RAIMOUEST: the French fishery of rays in the Western English Channel (VIIe), 2014 update.

Nicolas LEBLANC[1], Alain TETARD[2], Véronique LEGRAND[1], Eric STEPHAN[3], Laurence HEGRON MACÉ[4]

[1] Comité Régional des Pêches Maritimes et des Elevages Marins de Basse Normandie (CRPMEM-BN), 9 quai du Général Lawton Collins, BP 445, 50104 Cherbourg cedex, France.

[2] Institut français de recherche pour l'exploitation de la mer (IFREMER), Avenue Général de Gaulle, BP 32, 14520 Port-en-Bessin, France.

[3] Association Pour l'Etude et la Conservation des Sélaciens (APECS), 13 rue Jean-François Tartu, BP 51151, 29211 BREST Cedex 1, France.

[4] Syndicat Mixte pour l'équipement du Littoral (SMEL), Zone conchylicole, 50560 BLAINVILLE SUR MER, France.

Correspondence: nicolas.leblanc@crpbn.fr
alain.tetard@ifremer.fr
veronique.legrand@crpbn.fr
eric.stephan@asso-apecs.org
lhegronmace@smel.fr

Abstract

The landing ban of *Raja undulata* has raised misunderstanding for French fishermen, particularly for those fishing in the normano-breton gulf (Southeast of ICES Division VIIe) where this species is very abundant. In this context, the RAIMOUEST project was launched as a professional and scientist partnership in order to enhance fisheries data on the main ray species caught in the Normand-Breton Gulf (*Raja undulata*, *Raja brachyura*, *Raja clavata, Raja montagui* and *Raja microocellata*). The French ray fisheries fleet was identified and a sample of fishermen involved in rays fishing was interviewed. Landings and effort data (logbooks), auctions sales and sampling at sea aboard professional fishing vessels were analysed. This working document presents the current results of this study. The French fleet concerned by ray fishing in the Normand-Breton Gulf in 2012 was composed of 289 vessels, mainly coastal trawlers/dredgers and small length size netters and longliners. *R. undulata* is the main ray species in this area. This species seems to form a local stock in the Normand-Breton Gulf with some continuity in the Eastern English Channel and the Western part of the Western English Channel. Three ways of analysis were used to provide an indicative level of *R. undulata* stock: French landings before 2009 were estimated at least at 300 tons in the Western English Channel (VIIe) and 160 tons in the Normand-Breton Gulf; sales at auctions of the Basse-Normandie fleet before 2009 were estimated at 235 tons in the western English Channel and 35 tons in the eastern English Channel (VIId); discards by the French bottom trawl fleet in ICES Division VIIe in 2012 and 2013 were estimated at 750 tons. Information on the spatial distribution of the other ray species in the English Channel was also provided. The coastal localisation of nursery for *R. undulata* and *R. clavata* was highlighted.

SUMMARY

1. CONTEXT AND OBJECTIVES

Limited knowledge on biology and lack of data on fisheries for most of the ray species lead to significant issues when trying to define stocks units and assess their status, and establish management measures for sustainable fisheries.

In the Western English Channel (ICES Division VIIe), the principal concerns are for the blonde ray (*Raja brachyura),* the small-eye ray (*Raja microocellata*), the spotted ray (*Raja montagui*) and the undulate ray (*Raja undulata*), which stock status are considered uncertain by ICES. This situation is problematic for fishermen because, classified as 'data-limited stocks', a precautionary margin of −20% is applied to the ICES advice (ICES 2012). The situation is more problematic for *R. undulata* which has been listed as prohibited species by European Union from 2009 to 2013 despite a recommendation from ICES asking only not targeting this species (ICES recommended a "precautionary approach to the exploitation of these populations and no target fishery"). Paradoxically, there are currently no management measures for rays other than TACs or bans on fishing, such as minimum sizes, limitations of fishing effort or protected areas.

The landing ban of *R. undulata* has raised misunderstanding for French fishermen's, particularly for those fishing in the Normand-Breton Gulf where this species is abundant. Indeed, fishermen always said that *R. undulata* is the main ray species caught in this area and considered catches stable before the ban. This ban generates discards and the majority of the fleet is affected.

The lack of data resulting in a poorly known stock status could be explained by two elements. Before 2009, *R. undulata* was underrepresented in landings and sales notes because of confusion in the species' name (it was confused with the cuckoo ray *Leucoraja naevus*) or registration at higher taxonomic level, i.e. miscellaneous rays and skates. Since 2009, there are no data on landings and sales at auctions because of the ban on landing this species. Also, there is a lack of scientific fishery-independent survey in ICES Division VIIe.

In this context, the RAIMOUEST project was launched as a professional and scientist partnership in order to enhance fisheries data on the main ray species caught in the Normand-Breton Gulf (*Raja undulata*, *Raja brachyura*, *Raja microocellata*, *Raja clavata* and *Raja montagui*). The objectives were to describe the fisheries for rays, to provide information on spatial distribution and stocks status indicators (catch, landings, catch per unit effort, length distribution) and to locate the functional areas. The aim of RAIMOUEST project is thus to improve the diagnostic of these stocks, and subsequently, to propose appropriate and concerted management measures for sustainable exploitation of these resources.

Furthermore RAIMOUEST contributes to the RECOAM project carried out by APECS[1] in Atlantic and English Channel coastal waters on the main ray species (Stéphan *et al*., 2014). This project focuses on the biology, particularly size at sexual maturity, migrations and population structure.

2. MATERIAL AND METHODS

2.1. Study area

The study was carried out in the Southeast of ICES Division VIIe with an extension to the North Coast of the Cotentin peninsula (in ICES Division VIId), which corresponds to a sector where *Raja undulata* is abundant in coastal waters (Figure 1). This study area includes ICES rectangles 28E7, 27E7, 26E7, 26E8, the western part of 27E8 and 28E8 and the sub-rectangle 28E813. It is further referred to as Normand-Breton Gulf in this working document.

[1] Association pour l'étude et la conservation des sélaciens (http://www.asso-apecs.org/)

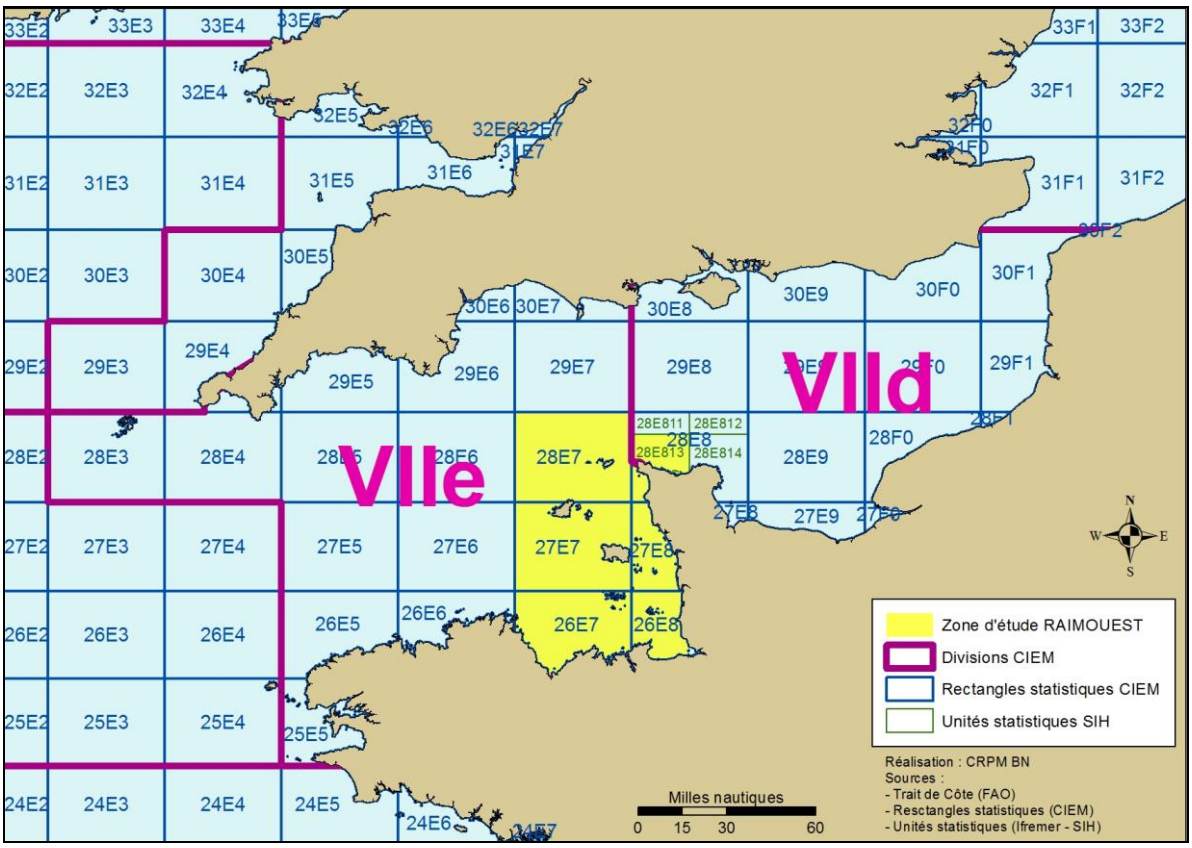


Figure 1: Map of the study area (yellow) in the western English Channel

2.2. Data sources

In the RAIMOUEST project, data come from (i.) fishery-dependent data from the SIH[2] database held at Ifremer, (ii.) local enquiries and additional sampling at sea aboard professional fishing vessels carried out by the Regional Fishing Committee of Lower Normandy (Comité Régional des Pêches Maritimes de Basse Normandie - CRPM-BN) and (iii.) sales in Lower Normandy auctions.

2.2.1. SIH data

The SIH network is based on several key actions for the collection of data. Landings and effort data (logbooks), auctions sales, sampling at sea aboard professional fishing vessels (ObsMer) were used in this study.

ObsMer (for "Observations en Mer") is the French observation at sea program in application of the Data Collection Framework (EC, 2008). This collection is mandatory for all EC Members States. Ifremer is involved as French technical support for the storage, the collection and the exploitation of data. The various stages of data collection are subject to quality control. The quality assurance includes a sampling plan stratified by métier, documentation and training of the observers for standardize the collection (http://sih.ifremer.fr/Acquisition-des-donnees/Echantillonnage-des-captures-a-bord-des-navires-de-peche), a software for data entry into the national database, validation tools and a standard data output format (http://wwz.ifremer.fr/cost/Cost-Project)...

The ObsMer data include physical characteristics of the fishing operations (fishing gear, position, effort) and sampling for both the retained and not retained parts of the catches (exhaustivity of species, weight, number, sex and length). Data are available at a national level from 2003 onwards, but the sampling effort is more intensive since 2009.

