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8.7 Eastern Channel case study

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8.7.1 Brief presentation of the CS and fisheries concerned

The Eastern Channel (EC) is a shallow epicontinental sea (maximum depth 100 m) covering a total area of approximately 35,000 km^2 (Figure 32). It is delimited by the United Kingdom in the North and France in the South, connected to the North Sea by the Dover strait in the East, and separated from the Western English Channel by the Cotentin peninsula. It corresponds to the ICEs division VIId and divided into 15 statistical rectangles.

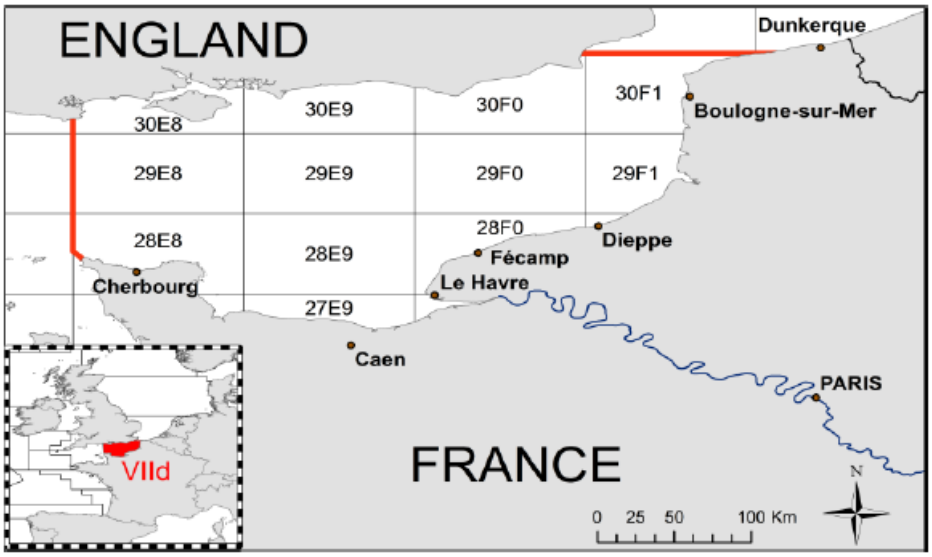

Figure 32: Statistical rectangles and main fishing harbours in the Eastern English Channel (ICES Sub-Divisions VIId). From Girardin, 2015.

The most important fishery operated in the EEC, both in number of vessels and in landings, is the French fishery (46% of the landings for 2006-2013[10]), followed by the Dutch with 22%, the UK with 16%, and Belgium 8%. Those countries mainly operate pelagic trawl (targeting herring, mackerel and horse mackerel), beam-trawls (targeting sole and plaice), otter trawl (targeting a mixed assemblage of quota and non-quota demersal species) and Danish seines (targeting mainly demersal non-quota species). Seven maritime districts are distributed along the French coast, from the North east to the South west, Dunkerque, Boulogne-sur-mer, Dieppe, Fécamp, Le Havre, Caen and Cherbourg.

[10] Official Nominal Catches 2006-2013. Accessed 28-04-2015 via http://ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock- assessment.aspx ICES, Copenhagen.

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In Discardless, we focus on the french mixed demersal fisheries, consisting of several fleets (netters, bottom trawlers, dredgers or passive demersal) using different métiers and targeting different species assemblages during the year. The main species caught are: sole (*Solea solea*), plaice (*Pleuronectes platessa*), cod (*Gadus morhua*), whiting (*Merlangus merlangus*), seabass (*Dicentrarchus labrax*), herring (*Clupea harengus*), mackerel *(Scomber scombrus)*, horse mackerel (*Trachurus trachurus*), red mullet (*Mullus surmuletus*), scallops (*Pecten maximus*), squid (*Loligo forbesii* and *Loligo vulgaris*), or cuttlefish (*Sepia officinallis*) (OBSMER 2014).

The mixed nature of these fisheries leads to high discards ratios, especially in the mixed demersal trawl fishery. The constraints exerted on fishers due to the combination of resource management measures, diverse fish communities and competition for space make the reduction of unwanted catches particularly challenging. The most discarded quota species are: horse mackerel, plaice, whiting and herring.

8.7.2 Causes of discarding

The main cause of discards haven analysed for the French trawlers targeting demersal species (Table 33) in the project CarRejet (Leleu et al, 2014).

