



Alternative Approach to Community Grouping of Marine Species

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Problem Statement



New bioindicators for ecosystem stability (MSF)

Species composition has major influence on ecosystem functioning and stability (Leland 2011) Are species organized in highly structured communities in space and time



Ecosystem Resilience to anthropological and environmental stressors

The degree to which habitat change is likely to influence ecosystem resilience will depend on community structure and connectivity



Quantifying the spatial structure of ecological communities

Have important applied implications as sampling campaigns for biomonitoring or conservation programs rely on the knowledge about the degree to which there is natural variation in communities across space



Methods : : Data

Survey	# species	# species selected	Beginning year	End year	Period
CGFS	114	41	1995	2014	15 Sept - 15 Nov
EVHOE	286	99	1997	2014	15 Oct- 01 Dec



Year	TRGPLAS	TRGPLAS
1997	0	0.00775193
1998	0.01587301	0.01587301
1999	0.03305785	0.03305785
2000	0.03252032	0.03252032
2001	0.03870967	0.03870967
2002	0.01298701	0.01298701
2003	0	0.00675675
2004	0.01438848	0.01438848
2005	0.01388888	0.01388888
2006	0.01538461	0.01538461
2007	0.02721088	0.02721088
2008	0.03973509	0.03973509
2009	0.02898550	0.02898550
2010	0.02836879	0.02836879
2011	0.03870967	0.03870967
2012	0.04477611	0.04477611
2013	0.01470588	0.01470588
2014	0.01986755	0.01986755



\$	Species with too many 0% or 100% occurrence
*	To limit the loss Remove the first years with really abundant 0% Add 1 random occurrence in 1 location on the given year

Standardized Isurvey with a large mouth bottom trawl

Methods : : Spatial Domain





Triangulated mesh generated by the stochastic partial differential equation (SPDE)



50 knots equivalent to a resolution of 4.6 by 4.6 km.

Methods : : Models



Predictor zero-inflation in a zero inflation negative binomial model = approximate spatio-temporal variations using a logit link

Predictor of mean intensity function count data = approximate mean intensity function as an exponential function

Assume intercept constant across year = correlation in abundance is explained by spatio-temporal factors



Hierarchical cluster analysis

Order the covariance or correlation matrices with dissimilarity measure

non-parametric bootstrap resampling is used to test the robustness of each cluster