2.2.2. Data collection through RAIMOUEST

Inquiries

French fishers identified as involved in rays fishing in the Normand-Breton Gulf in 2012 were identified by their corresponding fishing organisations. 23 % of these fishers were interviewed. The sample of fishers interviewed

[2] Système d'Information Halieutique (http://sih.ifremer.fr/)

was 67 (61 in Basse-Normandie and 6 in Brittany) and additionally 1 fisher from Jersey. Face-to-face interviews were carried from June 2012 to January 2014. Interview included five questions:
- ray species caught,
- fishing strategy, season and target species associated to catches of rays by métier,
- proportions of each ray species in the total catch of rays by fishing area,
- information on mating, spawning and nursery,
- economic impact and changes in fishing practices induced by the landing ban of *R. undulata.*

Sampling at sea aboard professional fishing vessels

32 additional samplings at sea aboard professional fishing vessels were carried out, with the objective of increasing the observed proportion of fishing activities that catch rays. This additional sampling was carried under ObsMer protocol and was used to supplement ObsMer data.

2.2.3. Sales at auctions of Cherbourg and Granville

Sales at Cherbourg auctions are available by ray species from 2004 to 2008. Total rays sales are available for Granville auction from 2003 to 2012 and for offshore trawlers landings at Port-en-Bessin auction from 2006 to 2011 (source Organisation de Producteurs de Basse-Normandie).

2.3. Data analysis

2.3.1. Selection of the sampling at sea data set

First of all, metiers likely to catch rays were selected after exploratory analysis. Sampling at sea data set from 2003 to the first quarter 2014 account for 1387 fishing operation samplings in the Normand-Breton Gulf, 3587 in the western English Channel (VIIe) and 7396 in the English Channel (VIIde). Sampling data set in the English Channel is detailed by métier, year and quarter in Annex 1. The location of the sampling in the English Channel is presented in Figure 2.

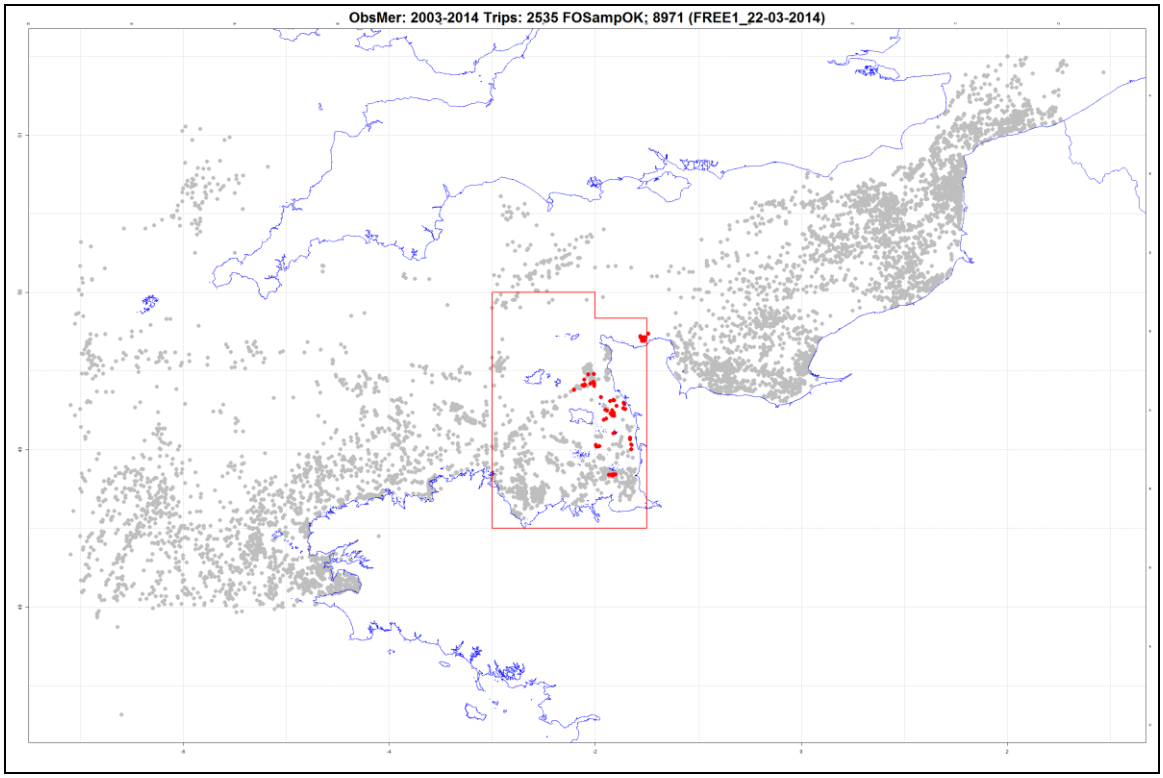


Figure 2: Sampled fishing operations for métiers likely to catch rays in the English Channel (VIIde) and the adjacent statistical rectangles from 2003 to the first quarter 2014 (ObsMer samplings in black, RAIMOUEST in red).

2.3.2. Ray fisheries

The French rays fisheries fleet in the Normand-Breton Gulf in 2012 was identified and described (number and average vessels characteristics for each métier) using the fishing organisations fleet database. This fleet includes vessels identified as catching or having caught rays before the *R. undulata* landing ban. Rays fishing

strategies were described by métiers (targeted or bycatch fishery, seasonality, gears, species associated) using inquiries.

2.3.3. Ray species caught

The proportions of each ray species in the total catch of rays in the Normand-Breton Gulf was estimated from inquiries and samplings at sea, completed by sales of rays by species at Cherbourg auction in 2008. The year 2008 was used to estimate the proportion of ray by species in the sales because from 2009, landings of *R. undulata* were banned.

2.3.4. Spatial distribution

The spatial distribution of the main ray species in the Normand-Breton Gulf was mapped at the resolution of 2x2 nautical mille square from the proportions of each ray species in the total catch of rays specified by the fishermen inquired on their fishing area. The location of the main ray species catches in the samplings at sea was mapped to represent their spatial distribution in the English Channel. The results of this analysis were confirmed by fishermen.

2.3.5. Nursery area

The location of the main ray species catches by total length categories (0-30, 30-50, 50-80, >80 cm) in the samplings at sea was mapped to identify potential nursery areas.

2.3.6. *R. undulata* landings before 2009

French landings of R. undulata in the western English Channel and in the Normand-Breton Gulf estimate from SIH data

The decrease step in the total ray landings between 2007-08 and 2009-10 can be analyzed as the loss of *R. undulata* in the sales and give an indicative level of the *R. undulata* landings before 2009.

Basse-Normandie fleet R. undulata sales at auction estimate

Ray sales at auction by the Basse-Normandie fleet take place in Granville, Cherbourg and Port-en-Bessin. The estimation of *R. undulata* sales at the auction of Granville was based on the decrease step in the total ray sales between 2006-08 to 2009-11 which was attributed to the loss of *R. undulata*. At Cherbourg auction, it was based on sales by ray species from 2004 to 2008 in which *R. undulata* was register separately. At Port-en-Bessin auction, *R. undulata* sales essentially came from offshore trawlers. Offshore trawlers inquired indicated that *R. undulata* contributed to 15 % of their total ray sales. So this proportion was affected to the total ray sales of this fleet from 2006 to 2008 to estimate *R. undulata* sales.

2.3.7. *R. undulata* discards estimate

The R-package COST was developed as a common "open source" tool (COST) for assessing the accuracy of the biological data and parameters estimates collected for stock assessment purposes within the framework of the Data Collection Framework. All available on-board observations from both the standard DCF sampling and RAIMOUEST were used to derive stock status indicators. It allows to raise observed discards and catches to the total fishing activities and to estimate length distribution per strata (time, space and technical). Several raising methods (by trips, by fishing operations, by an auxiliary variable, by fishing days) can be used and the results compared.

2.3.8. *R. undulata* length distribution

Length distribution of *R. undulata* catches (landings and discards) in samplings at sea was presented at the Normand-Breton Gulf level for bottom trawlers and netters (available data from longliners were insufficient). The lengths at maturity for male of this species in the Normand-Breton Gulf established by Stephan *et al.* (2014) are presented.

Length distribution of *R. undulata* catches by French Bottom trawlers (DCF métier OTB_DEF) in the western English Channel in 2012 was estimated using samplings at sea data and COST tools.

3. RESULTS

3.1. Ray fisheries

3.1.1. Ray fisheries fleet in the Normand-Breton Gulf

457 vessels operated in the Normand-Breton Gulf in 2012 (2/3 mainly with passive gears and 1/3 mainly with active gears). 289 vessels (63 %) of this fleet were identified as concerned by ray fishing (catching or having caught rays before the *R. undulata* landing ban) including 85 % of the fleet using mainly active gears and 48 % of the fleet using mainly passive gears.

Bottom trawlers represent around half of the ray fisheries fleet; the other vessels used passive gears, mainly trammel nets but also longlines (Table 1).

The bottom trawlers fleet consisted in 133 vessels (average length = 13.1 m), including a majority of coastal trawlers/dredgers and few offshore trawlers. Rays are caught all year long as bycatch of fishing operations targeting species like sole, cuttlefish or other flatfish, but could significantly contribute to the profitability of some fishing strategies. Fishing duration varies from 1 to 3 h. Nevertheless, most of this fleet practice dredging for scallops during winter.

The netters fleet consisted in 105 traditional coastal vessels (average length = 9.0 m) using trammel nets of 270 or 320 mm mesh size to target larger rays. This is an occasional fishing activity (40 days per year on average for the fishermen inquired) because of restrictions by natural constraints (algae catch putting down the nets when high coefficient tide, swell or rough sea; seasonal high density of spider crabs that deteriorate the nets; seasonal high density of Common stingray (*Dyasatis pastinaca)* which detangling is constraining). Soaking duration varies from 12 to 48 h.

The longliners fleet consisted in 37 coastal vessels (average length = 9.3 m) catching large individuals of rays all year long as bycatch of fishing operations targeting species like starry mouth-hound, conger, dogfish or sea bass. Rays could also be targeted by some vessels in certain area and season. Due to high flow tide in the Normand-Breton Gulf, soaking duration are shorts, varying from 1 to 24 h.

Comment: 5 trawlers and 11 netters from Jersey were also involved by ray fishing in the Normand-Breton Gulf.

Ray fisherie fleet	Number of vessels	Total power (KW)	Average power (KW)	Average length (m)
Trawlers	133	25964	195	13.1
Netters	105	11319	108	9.0
Longliners	37	4464	121	9.3
Netters / Longliners	14	1604	115	9.4
Total	**289**	**43351**	**150**	**11.5**

Table 1: Ray fisheries fleet characteristics by metier

3.1.2. Ray species caught

Before 2009, rays catches were generally register in landings and sales notes with a wrong species code or as miscellaneous rays and skates. Since 2009 rays landings must be reported by species level but species confusion still remains (for example *R. brachyura* is often registered as *R. montagui*).

In the Normand-Breton Gulf, *R. undulata* is the main species caught. It contributes to 50-74 % of the total catch of rays according to inquiries and sampling at sea data source (Table 2). The others species caught are *R. brachyura* (17-30 %), *R. clavata* (5 %), *R. microocellata* and *R. montagui*.