	Bottom trawlers <18 m targeting Sole in the EC	Bottom trawlers >18 m targeting demersal fish in the EC and southern North Sea
Plaice	**Minimal Landing Size** **Low market value** Quota optimization	**Minimal Landing Size** **Low market value** Quota optimization
Sole	**Minimal Landing Size**	
Dab		**Low market value**
Herring		**Quota optimization** Low market value
Horse mackerel		**Low market value**
Whiting	**Minimal Landing Size** Low market value	**Minimal Landing Size** Low market value
Mackerel		**Quota optimization** Low market value

Table 33: Primary (bold) and Secondary causes of discarding for the most discarded quota species caught by the Eastern Chanel trawlers. Translated from Leleu et al (2014).

The Minimal Landing Size (MLS) is the main reason for discarding sole, whatever the metier (undersized soles corresponded to 94% of discarded sole for bottom trawlers <18 m targeting Sole in the EC in 2011). The MLS is also one of the main reasons for discarding plaice, because of the difference between sole MLS (i.e. the target species, 24 cm) and plaice MLS (i.e. bycatch species, 27 cm), the gear selectivity being designed for sole (undersized plaice corresponded to 67 % of discarded plaice for bottom trawlers <18 m targeting Sole in the EC in 2011).

Economical drivers include: (1) Quota optimization, wich corresponds to size or quality highgrading; (2) Low market value, compared to the work and storage space involved.

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Older studies have identified minimal landing size, quota restriction and technical measures (EC No 2056/2001) as reasons for cod discarding in the Eastern Channel and southern North Sea (Fauconnet et Biseau, 2011; Dubé et al, 2012). For pelagic species (herring, mackerel and horse mackerel) the main reason for discarding mainly evocated are the technical measure and the percentage of species in the catches induced by the cod management plan (Leleu et al 2014).

There are, to our knowledge, no published data on the drivers of discarding for passive gears in the Eastern Channel, but it can be reasonable assumed that they are quite similar to those for active gears. However, due to a better selectivity (targeted species and size spectrum) passive gears are less impacted by discarding than bottom trawlers.

8.7.3 Effects of discarding

8.7.3.1 Mortality of discards and escapees

Survival rates of discarded species are currently being investigated in the Eastern Channel (project Ensure)

8.7.3.2 Ecological effects of discarding

A recent modelling study suggests high cascading effects throughout the foodweb (Girardin, 2015). These preliminary findings will be completed and further explored during the discardless project.

8.7.3.3 Economic effects of discarding

Not investigated

8.7.4 Discard data

8.7.4.1 Discard Sampling

8.7.4.1.1 Collection and use

Discards data are collected according to DCF protocols, through the use of onboard observers. Vessels are selected via a semi-random selection of vessels on opportunistic basis to meet sampling quotas by stratum. Groups of metiers are optimized to estimate discard per species and meet DCF target precision. Discards are then estimated by trips and summed for sampled vessels in stratum. Discards are raised to the fleet using either days at sea, or (in most cases) reported total fleet landings of stock and reported landings of stock by sampled vessels. Data are submitted to both ICES and STECF according to the data calls, and for most stocks, are included in the assessment and advice. For stocks assessed in the Eastern Channel (or shared in between North Sea and Eastern Channel, discards data for cod, whiting, plaice and sole are provided and used in the assessment and/or the advice

8.7.4.1.2 Coverage of total effort and fisheries covered

The coverage of total effort is presented for the metiers targeting demersal fish and taking place in the Eastern Channel (only or partly), listed in Table 34.

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Table 34: Métiers targeting demersal fish in the Eastern Channel sampled in the french observer program OBSMER. Based on OBSMER 2012,2013 and 2014.