Results : : Covariance

ZEUSFAB	0.15	SPONCAN		0.61
TRISMIN	074033	SEPIOFF		0.4 0.39
TRISLUS	0.740.740.33	RAJAUND		0.05 0 11 0 12
TRGPLAS	Spatial 0.130310310.14	TRGPLAS	spatial temporal	0.040.040.090.08
TRACTRA	COVARIANCE 0.74 0.31 0.74 0.74 0.33	FMAMMOD	covariance	0.01-0.090.090.090.090.090
SPRASPR	0.77 0.75 0.31 0.75 0.75 0.34	MULLSUR		0.81 0.02-0.010 03 0 28 0.58
SPONCAN	0.4 0.550.54 0.22 0.540 540 24	LOLI		0 520 630 03-0.050 020 09 0.37
SOLESOL	-2 -1 0 1 2 0.190.270.380.370.150.370.370.17	TRACTRA	-2 -1 0 1 2	0.57 0.430 54-0.02 0 0.04 0.08 0.42
SEPIOFF	0.23.0.21.0.3.0.420.41.0.19	SARDPIL		0.22 0.24 0.26 0.24 0.03-0.070.060.140.04
SCYOSTE	0.190.210.190.280.380.380.380.380.380.380.37	SCOMSCO		0.21 0.2 0.230 290 31 0.03-0.060.050.070.1
SCYOCAN	0.390.27 0.3 0.27 0.30 0.55 0.54 0.22 0.54 0.24	SCYOCAN		0.04-0.090.080.1140.150.170.010.020.01-0.010.08
SCOPRHO	0.090.190.150.140.150.190.270.280.110.280.280.12	SCYOSTE		0.020.03-0.050.040.040.09-0.1-0.010.020.01-0.040.03
SCOPMAX	0.080.080.17.0.12.0.13.0.12.0.17.0.25.0.24.0.1 0.24.0.24.0.11	TRISLUS		0.15-0.02 0 -0.040.050.160.01 0 0.03-0.090.030.06-0.06
SCOMSCO	0.440.18 0.2 0.41 0.290.41 0.560.57 0.23 0.57 0.25 0.25	MAJABRA		0.13.0.12-0.010.01-0.05-0.1-0.15-0.030.01.0.01.0.01.0.01.0.10.01
SARDPIL	0.56 0.4 0.17 0.16 0.37 0.26 0.26 0.26 0.26 0.21 0.51 0.51 0.23	MUST		0.27 0.17 0.13 0.01 0.05-0.160 210 250 15-0.1-0.010.050.05 0.23 0.04
RAJAUND	0.090.18 0.2 0.060.090.190.150.140.150.190.250.260.11 0.250.250.12	GADUMOR		0 86 0 46 0 33 0 28-0 020 02-0 150 2740 32-0 060 060 01 0 060 07 0 45 0 18
RAJACLA	0.210.140.27 0.3 0.130.140.29 0.2 0.22 0.2 0.24 0.4 0.390.160.390.390.17	MICTKIT		0.120.320.180.12 0.1 0 0.02-0.040.120.140.040.01 0 0.030.030.180.04
PI EUPLA	0370280160360440170280270280270280252022022022	CANCPAG		0.040.060 160.09 0.07 0.07 0 0.01-0.040.050 13-0.050.050.01 0 -0.010.03-0.05
PLATFLE	0.2 0.27 0.2 0.13 0.26 0.29 0.12 0.13 0.27 0.19 0.21 0.19 0.26 0.36 0.36 0.36 0.36 0.36 0.36 0.36 0.3	RAJACLA		0.020.020.020.050.040.020.020.010.02-0.050.050.09-0.09-0.1 0 0.01 0 0 -0.06
NECOPUB	0.360.270.370.260.190.570.410.170.190.360.270.290.570.390.540.530.220.530.530.24	ECITVIP		0.04-0.010.02 0 0.03-0.010.020.05-0.020.020.080.05-0.010.070.060.02-0.040.040.020.03
MUST	0.210.28 0.2 0.290.210.140.28 0.3 0.130.140.29 0.2 0.22 0.2 0.20 0.4 0.390.180.390.18	CHELCUC		0.03-0.030.01-0.01 0 -0.030.01-0.090.040.020.02-0.050.040.01-0.050.060.020.030.030.030.020.02
MULLSUR	0260,240,330,230,320,240,150,150,150,150,150,150,330,250,250,250,250,250,250,250,250,250,25	TRISMIN	0.02	0 02-0 030 01-0 01-0 01-0 030 01-0 0240 040 02 0 02-0 05-0 04-0 01-0 07-0 07-0 020 02 0 02 0 01 0
MICTKIT	0.240.260.22 0.3 0.21 0.3 0.22 0.15 0.290.320.140 15 0.3 0.21 0.32 0.23 0.21 0.3 0.430.42 0.17 0.42 0.42 0.19	SOLESOL	14-0.1	-0.120.14 0.07 0.23 0.33 0.9 0.44 0.38 0.45-0.08 0 -0.070 190.570.070.040.08-0.050.070 21-0.18
MERNMER	0 52 0 35 0 36 0 33 0 44 0 32 0 44 0 32 0 43 0 32 0 45 0 32 0 22 0 45 0 32 0 34 0 31 0 45 0 53 0 52 0 26 0 52 0 52	PLATELE	1 35 1 34-0.12	20.150.160.05 0.21 0.27 0.75 0.33 0.33 0.44-0.09-0.040.03-0.080.490.040.03 0.1 -0.1-0.120.1 -0.22
MAJABRA	0.180.310.210.230.190.280.190.280.190.280.190.280.120.130.280.120.130.280.190.280.370.280.150.380.380.150.380.380.150	BUGLLUT	1.29 1.29 1.26-0.14	40.160.160.020.190.260.750.290.330.42-0.11-0.060.11-0.020.320.210.26.0.1-0.09-0.10.18-0.04
LOLI	0.440.250.450.350.350.310.410.250.410.3 0.2 0.4 0.440.19 0.2 0.420.250.320.250.570.24 0.570.25 0.25	PLEUPLA	1.27 1.25 1.20 1.23-0.14	40 170 19 0.03 0 19 0 21 0 82 0 23 0 29 0 41 -0 1-0 070 11 0 01-0 390 14 0 12 0 11-0 190 140 04-0 21
LIMDLIM	0.420.430.260.470.320.35 0.3 0.4 0.29 0.4 0.3 0.190.390.430.18 0.2 0.410.290.31 0.260.410.570.580.230.580.580.25	LIMDLIM	1.191.221.18 1.2 1.1-0.14	40 17 0 2 0.01 0 160 160 480 14 0 24 0 37-0 11-0 090 17 0 09 -0 30 21 0 160 12-0 150 180 020 21
GALOGAL	0.1 0.210.210.140.230 150.170.15 0.2 0.140.190.14 0.1 0.190.210.09 0.1 0.2 0.140.150.14 0.2 0.280.270.11 0.27 0.27 0.12	MERNMER	0.640.86 0.9 0.86 0.9 0.85-0.1	-0.120.14 0.02 0.130.130.380.14 0.19 0.28-0.07-0.040.080.02-0.290.080.040.08-0.1-0.1+0.030.21