Rays sales by species at Cherbourg auction in 2008 confirm these species composition of the landings. Around 90 % of the rays sailed at the Cherbourg auction were caught in the western English Channel (particularly in the Normand-Breton Gulf) and 10 % from the eastern English Channel.

Species	Inquiries before 2009 GNB (%)	Sampling at sea 2005-2014 GNB (%)	Sales at Cherbourg auction 2008 (%)
R. undulata	74	50	58
R. brachyura	17	30	26
R. montagui	2	2	
R. clavata	5	5	10
R. microocelata	2	3	5
Raja spp.	-	11	-

Table 2: Proportions of each ray species in the total catch of rays from inquiries (in the Normand-Breton Gulf before 2009), samplings at sea (in the GNB from 2005 to 2014) and sales at Cherbourg auction in 2008.

3.1.3. Landings

The French total landings of rays in ICES Division VIIe are more or less stable from 2000 to 2005 and decrease afterwards (Figure 3). Years 2009 and 2010 mark a step decrease as a result of the *R. undulata* landing ban. It should be noted that the contribution of small coastal netters and longliners are underrepresented because a part of this fleet do not sell ray at the auction and do not report ray catch correctly on logbooks or monthly landings sheets (which may be used instead of EU-logbook for small vessels).

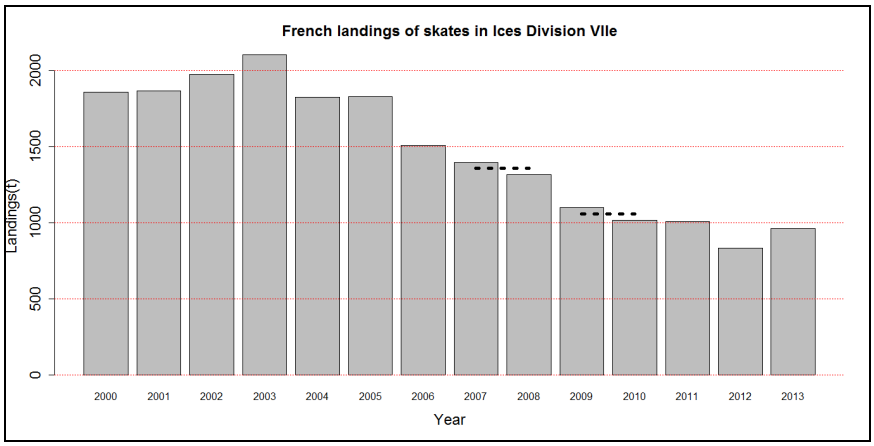


Figure 3: French landings of rays in the western English Channel (VIIe) from 2000 to 2013 (source SIH).

The decrease of 300 tons in the landings from 2007-08 to 2009-10 can be analyzed as the minimal loss of *R. undulata* because the landing ban was probably compensated by a change in fishing practices (report on other ray species). Due to poor information by species in the landings before the ban it is not possible to analyse these data further.

At the Normand-Breton Gulf level a corresponding decrease of 160 tons can be observed (Figure 4).

The decrease in the total landings is proportionally higher in the Normand-Breton Gulf because *R. undulata* has a higher proportion of the total catch in that area.

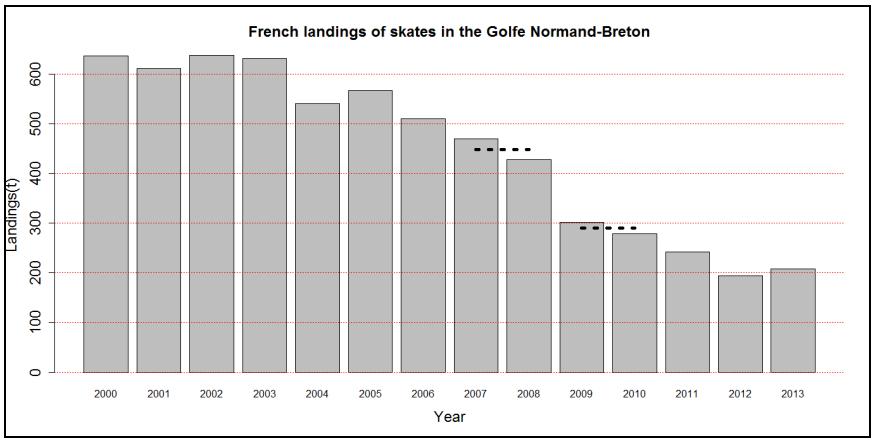


Figure 4: French landings of rays in the Normand-Breton Gulf from 2000 to 2013 (source SIH).

3.1.4. Impact of the landing ban of *R. undulata*

The principal impact of the landing ban of *R. undulata* is the loss of revenue related to the absence of this species in sales but it also induces indirect impacts by changes in fishing practices. Bottom trawlers and longliners continue to catch this species as bycatch and must discard it; some fishing areas where *R. undulata* is abundant have been abandoned. Almost all the netters have abandoned trammel netting targeting rays because this fleet of small length vessels fished on coastal waters where *R. undulata* is the main ray species caught (Table 2). All inquired fishermen indicated that the abundance of *R. undulata* has doubled, it even became problematic for longliners to avoid catch of this species when they try to target other species (e.g. sea bass).

A part of inquired fishermen indicated a report of the fishing activities on other ray species like *R. brachyura* or *R. clavata.*

3.2. Raja undulata

3.2.1. Spatial distribution

The analysis of fishermen inquiries indicates that *R. undulata* is the main species of ray caught in the Normand-Breton Gulf and is highly dominant in coastal waters (Figure 5). Samplings at sea show that *R. undulata* occurs in almost all the English Channel and that its distribution appears to be well constrained in a large central region of the English Channel. The data also confirm that this species is highly abundant on coastal waters of the Normand-Breton Gulf (Figure 6). This two coherent and complementary analysis seem to indicate that *R. undulata* forms a local stock in the Normand-Breton Gulf and that there are some continuity with the Eastern English Channel and the Western part of the Western English Channel. The RECOAM tagging/recapture operation carried out in the Normand-Breton Gulf seems to show high site fidelity (Stéphan *et al.*, 2014).

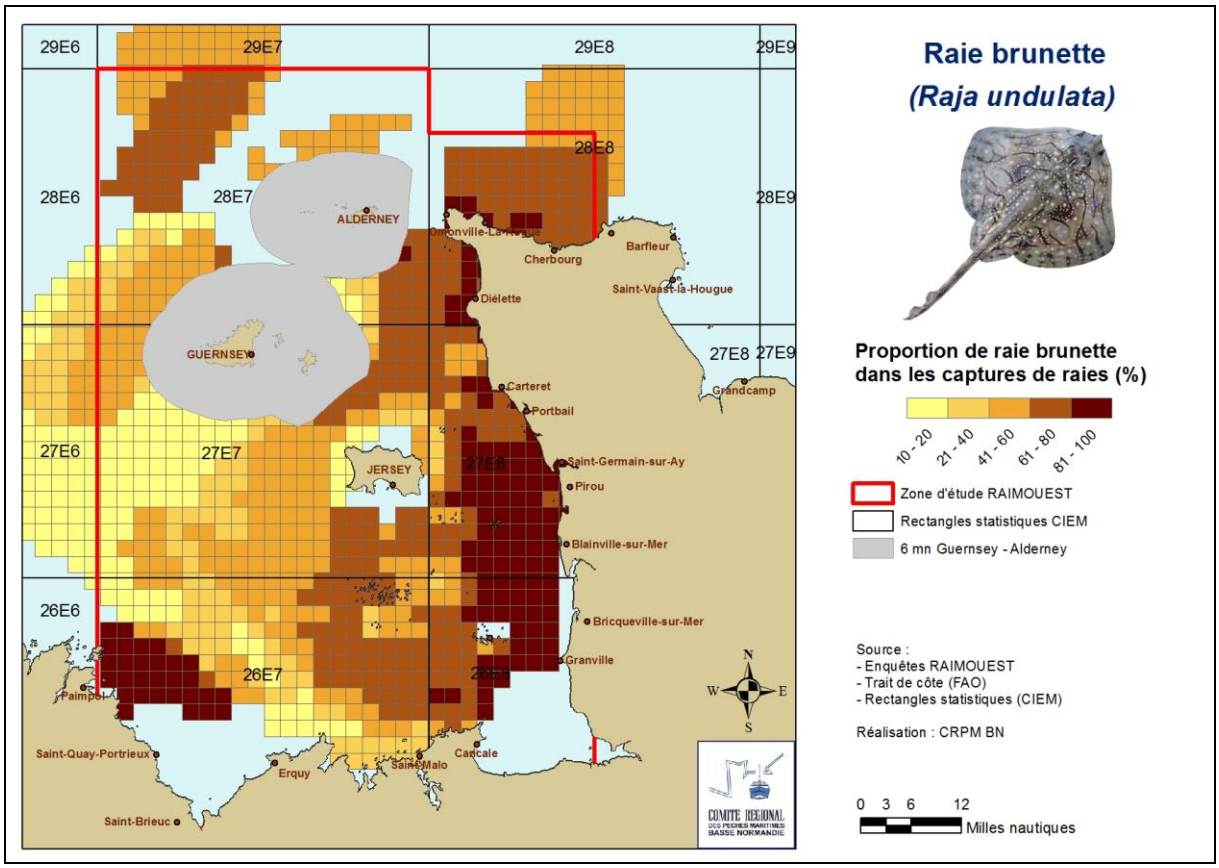


Figure 5: Proportion of R. undulata in the total catch of rays in the Normand-Breton Gulf from inquiries. The red line depicts the limit of the study area in the GNB.

