Mediterranean demersal resources and ecosystems: 25 years of MEDITS trawl surveys
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Scientia Marina 83S1
December 2019, S1-S7, Barcelona (Spain)
ISSN-L: 0214-8358

Stability of the relationships among demersal fish assemblages and environmental-trawling drivers at large spatio-temporal scales in the northern Mediterranean Sea

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Supplementary material

Table S1. – Number (n) of hauls analyzed per Geographical Sub-Areas (GSA). N=18062 hauls sampled between 1999 and 2015 within the 17 GSAs (see Fig.1 for map of locations and GSA names).

GSA	1	5	6	7	8	9	10	11	15	16	17	18	19	20	22	23	25
n hauls	706	814	1126	1072	360	2122	1233	1739	492	1440	2778	1594	1199	367	650	190	180

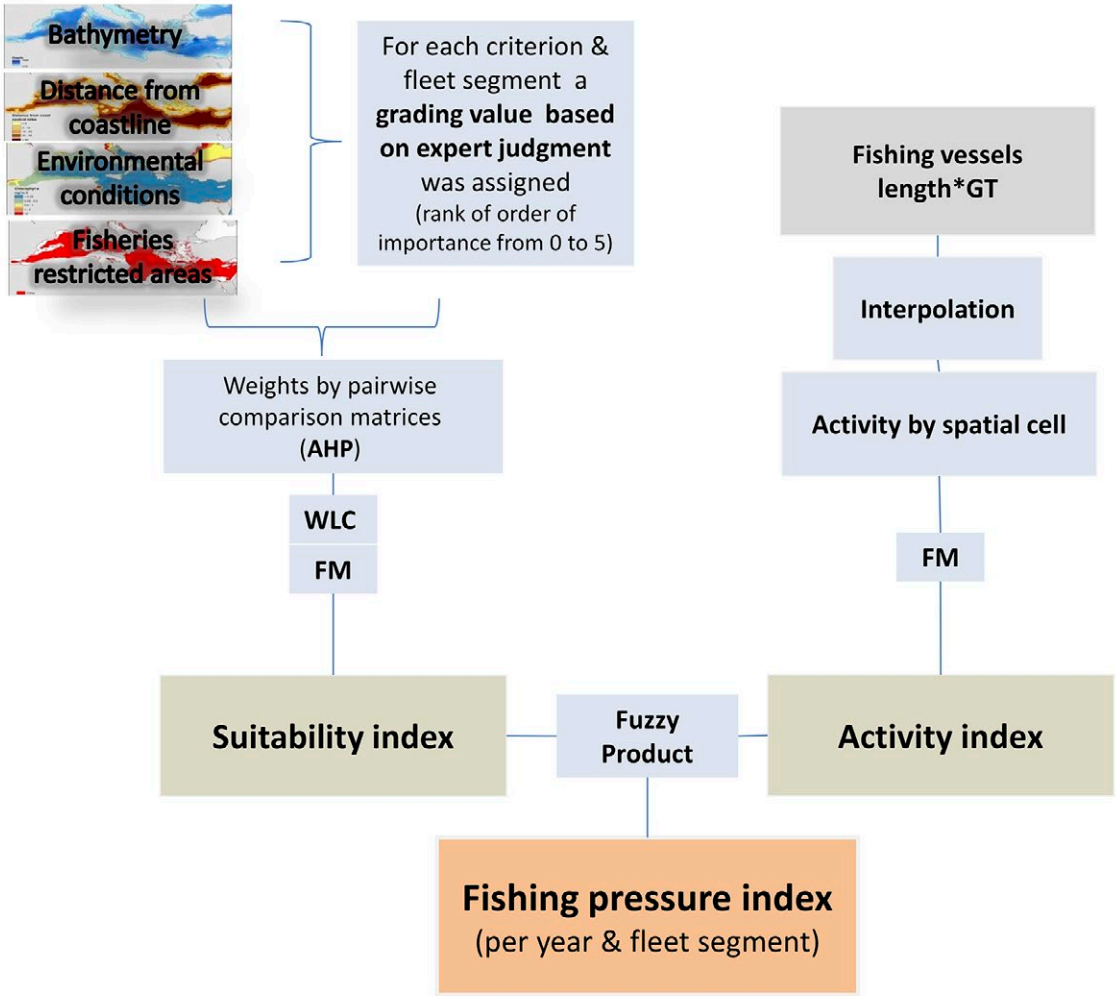

Fig. S1. – Flowchart of the Multi-Criteria Decision Analysis (MCDA) used to compute the Fishing Pressure Index (FPI). AHP, Analytic Hierarchy Process; WLC, Weighted Linear Combination; FM, linear Fuzzy Membership function; GT, Gross Tonnage.