Métiers	**Coded here as**	**Main species landed**
Beam trawling targeting demersal species in the Channel (both Eastern and Western)	TBB_DEF	Sole, plaice, lesser spotted dogfish, pout whiting
Otter trawling targeting common shrimp in the Eastern Channel and southern North Sea	OT_CRU	Common shrimp
Otter trawling targeting demersal species in the Eastern Channel and southern North Sea (<18 m)	OT_DEF_1	Plaice, sole, pout whiting, common cuttlefish, mackerel, red mullet
Otter trawling targeting demersal species in the Eastern Channel and southern North Sea (>18 m)	OT_DEF_2	Whiting, horse mackerel, mackerel, bass, herring, common cuttlefish, red mullet
Netting targeting demersal species in the Eastern Chanel Sea and southern North Sea	Fil_DEF	Sole, plaice, cod, thornback ray, lesser spotted dogfish
Danish Seining targeting demersal species in the Channel (both Eastern and Western)	SDN_DEF	Haddock, cod and hake (2013) Red mullet, tub gurnard and whiting (2012)

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Table 35: Sampling cover of the French métiers in 2011 to 2013.

	2011			2012			2013		
Métiers	Total landings (t)	Sampled trips/ total trips	Sampled boats / Total boats	Total landings(t)	Sampled trips/ total trips	Sampled boats / Total boats	Total landings (t)	Sampled trips / total trips	Sampled boats / Total boats
TBB_DEF	989	8/2198 (0.4%)	3/46 (6.5%)	330	6/593 (1%)	3/9 (33.3%)	292	6/597 (1%)	4/10 (40%)
OT_CRU				223	11/1710 (0.6%)	5/39 (12.8%)	211	12/2041 (0.6%)	8/41(19.5%)
OT_DEF_1	3906	36/7622 (0.5%)	20/156 (12.8%)	4281	35/7928 (0.4%)	23/150 (15.3%)	4778	52/10608 (0.5%)	34/226 (15%)
OT_DEF_2	15267	33/2210 (1.5%)	17/55 (30.9%)	13078	31/2730	15/58 (25.9%)	13526	19/3280 (0.6%)	10/49 (20.4%)
Fil_DEF	4258	63/17027 (0.4%)	46/151 (30.5%)	5536	105/19663 (0.5%)	49/171 (28.7%)	5799	119/19875 (0.6%)	50/175 (28.6%)
SDN_DEF				689	6/168 (3.6%)	2/4 (50%)	300	3/100 (3%)	1/5 (20%)

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8.7.4.2 Discard rates and levels

The discard rates are indicated in Table 36 for the most landed species in the Eastern Channel in 2011, 2012 and 2013. They have been calculated from the landings and discards listed in the STECF database (STECF, 2014).

Landings and discards by species are summed over the different gears and vessel size (merging over and under 10 m boats) only removing longlines and pelagic trawls. % cover corresponds to the percentage of total landings with discards associated in the database.

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Species		2011			2012			2013		
FAO 3-Alpha code	Common name	Total landings	% cover	Discard rate %	Total landings	% cover	Discard rate %	Total landings	% cover	Discard rate %
SCE	King scallop	14064	100	**2.9**	13210	98	**25.9**	15538	2	**5.8**
WHG	Whiting	5666	100	**46.8**	2512	100	**59.1**	2805	100	**43.1**
SOL	Sole	2070	100	**6.8**	2223	99	**19.3**	2603	97	**26.1**
MAC	Atlantic Mackerel	5786	100	**1.9**	2522	98	**11.3**	2075	100	**7.0**
PLE	European Plaice	1971	99	**32.1**	1652	99	**57.7**	1737	96	**48.2**
DAB	Common dab	899	99	**52.8**	730	99	**73.5**	719	99	**68.7**
COD	Atlantic cod	876	99	**4.7**	742	99	**6.7**	684	93	**13.4**
HER	Herring	721	94	**60.9**	736	97	**88.8**	654	97	**45.2**
BSS	Seabass	494	98	**1.3**	658	97	**17.3**	494	97	**68.4**
JAX	Horse Mackerel	10	100	**73.1**	19	100	**49.6**	432	100	**86.0**
LEM	Lemon sole	208	100	**21.2**	124	99	**27.9**	153	100	**6.5**
POL	Pollack	186	99	**0.0**	102	89	**0.1**	160	77	**30.6**
TUR	Turbot	196	61	**0.7**	216	96	**0.2**	166	84	**9.8**

Table 36: Discard rates of the most landed species in the Eastern Channel, based on the STECF database (STECF, 2014). Species under European quota in the Eastern Chanel are underlined. (Turbot, dab and lemon sole are under quotas in the North Sea, King scallop and sea bass have national regulation including maximum daily/monthly allowed catches)

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8.7.5 Methods for reducing discards

Several national projects have been developed the last years to develop and improve gears in order to reduce discards in the bottom trawl fisheries in the EC and the southern North Sea. Among them SAUPLIMOR (Mortreux et al., 2001) focused on the improvement of escapement of plaice and cod juvenile in the EC, SELECMER (Leonardi et al., 2009) focused on improvement on whiting and SELECCAB (Viera el al. 2010) focused on improving cod selectivity.