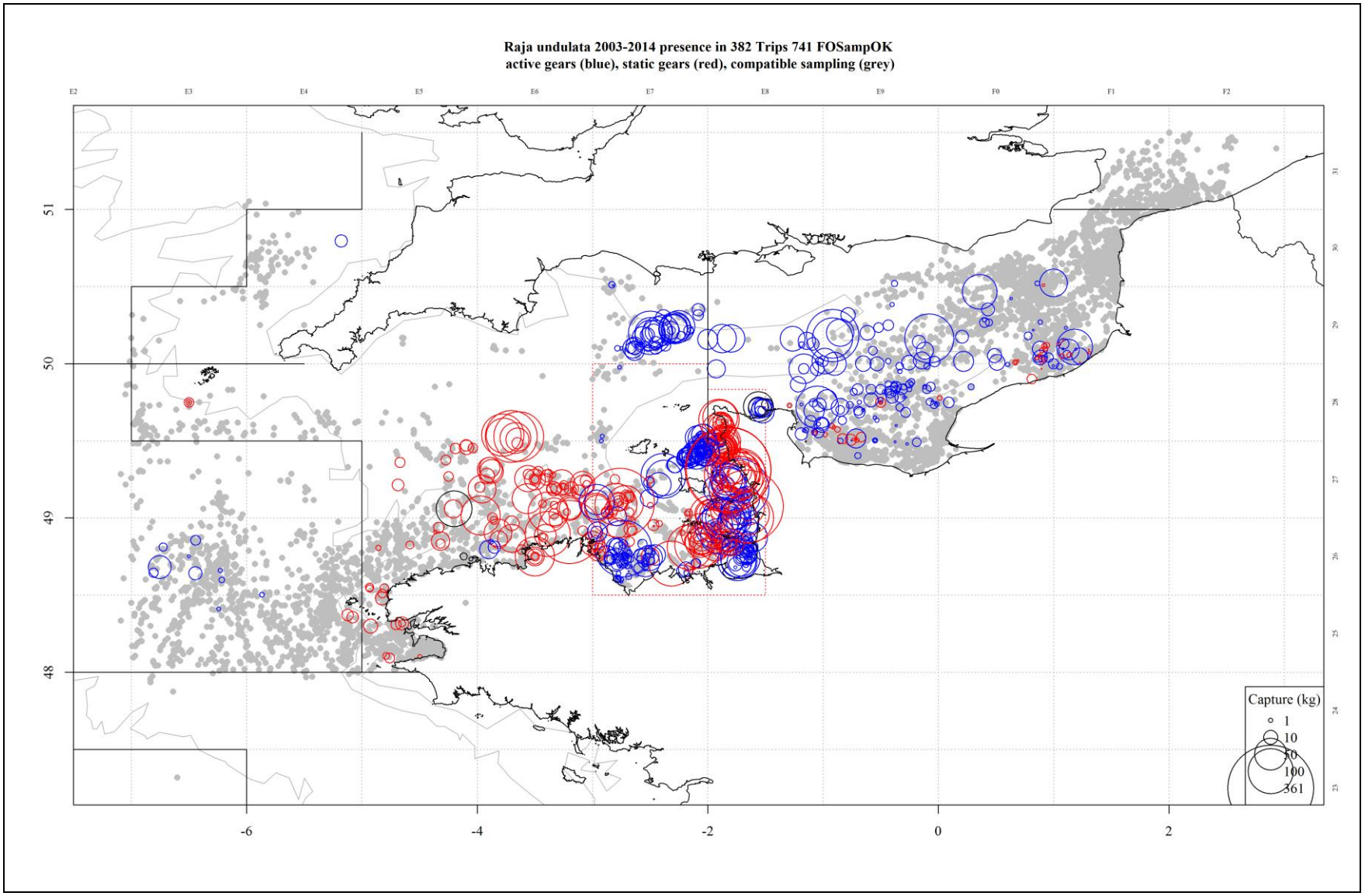


Figure 6: R. undulata catches (Kg) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = compatible sampling, blue = active gears, red = passive gears).

3.2.2. Nursery area

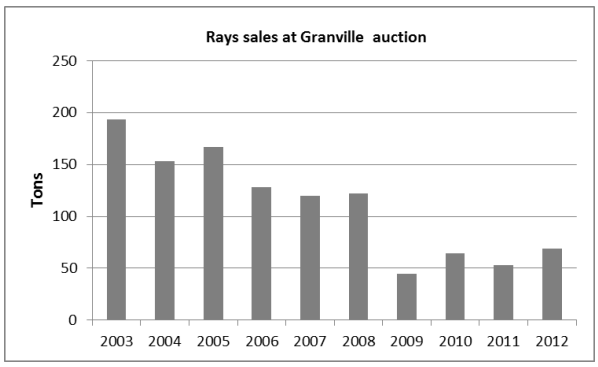
Catches of small individuals of *R. undulata (*0-30 and 30-50 cm of total length) occurs on coastal waters, mainly in the Normand-Breton Gulf and also in lower proportions in the Eastern English Channel but slightly further from the coast (Figure 12). Inquired fishermen from the Normand-Breton Gulf reported high abundance of small individuals in the Mont-St-Michel and St-Brieuc bay and in shallow waters (0-5 m) of the South-Est of this Golf. These results suggest that coastal waters of the Normand-Breton Gulf, especially the Mont-St-Michel and St-Brieuc bay and shallow waters of the South-Est of this Gulf, constitute nursery areas for *R. undulata.*

3.2.3. Landings

French landings of R. undulata in the western English Channel and in the Normand-Breton Gulf from SIH data

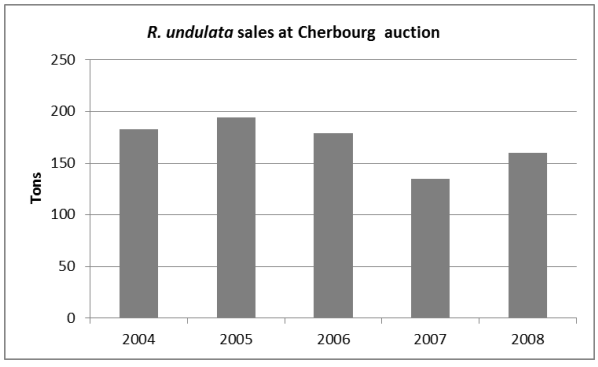
Based on the decrease in the total ray landings from 2007-08 to 2009-10 (Figure 3), the annual French landings of *R. undulata* were estimated at least at 300 tons in the Western English Channel (VIIe) and 160 in the Normand-Breton Gulf (Figure 4). The real level of landings could be considered higher than this estimation because of changes in fishing practices (inquired fishermen reported changes in fishing activities with more targeting on other ray species, e.g. *R. brachyura* or *R. clavata,* as a consequence of the ban of *R. undulata* landings) and the underrepresentation of small coastal netters and longliners who exploited the coastal waters where *R. undulata* is particularly abundant (incomplete declarative data and part of sales out of auctions).

Basse-Normandie fleet R. undulata sales at auction estimate



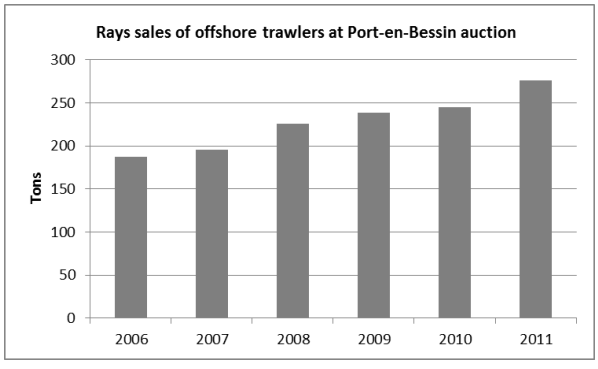
Based on the step decrease in the total ray sales at Granville from 2008 to 2009, the annual sales of *R. undulata* are estimated to be at least 70 tons (Figure 7). All rays sailed at the Granville auction were caught in the Normand-Breton Gulf.

Figure 7: Total ray sales (tons) at auction Granville from 2003 to 2012.



R. undulata sales at Cherbourg auctions from 2004 to 2008 are relatively stable at 170 tons on average (Figure 8). Based on the fishing area of the vessels concerned, around 90 % (~150 tons) were caught in the western English Channel, particularly in the Normand-Breton Gulf, and 10 % (~20 tons) from the eastern English Channel.

Figure 8: R. undulata *sales (tons) at Cherbourg auctions from 2004 to 2008.*



R. undulata sales at the auction of Port-en-Bessin essentially came from offshore trawlers. These vessels sold around 200 tons of rays per year at Port-en-Bessin auction from 2006 to 2008 (Figure 9). Fishermen inquired indicated that *R. undulata* contributed to 15 % of the total ray catches (half from the western English Channel and the other from the eastern English Channel). So *R. undulata* sales could be estimate at 30 tons, 15 tons from VIId and 15 tons from VIId.

Figure 9: Total ray sales (tons) of offshore trawlers at the

Port-en-Bessin auctions from 2004 to 2008.

The total *R. undulata* sales at auctions of the Basse-Normandie fleet before 2009 could be estimated at 270 tons (around 235 tons from the western English Channel and 35 from the eastern English Channel). Most of the rays landed by trawlers are sold at the auction but one part of those landed by netters and longliners are sold out of the auction, particularly in the case of small vessels of the western English Channel, so the total *R. undulata* landings was higher than this value.

3.2.4. Discards estimate

Preliminary results on discards estimates of *R. undulata* by the French fleet in ICES Division VIIe in 2012 were done using ObsMer sampling and COST tools, these results were presented in 2013 (Leblanc *et al.*, 2013). We choose to raise the data by fishing days, which seem the most accurate method after exploratory analysis and to use a quarterly stratification. The same exercise was realised for 2011 and 2013, lower CVs are in green, 2012 results show slight differences with previous ones due to update of data (Table 3).

			2011		2012		2013	
space	technical	time	estim(kg)	cv	estim(kg)	cv	estim(kg)	cv
VIIe	DRB_MOL	1	72 802	0.44				
VIIe	GNS_CRU	1					12	76.43
VIIe	GNS_DEF	1					1 250	3.23
VIIe	GTR_DEF	1			708	8.16	3 857	8.42
VIIe	OTB_DEF	1	824 104	0.00	291 476	0.09	258 535	0.40
VIIe	TBB_DEF	1			5 932	0.08		
VIIe	GNS_CRU	2	256	19.64			161	32.93
VIIe	GNS_DEF	2			356	5.71	1 691	5.57
VIIe	GTR_DEF	2	1 004	10.83	1 293	9.87	2 155	6.80
VIIe	OTB_CEP	2					28 696	0.14
VIIe	OTB_DEF	2	7 417	0.22	684	0.34	101 723	0.39
VIIe	OTT_CEP	2					4 462	0.00
VIIe	OTT_DEF	2	463	0.00				
VIIe	TBB_DEF	2	10 180	0.71			5 835	0.48
VIIe	GNS_CRU	3	20	36.43	18	45.69	9	0.00
VIIe	GNS_DEF	3					297	4.71
VIIe	GTR_DEF	3	63	9.14	29	18.08	529	5.63
VIIe	OTB_CEP	3					37 187	0.35
VIIe	OTB_DEF	3	9 819	0.39	149 378	0.07	130 023	0.14
VIIe	OTB_MOL	3			62 101	0.00		
VIIe	OTT_CEP	3					1 237	0.00
VIIe	TBB_DEF	3	780	0.48	4 408	0.23	9 108	0.00
VIIe	GNS_DEF	4	123	9.22			1 714	0.54
VIIe	GTR_CRU	4			175	0.00		
VIIe	GTR_DEF	4	981	6.87			2 820	8.70
VIIe	OTB_CEP	4					50 411	0.65
VIIe	OTB_DEF	4	7 089	0.89	216 470	0.27	248 336	0.00
VIIe	SDN_DEF	4	223	0.05				
VIIe	TBB_DEF	4			906	0.00		

			2011		2012		2013	
space	technical	**Total**	estim(kg)		estim(kg)		estim(kg)	
VIIe	DRB_MOL	**Total**	72 802					
VIIe	GNS_CRU	**Total**	277		18		182	
VIIe	GNS_DEF	**Total**	123		356		4 951	
VIIe	GTR_CRU	**Total**			175			
VIIe	GTR_DEF	**Total**	2 048		2 030		9 362	
VIIe	OTB_CEP	**Total**					116 293	
VIIe	OTB_DEF	**Total**	848 429		658 008		738 616	
VIIe	OTB_MOL	**Total**			62 101			
VIIe	OTT_CEP	**Total**					5 699	
VIIe	OTT_DEF	**Total**	463					
VIIe	SDN_DEF	**Total**	223					
VIIe	TBB_DEF	**Total**	10 960		11 245		14 943	
Total	**Total**	**Total**	935 325		733 934		890 046	

Table 3: Estimation of R. undulata discards (Kg) by the French fleet in VIIe, 2011, 2012 and 2013 from COST-analysis. Values (Kg) are presented by season and by metier with the corresponding coefficient of variation (cv), values below 0.50 are in green.

