Supplementary material to: Using trophic models to assess the impact of fishing on marine ecosystems. Application to the Bay of Biscay and Celtic Sea case study

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Table S1 - List of species included in the trophic groups of the Celtic/Biscay Ecopath model, and related parameters (from Fishbase) used to calculate production parameters and group similar species

Numero	Group	Famille	Nom scientifique	Common na	Habitat	TL	a	b	M (fishbase)	k (fishbase)	Linf (cm)
3	Sharks L	Ginglymostor	Ginglymostoma cirratum	Nurse shark	reef-associate	3,83	0,0135	2,892	0,09	no k	432,1
3	Sharks L	Carcharhinida	Prionace glauca	Blue Shark	pelagic	4,24	0,0039	3,41	0,18	0,16	343,0
3	Sharks L	Lamnidae	Carcharodon carcharias	Great white s	pelagic	4,53	0,0083	3,14	0,07	0,06	764,0
3	Sharks L	Scyliorhinidae	Scyliorhinus stellaris	Nursehound	reef-associate	4,03	no a	no b		no k	165,3
3	Sharks L	Triakidae	Galeorhinus galeus	Tope shark	benthopelagic	4,2	0,0109	2,83	0,12	0,08	216,0
3	Sharks L	Alopiidae	Alopias vulpinus	Thintail thresh	pelagic	4,5	0,0188	2,519	0,11	0,1	651,0
3	Sharks L	Lamnidae	Lamna nasus	Porbeagle	pelagic	4,5	0,114	2,509	0,13	0,12	280,0
3	Sharks L	Lamnidae	Isurus oxyrinchus	Shortfin mako	pelagic- ocea	4,5					
3	Sharks L	Alopiidae	Alopias vulpinus	Thresher sha	pelagic ocean	4,5					
4	sharks/rays	Centrophorida	Deania calcea	Birdbeak dog	bathydemersa	4,22					
4	sharks/rays	Centrophorida	Centrophorus granulosus	Gulper shark	bathydemersa	4,13	no L/W	no L/W	0,18	no k	163,3
4	sharks/rays	Centrophorida	Centrophorus squamosus	Chlamydosel	bathydemersa	4,22	no L/W	no L/W	0,18	no k	163,3
4	sharks/rays	Dalatiidae	Centroscyllium fabricii	Black dogfish	bathydemersa	3,9	0,0009	3,42	0,28	no k	86,6
4	sharks/rays	Dalatiidae	Centroscymnus coelolepis	Portuguese d	bathydemersa	4,35	0,0043	3,12	0,22	no k	123,1
4	sharks/rays	Dalatiidae	Centroscymnus crepidater	Longnose vel	bathydemersa	4,16	0,0024	3,25	0,21	no k	133,1
4	sharks/rays	Etmopteridae	Etmopterus pusillus	Smooth lante	benthopelagic	4,22					
4	sharks/rays	Etmopteridae	Etmopterus princeps	Great lantern	bathydemersa	4,17					
4	sharks/rays	Scyliorhinidae	Apristus laurussonii	Iceland catsh	bathydemersal						
4	sharks/rays	Scyliorhinidae	Apristurus melanoasper	Black roughs	bathypelagic	3,75					
4	sharks/rays	Scyliorhinidae	Scyliorhinus canicula	Small-spotte	demersal	3,69	0,0036	2,779	0,22	0,13	102,8
4	sharks/rays	Somniosidae	Scymnodon ringens	Knifetooth do	bathypelagic	3,88					
4	sharks/rays	Squalidae	Squalus acanthias	Piked (=Spin	benthopelagic	4,3	0,0058	2,89	0,07	0,04	129,0
4	sharks/rays	Triakidae	Mustelus asterias	Starry smoot	demersal	3,71					
4	sharks/rays	Triakidae	Mustelus mustelus	Smooth-houn	demersal	3,83					
4	sharks/rays	Myliobatidae	Myliobatis aquila	Common eag	benthopelagic	3,61					
4	sharks/rays	Rajidae	Leucoraja naevus	Cuckoo ray	demersal	3,94	0,0024	3,233	0,19	0,21	71,4
4	sharks/rays	Rajidae	Raja microocellata	Small-eyed ra	demersal	3,89					
4	sharks/rays	Rajidae	Raja montagui	Spotted Ray	Demersal	3,67	0,002	3,311		0,19	68,7
4	sharks/rays	Rajidae	Raja undulata	Undulate ray	demersal	3,5					
4	sharks/rays	Rajidae	Amblyraja radiata	Thorny skate	demersal	4,02	0,0409	2,896	0,29	0,23	66,0
4	sharks/rays	Rajidae	Raja clavata	Thornback ra	Demersal	3,76	0,0032	3,201		0,21	85,6
4	sharks/rays	Rajidae	Leucoraja fullonica	Shagreen ray	bathydemersa	3,5	no a	no b	0,21	no K	102,8
4	sharks/rays	Rajidae	Leucoraja circularis	Sandy ray		3,5					
4	sharks/rays	Rajidae	Raja oxyrinchus	Longnosed sk	bathydemersal		no a	no b	0,19	no K	153,3
4	sharks/rays	Rajidae	Bathyraja pallida	Pale ray	bathydemersa	3,6	no L/W	no L/W	0,18	no k	163,3
4	sharks/rays	Rajidae	Bathyraja richardsoni	Richardson's	bathydemersa	4,02	no L/W	no L/W	0,17	no k	178,4
4	sharks/rays	Rajidae	Dipturus batis	Blue Skate	Demersal	3,96	0,0108	3,079		0,057	254
4	sharks/rays	Dasyatidae	Dasyatis pastinaca	Common stin	demersal	4,05					
4	sharks/rays	Rajidae	Raja batis								
5	Whiting	Gadidae	Merlangius merlangus	Whiting	benthopelagic	4,37	0,0034	3,258	0,41	0,25	49,2
6	Mackerel	Scombridae	Scomber scombrus	Atlantic mack	pelagic	3,65	0,0053	3,084	0,82	0,47	37,0
7	Horse macke	Carangidae	Trachurus trachurus	Atlantic Hors	pelagic	3,64	0,0072	3,033	0,24	0,13	45,3
8	Anchovy	Engraulidae	Engraulis encrasicolus	European and	pelagic	3,11	0,0042	0,9587	0,58	0,32	24,6
11	Herring	Clupeidae	Clupea harengus	Herring	pelagic	3,23	0,004	3,22	0,48	0,33	35,3
9	Sardine	Clupeidae	Sardina pilchardus	European pilc	pelagic	3,05	0,0059	3,077	0,82	0,49	21,6
10	Sprat	Clupeidae	Sprattus sprattus	European spr	pelagic	3	0,0022	3,475	1,1	0,7	13,0
12	Pelagic M	Osmeridae	Osmerus eperlanus	European sm	pelagic	3	0,0042	3,163	0,42	0,26	32,4
12	Pelagic M	Exocoetidae	Cheilopogon heterurus	Mediterranea	pelagic	3,4	no L/W	no L/W	0,48	no k	41,7
12	Pelagic M	Scomberesoc	Scomberesox saurus	saury (import	pelagic	3,64	0,0015	3,193	0,47	no k	52,0
12	Pelagic M	Atherinidae	Atherina presbyter	Sand smelt	pelagic	3,67	0,0069	3	1,16	0,7	15,4
12	Pelagic M		Spondyliosoma cantharus	black seabrea	benthopelagic	3,29	0,0089	3,174	0,43	0,3	66,1
12	Pelagic M	Sparidae	Pagellus bogaraveo	Blackspot se	benthopelagic	3,73	0,007	3,209	0,18	0,09	61,2
12	Pelagic M	Clupeidae	Alosa alosa	Allis shad	pelagic	3,62	0,0049	3,203	0,39	0,27	75,4
12	Pelagic M	Carangidae	Selar crumenophthalmus	big eye	recifal	3,9	0,0074	3,29	no M	no k	62,2
13	Pelagic L	Belonidae	Belone belone	Garfish (Garp	pelagic	4,21	0,0038	2,87	no M	no k	92,7
13	Pelagic L	Scombridae	Sarda sarda	Atlantic bonit	pelagic	4,5	0,0051	3,18	0,81	0,69	64,0
13	Pelagic L	Sebastidae	Sebastes marinus	ocean perch	pelagic	4,1	no a	no b	0,13	0,06	73,2
13	Pelagic L	Pomatomidae	Pomatomus saltatrix	bluefish	m p	4,5	0,0131	2,93	0,32	0,18	126,7
14	Hake	Merlucciidae	Merluccius merluccius	European hak	Demersal	4,42	0,0051	3,074		0,184	105
16	Cod	Gadidae	Gadus morhua	Atlantic cod	benthopelagic	4,42	0,0084	3,053	0,1	0,219	126,0
18	Sole	Soleidae	Solea solea	Common sole	pelagic	3,13	0,0048	3,175	0,28	0,16	53,8
19	Plaice	Pleuronectida	Pleuronectes platessa	European pla	demersal	3,26	0,0053	3,225	0,12	0,06	81,6