The last project, SELECFISH aimed at testing and developing selective devices for the French artisanal trawler fleets operating in the Eastern Channel and North Sea. The pursued goal was to allow a reduction of discards particularly for species under TAC and being impacted by the landing obligation. Impacts of tested devices were thus evaluated on whiting, plaice, horse mackerel, herring (species subjected to the landing obligation and abundantly discarded by this fishery) and squid, cuttlefish, red mullet, mackerel and cod (commercial species of importance for these fisheries).

The project allowed a test of square mesh cylinders (SMC) of various sizes (80, 100 and 115mm gauge) and various lengths (1 and 2m). The association of SMC in 80mm of 2m length with selective grids was also tested. Each device was trialed at sea for at least 5 days on board professional fishing vessels. The method used to carry out the tests consisted in parallel hauls: two trawlers fished side by side, one equipped with the selective device, the other with traditional gear and onboard observers sampled the catches on both vessels. The reductions in discards allowed by tested devices ranged from 20 to 78% depending on the device considered. Their use however caused immediate commercial losses which ranged between 0 and 35% of the sales. SMC have interesting effects on whiting: they allow a large reduction of discarded quantities (from 35 to 60%) while maintaining or even increasing the marketable catches. These SMC are also very effective for small pelagic species escapement (horse mackerel, herring, mackerel). However, they are rather inefficient on flat fishes (except for the biggest mesh sizes) because le level of escapement for marketable fish is as high as for discarded fish. The association of SMC in 80mm of 2m length with selective grids were not significant but do not seem much more interesting than the SMC on its own. With SELECMER semi rigid grids of 23mm spaced vertical bars, the results on whiting are similar as with the SMC alone. With SAUPLIMOR rigid grid, discards are reduced by almost 80%. Associated commercial losses are nevertheless very important (in particular, a twofold decrease in cuttlefish and squid catches).

These tests highlight once again the complexity of selectivity improvement for mixed fisheries. Some of the tested devices revealed appropriate when a specific species is targeted, but none of them is suitable for a year-round activity.

8.7.6 Ecosystem modelling of the Eastern Channel

8.7.6.1 ISIS-Fish

The Eastern Channel ISIS-Fish application focuses on the French fleets operating in ICES area VIId and on the most valuable species landed by French fleets: sole (*Solea solea*) and scallops

(*Pectens maximus*). The majority of sole landings comes from netters and, to a more limited extend, bottom trawlers and mixed trawlers. Scallops are mainly landed by dredgers. The model therefore focuses on these four fleets, consisting of a total of 448 boats in average over 2008-2010. The fleet segmentation used is the segmentation created by the French Fishery Information System (SIH), which groups French vessels based on the main, or two main, gears used during the year. We further segmented these SIH-fleets according to length class of the vessel and home region. The other boats operating in the EEC (including international fleets) are pooled into an inexplicit fleet "OTHER" which impact is modelled through a fishing mortality adjusted to management constraints. The rest of the value landed by the selected fleets mainly consists in cephalopods, sea bass, whiting, red mullet, cod and plaice. The model currently describes the dynamics of scallops (2 populations), sole, plaice, red mullet and cephalopods (2 populations of squids, a population of cuttlefish). The biological models build on the structure and parameters of the assessment models when available and on scientific survey data and literature otherwise. It accounts for population spatial distribution and migrations in course of the year.

Population zones in the ISIS-Fish model of the Eastern Channel are based on the habitat structure identified by Girardin for the Atlantis model (Girardin, 2015, Figure 33). Regarding métier zones, logbooks helped identifying the main ices rectangles of practice for each gear and fleet. One métier per main rectangle is consequently created (e.g. OTB-27E9) while ICES rectangles with low effort for a given gear and fleet are pooled together in a unique métier (e.g. OTB-left). The structuring hypothesis of ISIS-Fish is the homogeneity of any variable (effort, abundance…) within a zone. Fleet behavior is modeled through the dynamical modification of effort allocation on métiers in course of the simulation. A gravity model accounts for the mix of tradition and opportunist behavior of fishers when they choose which métier to practice. More details about the EEC application can be found in Lehuta et al. (2015).