There were a few slight differences in annual sampling plans occurred (e.g. DRB_MOL was sampled in 2011 only) and some discrepancies for some year/quarter. In particular, high discards were estimated for OTB_DEF in the first quarter of 2011 owing to one single observed trip (resulting in a 0 cv). Nevertheless, these three years results are consistent with previous ones. Only estimates for trawling are possible and OTB_DEF is the main contributor with a mean annual discards in 2011-2013 of 750 tonnes.

As in last year, the very low contribution of the netting is a cause of concern. For this métier, the CVs are very high and contribution is much less important than in the samplings. This problem is certainly linked to the fact that the boats concerned are small and polyvalent and that the logbook data are not very reliable. Also raising by fishing days may not be much appropriate for passive gears.

3.2.5. Length distribution

Bottom trawls catch all sizes (15-103 cm) with a majority of juveniles (Figure 10). *R. undulata* catches with trammel nets of mesh size < 270 mm are composed of a large size distribution (30-98 cm) with around half of juveniles and half adults. Trammel nets of mesh size ≥ 270 mm are used to target large individuals (50-104 cm) with a majority of adults, highlighting the selective effect of the mesh size used to target rays. Data available are insufficient to provide length distribution for longlining but fishermen inquired indicated that ray catches are essentially composed of large individuals (use of large hooks). Length distribution at the English Channel level for this gear shows a similar trend.

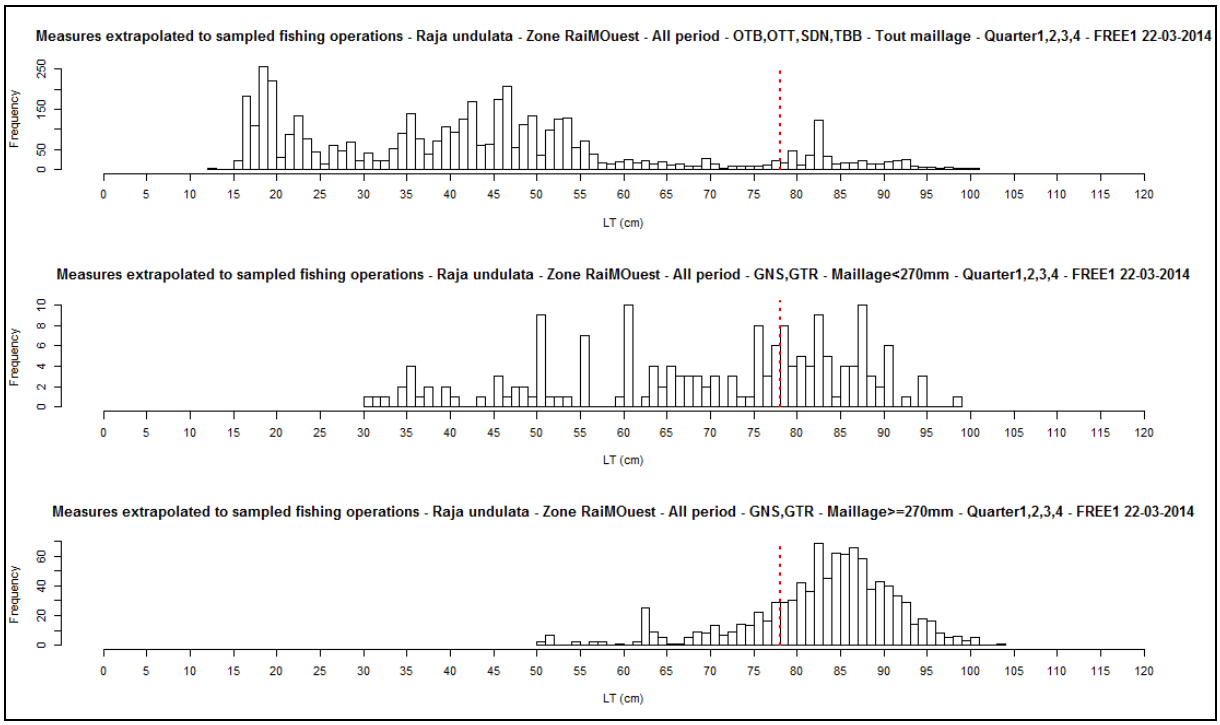


Figure 10: Length distribution of R. undulata catches in samplings at sea in the Normand-Breton Gulf for bottom trawlers and netters (mesh size <270 mm and ≥270 m, from 2003 to the first quarter 2014). Length at maturity for male in the Normand-Breton Gulf established by Stephan et al. (2014) was represented in red.

The estimation of the length distribution of *R. undulata* catches by French bottom trawlers (OTB_DEF) in the western English Channel in 2012 show an important proportion of juveniles, a small proportion of large juveniles and a peak of adults (Figure 11). Result shows a similar trend in 2013 but is different in 2011, probably due to a less representativeness of sampling.

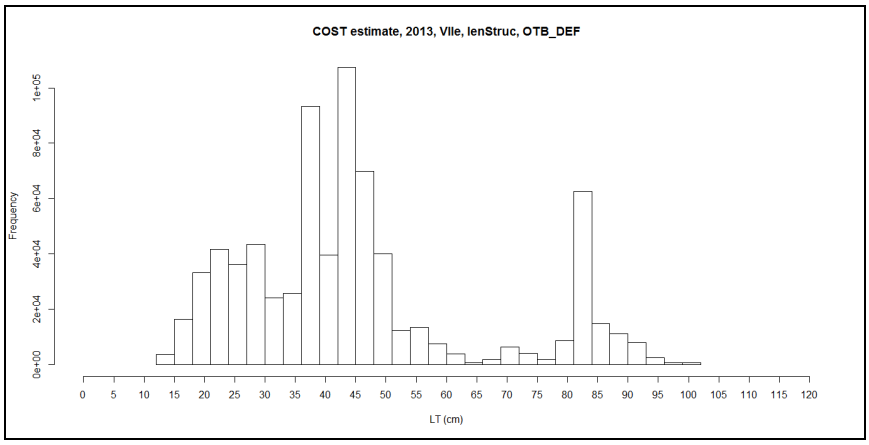


Figure 11: Estimation of length distribution of R. undulata catches (three centimetres classes) by French Bottom trawlers (OTB_DEF) in the western English Channel in 2013.

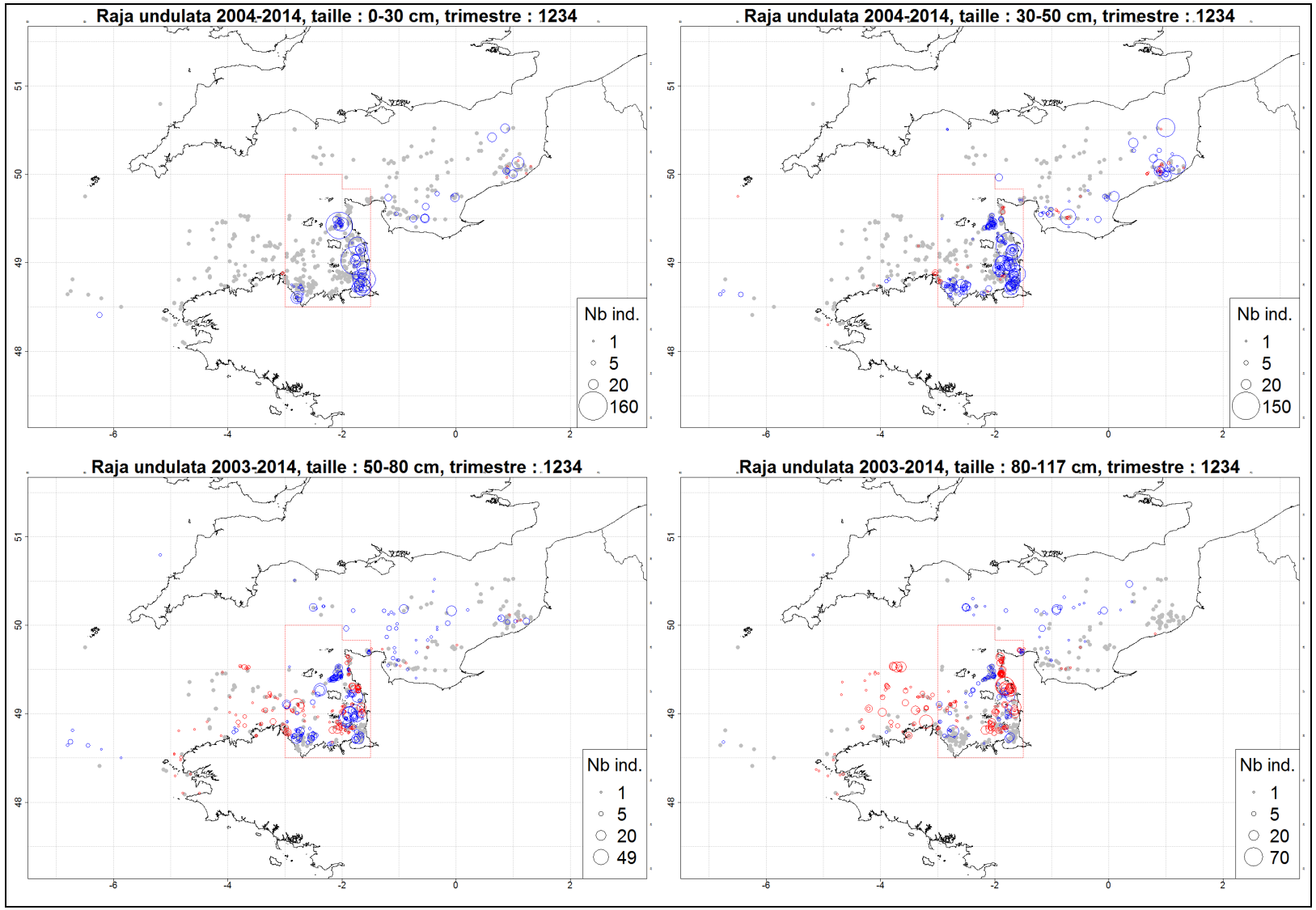


Figure 12: R. undulata catches (number of individuals) by total length category (0-30, 30-50, 50-80, >80 cm) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = sampling with catch of R. undulata, blue = active gears, red = passive gears).