20	Demersal L	Moronidae	Dicentrarchus labrax	European sea	Demersal	3,79	0,0123	2,955		0,059	110,44
20	Haddock	Gadidae	Melanogrammus aeglefinus	Haddock	Demersal	3,6	0,132	2,901		0,19	68
20	Demersal L	Sciaenidae	Argyrosomus regius	Meagre	benthopelagic	4,29	0,0083	3,059	0,13	0,09	210,0
20	Demersal L	Carangidae	Seriola dumerili	Greater ambe	reef-associate	4,5	0,0221	2,94	0,3	0,25	158,1
20	Demersal L	Lotidae	Molva molva	Ling	Demersal	4,25	0,001	3,436		0,17	132
20	Demersal L	Lotidae	Molva dypterygia	Blue ling	Demersal	4,5	0,0019	3,149		0,157	113
20	Demersal L	Muraenidae	Muraena helena	Mediterranea	reef-associate	4,18	no a	no b	0,19	no k	153,3
20	Demersal L	Gadidae	Pollachius pollachius	Pollack	benthopelagic	4,15	0,0041	3,21	0,21	no k	133,1
20	Demersal L	Anarhichadid	Anarhichas lupus	Wolfish	demersal	3,4	0,0033	3,249	0,08	0,04	167,0
20	Demersal L	Gadidae	Pollachius virens	Saithe	Demersal	4,38	0,0104	2,972		0,07	177
20	Demersal L	Sparidae	Sparus auratus	Gilthead seab	demersal	3,26	0,0104	3,079	0,41	0,27	57,7
20	Demersal L	Sparidae	Pagrus pagrus	Common sea	m/l p	3,65	0,0116	2,866		0,14	64,5
20	Demersal L	Phycidae	Phycis blennoides	Greater forkb	benthopelagic	3,73	0,0012	3,316	0,29	0,17	57,7
20	Demersal L	Phycidae	Phycis phycis	Forkbeard	benthopelagic	4,26	0,0049	3,169	0,31	0,19	65,3
20	Demersal L	Lotidae	Brosme brosme	Tusk (=Cusk)	demersal	4,2	no L/W	no L/W	0,22	0,13	84,3
20	Demersal L	Scophthalmid	Scophthalmus maximus	Turbot	demersal	3	0,0105	3,168	0,25	0,15	70,0
20	Demersal L	Scophthalmid	Scophthalmus rhombus	Brill	Demersal	3,79	0,0063	3,229		0,5	38,4
20	Demersal L	Zeidae	Zeus faber	John dory	benthopelagic	4,5	0,0211	2,931	0,25	0,15	69,3
20	Demersal L	Congridae	Conger conger	European cor	demersal	4,29	0,0002	3,509	0,11	0,07	229,0
21	Pouts	Gadidae	Trisopterus minutus	poor cod	benthopelagic	3,83	0,0086	2,98	0,33	0,18	33,5
21	Pouts	Gadidae	Trisopterus luscus	pouting	benthopelagic	3,73	0,0075	3,15	0,73	0,59	41
21	Pouts	Gadidae	Trisopterus esmarkii	Norway pout	benthopelagic	3,24	0,0066	3	0,54	0,36	27,2
22	Blue whiting	Gadidae	Micromesistius poutassou	Blue whiting (	benthopelagic	3,6	0,0038	3,082	0,34	0,18	44,5
23	Demersal M	Sparidae	Pagellus erythrinus	Common pan	benthopelagic	3,4	0,168	3,06	0,25	0,12	50,6
23	Demersal M	Labridae	Labrus bergylta	Ballan wrass	reef-associate	3,07	0,0145	3	0,21	0,11	57,8
23	Demersal M	Mugilidae	Chelon labrosus	Thicklip grey	demersal	2,59	0,0207	2,98	0,22	0,12	70,3
23	Demersal M	Soleidae	Dicologlossa cuneata	Wedge sole	pelagic	3,3	0,0066	3,001	0,77	0,47	24,7
23	Demersal M	Pleuronectida	Microstomus kitt	Lemon sole	Demersal	3,25			0,4	0,42	37
23	Demersal M	Pleuronectida	Platichthys flesus	European flou	Demersal	3,19	0,0093	3,066		0,44	38
23	Demersal M	Pleuronectida	Limanda limanda	Dab	Demersal	3,3	0,0085	3,091	1,09	0,604	22
23	Demersal M	Pleuronectida	Glyptocephalus cynogloss	Witch Flound	Demersal	3,14	0,0017	3,39		0,312	30,9
23	Demersal M	Soleidae	Pegusa lascaris	Sand sole	pelagic	3,2	0,0069	3,117	no M	0,18	41,7
23	Demersal M	Trachinidae	Trachinus draco	Greater weev	Demersal	4,18	0,0093	2,874			39,9
23	Demersal M	Macrouridae	Nezumia bairdi	Common Atla	benthopelagic	3	no L/W	no L/W	0,55	no k	41,7
23	Demersal M	Macrouridae	Caelorinchus caelorhincus	Hollowsnout g	benthopelagic	2,75	no L/W	no L/W	0,48	no k	41,7
23	Demersal M	Sparidae	Pagellus acarne	Axillary seab	benthopelagic	3,48	0,0086	3,131	0,48	0,27	30,0
23	Demersal M	Phycidae	Phycis chesteri	longfin hake	benthopelagic						
23	Demersal M	Triglidae	Chelidonichthys lucerna	Tub gurnard	demersal	3,65	0,0049	3,202	0,5	0,33	48,4
23	Demersal M	Triglidae	Aspitrigla cuculus	Red gurnard	demersal	3,85	0,0021	3,441	0,74	0,51	37,1
23	Demersal M	Triglidae	Eutrigla gurnardus	Grey gurnard	demersal	3,57	0,0054	3,13	1,07	0,85	38,0
23	Demersal M	Caproidae	Capros aper	Boarfish	demersal	3,14	0,0282	2,81	fb	no k	31,5
23	Demersal M	Mullidae	Mullus surmuletus	Striped Red M	Demersal	3,42	0,0044	3,351		0,53	28,5
23	Demersal M	Triglidae	Chelidonichthys lastoviza	Streaked gur	demersal	none	0,0128	2,963	0,89	0,65	36,9
23	Demersal M	Scophthalmid	Lepidorhombus boscii	fourspotted m	demersal	3,69	0,0046	3,09	0,25	0,14	44,0
23	Demersal M	Carangidae	Caranx ruber	bar jack	m reef	4,4	0,0043	3,237	0,33	0,14	70,0
23	Demersal M	Priacanthidae	Priacanthus arenatus	Atlantic bigeye	m reef	4,2	0,0119	3,039	fb	no k	42,5
23	Demersal M	Sparidae	Diplodus sargus cadenati	Moroccan wh	reef-associate	3,04	no a	no b	no M	no k	46,9
23	Demersal M	Cepolidae	Cepola macrophthalma	Red bandfish	demersal	3,13	0,0128	2,169	0,33	0,21	67,6
23	Demersal M	Callionymidae	Callionymus lyra	Dragonet	demersal	3,27	0,014	2,709	0,75	0,43	25,0
23	Demersal M	Sparidae	Lithognathus mormyrus	Sand steenbr	Demersal						
23	Demersal M	Sparidae	Boops boops	Bogue	demersal	2,97	no L/W	no L/W	0,33	0,17	33,9
23	Demersal M	Callanthiidae	Callanthias ruber	Parrot seaper	demersal	3,8	no L/W	no L/W	0,36	no k	62,2
23	Demersal M	Triglidae	Chelidonichthys obscurus	Longfin gurna	demersal	3,44	no L/W	no L/W		no k	
24	Demersal S	Caproidae	Antigonia capros	Deepbody bo	demersal	4,05	0,0392	2,95	0,58	no k	32,0
24	Demersal S	Soleidae	Buglossidium luteum	Solenette	demersal	3,31	0,0055	3,267		0,28	15,8
24	Demersal S	Gobiesocidae	Apletodon dentatus	Small-headed	demersal	3,12	no L/W	no L/W		no k	
24	Demersal S	Gobiidae	Lesueurigobius friesii	gobies	s d	3,15	0,0026	3,515		0,44	12,7
24	Demersal S	Ammodytidae	Ammodytes marinus	Lesser sande	benthopelagic	2,71	0,0031	3	0,72	0,4	20,0
24	Demersal S	Agonidae	Agonus cataphractus	Hooknose	demersal	3,43	0,0196	2,614	0,88	0,48	15,0
24	Demersal S	Bothidae	Arnoglossus imperialis	Imperial scald	demersal	3,84	0,0045	3,17	0,67	no k	26,3
24	Demersal S	Pomacentrida	Chromis chromis	damselfish	reef-associate	3,04	0,0383	2,415	0,67	no k	26,3
24	Demersal S	Blenniidae	Blennius ocellaris	Butterfly blen	demersal	3,49	0,0168	2,91	0,78	no k	21,1
24	Demersal S	Labridae	Ctenolabrus rupestris	Goldsinny-wra	reef-associate	3,4	0,0123	3	0,63	0,31	16,1
24	Demersal S	Bothidae	Arnoglossus laterna	Scaldfish	demersal	3,59	0,0025	3,45		0,57	15,8
24	Demersal S	Haemulidae	Haemulon aurolineatum	Tomtate grun	s reef	3,2	0,0086	3,09	0,53	0,21	32,5
24	Demersal S	Mullidae	Mullus barbatus	Red mullet	demersal	3,15	0,0088	3,1	0,54	0,27	21,5
24	Demersal S	Gadidae	Gadiculus argenteus	silvery cod	s p	3,51	0,0023	3,499	0,82	0,5	16,2
24	Demersal S	Callionymidae	Callionymus reticulatus	Reticulated d	demersal	3,28	no L/W	no L/W	1,19	no k	11,7
24	Demersal S	Labridae	Centrolabrus exoletus	Rock cook	reef-associate	3,5	0,0033	3,31	1,19	0,69	13,2
24	Demersal S	Callionymidae	Callionymus maculatus	none	demersal	3,25	0,0156	2,49	0,92	no k	16,9
24	Demersal S	Apogonidae	Apogon imberbis	Cardinal fish	demersal	3,92	no L/W	no L/W	1,42	0,91	15,0
24	Demersal S	Gobiidae	Buenia jeffreysii	Jeffrey's goby	reef-associate	3,62	no L/W	no L/W	1,82	no k	6,5
24	Demersal S	Ammodytidae	Ammodytes tobianus	Small sandee	demersal	3,11	0,0015	3,169	1,1	0,71	19,7
24	Demersal S	Gobiidae	Aphia minuta	Transparent g	demersal	3,1	0,0007	3,55	3,58	2,21	5,4