Table S2. – List of the 154 species included in the study. Species codes used in figures corresponds to the first four letters of the genus name and the first three letters of the species name.

Acantholabrus palloni (Risso, 1810)
Alepocephalus rostratus Risso, 1820
Anthias anthias (Linnaeus, 1758)
Aphia minuta (Risso, 1810)
Argentina sphyraena Linnaeus, 1758
Argyropelecus hemigymnus Cocco, 1829
Arnoglossus imperialis (Rafinesque, 1810)
Arnoglossus laterna (Walbaum, 1792)
Arnoglossus rueppelii (Cocco, 1844)
Arnoglossus thori Kyle, 1913
Aulopus filamentosus (Bloch, 1792)
Bathypterois dubius Vaillant, 1888
Bathysolea profundicola (Vaillant, 1888)
Bellottia apoda Giglioli, 1883
Benthocometes robustus (Goode and Bean, 1886)
Blennius ocellaris Linnaeus, 1758
Bothus podas (Delaroche, 1809)
Buglossidium luteum (Risso, 1810)
Callionymus lyra Linnaeus, 1758
Callionymus maculatus Rafinesque, 1810
Callionymus risso Lesueur, 1814
Capros aper (Linnaeus, 1758)
Carapus acus (Brünnich, 1768)
Cataetyx alleni (Byrne, 1906)
Centracanthus cirrus Rafinesque, 1810
Centrolophus niger (Gmelin, 1789)
Centrophorus granulosus (Bloch and Schneider, 1801)
Centrophorus uyato (Rafinesque, 1810)
Cepola macrophthalma Linnaeus, 1758
Chelidonichthys cuculus (Linnaeus, 1758)
Chelidonichthys lucerna (Linnaeus, 1758)
Chelidonichthys obscurus (Walbaum, 1792)
Chimaera monstrosa Linnaeus, 1758
Chlorophthalmus agassizi Bonaparte, 1840
Citharus linguatula (Linnaeus, 1758)
Coelorinchus caelorhincus (Risso, 1810)
Dalatias licha (Bonnaterre, 1788)
Dasyatis pastinaca (Linnaeus, 1758)
Deltentosteus quadrimaculatus (Valenciennes, 1837)
Dentex dentex (Linnaeus, 1758)
Dicologlossa hexophthalma (Bennett, 1831)
Diplodus annularis (Linnaeus, 1758)
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)
Dipturus oxyrinchus (Linnaeus, 1758)
Dysomma brevirostre (Facciolà, 1887)
Echiodon dentatus (Cuvier, 1829)
Epigonus constanciae (Giglioli, 1880)
Epigonus denticulatus Dieuzeide, 1950
Epigonus telescopus (Risso, 1810)
Etmopterus spinax (Linnaeus, 1758)
Eutelichthys leptochirus Tortonese, 1959
Eutrigla gurnardus (Linnaeus, 1758)
Gadella maraldi (Risso, 1810)
Gadiculus argenteus Guichenot, 1850
Gaidropsarus biscayensis (Collett, 1890)
Gaidropsarus mediterraneus (Linnaeus, 1758)
Galeorhinus galeus (Linnaeus, 1758)
Galeus atlanticus (Vaillant, 1888)
Galeus melastomus Rafinesque, 1810
Glossanodon leioglossus (Valenciennes, 1848)
Gnathophis mystax (Delaroche, 1809)
Gobius niger Linnaeus, 1758
Gonostoma denudatum Rafinesque, 1810
Gymnura altavela (Linnaeus, 1758)
Helicolenus dactylopterus (Delaroche, 1809)
Heptranchias perlo (Bonnaterre, 1788)
Hexanchus griseus (Bonnaterre, 1788)
Hoplostethus mediterraneus mediterraneus Cuvier, 1829
Hymenocephalus italicus Giglioli, 1884
Lepidopus caudatus (Euphrasen, 1788)
Lepidorhombus boscii (Risso, 1810)
Lepidorhombus whiffiagonis (Walbaum, 1792)