3.3. Raja brachyura

3.3.1. Spatial distribution

The analysis of fishermen inquiries shows that *R. brachyura* is locally dominant in the Normand-Breton Gulf (Figure 13). Inquired fishermen indicated that this species aggregates on coarse sand banks and hydraulic dune. Samplings at sea show that this species is mainly caught on the western English Channel (Figure 14). The seafloor on areas of higher catches seems to be coarse sand banks and hydraulic dune. Correlation analyses between the nature of the habitat and bottom trawling and netting catch per unit effort indices will be undertaken to test this hypothesis and highlight potential preferential habitat.

3.3.2. Nursery area

Catches of small individuals of *R. brachyura (*0-30 and 30-50 cm of total length) mainly occurs in coastal waters while catches of large individuals occurs both in coastal and offshore waters suggesting that nursery are localised on coastal waters (Figure 15).

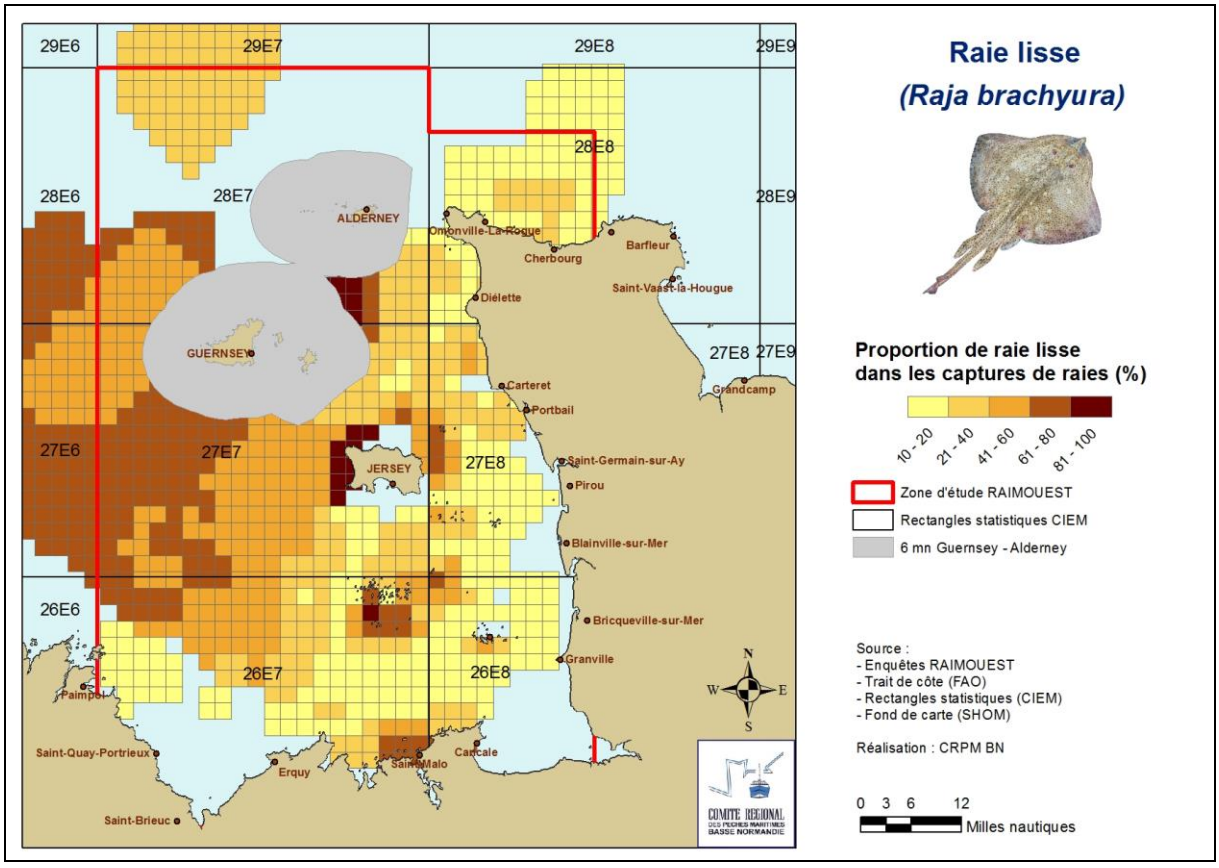


Figure 13: Proportion of R. brachyura in the total catch of rays in the Normand-Breton Gulf from inquiries. The red line depicts the limit of the study area in the GNB.

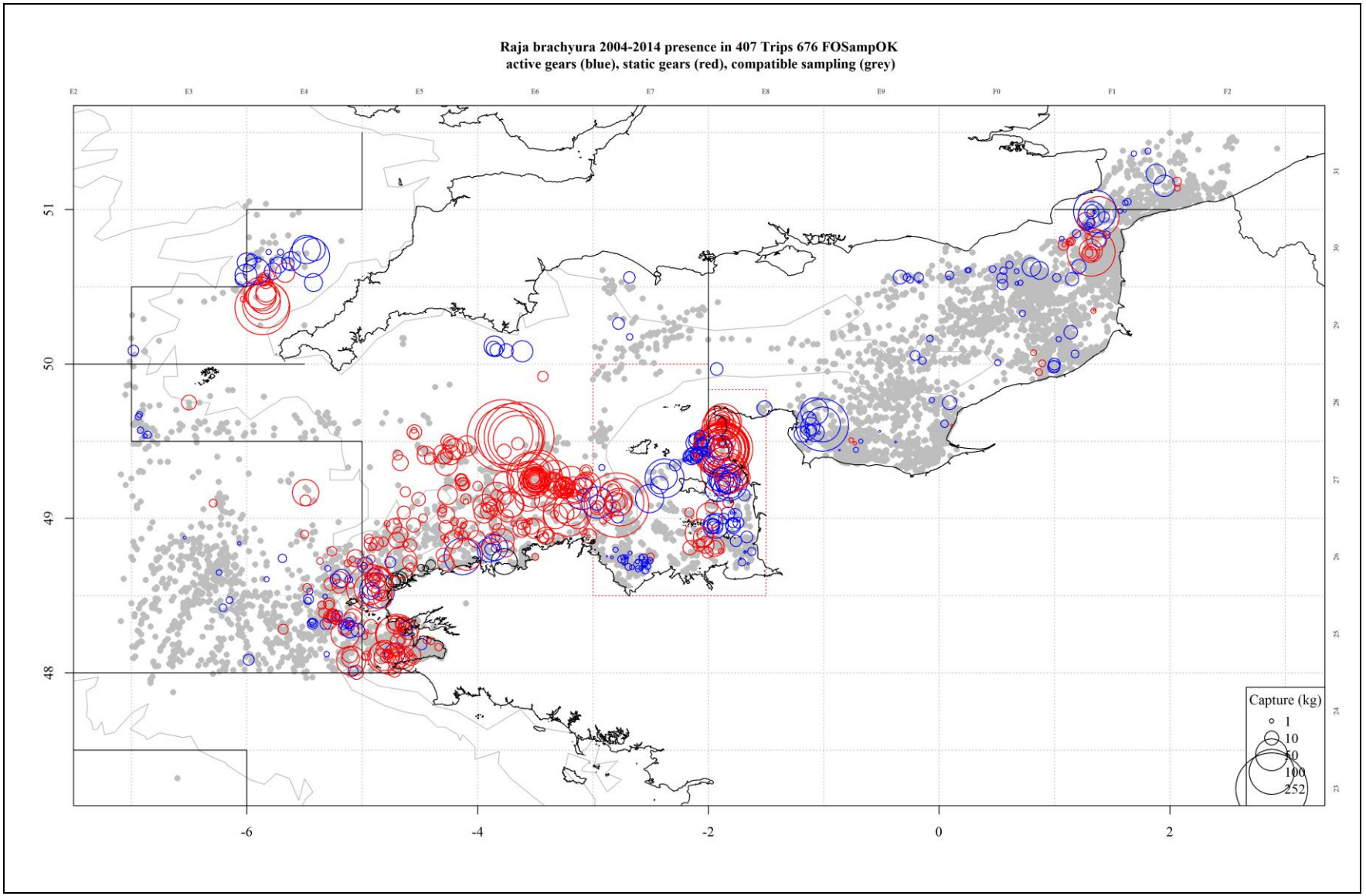


Figure 14: R. brachyura catches (Kg) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = compatible sampling, blue = active gears, red = passive gears).

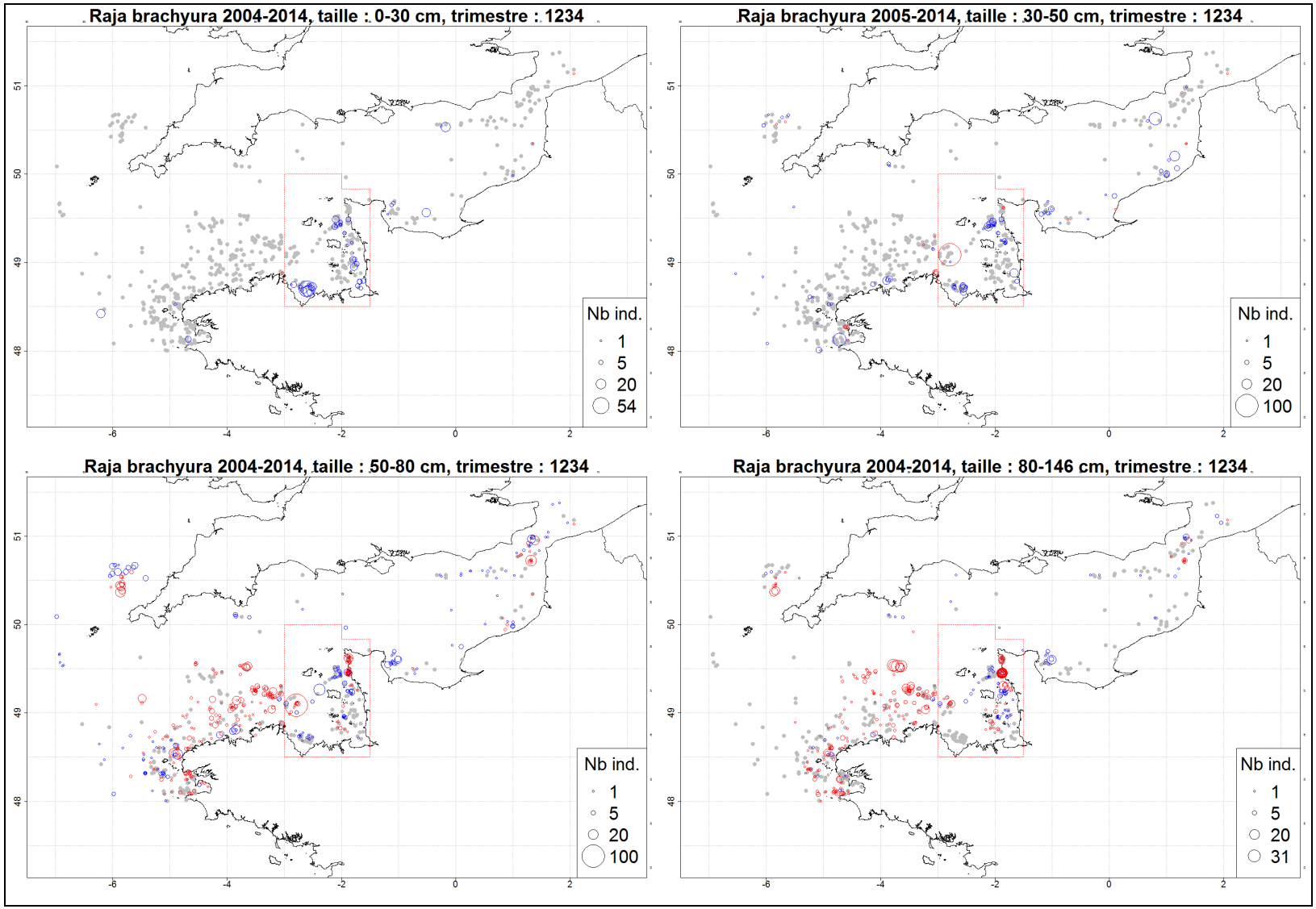


Figure 15: R. brachyura catches (number of individuals) by total length category (0-30, 30-50, 50-80, >80 cm) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = sampling with catch of R. brachyura, blue = active gears, red = passive gears).