25	Monkfish	Lophiidae	Lophius piscatorius	Angler fish	bathydemersa	4,45	0,0255	2,846	0,2	0,13	131,0
25	Monkfish		Lophius budegassa	Black-bellied	deep	4,48	0,0111	3	0,18	0,1	84,8
26	Bathy L	Chimaeridae	Chimaera monstrosa	Rabbit fish	bathydemersa	3,5	no L/W	no L/W	0,22	no k	123,1
26	Bathy L	Bramidae	Brama brama	Atlantic pomf	bathypelagic	4,08	0,0011	3,609	0,25	no k	102,8
26	Bathy L	Anotopteridae	Anotopterus pharao	Daggertooth	bathypelagic	4,34	no L/W	no L/W	0,19	no k	149,3
26	Bathy L	Berycidae	Beryx decadactylus	Alfonsino	demersal	4,13	no L/W	no L/W	0,25	no k	102,8
26	Bathy L	Berycidae	Beryx splendens	Splendid alfo	benthopelagic						
26	Bathy L	Trichiuridae	Aphanopus carbo	Black scabba	benthopelagic	4,5	0,0002	3,452	0,31	0,25	139,0
26	Bathy L	Trichiruidae	Lepidopus caudatus	Silver scabba	benthopelagic	3,85	0,0003	3,19	0,12	0,06	95,0
26	Bathy L	Macrouridae	Odontomacrurus murrayi	Roundhead grenadier	bathypelagic	none	no L/W	no L/W	0,26	no k	66,3
26	Bathy L	Macrouridae	Coryphaenoides rupestris	Roundnose g	bathypelagic	3,54	0,0732	2,587	0,14	0,08	105,0
26	Bathy L	Macrouridae	Macrourus berglax	Roughhead g	bathypelagic	4,5					
27	Megrim	Scophthalmic	Lepidorhombus whiffiagonis	Megrim	bathydemersa	4,24	0,0029	3,26	0,24	0,13	59,4

Supplementary material S2 - Diet information

Fish diet information (Table. 1.1) was taken from the region when possible, or from other regions with similar climates, or from general information provided in Fishbase (Froese and Pauly 2012). Fishbase was used to locate diet information for each species unless local publications were available. Marine mammals diet was rarely available for the Bay of Biscay and was often derived for general information for the North Atlantic (Table 1.2). Diet information for crabs and lobsters are based on qualitative information for Norway lobster (Cristo 1998, Fontaine and Warluzel 1969), edible crab (Latrouite 2002), spider crab (Forest 2001, Le Foll 1993) and European lobster (Forest 2001). Diet for shrimps and benthic organisms were adapted from (Ainsworth et al. 2001). The 2 groups of zooplankton were assigned a diet based on general information.

Cephalopods diet information was estimated using European squid (*Loligo vulgaris*), European flying squid (*Todarodes sagittatus*), northern short-fin squid (*Illex illecebrosus*), octopus (*Octopus vulgaris*) and cuttlefish (*Sepia officinalis*). All diet information is based on detailed, but qualitative accounts from Cephbase (Wood and Day 2000) except for common octopus (Boletzky and Hanlon 1983).