GADUMOR	0.2 0.14 0.29 0.3 0.190 32 0.22 0.34 0.2 0.27 0.2 0.27 0.2 0.130 38 0.290 1.130 140 38 0.2 0.21 0.2 0.280 390 380 180 380 0.17	AGONCAT	0.62 0.6 0.81 0.87 0.89 0.91 0.91-0.00	H0 1 0 12 0 03 0 14 0 19 0 550 24 0 24 0 3 -0 060 030 03-0 06-0 30 060 060 07-0 060 070 11-0.09
FMAMMOD	0.560.270.190.390.40250.430290.320.270.370260360.270160.360390.170160.370260260.260.370.520.510.210510.210	ALOS	0.5 0.550.560.76 0.8 0.810.78-0.00	H0.10.120.010.120.140.420.150.190.28-0.070.060.080.01-0.210.120.130.07-0.070.080.08-0.08
EUTRGUR	0220280210.1503103102.0340250250250220290.210290.210140280310.13014029021022.02.0290.410.4017.0.4.0.4	CALM	0.430.410.410.480.880.850.84 0.6 0.5 -0.1	-0.110.13-0.030.060.040.18 0 0.090.18-0.090.090.2 0.15 0 0.280.290.07-0.1-0.090.020.01
ECITVIP	0.350 280.350 280.100 380 390 250 430 290 310 270 380 280 380 270 180 380 270 1 10 370 280 380 270 1 10 10 280 370 280 280 370 280 370 280 370 280 370 280 380 280 370 280 380 280 280 280 280 280 280 280 280 280 2	CHELLUC	0.35 0.36 0.4 0.420.41 0.59 0.61 0.64 0.6 0.56-0.06	10.090.1 -0.010.08 0.1 0.39 0.1 0.140.19-0.070.070.120.05-0.040.220.27 0.05-0.050.050.11 0.07
DICELAB	025 03 024 03 0220.16 0350.34 021 036 025 027 023 031 022 031 023 015 03 033 0.14 015 031 022 0.24 022 0.32 0.44 043 018 043 048 019	SPRASPR	0.310.290.350.370.370.420.590.590.580.580.48-0.06	80.000 11-0.010.060.040 150.01 0.09 0 17-0.060.060 13 0 1 -0.10.150.120.06-0.090.090.070.11
CLUPHAR	0.560.380.440.350.450.330.340.490.50.320.540.370.40.350.480.330.480.340.220.450.50.210.230.470.330.380.330.470.280.450.270.280.450.210.230.470.280.250.470.280.280.280.280.280.280.280.280.280.28	SCOPMAX	0.260.280.29 0.33 0.34 0.34 0.37 0.53 0.53 0.52 0.5 0.43-0.07	20.090.1 -0.020.050.050.170.020.090.15-0.090.070.14 0.1 -0.030.2 0.2 0.05-0.070.07 0 -0.01
CHELLUC	0.16 0.3 0.2 0.230 190.240 160.130.260.260 170.290.190.210 180.240.170.240 180 12 0.240.260.110 12 0.250.170.190.170.250.350.340 140.340.340.15 CLI UPHAR		02802502802703203403503905505505050505070400801 0 00800501800300005-008005011007-01013012008-0080080080080	
CHELCUC	0.26 0.2 0.38 0.26 0.3 0.24 0.3 0.23 0.16 0.33 0.34 0.22 0.37 0.25 0.27 0.23 0.31 0.22 0.31 0.23 0.15 0.31 0.34 0.14 0.15 0.32 0.22 0.34 0.22 0.32 0.45 0.44 0.18 0.44 0.18 0.44 0.44 0.2	SCOPRHO	0 26 0 25 0 25 0 27 0 29 0 31 0 36 0 38 0 39 0 54 0 56 0 56 0 55 0 51-0.07	40.080.09 0 0.07 0.08 0 25 0.08 0.12 0 17-0.08 0.050.09 0.04-0.110 130.14 0.05-0.080.060.03-0.04
CANCPAG	0.1 0.160.120.240.160.190.160.190.14 0.1 0.21 0.21 0.130.230 150.170.140.190.140.190.140.090.190.21 0.09 0.1 0.2 0.140.150.14 0.2 0.260.270.11 0.27 0.270.12	FUTRGUR	0.290.240.240.240.260.270.310.320.330.350.505050470.42-0.07	20.080.09-0.010.050.050.180.030.090.14-0.060.080.120.08-0.030.180.190.05-0.070.080.01-0.01
CALM	0.370.190.310.240.460.310.360.250.360.270.190.4020.520.520.320.250.370.270.370.250.150.350.40.170150.360.270.290.250.350.520.520.520.520.520.520.520.520.520.5	DICELAB	0.120.160.170.170.170.16 0.2 0.21 0.240.260.260.360.370.380.370.35-0.04	40.050.06 0 0.050.060.190.060.090.12-0.040.030.060.02-0.070.09 0.1 0.03-0.040.040.04-0.01
BUGULUT	0220280.150.240.180.350.220.270.220.280.210.15 0.3 0.31 0.2 0.340.230.250.210.29 0.2 0.280.210.140.280.310.130.140.29 0.2 0.22 0.2 0.200.41 0.4 0.17 0.4 0.4 0.18	NECOPUB	0.080.090.130.130.120.130.130.180.170.170.180.170.260.260.260.250.23-0.04	40 040 05-0.010.030 040 140 03 0.06 0 08-0 040 040 07 0.04 0 020 130 17 0 02-0 020 020 06 0 07
ALOS	0.07 0 12 0.16 0.06 0.13 0.1 0.190 130.15 0.12 0.15 0.11 0.06 0 17 0.17 0.11 0.190 130 140.12 0.16 0.11 0.12 0.06 0.15 0.17 0.07 0.060.16 0.11 0.12 0.11 0.16 0.23 0.22 0.09 0.22 0.22 0.2	GALOGAL	0.05-0.050.050.050.090.09-0.1-0.090.120.140.140.09-0.1-0.170.150.170.150.090.03	0.03-0.040.02 0 0 -0.040.02-0.020.030.030.05-0.090.070.090 190 190 020.020.020.02-0.090.08
AGONCAT	0210120210280150240180250250250270220280210150303102028022025021029022028021014028031013014029020202004104018040180440180401804001804400480400048040048040004804000000	ZEUSEAR	0.03-0.040.050.050.070.070.060.070.06 0.1 0.1 0.090.090.080 130 130 150 120 11-0.02	40.020.02-0.010.010.030.090.020.030.04-0.020.030.050.030.04.0.1.0.140.01-0.01.0.0.060.08
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Results : : Communities