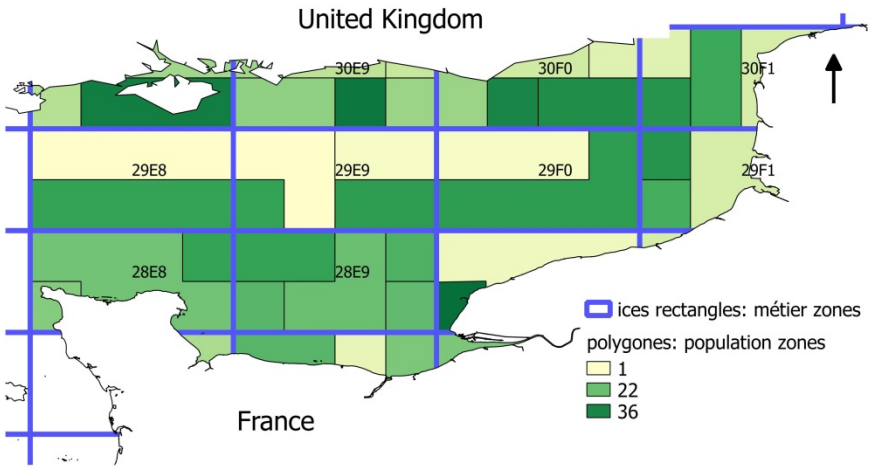

Figure 33: Spatial structure of the ISIS-Fish model of the EEC showing the overlap between population zones and metier zones.

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8.7.6.2 Atlantis

The Eastern Channel Atlantis model covers the ICES division VIId (approximately 35000 km^2). The model grid uses 35 polygons with three water column depth layers on the vertical axis, and a single sediment layer (Figure 34). 40 functional groups were defined on the basis of their habitat, preys and predators, growth characteristics (mainly maximum size and longevity) and migration patterns (Table 37). Vertebrates alone accounted for 21 of those groups, including a seabird and two mammal groups, seven groups of fish species of commercial interest and eleven other functional groups. We also included 16 groups of invertebrates, among which four planktonic groups and seven groups of commercial interest. Finally, detritus were binned into three separate functional groups as required by Atlantis.

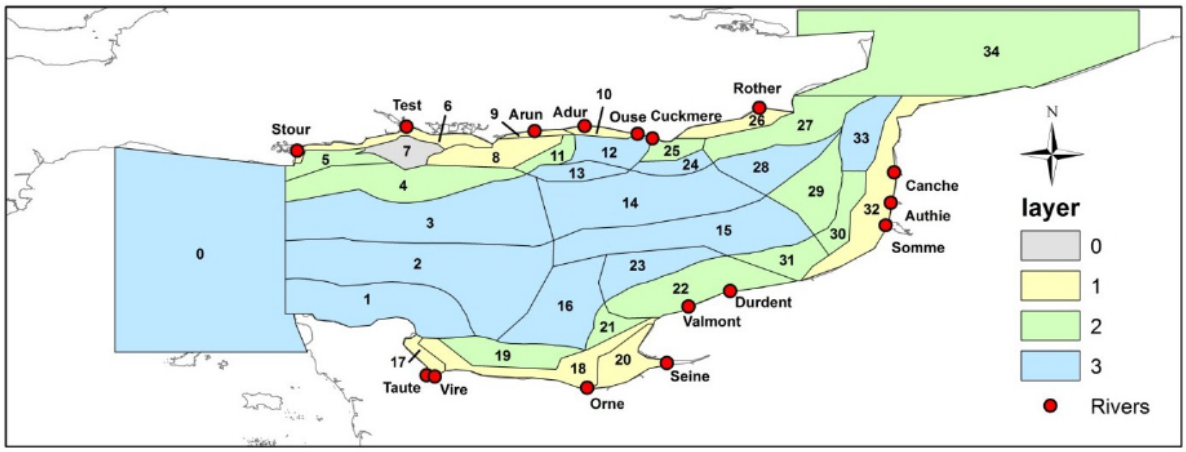

Figure 34: Spatial structure of the Atlantis application in the Eastern English Channel. The number of layers are shown with different colours, yellow for one layer (<15m), green for two (<30m) and blue for three (<60m). Red dots represent the position of river estuaries. The river names are indicated for reference.