Table S2.1. Source of fish diet by species, listing the reference specifying if the results of a study were taken from Fishbase compilation (column In), the type of data, the location of the study, and the percentage of unidentified fish.

functional group	Species	reference	In [b]	type [a]	location	% unid-entified fish
Sharks L	*Alopias vulpinus*	Bowman et al. (Bowman et al. 2000a)	FB	1	USA, NW Atl.	0.7
Sharks L	*Carcharodon carcharias*	food items in FB & Bowman et al. (Bowman et al. 2000a)	FB	1	USA NW Atl	35.5
Sharks L	*Galeorhinus galeus*	Morato et al. (2003)	FB	1	Azores Islands	0.0
Sharks L	*Scyliorhinus stellaris*	Ellis et al. (1996)	FB	1	NE Atlantic	12.9
Sharks L	*Prionace glauca*	Clarke et al. (1996)	FB	1	France Bay of Biscay	0.0
		Bowman et al. (2000a)	FB	1	USA NW Atl	7.8
sharks/rays	*Amblyraja radiata*	Berestovskiy (1990) & food items in FB		1	Barents and Norwegian Seas	0.0
sharks/rays	*Centrophorus squamosus*	Ebert et al. (1992)	FB	1	between Walvis Bay and the Agulhas Bank	10.3
sharks/rays	*Cetorhinus maximus*	Cortés (1999)	FB	1	general	0.0
sharks/rays	*Raja montagui*	Ajayi (1982)	FB	1	UK England, Whales	18.2
sharks/rays	*Leucoraja naevus*	Ellis et al. (1996)	FB	1	Northeastern Atlantic, 1981-1985	19.9
sharks/rays	*Raja microocellata*	Ajayi (1982)	FB	1	UK England, South Whales	20.5

sharks/rays	*Centroscymnus coelolepis*	Ebert et al. (1992)	FB	1	South Africa W coast	17.8
sharks/rays	*Centroscyllium fabricii*	Ebert et al. (1992)	FB	1	South Africa W coast	10.2
sharks/rays	*Squalus acanthias*	Ebert et al. (1992)	FB	1	S. Africa, west coast	24.5
		Ebert et al. (1996)	FB	1	NE Atlantic 1981-85	15.9
sharks/rays	*Scyliorhinus canicula*	Ellis et al. (1996)	FB	1	general	5.5
Whiting	*Merlangius merlangus*	Du Buit and Merlinat (1985)		1	Celtic Sea	3.7
Mackerel	*Scomber scombrus*	Fishbase	FB	1		0.0
Horse mackerel	*Trachurus trachurus*	Smith-Vaniz (1986)	FB	2	general	0.0
		Greenstreet (1995)	FB	1	North Sea	0.0
		Olaso and Rodriguez-Marin (1995)	FB	1	Cantabrian Sea	0.0
Anchovy	*Engraulis encrasicolus*	Plounevez and Champalbert (1999)		3	Bay of Biscay spring spawning	0.0
Herring	*Clupea harengus*	Rice (1963)	FB	1	Isle of Man Irish Sea	14.6
Sardine	*Sardina pilchardus*	(Bode et al. 2004, Whitehead 1985)	FB	1	general	0.0
Sprat	*Sprattus sprattus*	Oven et al. (1995)	FB	1	Black Sea	0.0
Pelagic M	*Osmerus eperlanus*	Sterligova et al. (1995)	FB	1	Finland	0.0
Pelagic M	*Atherina presbyter*	Billard (1997)	FB	1	France	0.0
Pelagic M	*Cheilopogon heterurus*	Lipskaya (1987)	FB	1	Eastern Pacific	0.0
Pelagic M	*Pagellus bogaraveo*	Bauchot and Hureau (1990)	FB	2	general	0.0
		Morato et al. (2001)		1	Azores	25.9
Pelagic M	*Scomberesox saurus*	Bowman et al. (2000a)	FB	1	Georges Bank, USA	0.0
Pelagic M	*Spondyliosoma cantharus*	Bell and Harmelin-Vivien (1983)	FB	1	France Marseille	0.0
		Pita et al. (2002a)		1	Algarve, Portugal	0.0
Pelagic L	*Belone belone*	Dorman (1991)	FB	1	Sweden	20.7
Pelagic L	*Sarda sarda*	(Collette and Nauen 1983)	FB	2	general	4.4
		Bowman et al. (2000a)	FB	1	USA Georges Bank	80.7
Hake	*Merluccius merluccius*, adult	Kacher (2004)		1	Bay of Biscay	0.0
	adult	Guichet (1995)	FB	1	Bay of Biscay	0.0
	adult	Mahe et al. (2007)		1	Celtique north and south Bay of Biscay	1.7
	fish 23-102cm	Du Buit (1996)		1	North Celtic	0.0
	fish 23-102cm	Du Buit (1996)		1	Centre Celtic	0.0

	fish 23-102cm	Du Buit (1996)		1	South Celtic	0.0
	juvenile	Mahe et al. (2007)		1	Bay of Biscay and Celtic Sea	3.7
Cod	*Gadus morhua* age 1-7 yrs	Du Buit (1995)		1	Celtique, total area	0.4
	recruit mean 6cmTL	Robb (1981)	FB	1	northern NSea	0.0
	recruit mean 13.5 cmtTL	Greenstreet (1995)	FB	1	NSea Q=2	0.0
	1 yr old	Du Buit (1995)		1	Celtic Sea	230.0
	2 yr old	Du Buit (1995)		1	Celtic Sea	93.0
Haddock	*Melanogrammus aeglefinus*	Robb (1981)	FB	1	North Sea, Quarter=2	66.2
		Bowman et al. (2000a)	FB	1	Scotian Shelf USA	0.0
Sole	*Solea solea*	Costa (1988)	FB	1	Portugal	0.0
Plaice	*Pleuronectes platessus*	Fishbase	FB	2	general	0.0
Demersal L	*Anarhichas lupus*	Bowman et al. (2000b)	FB	1	Cape Hatteras Usa	0.0
Demersal L	*Argyrosomus regius*	Caverivière and Rabarison Andriamirado (1997)		1	Senegal	50.0
Demersal L	*Conger conger*	Morato (2000)		1	Azores	11.0
Demersal L	*Molva molva*	Svetovidov (1986)	FB	2	general	20.0
Demersal L	*Molva dypterygia*	Cohen et al. (1990)	FB	2	general	0.0
		Bergstad (1991)	FB	1	deep water Norway	5.1
Demersal L	*Phycis blennoides*	Sorbe (1977)		1	Bay of Biscay south	0.0
Demersal L	*Phycis phycis*	Morato et al. (1999)		1	Azores	9.5
Demersal L	*Pollachius virens*	Greenstreet (1995)		1	North Sea Q2	58.5
Demersal L	*Seriola dumerili*	Randall {, 1967 #3254}	FB	2	West Indies	0.0
		Bowman et al. (2000b)	FB	1	offshore Cape Hatteras, USA	67.6
Demersal L	*Sparus auratus*	Pita et al. (2002b)		1	Portugal, Algarve	0.0
Demersal L	*Zeus faber*	Stergiou and Fourtouni (1991)	FB	1		0.0
		Silva (1999)		1	Portugal	17.4
Pouts	*Trisopterus minutus*	Armstrong (1982)	FB	1	Isle of Man, UK	0.0
Pouts	*Trisopterus luscus*	Armstrong (1982)	FB	1	Isle of Man, UK	0.0
Pouts	*Trisopterus esmarkii*	Bergstad (1991)	FB	1	deep water Norway	0.6
Blue whiting	*Micromesistius poutassou*	Sorbe (1980)		1	Bay of Biscay	2.8
		Olaso and Rodriguez-Marin (1995)	FB	1	Spain, ICES VIIIc	2.1