3.4. Raja clavata

3.4.1. Spatial distribution

The analysis of fishermen inquiries shows that *R. clavata* is caught on all the Normand-Breton Gulf but in very low proportions, suggesting that this species is scarce on this area (Figure 16). Fishermen also indicated that these species is seasonally abundant on the north of the Cotentin. Samplings at sea show that this species is essentially caught on the eastern English Channel and at least in the Southern statistic rectangles of the North Sea (Figure 17). Catches are scarce in the western English Channel. This information on the distribution of *R. clavata* suggests that the stock diagnostic of this species in the western English Channel might be attached to the eastern English Channel stock unit diagnostic.

3.4.2. Nursery area

0-30 cm total length *R. clavata* catches are confined on very coastal waters, in particularly closely to the Seine estuary and the Bay de Somme in the eastern English Channel and to a lesser amount to the St-Brieuc and Mont-St-Michel bay in the western English Channel (Figure 18). 30-50 cm total length individuals occur further from the coast around these areas. This spatial distribution of the *R. clavata* juveniles indicates that these bays and estuaries provide nurseries areas for this species. Beillois *et al.* (1979) have already identified the Mont-St-Michel bay as nursery for *R. clavata*. Larger individuals (> 50 cm) occur on the whole English Channel but to a lesser amount on coastal waters.

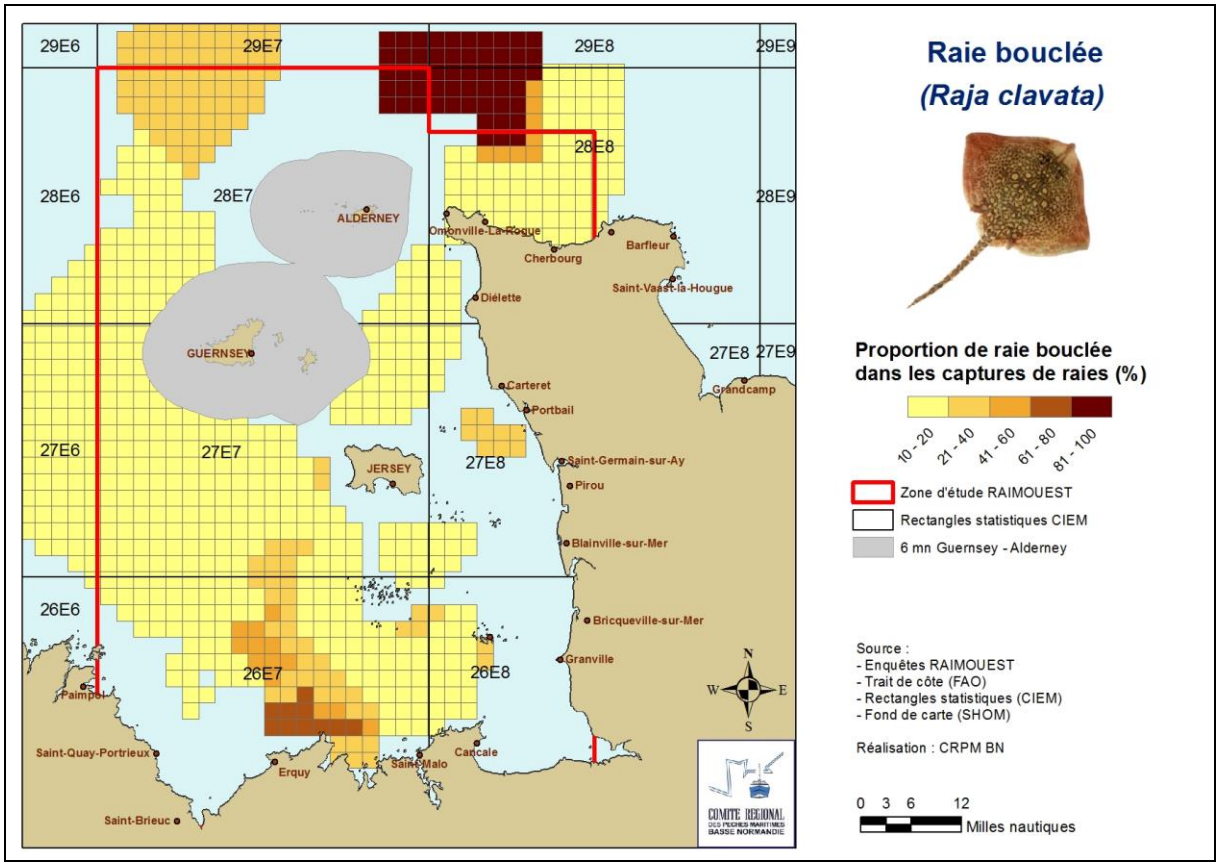


Figure 16: Proportion of R. clavata in the total catch of rays in the Normand-Breton Gulf from inquiries. The red line depicts the limit of the study area in the GNB.

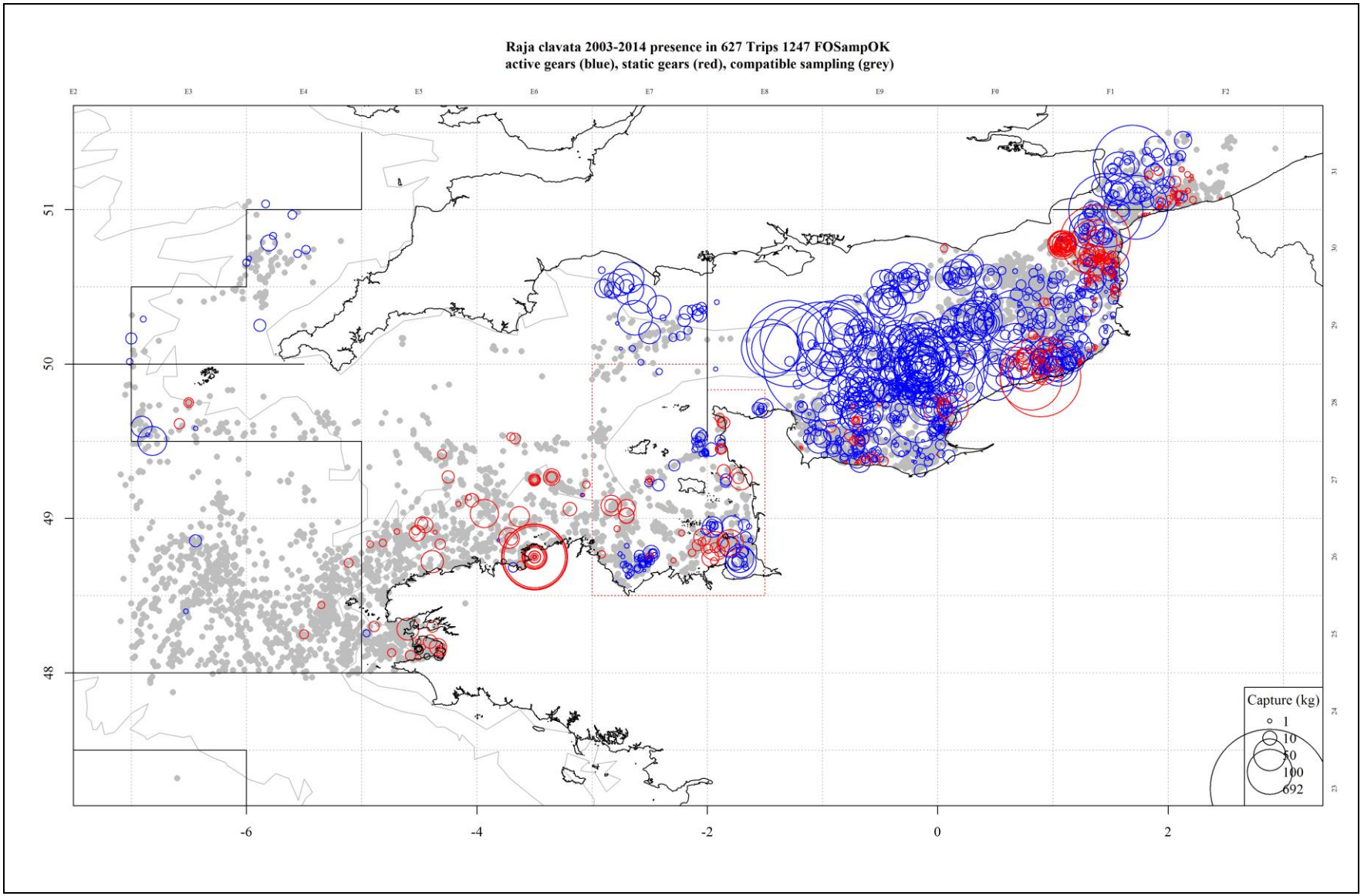


Figure 17: R. clavata catches (Kg) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = compatible sampling, blue = active gears, red = passive gears).