Lepidotrigla cavillone (Lacepède, 1801)
Lepidotrigla dieuzeidei Blanc and Hureau, 1973
Lesueurigobius friesii (Malm, 1874)
Lesueurigobius sanzi (De Buen, 1918)
Lesueurigobius suerii (Risso, 1810)
Pegusa impar (Bennett, 1831)
Pegusa lascaris (Risso, 1810)
Peristedion cataphractum (Linnaeus, 1758)
Phycis blennoides (Brünnich, 1768)
Physiculus dalwigki Kaup, 1858
Platichthys flesus (Linnaeus, 1758)
Polyprion americanus (Bloch and Schneider, 1801)
Pomatoschistus marmoratus (Risso, 1810)
Raja asterias Delaroche, 1809
Raja brachyura Lafont, 1873
Raja clavata Linnaeus, 1758
Raja miraletus Linnaeus, 1758
Raja montagui Fowler, 1910
Raja polystigma Regan, 1923
Rostroraja alba (Lacepède, 1802)
Schedophilus ovalis (Cuvier, 1833)
Scophthalmus maximus (Linnaeus, 1758)
Scophthalmus rhombus (Linnaeus, 1758)
Scorpaena elongata Cadenat, 1943
Scorpaena loppei Cadenat, 1943
Scorpaena notata Rafinesque, 1810
Scorpaena porcus Linnaeus, 1758
Scorpaena scrofa Linnaeus, 1758
Scyliorhinus canicula (Linnaeus, 1758)
Scyliorhinus stellaris (Linnaeus, 1758)
Leucoraja circularis (Couch, 1836)
Leucoraja fullonica (Linnaeus, 1758)
Leucoraja melitensis (Clarck, 1926)
Leucoraja naevus (Müller and Henle, 1841)
Lophius spp. Linnaeus, 1758
Macroramphosus scolopax (Linnaeus, 1758)
Maurolicus muelleri (Gmelin, 1789)
Merluccius merluccius (Linnaeus, 1758)
Microchirus ocellatus (Linnaeus, 1758)
Microchirus variegatus (Donovan, 1808)
Micromesistius poutassou (Risso, 1826)
Molva dypterygia (Pennant, 1784)
Molva molva (Linnaeus, 1758)
Monochirus hispidus Rafinesque, 1814
Mora moro (Risso, 1810)
Mullus barbatus barbatus Linnaeus, 1758
Mustelus asterias Cloquet, 1821
Mustelus mustelus (Linnaeus, 1758)
Myctophum punctatum Rafinesque, 1810
Nettastoma melanurum Rafinesque, 1810
Nezumia sclerorhynchus (Valenciennes, 1838)
Oxynotus centrina (Linnaeus, 1758)
Pagellus acarne (Risso, 1827)
Pagellus bogaraveo (Brünnich, 1768)
Pagellus erythrinus (Linnaeus, 1758)
Pagrus pagrus (Linnaeus, 1758)
Serranus cabrilla (Linnaeus, 1758)
Serranus hepatus (Linnaeus, 1758)
Solea solea (Linnaeus, 1758)
Spondyliosoma cantharus (Linnaeus, 1758)
Squalus acanthias Linnaeus, 1758
Squalus blainville (Risso, 1827)
Squatina aculeata Cuvier, 1829
Squatina squatina (Linnaeus, 1758)
Symbolophorus veranyi (Moreau, 1888)
Symphurus ligulatus (Cocco, 1844)
Symphurus nigrescens Rafinesque, 1810
Synapturichthys kleinii (Risso, 1827)
Synchiropus phaeton (Günther, 1861)
Synodus saurus (Linnaeus, 1758)
Torpedo marmorata Risso, 1810
Torpedo nobiliana Bonaparte, 1835
Torpedo torpedo (Linnaeus, 1758)
Trachinus araneus Cuvier, 1829
Trachinus draco Linnaeus, 1758
Trachinus radiatus Cuvier, 1829
Trachyrincus scabrus (Rafinesque, 1810)
Trigla lyra Linnaeus, 1758
Trigloporus lastoviza (Bonnaterre, 1788)
Trisopterus capelanus Lacepède, 1880
Uranoscopus scaber Linnaeus, 1758
Zeus faber Linnaeus, 1758