Demersal M	*Pagellus erythrinus*	Olaso and Rodriguez-Marin (1995)	FB	1	Spain, ICES VIIIc	0.0
Demersal M	*Pagellus acarne*	Domanevskaya and Patokina (1984)	FB	1	Central eastern Atlantic	4.0
		Morato et al. (2001)		1	Azores	20.4
Demersal M	*Nezumia bairdi*	(Langton and Bowman 1980)	FB	1		0.0
Demersal M	*Mullus surmuletus*	Olaso and Rodriguez-Marin (1995)	FB	1	Spain, ICES VIIIc	0.0
Demersal M	*Platichthys flesus*	Gibson and Robb (1996)	FB	1	Scotland	13.9
Demersal M	*Aspitrigla cuculus*	Velasco et al. (1996)	FB	1	Spain, ICES VIIIc	5.8
Demersal M	*Capros aper*	Macpherson (1979)	FB	1	Med, Baleares	0.0
Demersal M	*Chelidonichthys lastoviza*	Richard et al. (1981)	FB	2	general	0.0
Demersal M	*Microstomus kitt*	Rae (1965)	FB	1	NW Scotland	0.0
Demersal M	*Lepidorhombus boscii*	Mannini et al. (1990)	FB	1	Tyrrhenian Sea	9.0
Demersal M	*Pegusa lascaris*	Desoutter (1990)	FB	1	general	0.0
Demersal M	*Cepola macrophthalma*	Stergiou (1993)		1	western Aegean Sea, Greece	0.0
Demersal M	*Callionymus lyra*	Fricke (1986)	FB	2	general	0.0
Demersal M	*Eutrigla gurnardus*	Moreno-Amich (1994)	FB	1	general	2.7
Demersal M	*Glyptocephalus cynoglossus*	Langton and Bowman (1981)	FB	1	general	4.6
Demersal M	*Dicologlossa cuneata*	Desoutter (1990)	FB	2	general	0.0
Demersal S	*Ammodytes marinus*	Reay (1986)	FB	1	general	0.0
Demersal S	*Agonus cataphractus*	Gibson and Robb (1996)	FB	1	Scotland	1.4
Demersal S	*Arnoglossus laterna*	Gibson and Ezzi (1987)	FB	1	Scotland	22.7
Demersal S	*Blennius ocellaris*	Zander (1986)	FB	2	Marseille	0.0
Demersal S	*Chromis chromis*	Bell and Harmelin-Vivien (1983)	FB	1	French Mediterranean	0.0
Demersal S	*Ctenolabrus rupestris*	Fjøsne and Gjøsæter (1996)	FB	1	Norway	7.1
Demersal S	*Mullus barbatus*	Labropoulou and Eleftheriou (1997)	FB	1	South Aegean Sea, Greece	0.0
Demersal S	*Apogon imberbis*	Pinnegar and Polunin (2000)	FB	1	Corsica	42.0

Demersal S	*Ammodytes tobianus*	Reay (1986)	FB	1	general	0.0
Demersal S	*Aphia minuta*	Maugé (1986)	FB	1	general	0.0
Demersal S	*Antigonia capros*	Karrer and Post 1990()	FB	1	general	0.0
Monkfish	*Lophius piscatorius*	Velasco et al. (1996)	FB	1	ICES VIIIc, Spain	7.1
		Crozier (1985)		1	N Irish sea	40.9
Bathy L	*Coryphaenoides rupestris*	Cohen et al. 1990()	FB	2	general	50.0
Bathy L	*Aphanopus carbo*	FB items	FB	2	Rockall Through'	25.0
Bathy L	*Anotopterus pharao*	Hart (1973)		2	Pacific Ocean, Canada	9.1
Bathy L	*Lepidopus caudatus*	Meyer and Smale (1991)	FB	1	S. Africa	2.3
Bathy L	*Beryx decadactylus*	Morato et al. (2000)		1	Azores	12.9
Megrim	*Lepidorhombus whiffiagonis*	(ICES 2007, Morte et al. 1999, Trenkel et al. 2005)	partially	1	Spain, Valencia	71.0
Bathy M	*Arctozenus risso*	Il'inskiy et al. (1995)	FB	1	Kuril Is, Pacific	1.6
Bathy M	*Argentina sphyraena*	Cohen (1984)	FB	2	general	33.3
Bathy M	*Argentina silus*	(Bowman and Michaels 1984)	FB	1	Gulf of Maine	41.2
Bathy M	*Alepocephalus rostratus*	Carrasson and Matallanas (1998)		1	Western Mediterranean Sea	0.0
Bathy S	*Argyropelecus hemigymnus*	Hopkins and Baird (1985)		1	Eastern Gulf of Mexico	0.0
Bathy S	*Maurolicus muelleri*	Gorelova and Krasil'nikova (1990)		1	Mount Discovery 1983	0.0
Bathy S	*Benthosema glaciale*	FB items	FB	2	general	0.0
Bathy S	*Argyropelecus hemigymnus*	Hopkins and Baird (1985)		1	Eastern Gulf of Mexico	0.0

[a]. 1= quantitative, 2= qualitative, 3= importance index

[b] FB if data were taken directly in Fishbase (Froese and Pauly 2012)

Table S2.2 Source and type of marine mammal diet by species.

Latin name	Common name	Reference	Type
Balaenoptera acutorostrata	Minke whale	Lindstrøm et al. (1998)	quantitative
Megaptera novaengliae	Humpback whale	Perry et al. (1999)	qualitative
Balaenoptera borealis	Sei whale	Perry et al. (1999)	qualitative
Balaenoptera physalus	Fin whale	Perry et al. (1999)	qualitative
Balaenoptera musculus	Blue whale	Perry et al. (1999)	qualitative
Physeter macrocephalus	Sperm whale	Martin and Clarke (1986)	quantitative
Halichoerus grypus	Grey seal	Ridoux et al. (2007)	quantitative
Phocoena phocoena	Harbour porpoise	Bundy et al. (2000)	quantitative
Delphinus delphis	Common dolphin	Meynier et al. (2008)	quantitative
Stenella coeruleoalba	Striped dolphin	ICES (2008)	qualitative
Grampus griseus	Risso's dolphin	ICES (2008)	qualitative
Lagenorhynchus albirostris	White-beaked dolphin	ICES (2008)	qualitative
Lagenorhynchus acutus	Atlantic white-sided dolphin	ICES (2008)	qualitative
Tursiops truncatus	Bottlenose dolphin	ICES (2008)	qualitative

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Supplementary material Table S3 - Diet matrix of the Celtic/Biscay 1980 Ecopath model

