4. Sharks/rays and skate biomass ( $t \cdot km^{-2}$ ); 5. Kempton's index of biodiversity; 6. Tot Catch: Total Catch ( $t \cdot km^{-2} \cdot year^{-1}$ ); 7. mTLco: Mean trophic level of the community; 8. mTL>3.25: Mean trophic levels of groups having trophic level >3.25 (excluding marine mammals, sea turtles and seabirds); 9 mTLC: Mean trophic level of the catches) estimated from results of the Ecosim model for the period 1950-2011 for the Adriatic Sea. Blue shadow represents the 95% percentile and 5% percentile obtained through the Monte Carlo routine.**



**S12. Ecological indicators (1. Forage fish biomass ( $t \cdot km^{-2}$ ); 2. Demersal fish biomass ( $t \cdot km^{-2}$ ); 3. Invertebrates biomass ( $t \cdot km^{-2}$ ); 4. Sharks/rays and skate biomass ( $t \cdot km^{-2}$ ); 5. Kempton's index of biodiversity; 6. Tot Catch: Total Catch ( $t \cdot km^{-2} \cdot year^{-1}$ ); 7. mTLco: Mean trophic level of the community; 8. mTL>3.25: Mean trophic levels of groups having trophic level >3.25 (excluding marine mammals, sea turtles and seabirds); 9 mTLC: Mean trophic level of the catches) estimated from results of the Ecosim model for the period 1950-2011 for the Ionian Sea Sea. Blue shadow represents the 95% percentile and 5% percentile obtained through the Monte Carlo routine.**



**S13. Ecological indicators (1. Forage fish biomass ( $t \cdot km^{-2}$ ); 2. Demersal fish biomass ( $t \cdot km^{-2}$ ); 3. Invertebrates biomass ( $t \cdot km^{-2}$ ); 4. Sharks/rays and skate biomass ( $t \cdot km^{-2}$ ); 5. Kempton's index of biodiversity; 6. Tot Catch: Total Catch ( $t \cdot km^{-2} \cdot year^{-1}$ ); 7. mTLco: Mean trophic level of the community; 8. mTL>3.25: Mean trophic levels of groups having trophic level >3.25 (excluding marine mammals, sea turtles and seabirds); 9 mTLC: Mean trophic level of the catches) estimated from results of the Ecosim model for the period 1950-2011 for the Eastern Mediterranean Sea. Blue shadow represents the 95% percentile and 5% percentile obtained through the Monte Carlo routine.**



**S14. Final vulnerabilities, obtained after the fitting procedure, for each functional groups of the sub-regions (W: Western; A: Adriatic; I: Ionian and E: Eastern) and of the whole Mediterranean Sea. Top-down controls are given by vulnerabilities >3, bottom-up controls by vulnerabilities <2, while mixed effect interactions are given by vulnerabilities ( $v$ )  $2 \leq v \leq 3$ .**

#	Predator functional group	M	W	A	I	E
1	Piscivorous Cetaceans		1.0	1.0	2	1
2	Other cetaceans	2.0	1.0E+10	2.0	5.4	2.0
3	Pinnipeds		2.0	1.0	1.0	2.0
4	Seabirds		1.0E+10	1.0E+10	147.2	1.0
5	Sea turtles	2.0	2.0	1.0	2.0	1.0E+10
6	Large Pelagics	1.0	1.0	1.0	1.0	1.0E+10
7	Medium Pelagics		1.1	4.0	2.0	1.0
8	European pilchards		2.1	1.0	1.0	1.3
9	European anchovies		3.5	1.0	1.0	1.5
10	Other Small Pelagics		1.7	1.0	13.8	1.0
11	Large Demersals		4.1	1.0E+10	1.0	1.0E+10
12	European Hake		1.2	1.0	1.0	1.0
13	Medium Demersals		1.5	1.0	1.0	1.0
14	Small Demersals		3.0	1.0	1.9	3.4
15	Deep-sea Fish		1.0E+10	1.0	1.0	1.0
16	Sharks		1.8	1.0	1.9	1.0
17	Rays and skates		1.0E+10	1.0	1.0	5.5
18	Benthopelagic Cephalopods		1.0	1.0	1.1	1.0
19	Benthic Cephalopods		4.1	1.0	1.0	3.2
20	Bivalves and gastropods		1.0E+10	1.0	5.8	2.0
21	Crustaceans		1.0	1.0	2.4	5.7
22	Jellyfish		1.0E+10	1.0E+10	1.0E+10	1.0
23	Benthos		1.0	1.0	1.0	1.0
24	Zooplankton		1.0	1.0E+10	1.0E+10	1.0E+10

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