Fisheries were explicitly built in our model through a selection of fishing fleets operating a variety of métiers. Both fleets and métiers were defined using the EU DCF (Data Collection Framework) terminology (EC, 2008b). In this study, we focused on the French fishing fleets targeting sole, which has traditionally been one of the main commercial species in the Eastern English Channel. This reduced the number of DCF fleets to 21 (essentially netters and dredgers), to which we added one group to include all the other French and foreign vessels operating in the Eastern English Channel (hereby referred to as the international fleet), making it 22 fleets overall (Table 38).

Groups		
Seabirds	Other flatfishes	Scallops
Toothed cetaceans	Mackerels	Bivalves
Seals	Clupeidae	Echinoderm
Cod	Sparidae	Zooplankton
Rays and dogfishes	Gurnards	Carnivorous zooplankton
Sharks	Mugilidae	Gelatinous zookplancton
Cephalopods	Other gadoids	Phytoplankton
Whiting	Small demersal fishes	Benthic detrital
Pollack	Lobsters	Pelagic bacteria
Large bottom fish	Crabs	Labile detrital
Seabass	Shrimps	Refractory detrital

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Sole	Whelks	Discards
Plaice	Suspension feeder	
Dab	Deposit feeder	

Table 37: Description of functional groups species composition in Atlantis Eastern English Channel application. Single species groups are underlined.

Index	DCF fleets	DCF métiers	Implementation	Selectivity	Main species
FC1	dredgers 10-12m	dredge on scallops	Spatial effort	Logistic	SCE
FC2	dredgers 10-12m	bottom trawl on demersal fish	Spatial effort	Logistic	PLE, CEP
FC3	dredgers 10-12m	beam trawl on demersal fish	Spatial effort	Logistic	SOL, PLE, OFI
FC4	dredgers 10-12m	trammel nets	Spatial effort	Normal	SOL
FC5	dredgers 10-12m	others	Spatial effort	Logistic	PLE, MAC
FC6	dredgers 12-18m	dredge on scallops	Spatial effort	Logistic	SCE
FC7	dredgers 12-18m	bottom trawl on demersal fish	Spatial effort	Logistic	CEP, MAC, RA
FC8	dredgers 12-18m	bottom trawl on cephalopods	Spatial effort	Logistic	CEP, RAY
FC9	dredgers 12-18m	beam trawl on demersal fish	Spatial effort	Logistic	RAY, SOL, PLI
FC10	dredgers 12-18m	mid water otter trawl on pelagic fish	Spatial effort	Logistic	MAC, CLU
FC11	dredgers 12-18m	trammel nets	Spatial effort	Normal	SOL, PLE, OFI
FC12	dredgers 12-18m	others	Spatial effort	Logistic	PLE, MAC, CR
FC13	Passive gears <10m	trammel nets	Spatial effort	Normal	SOL, PLE, RA
FC14	Passive gears <10m	others	Spatial effort	Logistic	CEP, BSS, WH
FC15	Passive gears 10-12m	dredge on scallops	Spatial effort	Logistic	SCE
FC16	Passive gears 10-12m	trammel nets	Spatial effort	Normal	SOL, PLE, RA
FC17	Passive gears 10-12m	others	Spatial effort	Logistic	RAY, MAC, W
FC18	Trammel netters 12-18m	dredge on scallops	Spatial effort	Logistic	SCE
FC19	Trammel netters 12-18m	trammel nets	Spatial effort	Normal	SOL, PLE, RA
FC20	Trammel netters 12-18m	others	Spatial effort	Logistic	SOL,PLE, COD
International fleet			Fishing mortality		

Table 38: Description of the fishing fleets considered in the Atlantis Eastern English Channel model.