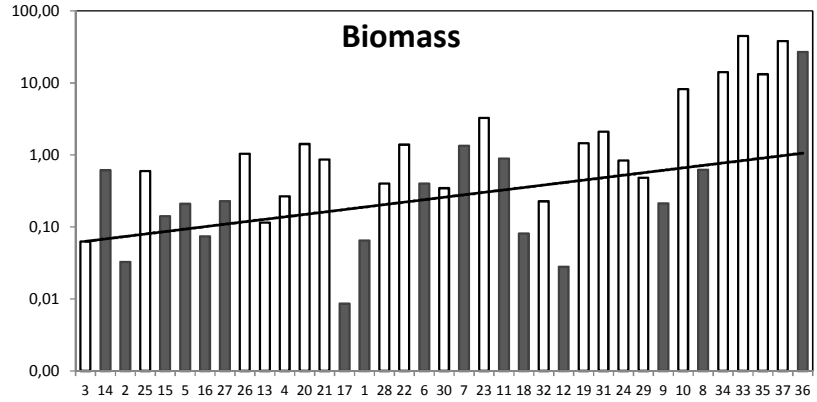
	Prey \ predator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Baleen whales			0,010														
2	Toothed whales			0,032														
3	Sharks L		0,006	0,020														
4	sharks/rays		0,006	0,044	0,000												0,046	
5	Whiting		0,005	0,006	0,004									0,020	0,001	0,008	0,003	0,000
6	Mackerel	0,020	0,018	0,042	0,001	0,002								0,001	0,090		0,008	
7	Horse mackerel		0,021	0,037	0,004	0,050		0,007						0,070	0,180	0,230	0,022	
8	Anchovy	0,020	0,010	0,012	0,001		0,005	0,000			0,001			0,040	0,015	0,021		
9	Sardine		0,056	0,006	0,009	0,010	0,070	0,017			0,026			0,057	0,090	0,049		
10	Sprat		0,018	0,006	0,015	0,050	0,026	0,024				0,050		0,040	0,020		0,004	0,007
11	Herring	0,142	0,047	0,001	0,009	0,002	0,001	0,000				0,004		0,099	0,005		0,006	0,001
12	Pelagic M	0,050	0,046	0,015	0,005	0,022		0,005						0,109	0,001	0,008		
13	Pelagic L		0,010	0,110	0,001									0,029	0,005			
14	Hake			0,041	0,004										0,077			
15	Hake juv		0,010		0,002										0,048	0,045		0,014
16	Cod		0,003		0,001										0,000			0,005
17	Cod juv														0,001	0,000	0,000	
18	Sole		0,005		0,002	0,003											0,016	
19	Plaice		0,001		0,000	0,001											0,005	
20	Demersal L		0,007	0,011	0,005	0,014	0,001	0,009							0,001	0,012	0,005	0,008
21	Pouts		0,103	0,002	0,007	0,350		0,008				0,010			0,200	0,033	0,190	0,006
22	Blue whiting		0,077	0,002	0,008	0,090	0,008	0,002				0,010			0,100	0,122	0,035	
23	Demersal M		0,031	0,082	0,074	0,050	0,008	0,005					0,000	0,026	0,060	0,080	0,076	0,020
24	Demersal S	0,090	0,158	0,083	0,100	0,017	0,017	0,010				0,089	0,053	0,090	0,008	0,089	0,125	0,363
25	Monkfish		0,037	0,038	0,005												0,005	
26	Bathy L			0,012	0,005										0,000			
27	Megrim			0,012	0,008		0,003								0,001		0,000	
28	Bathy M		0,039	0,010	0,001	0,020	0,002								0,016	0,020	0,003	
29	Bathy S		0,006	0,009	0,084	0,033	0,076	0,016					0,031		0,006	0,015		
30	Cephalopods	0,052	0,262	0,239	0,144	0,027	0,067	0,040				0,004	0,004	0,148	0,001		0,007	0,001
31	Lobsters/crabs			0,009	0,010			0,035									0,043	0,000
32	Shrimps/crabs		0,000	0,071	0,296	0,014		0,035			0,006	0,075	0,032	0,014	0,010	0,115	0,310	0,086
33	Benthos			0,014	0,098			0,101			0,001	0,052	0,144	0,084	0,004	0,009	0,090	0,136
34	Zooplankton L	0,466		0,001	0,064	0,077	0,464	0,252	0,300		0,297	0,325	0,391			0,144		0,174
35	Zooplankton S	0,160			0,026		0,206	0,233	0,700	1,000	0,669	0,376	0,345	0,083				0,178
36	Phytoplankton																	
37	Benthic produc.											0,005		0,014				
38	Detritus			0,001	0,004	0,078												
39	Import		0,018	0,021	0,003	0,090	0,047	0,201					0,000	0,077	0,061			

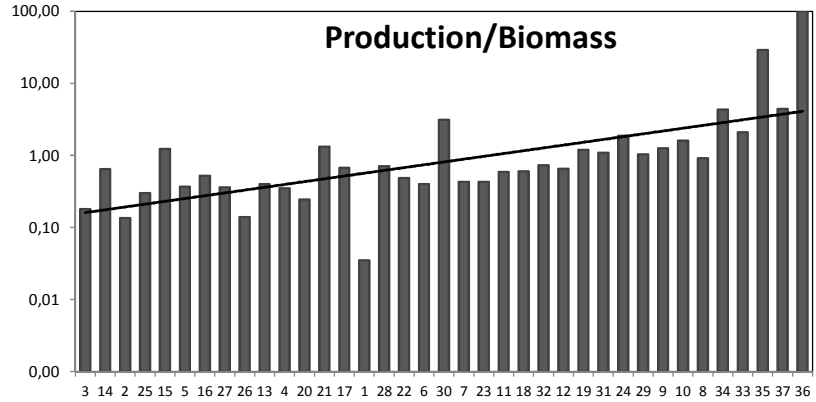
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1																		
2																		
3																		
4								0,025										
5			0,007					0,000										
6								0,000	0,001	0,010								
7				0,000				0,026										
8				0,000	0,004	0,000			0,010		0,003		0,002					
9				0,000				0,001	0,017		0,007		0,011					
10				0,000				0,002		0,020	0,007		0,005					
11				0,000				0,020					0,001					
12			0,009										0,003					
13			0,000															
14									0,015									
15									0,005									
16								0,002										
17			0,002					0,000										
18			0,002	0,001		0,000		0,001										
19			0,002	0,000		0,000		0,000										
20			0,021					0,031	0,010	0,010				0,002				
21				0,008				0,066										
22					0,010			0,051	0,025									
23			0,090	0,007	0,012	0,000		0,205	0,033	0,235				0,002	0,000			
24			0,100	0,027	0,121	0,007	0,002	0,072	0,150	0,185	0,028		0,040					
25			0,005						0,000									
26			0,006					0,056	0,010									
27			0,007					0,003										
28			0,032		0,005	0,003		0,010	0,050	0,030			0,003					
29			0,002		0,033	0,002		0,068	0,228	0,235	0,094	0,000	0,097	0,010				
30			0,003	0,010		0,003		0,027	0,131	0,060	0,036		0,015					
31			0,007	0,100	0,040	0,007	0,025	0,057	0,044		0,030	0,000		0,020				
32	0,120		0,174	0,440	0,093	0,174	0,161	0,071	0,154	0,215	0,233	0,000	0,110	0,050	0,050			
33	0,880	1,000	0,241	0,074	0,050	0,390	0,464	0,008	0,044		0,190	0,549	0,683	0,214	0,600	0,020		
34			0,043	0,269	0,572	0,317	0,034		0,073		0,322	0,058	0,030	0,563	0,050	0,050		
35			0,001	0,062	0,061	0,096	0,193		0,000		0,050	0,393		0,040	0,030	0,280	0,500	0,020
36							0,122									0,100	0,400	0,900
37						0,000								0,020	0,020	0,050		
38			0,001			0,001								0,080	0,250	0,500	0,100	0,080
39			0,245					0,196										

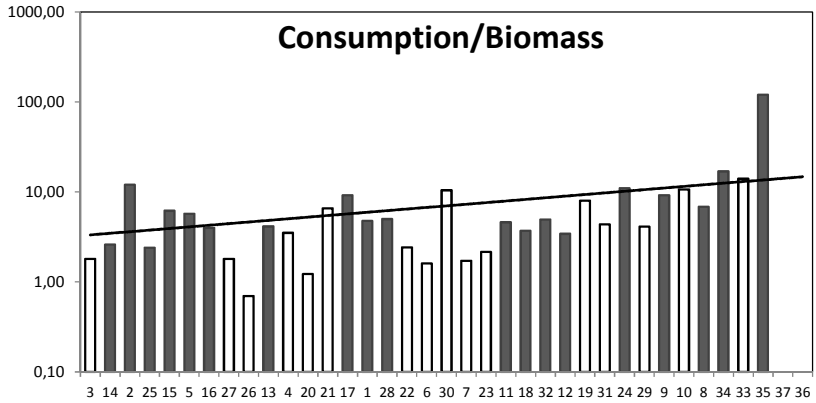
Table S4 - Parameters of the 1980 Ecopath model of the Celtic/Biscay ecosystem (values in bold were estimated by Ecopath). Y is the catch in t/km^2; Acces. is the accessibility to the fishery used in Ecotroph