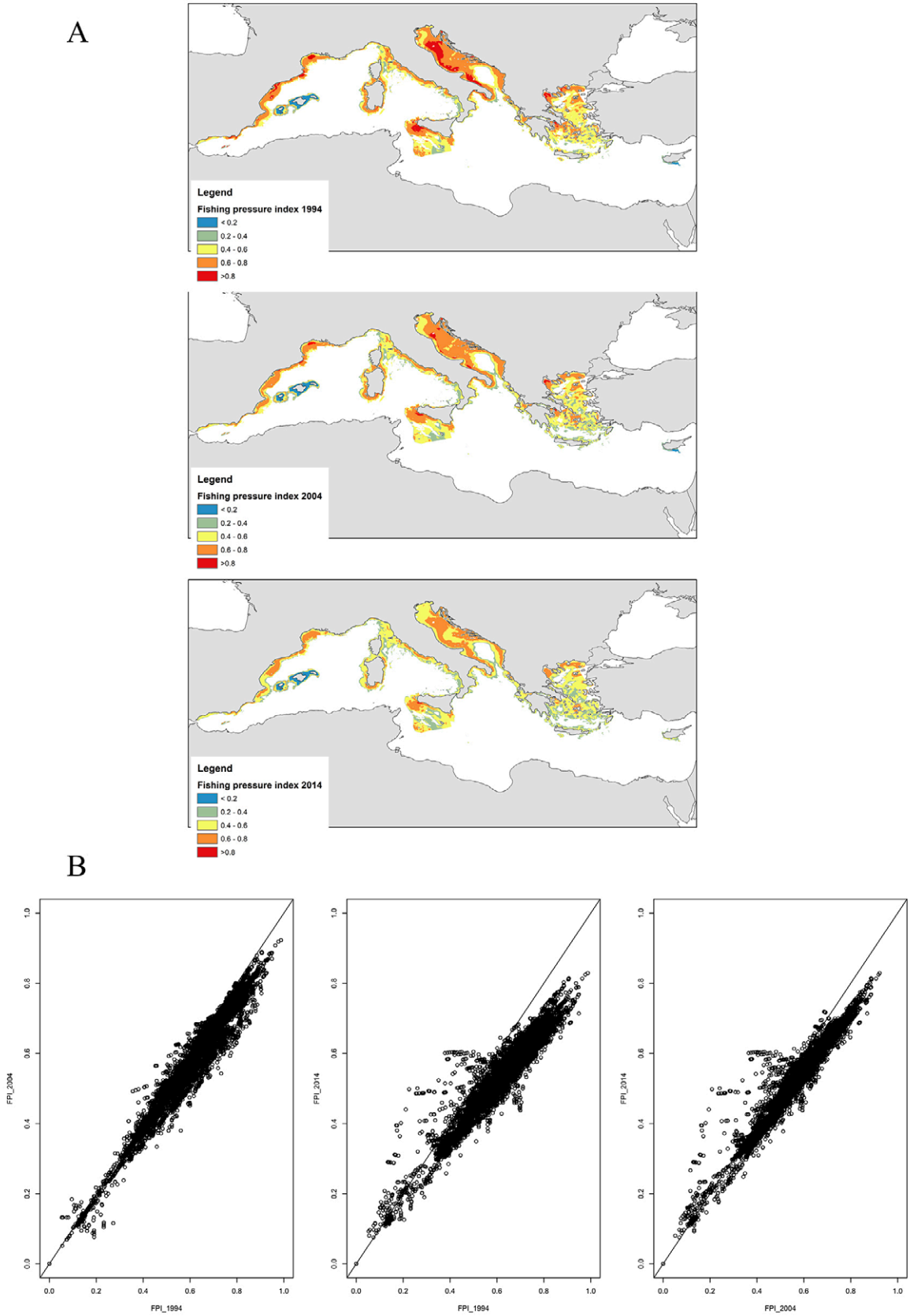

Fig. S2. – Fishing Pressure Index (FPI). A, maps for years 1994, 2004 and 2014. B, pairwise relationships of FPI among the three years 1994, 2004 and 2014. FPI values were generated for haul locations provided in Fig. 1 of the article. The black line represents the first bisector for which x=y (i.e same FPI values among the two years considered). See the Material and Methods section of the article for more details about the FPI computation.