8.7.6.3 Osmose

OSMOSE is applied to the eastern English Channel by explicitly representing 14 species of the main fish of the community (importance in term of surveyed biomass, catch and/or trophic role): mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), poor cod (*Trisopterus minutus*), cod (*Gadus morhua*), whiting (*Merlangius merlangus*), pouting (*Trisopterus luscus*), dragonets (mostly *Callionymus lyra*), lesser spotted dogfish (*Scyliorhinus canicula*), sole (*Solea solea*), plaice (*Pleuronectes platessa*), red mullet (*Mullus surmuletus*), Herring (*Clupea harengus*), Sardine (*Sardina pilchardus*) and a squids group (*Loligo vulgaris* and *Loligo forbesii*). Most species parameters and distribution maps are derived from the CGFS survey, the intereg 4a CHARM 2 project and literature.

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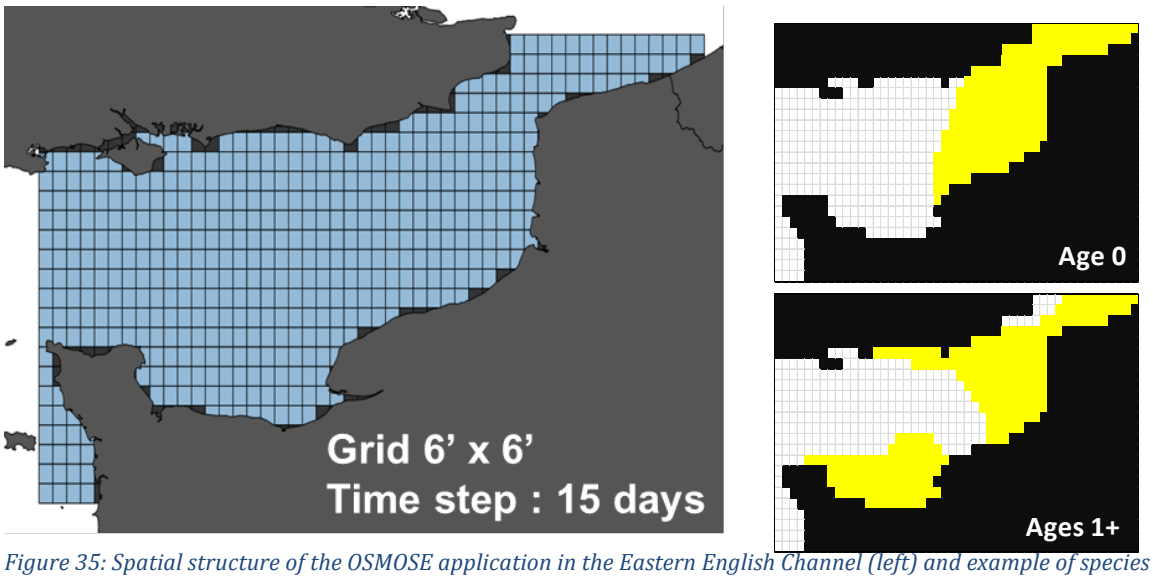

Figure 35: Spatial structure of the OSMOSE application in the Eastern English Channel (left) and example of species distribution,possibly according to age and season (right, here for mackerel) .

For the eastern English Channel application, plankton prey fields were derived from the bio-physical model ECOMARS3D. Size classes have been attributed to the modeled plankton functional groups in order to allow a size-based predation between fish and plankton: Dinoflagellates (2-20µm), Diatoms (20-200µm), Microzooplankton (20-200µm) and Mesozooplankton (0.2-2mm). MARS-3D output are integrated over 15 days and used offline within OSMOSE. The seasonality is well reproduced by the model as well as the main spatial patterns. The model has been run and validated for the period 2000-2006 (P. Cugier, pers com). As the eastern English Channel is a shallow ecosystem with no stratification of waters, benthos plays an important role as food for fish and must be included in the model. To do so, additional prey fields are included in the model: macrozooplankton (not modelled in ECOMARS3D; 2-20mm) and 5 benthic groups defined by their size (0.2-5mm; 5-10mm; 1-5cm; 5-10cm; 10-15cm). The biomass of these groups is considered homogeneous in the area, and no seasonal variation is implemented due to lack of data. The level of biomass available to fish predation is estimated by calibration.
Due to this coupling to low trophic levels, the model can address effects of both fishing pressure and environmental variability. Indeed, changes of abiotic environment and the effects on plankton groups can be simulated within MARS3D, and have repercussions on the entire food web. Biological interactions constitute the basis of OSMOSE, making this model suitable for investigating predation and competition relationships, variable in time and space and according to forcing factors such as fishing pressure.

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