

Supplement 1

Brief interpretation of the table:

In terms of the species summarized by the spatial indicators, 49 works were focused on fish (31 with one species and 17 with more than two) and only four works focused on invertebrates (cephalopods and crustaceans). Spatial indicators have been used primarily to summarize longer time series, as only 4 works accounted for 1 to 2 years, whereas in 32 works, more than 10 years of data were integrated. In terms of the sampling device used, in 25 works the data was sampled during bottom trawl surveys, in 10 of them, the main data source was based on acoustic sampling and in five, plankton and eggs sampling was carried out. In terms of geographic origin, most works were located on the North-East Atlantic area, including North Sea, Bay of Biscay-North-West Ireland, Iberian coast, English Channel and in the North-West Atlantic, namely Georges Bank, Gulf of Maine, Gulf of St. Lawrence and Newfoundland (9 works). Six works focused on Mediterranean and other 6 on the North Pacific. Only one work integrated data from surveys taken in different parts of the world, but it used a model-based approach to estimate the indicators.

Besides changes in the species spatial-temporal distribution, these indicators have been used to address the effect of climate change, bottom temperature, other oceanographic indices and fishing effort. The spatial indicators have also been used to compare the prey and predator distributions, different life stages of a species (e.g. larval stages, juveniles, adults or different ages/cohorts) and co-existing species (e.g. sardine and anchovy). Often, spatial indicators have been used to explore species density-occupancy relationships, test for MacCall's hypothesis or for the Ideal Free Distribution Theory. Another common previous application of the spatial indicators has been in model validation (e.g. individual model, ecosystem models, fisheries models), by comparing the spatial distribution of the modelled results with survey data (reality).

S1 Table : Table of previous works using the spatial indicators (literature review), by subject, with a brief quantitative description on the indicators used, the inclusion of the areas of influence in its calculations (if it is mentioned and whether the details for calculation were provided), the species, temporal interval considered, type of sampling and area studied. Spatial indicators: CG: center of gravity; I: inertia; PA: positive area; EA: equivalent area; SA: spreading area; IC: index of collocation (either global or local); SP: spatial patches; G: Gini; MS: microstructure index;

IA: index of aggregation; OC: occupied area; Sampling: bts=bottom trawl surveys; as=acoustic surveys; Note that Voronoi was considered to be equivalent to Dirichlet tessellation.

Reference	Subject	Indicators used	Areas of influence	Species (groups)	Period	Sampling	Area
Petitgas (2009)	methods description	CG, I, i, PA, SP, EA, MS	not mentioned	<i>Gadus morhua</i> (different ages)	1985-2005	bts (DA-TRAS-ICES)	North Sea
Wuillez, Rivoirard, and Petitgas (2009)	methods description	CG, I, i, IC, PA, SP, EA, MS, SP	Voronoi, but not detailed				
Adams et al. (2018)	spatio-temporal dynamics	CG, I, PA	Voronoi, but not detailed	9 fish sp	1963-2016	bts	Northwest Atlantic
Adams (2017)	spatio-temporal dynamics	CG, I, PA	Voronoi, but not detailed	<i>Peprilus triacanthus</i> (fish)	1982-2013	bts	Northeast US
Alvarez et al. (2004)	spatio-temporal dynamics	CG, distribution ellipses	not mentioned	<i>Merluccius merluccius</i> (fish eggs and larvae)	1995-1998	Bongo (ICES plankton surveys)	Bay of Biscay to the north-west of Ireland.
Alvarez et al. (2001)	spatio-temporal dynamics	CG, distribution ellipses	not mentioned	<i>Merluccius merluccius</i> (fish eggs and larvae)	1983-1995	Bongo (ICES plankton surveys)	Bay of Biscay
Atkinson et al. (1997)	spatio-temporal dynamics	statistical ellipses, area occupied	not mentioned	<i>Gadus morhua</i>	1981-1993	bts	Newfoundland
Barra et al. (2015)	spatio-temporal dynamics	CG, NP, I, i, PA, AS, EA, IC	areas of influence from gridding	<i>Sardina pilchardus</i> and <i>Engraulis encrasicolus</i>	2002-2010/2004-2006	as (MEDIAS)	Strait of Sicily and North Aegean Sea,
Baudron and Fernandes (2015)	spatio-temporal dynamics	CG	not mentioned	<i>Merluccius merluccius</i>	1978-2011	bts	North Sea, West of Scotland, Celtic Sea, Porcupine bank and Bay of Biscay
Bez and Rivoirard (2000)	spatio-temporal dynamics	CG, I	not mentioned	<i>Scomber scombrus</i> (eggs/larvae)	1989	as (ICES)	North-east Atlantic (Bay of Biscay, Celtic Sea, and west of Ireland).
Bitetto et al. (2012)	spatio-temporal dynamics	CG, IC, I, PA SP	not mentioned	<i>Aristaeomorpha foliacea</i> (crustacea)	1994-2010	bts (MEDITS)	Central-southern Tyrrhenian Sea (GSA)
Blanchard et al. (2005)	spatio-temporal dynamics	area occupied (#ices rectangles) with >95% of population	not relevant	<i>Gadus morhua</i> (juvenile)	1977-2012	bts	North Sea
Bonanno et al. (2017)	spatio-temporal dynamics	PA, SA, EA, CG, I, i, SP	not mentioned	<i>Engraulis encrasicolus</i> , <i>Sardina pilchardus</i> , <i>Sardinella aurita</i> , <i>Trachurus trachurus</i> and <i>Boops boops</i>	2006-2015	as	Central Mediterranean Sea (Sicily)
Bourdaud et al. (2017)	spatio-temporal dynamics	IC	not relevant	several sp	1998-2014	bts (CGFS)/onboard sampling (OBSMER)	English channel