Code	Species
AGONCAT	Agonus cataphractus
ALOS	Alosa *
BUGLLUT	Buglossidium luteum
CALM	Callionymus
CANCPAG	Cancer pagurus
CHELCUC	Chelidonichthys cuculus
CHELLUC	Chelidonichthys lucernus
CLUPHAR	Clupea harengus
DICELAB	Dicentrarchus labrax *
ECITVIP	Echiichthys vipera
EUTRGUR	Eutrigla gurnardus
FMAMMOD	Ammodytidae
GADUMOR	Gadus morhua *
GALOGAL	Galeorhinus galeus *
LIMDLIM	Limanda limanda
LOLI	Loligo
MAJABRA	Maja brachydactyla *
MERNMER	Merlangius merlangus
МІСТКІТ	Microstomus kitt
MULLSUR	Mullus surmuletus *
MUST	Mustelus *
NECOPUB	Necora puber
PLATFLE	Platichthys flesus *
PLEUPLA	Pleuronectes platessa *
RAJACLA	Raja clavata *
RAJAUND	Raja undulata
SARDPIL	Sardina pilchardus
SCOMSCO	Scomber scombrus *
SCOPMAX	Scophthalmus maximus *
SCOPRHO	Scophthalmus rhombus *
SCYOCAN	Scyliorhinus canicula
SCYOSTE	Scyliorhinus stellaris
SEPIOFF	Sepia officinalis
SOLESOL	Solea solea *
SPONCAN	
	Spondyliosoma cantharus *
SPRASPR	Spondyliosoma cantharus * Sprattus sprattus
SPRASPR TRACTRA	Spondyliosoma cantharus * Sprattus sprattus Trachurus trachurus *
SPRASPR TRACTRA TRGPLAS	Spondyliosoma cantharus * Sprattus sprattus Trachurus trachurus * Trigloporus lastoviza
SPRASPR TRACTRA TRGPLAS TRISLUS	Spondyliosoma cantharus * Sprattus sprattus Trachurus trachurus * Trigloporus lastoviza Trisopterus luscus
SPRASPR TRACTRA TRGPLAS TRISLUS TRISMIN	Spondyliosoma cantharus * Sprattus sprattus Trachurus trachurus * Trigloporus lastoviza Trisopterus luscus Trisopterus minutus