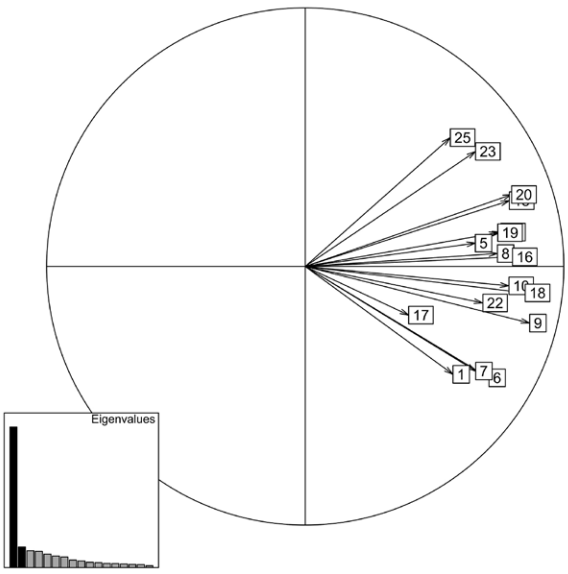

Fig. S3. – Projection of each Geographical Sub-Area (GSA) on the two first factorial axes of the STATICO-CoA inter-structure (axis 1: horizontal, 51.56%; axis 2: vertical, 7.51%), with barplot showing the eigenvalues of each axis. Correspondence between GSA numbers and their names is given in Figure 1. Note that for this kind of multi-tables analysis, only axis 1 of the inter-structure has a meaning for the construction of the compromise, and is thus used to determine the contribution of tables to the compromise. The other axes are not used for that purpose, and should not be interpreted (axis 2 is used for display purpose).