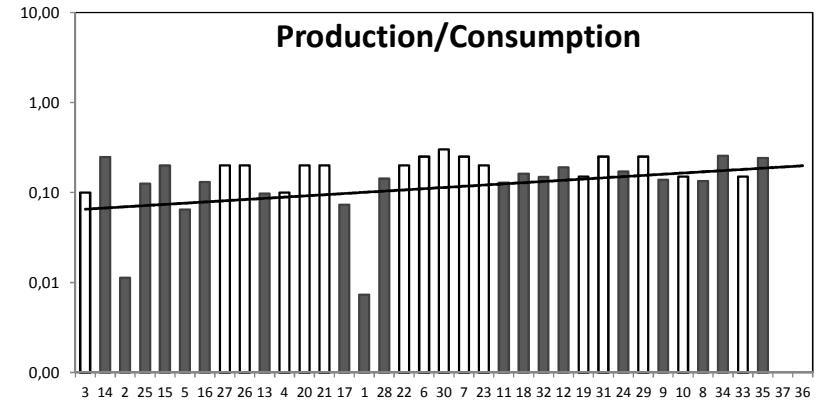
	Group name	TL	B	P/B	Q/B	EE	P/Q	Y1980	Acces.
1	Baleen whales	**3.78**	0.065	0.035	4.775	**0.362**	**0.007**	0	0.0
2	Toothed whales	**4.60**	0.033	0.135	11.998	**0.598**	**0.011**	0	0.0
3	Sharks L	**4.75**	**0.046**	0.18	**1.8**	0.8	0.1	0.003	0.6
4	sharks/rays	**4.14**	**0.248**	0.35	**3.5**	0.8	0.1	0.018	0.6
5	Whiting	**4.33**	0.089	0.9	5.708	**0.942**	**0.158**	0.045	0.8
6	Mackerel	**3.64**	3.2	0.39	**1.56**	**0.904**	0.25	0.942	0.4
7	Horse mackerel	**3.57**	2.0	0.27	**1.08**	**0.812**	0.25	0.118	0.4
8	Anchovy	**3.17**	0.03	1.8	9.13	**0.951**	**0.197**	0.010	0.8
9	Sardine	**3.02**	0.549	1.45	6.8	**0.889**	**0.213**	0.076	0.8
10	Sprat	**3.20**	**0.401**	1.03	**4.12**	0.95	0.25	0.058	0.8
11	Herring	**3.49**	0.131	0.82	4.59	**0.925**	**0.179**	0.040	0.8
12	Pelagic M	**3.41**	**0.204**	0.73	4.92	0.95	**0.148**	0.006	0.4
13	Pelagic L	**4.19**	**0.098**	0.4	4.13	0.90	**0.097**	0.006	0.4
14	Hake	**4.68**	0.230	0.83	2.6	**0.964**	**0.319**	0.121	0.6
15	Hake juv	**4.35**	0.067	1.05	5.655	**0.968**	**0.186**	0.004	0.4
16	Cod	**4.34**	0.044	0.67	4	**0.894**	**0.168**	0.021	0.8
17	Cod juv	**3.82**	0.008	0.67	8.595	**0.952**	**0.078**	0.001	0.6
18	Sole	**3.47**	0.1	0.45	3.7	**0.784**	**0.122**	0.019	0.8
19	Plaice	**3.39**	0.038	0.44	3.42	**0.934**	**0.129**	0.009	0.8
20	Demersal L	**3.98**	**1.258**	0.244	**1.22**	0.90	0.2	0.122	0.6
21	Pouts	**3.84**	**0.455**	1.316	**6.58**	0.95	0.2	0.032	0.6
22	Blue whiting	**3.71**	**0.870**	0.484	**2.42**	0.95	0.2	0.042	0.4
23	Demersal M	**3.53**	**2.011**	0.538	**2.69**	0.95	0.2	0.105	0.4
24	Demersal S	**3.28**	**1.547**	1.09	**4.36**	0.95	0.25	0.008	0.05
25	Monkfish	**4.55**	**0.614**	0.3	2.4	0.80	**0.125**	0.117	0.8
26	Bathy L	**4.27**	**0.946**	0.14	**0.7**	0.90	0.2	0.016	0.1
27	Megrim	**4.32**	0.290	0.4	**2**	**0.810**	0.2	0.057	0.6
28	Bathy M	**3.75**	0.350	0.71	5	**0.846**	**0.142**	0.003	0.05
29	Bathy S	**3.25**	1.220	1.87	10.97	**0.738**	**0.170**	0	0.0
30	Cephalopods	**3.62**	**0.404**	3.12	**10.4**	0.90	0.30	0.029	0.1
31	Lobsters/crabs	**3.37**	**1.148**	1.2	**8**	0.90	0.15	0.189	0.4
32	Shrimps/crabs	**3.04**	**8.129**	1.6	**10.667**	0.80	0.15	0.008	0.02
33	Benthos	**2.39**	**44.458**	2.1	**14**	0.90	0.15	0.071	0.01
34	Zooplankton L	**2.51**	14.200	4.3	16.9	**0.827**	**0.254**	0	0.0
35	Zooplankton S	**2.02**	13.500	29	120	**0.880**	**0.242**	0	0.0
36	Phytoplankton	1	27	100	0	**0.599**		0	0.0
37	Benthic produc.	1	**37.720**	4.4	0	0.2		0.146	0.02
38	Detritus	1	130			**0.228**		0	

Figure S5 – PREBAL diagnostic (according to Link, 2010) of the 2012 Ecopath model of the Celtic/Biscay ecosystem (black column for values entered in Ecopath, white for values estimated by Ecopath; see group names on table S4).









The PREBAL diagnostic does not reveal major inconsistency, according to the "rule of thumb" defined by Link (2010). On graphs, Ecopath trophic boxes are ordered by decreasing trophic levels, highlighting an overall increase in biomass, in productivity ratio P/B, in consumption rate Q/B, and in gross efficiency P/Q, for low TLs.

Compared to the mean trend, the low biomass of groups such as cod juvenile (17) or medium pelagics (12, which is a group of 'others', which does not include any of the main small pelagics) are logical, as well as the rather high biomass estimated for large groups such as bathy-demersals L (26), demersals M (23), benthos (33) or benthic producers (37).