Results : : Species composition





Trigloporus lastoviza (striked gunnard)



Raja undulata (undulate Ray)

IUCN Red List : Endangered

Bycatch by trawls trammel net and other demersal fisheries

Retained and marketed for human consumption Patchy distribution

Distance: abscor Cluster method: average

Results : : Correlation in indices





Results : : Spatial temporal species distribution







Conclusion



Community spatial structure seem consistent temporally despite high fishing effort and change in the environment.



Inference could be made about the fishing behavior fishing effort market prices



Predict catch composition ratios for multispecies fisheries



Predict likelihoods of bycatch species by knowing dynamics between bycatch and target species



These results give insights into the magnitude of spatial variation in nature and should be highly beneficial for conservation and bioassessment programs that are built on the information about how communities vary in space.



It's a work in progress



Linking Habitat to these results (Sophie)



Test the spatial temporal grouping to spatial resolution



Add fishing behavior and effort of targeted species and try to predict bycatch.



Compare with the results from the fishery dependent data



No model diagnostics for zero-inflated negative binomial count data



Abundance proxies for Endangered IUCN red list of european marine Communities

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Methods : : Data

IUCN status	ACRONYM	Definition	# species
Extinct	EX	No known individuals remaining	0
Extinct in the wild	EW	Known only to survive in captivity, or as a naturalized population outside its historic range	0
Critically endangered	CR	Extremely high risk of extinction in the wild	1
Endangered	EN	High risk of extinction in the wild	2
Vulnerable	VU	High risk of endangerment in the wild	8
Near threatened	NT	Likely to become endangered in the near future	5
Least concern	LC	Lowest risk; does not qualify for a higher risk category. Widespread and abundant taxa are included in this category.	76
Data deficient	DD	Not enough data to make an assessment of its risk of extinction	10
Not evaluated	NE	Has not yet been evaluated against the criteria.	20

Methods : : Indices

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Spatially aggregated abundance Indices

$$d(x, c, t) = r_1^*(x, c, t) \times r_2^*(x, c, t)$$

$$I(c,t,l) = \sum_{x=1}^{n_x} (a(x,l) \times d(x,c,t))$$



Assume intercept constant across year = correlation in abundance is explained by spatio-temporal factors