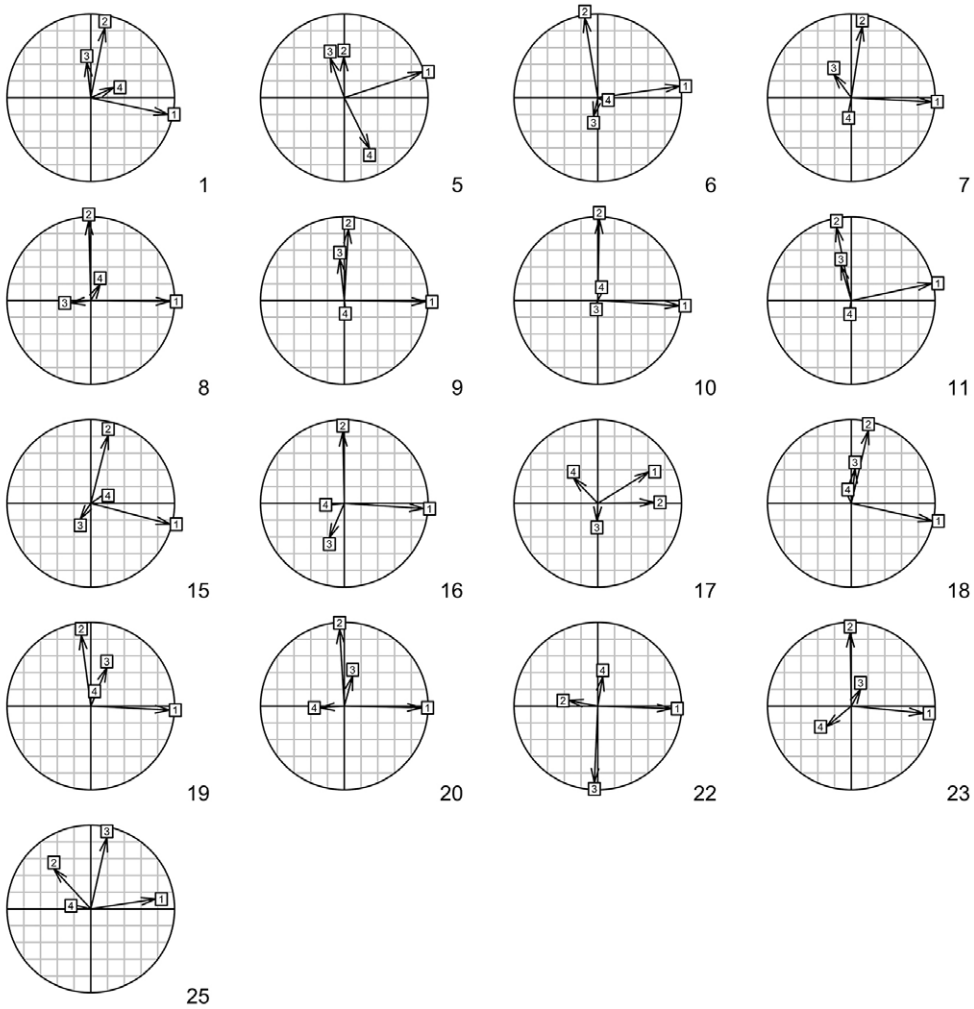

Fig. S4. – Projection of the four factorial axes (arrows) of the separate Correspondence Analysis of each Geographical Sub-Area (GSA) on the two first factorial axes of the STATICO-CoA compromise (axis 1: horizontal; axis 2: vertical). Correspondence between GSA numbers and their names is given in Figure 1.

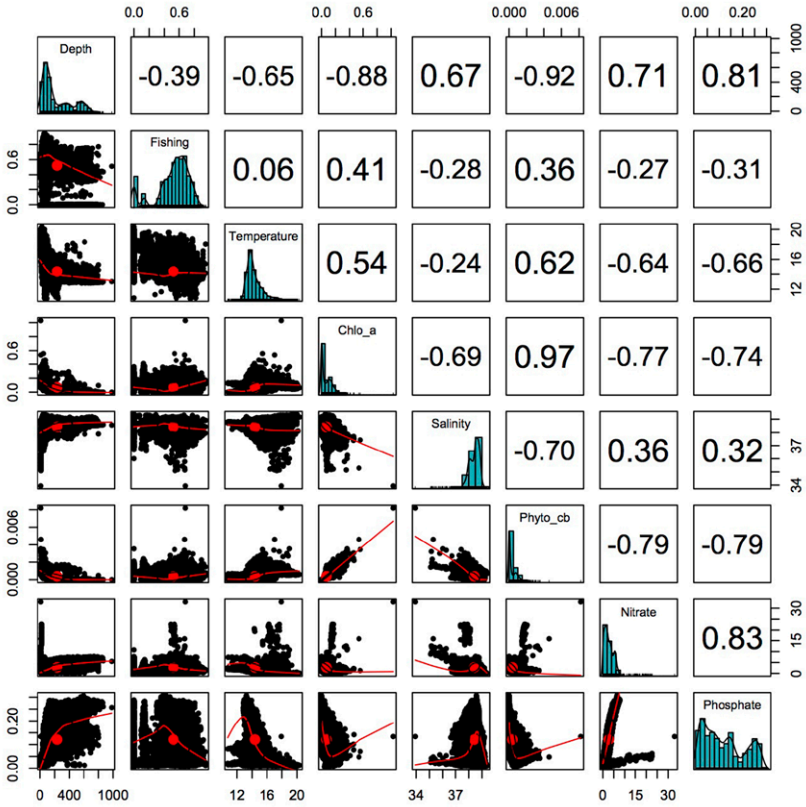

Fig. S5. – Draftsman plot of the eight environmental and trawling variables (Spearman correlation coefficient).