Boyra et al. (2013)	spatio-temporal dynamics	CG	not mentioned	<i>Engraulis encrasicolus</i> (juvenile)	2003-2010	as (JUVENA)	Bay of Biscay
Bruge et al. (2016)	spatio-temporal dynamics	CG, P5, P95	not mentioned	<i>Scomber scombrus</i> (Pres/Abs data and egg production)	1992–2013	eggs survey	EU North Atlantic coast
De Robertis and Cokelet (2012)	spatio-temporal dynamics	CG	not mentioned	<i>Theragra chalcogramma</i> /zooplankton	2007-2008	as/commercial vessels	Bering Sea
Engelhard et al. (2011)	spatio-temporal dynamics	CG, Weighted standard deviations and standard errors of the weighted mean latitudes were calculated	not mentioned (gridded)	<i>Solea solea</i> ; <i>Pleuronectes platessa</i>	1913-2007	catch and effort data for British North Sea trawlers	North Sea
Faraj and Bez (2007)	spatio-temporal dynamics	CG, I, i, IA	mentioned but no detail given	<i>Octopus vulgaris</i>	1998-2004	bts	Atlantic coast of Marrocco
Gastauer, et al. (2016)	spatio-temporal dynamics	CG, I, i, PA, EA, G, IC	mentioned but no detail given	<i>Micromesistius poutassou</i>	2006–2014	as (IBWSS)	West of British Isles and Ireland
Honkalehto et al. (2011)	spatio-temporal dynamics	CG, I, IC	not mentioned	<i>Theragra chalcogramma</i>	2006-2009	Acoustic-trawl, bottom trawl and acoustic data collected from commercial fishing vessels	Eastern Bering Sea
Hughes et al. (2014)	spatio-temporal dynamics	CG, I, i	not mentioned	<i>Scomber scombrus</i> (eggs)	1977-2010	eggs survey (NEA-WSC; plankton tows)	North-west Atlantic
Modica et al. (2016)	spatio-temporal dynamics	%presence, CG, I	not mentioned	<i>Helicolenus dactylopterus</i> , <i>Merluccius merluccius</i> and <i>Lophius budegassa</i>	1983-2010	bts (DEMERSALES)	southern Bay of Biscay
Morfin et al. (2012)	spatio-temporal dynamics	CG, I, presence area	not mentioned	12 sp	1994-2010	bts (MEDITS)	Gulf of Lions
Murawski, Finn and Finn (1988)	spatio-temporal dynamics	CG, Green's index of spatial dispersion;	not mentioned	7 fish sp/different ages	1963-1981	bts (NEFC-NMFS)	Georges Bank
Myers et al. (1995)	spatio-temporal dynamics	G	by strata	<i>Hippoglossoides platessoides</i> , <i>Reinhardtius hippoglossoides</i> , <i>Glyptocephalus cynoglossus</i> and <i>Lirmanda ferruginea</i>	1971-1994	bts	Newfoundland
Paulino et al. (2017)	spatio-temporal dynamics	CG, I	not mentioned (gridded)	<i>Dosidicus gigas</i> (cephalopod)	2004-2015	satellite luminosity	Peru
Perry et al. (2014)	spatio-temporal dynamics	mean latitude (center of distribution)	not mentioned	36 fish sp	1977-2001	bts	North Sea
Persohn, Lorange and Trenkel (2009)	spatio-temporal dynamics	area occupied (adapted spreading area) and occurrence, cumulative distribution	specific weighting method	8 fish sp	1992-2006	bts (EVHOE)	Bay of Biscay and Celtic Sea, North-East Atlantic