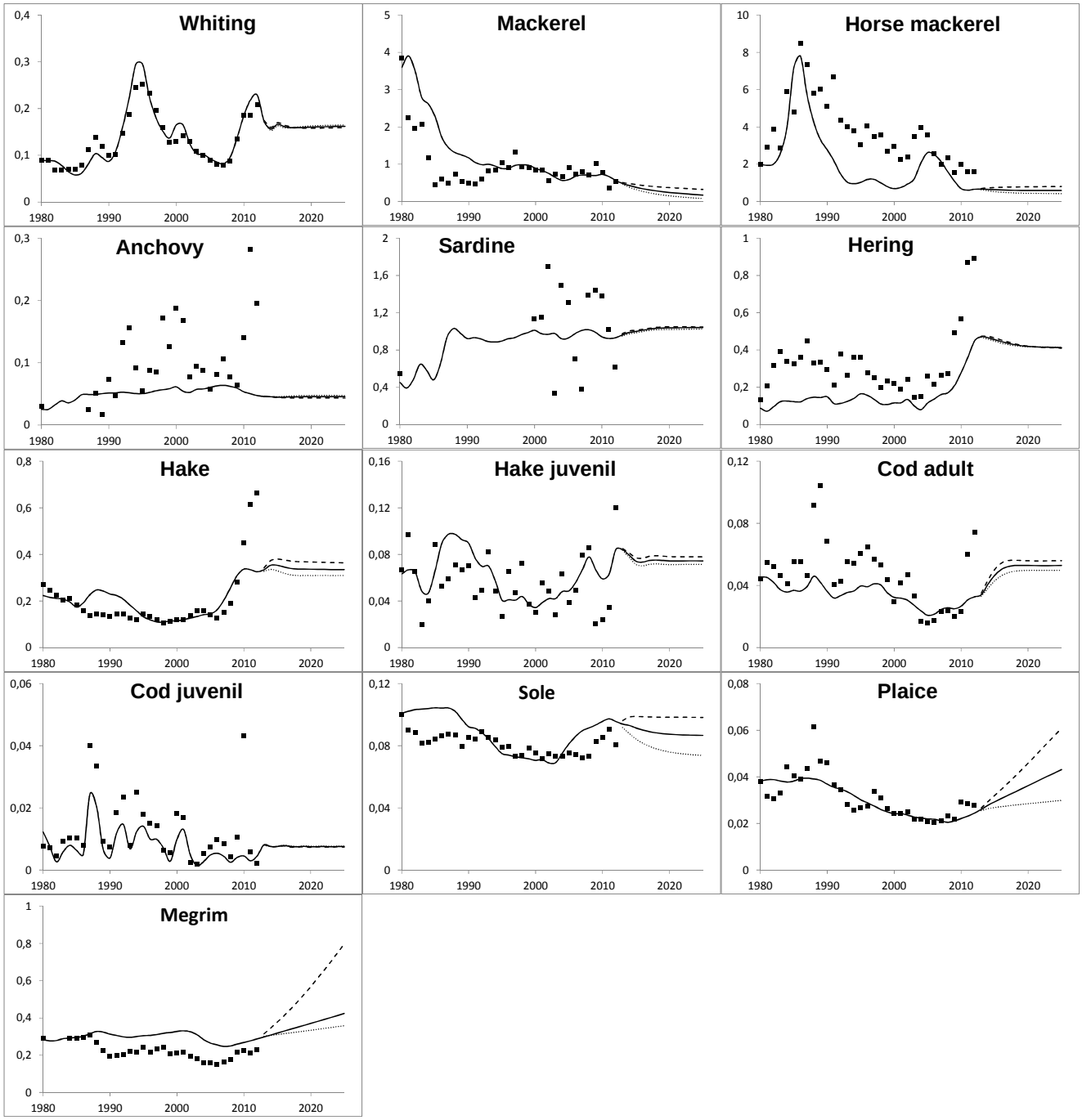
Ratios of productivity P/B follow the general trend, with productivities which are logically low for baleen whales (1) and very high for small zooplankton (35) and phytoplankton (36).

Consumption rates Q/B do not exhibit major discrepancies, with high values for small zooplankton (35), and low estimates for large demersals (20) and bathy-demersals (26). Ratios are also rather small for mackerel (6) and horse mackerel (7), due to high values of P/Q assumed in the model as a compromise during the balancing process. Finally Q/B appears high for toothed whales, but due to the very low biomass of this group, consequences on the whole model should be negligible.

Logically, P/Q ratios are small for whales (1 and 2). Estimates values appear consistent.

Figure S6 - Trends in biomass (top) and catch (bottom) fitted in the 1980/2012 Ecosim model (final run using fishing mortalities F as forcing function and recruitment as environmental anomalies; see text) and simulations 2013-2015. Dots: data from ICES stocks assessments and Statlant; lines: Ecosim estimates and status quo scenario; dot-lines: scenario of increased fishing mortalities (+20%); large dot-line scenario of decreased fishing mortalities (-20%).

Biomass



Catch

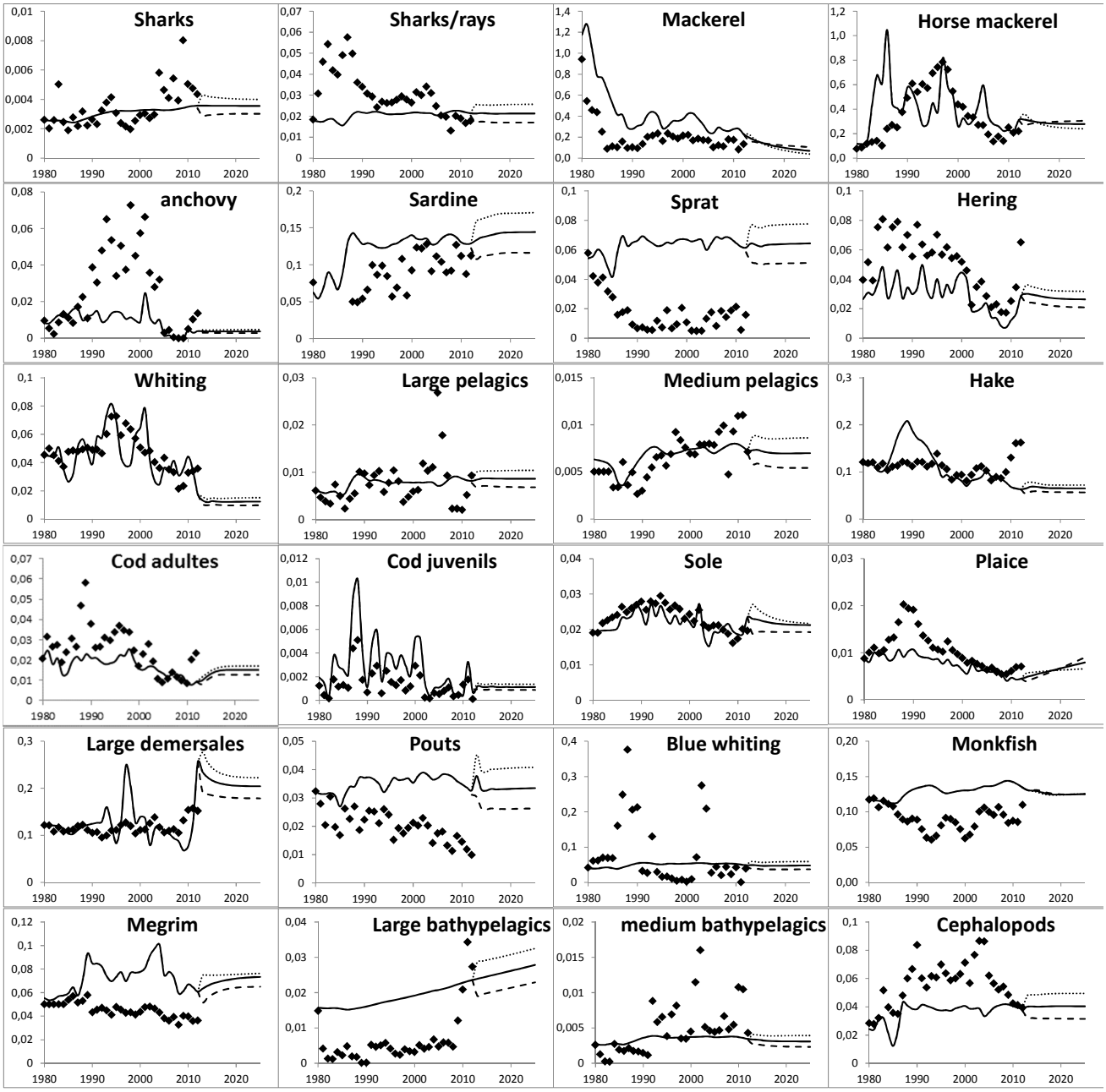

Sharks
Sharks/rays
Mackerel
Horse mackerel
anchovy
Sardine
Sprat
Hering
Whiting
Large pelagics
Medium pelagics
Hake
Cod adultes
Cod juvenils
Sole
Plaice
Large demersales
Pouts
Blue whiting
Monkfish
Megrim
Large bathypelagics
medium bathypelagics
Cephalopods

Figure S7 - Outputs of the Celtic/Biscay Ecosim model. for the exploited functional groups: (a) ratios of biomasses B2012/B1980. from surveys data (referred to as observed) and from the Ecosim model fitted to time series; (b) ratios of catch Y2012/Y1980