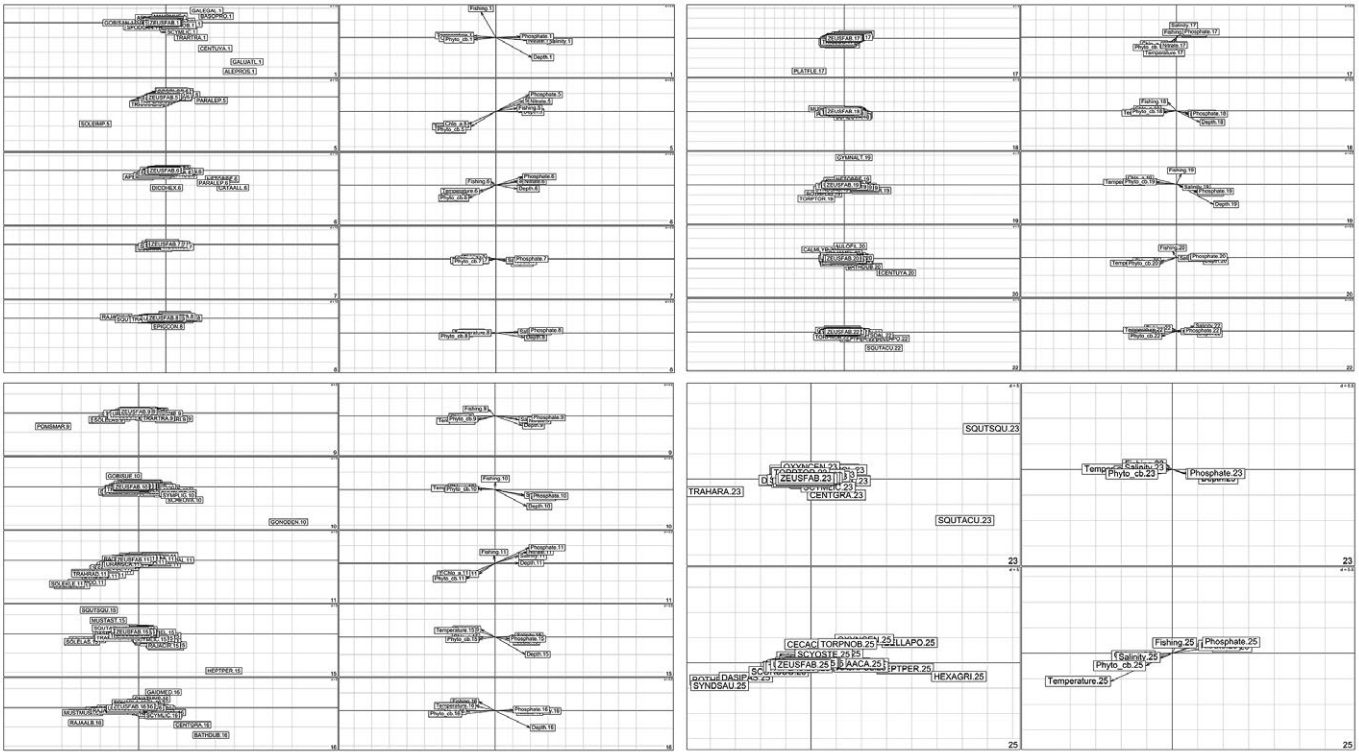

Fig. S6. – Plots for each Geographical Sub-Area (GSA) of the STATICO-CoA analysis: in the left column, projection of the eight environmental and trawling variables on the first factorial plane, and in the right column, projection of the average positions of species. Correspondence between GSA numbers and their names is given in Figure 1.

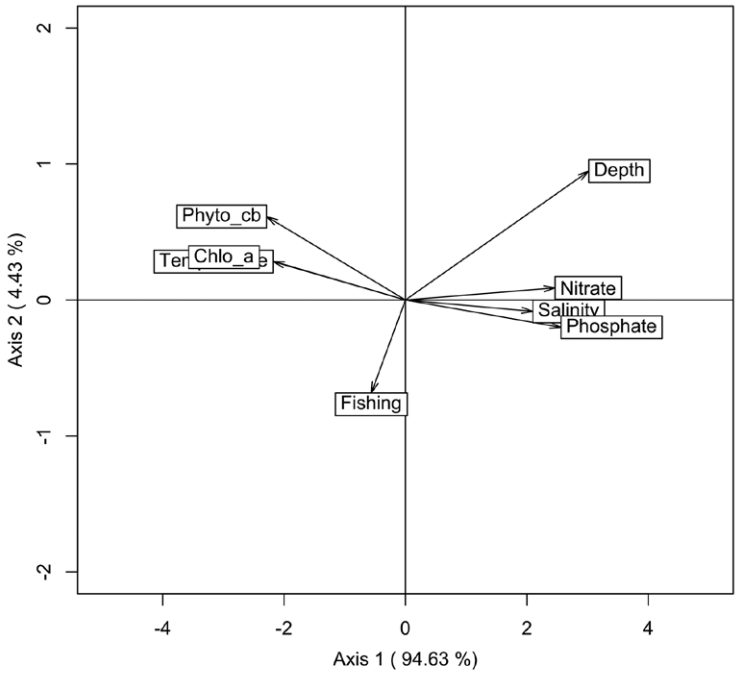

Fig. S7. – Projections of environmental and trawling variables on the compromise of the STATICO-CoA analysis based on a data set of 71 species (without 83 rare species, i.e. those present in less than 5% of the hauls). It shows the stable part of the species-environment- trawling relationships. Axis 1 and 2 explained 94.63% and 4.43% of the total variability, respectively. Species names are provided in Table S2.