Reuchlin-Hughenoltz, Shackell and Hutchings (2015)	spatio-temporal dynamics	functions (CDFs), D90, G, area occupied, density area	by strata	9 fish sp	1970-2011	bts	Scotian Shelf and Bay of Fundy
Rindorf, Lewy and Rose (2012)	spatio-temporal dynamics	Lloyds, I, Ellipses, Gini, D95, ...	not relevant	<i>Gadus morhua</i>			North sea
Rindorf and Lewy (2006)	spatio-temporal dynamics	CG (alternative formula)	not mentioned	<i>Gadus morhua</i>	1983-2003	bts	North Sea
Saraux et al. (2014)	spatio-temporal dynamics	CG, I, IC, SP	not mentioned	<i>Sardina pilchardus</i> and <i>Engraulis encrasicolus</i>	2003-2012	as (PELMED)	Gulf of Lions
Spedicato, Woillez and Rivoirard (2007)	spatio-temporal dynamics	CG, I, i, IC, SP, PA, AS, EA, MS	mentioned but no detail given	<i>Mullus barbatus</i>	1994-2004	bts (GRUND/ME DITS)	south Tyrrhenian sea
Swain and Sinclair (1994)	spatio-temporal dynamics	G, D90	not relevant	<i>Gadus morhua</i>			Gulf of St. Lawrence
Vikebø et al. (2005)	spatio-temporal dynamics	CG	not relevant				
Volkenandt et al. (2014)	spatio-temporal dynamics	CG	mentioned but no detail given	<i>Clupea harengus</i>	2005-2012	as	Celtic sea
Woillez et al. (2007)	spatio-temporal dynamics	CG, I, i, IC, PA, SP, EA, MS, SP	mentioned but no detail given	<i>Merluccius merluccius</i>	1987-2004	bts	Bay of Biscay
Brodeur et al. (2014)	spatial overlap	CG, I, IC	not mentioned	<i>Clupea pallasii</i> , <i>engraulis mordax</i> , <i>Sardinops sagax</i> and <i>Chrysaora fuscescens</i> (medusae)	1999-2011	pelagic rope trawl	Washington and Oregon coast
Decker et al. (2018)	spatial overlap	CG, I, IC, Cramér-von Mises randomization test	not mentioned	<i>Gadus chalcogrammus</i> , <i>Clupea pallasii</i> , <i>Mallotus villosus</i> and <i>Gadus macrocephalus</i> (fish) and <i>Chrysaora melanaster</i> (jellyfish)	2004-2012	bts (NMFS AFSC and BASIS)	Bering Sea
Marino, Juanes and Stokesbury (2009)	spatial overlap	center of abundance, standard ellipse and 95% confidence ellipse were Superimposed on the scallop density distribution maps to determine the spatial overlap	not relevant	<i>Placopecten magellanicus</i> (bivalve)	1999-2006	video surveys	Georges Bank
Tableau et al. (2016)	spatial overlap	CG, I, IC	not mentioned	7 fish	2008	beam trawl (NURSE)	Bay of Vilaine (Bay of Biscay)
Petitgas et al. (2012)	growth	CG, I		<i>Engraulis encrasicolus</i>	2001-2011	fish otoliths	Bay of Biscay

Doray et al. (2017)	indicators integration	CG, I, i, PA, EA, MS	Voronoi with respective details	multiple (small pelagic fish)	2000-2015	as (PELGAS)	Bay of Biscay
Guan et al. (2017)	model based	CG, AO	not relevant (model based)	<i>Gadus morhua</i>	1982-2013	bts	Gulf of Maine
Thorson, Pinsky and Ward (2016)	model based	CG, AO	not relevant (model based)	18 fish sp	1977-2013	bts	West coast of the USA
Thorson et al. (2016)	model based	CG, AO	not relevant (model based)	92 sp of fish			6 marine regions
Thorson (2017)	model based	CG, AO	not relevant (model based)	<i>Gadus chalcogrammus</i>	1982-2017	bts	Eastern Bering Sea
Chust et al. (2013)	model validation	CG	not relevant (model validation)	<i>Calanus</i> sp	1959-2004	Continuous Plankton Recorder survey coupled with model	North Atlantic Ocean
García-García, Ruiz-Villarreal and Bernal (2016)	model validation	CG, PA, EA, Coefficient of variation (PA/EA)	not relevant	<i>Sardina pilchardus</i>	2006-2007		Atlantic Iberian margin
Hinckley et al. (2016)	model validation	CG, I, i, Getis-Ord, NDI, Overlap coefficient, Syrjala tests	not relevant (model validation)	<i>Gadus chalcogrammus</i>			Gulf of Alaska
Huret, Petitgas and Woillez (Huret, Petitgas, and Woillez 2010)	model validation	CG, I, i, PA, AS, EA and coefficient of variation of positive values of densities	not relevant (model validation)	<i>Engraulis encrasicolus</i> (model of larvae dispersal)			Bay of Biscay
Lewy and Kristensen (Lewy and Kristensen 2009)	model validation	CG, concentration, AO	not relevant (model validation)	<i>Gadus morhua</i>	1983-2006	bts	North Sea
Petrik et al. (2015)	model validation	CG, I, IC	not relevant (model validation)				
Pointin et al. (2018)	model validation	CG, I, IC	not mentioned	discards/landings	2011-2016	onboard observers (OBSMER)	Celtic Sea and western English Channel

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