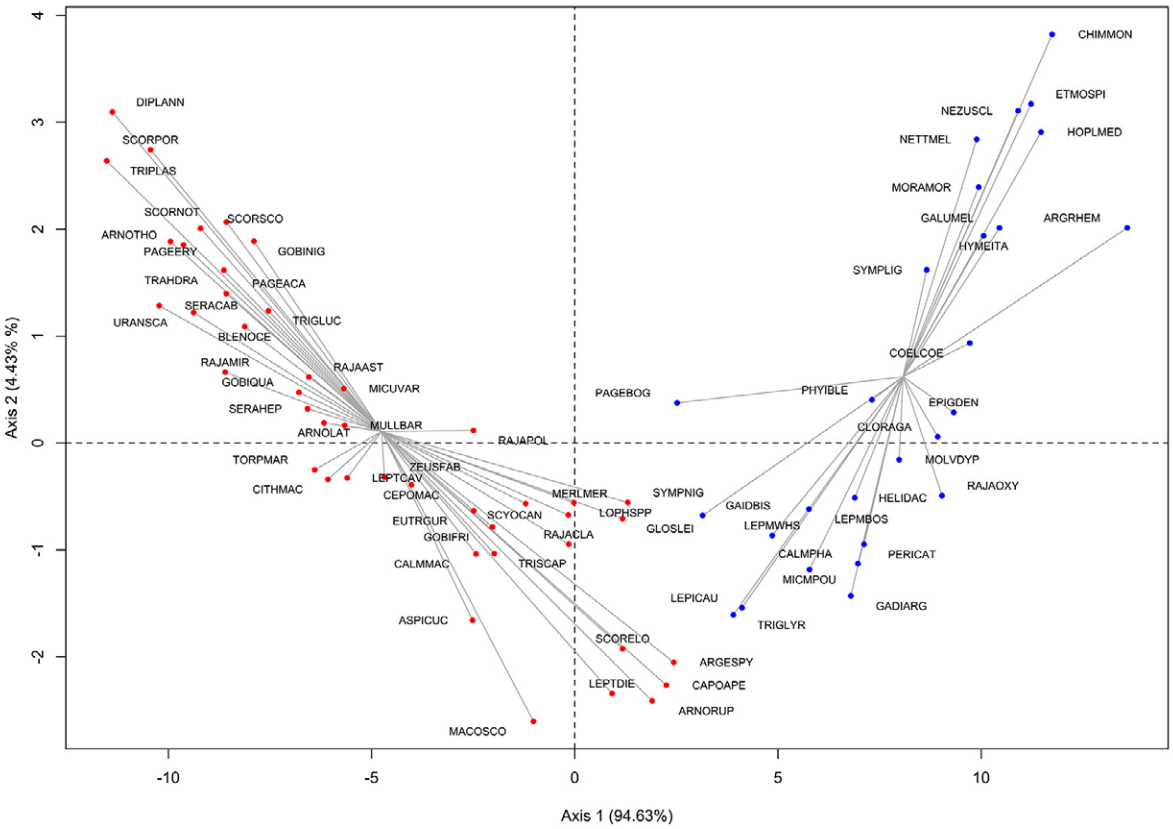

Fig. S8. – Projections of demersal species variables and assemblage groups on the compromise of the STATICO-CoA analysis based on data set of 71 species (without 83 rare species, i.e. those present in less than 5% of the hauls). It shows the stable part of the species and environment-fishing relationships. Axis 1 and 2 explained 94.63% and 4.43% of the total variability, respectively. On the first factor plane are shown the two main species assemblages (in blue and red) obtained by hierarchical clustering (UPGMA criterion) and optimum number of groups approach (see Materials and Methods section). Species codes are given in Table S2.