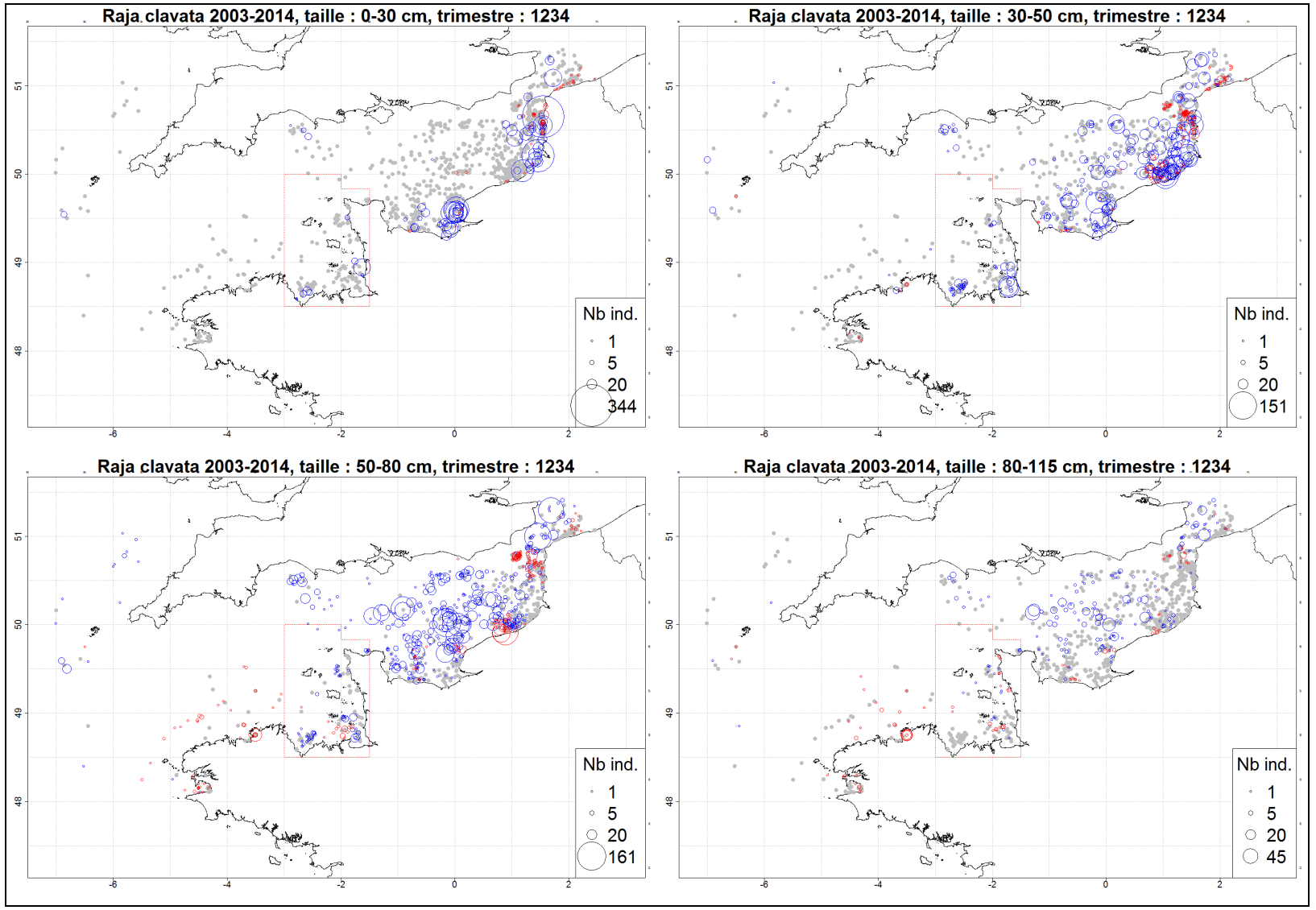


Figure 18: R. clavata catches (number of individuals) by total length category (0-30, 30-50, 50-80, >80 cm) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = sampling with catch of R. clavata, blue = active gears, red = passive gears).

3.5. Raja montagui

3.5.1. Spatial distribution

Fishers inquiries indicated very few catch events of *R. montagui* (Figure 19) but fishers often confused *R montagui* with *R. brachyura* so this result should not be considered relaible. Samplings at sea show that this species is mainly caught on the western English Channel, particularly on the north of Brittany and locally along the coast of Portland (where?) and Fécamp (eastern Channel) (Figure 20).

3.5.2. Nursery area

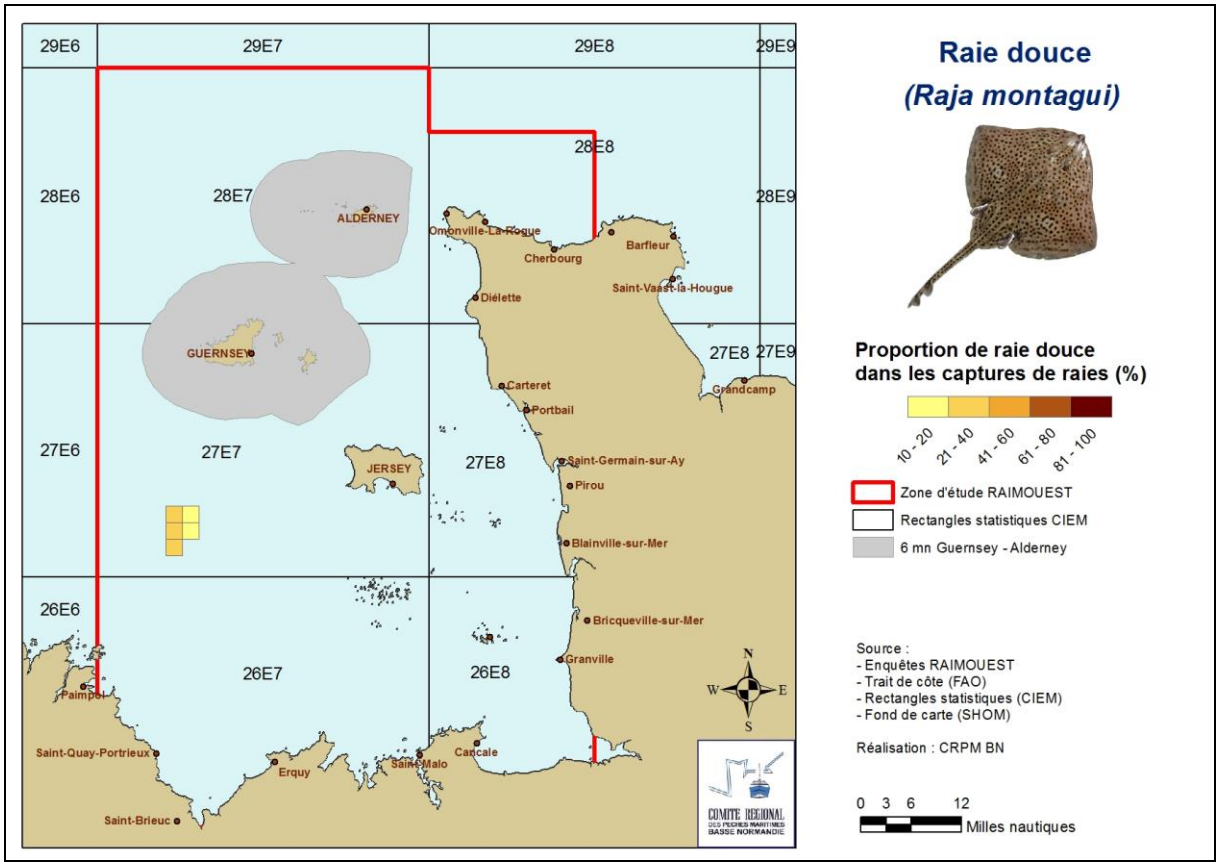


Figure 19: Proportion of R. montagui in the total catch of rays in the Normand-Breton Gulf from inquiries. The red line depicts the limit of the study area in the GNB.

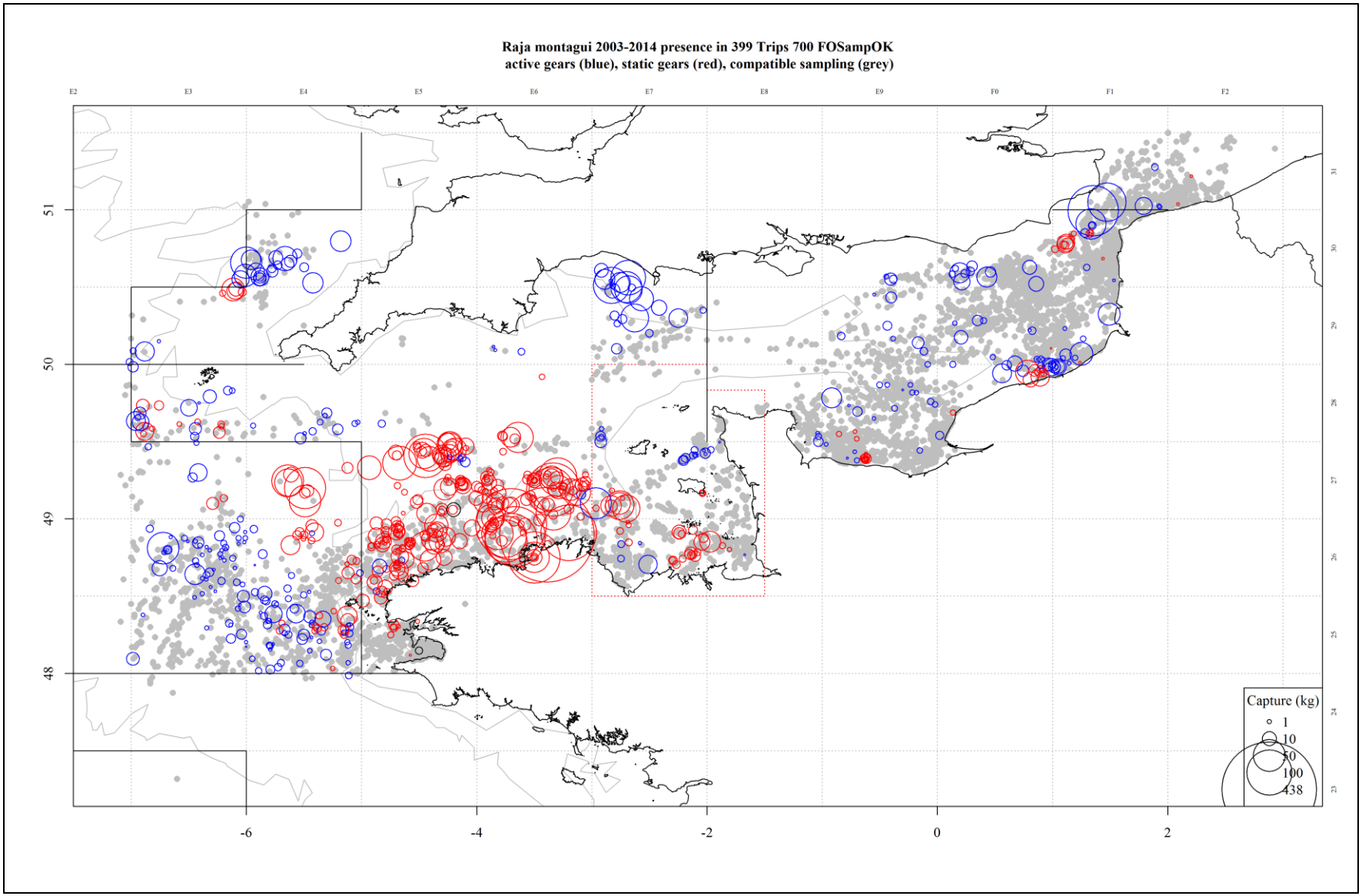


Figure 20: R. montagui catches (Kg) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = compatible sampling, blue = active gears, red = passive gears).

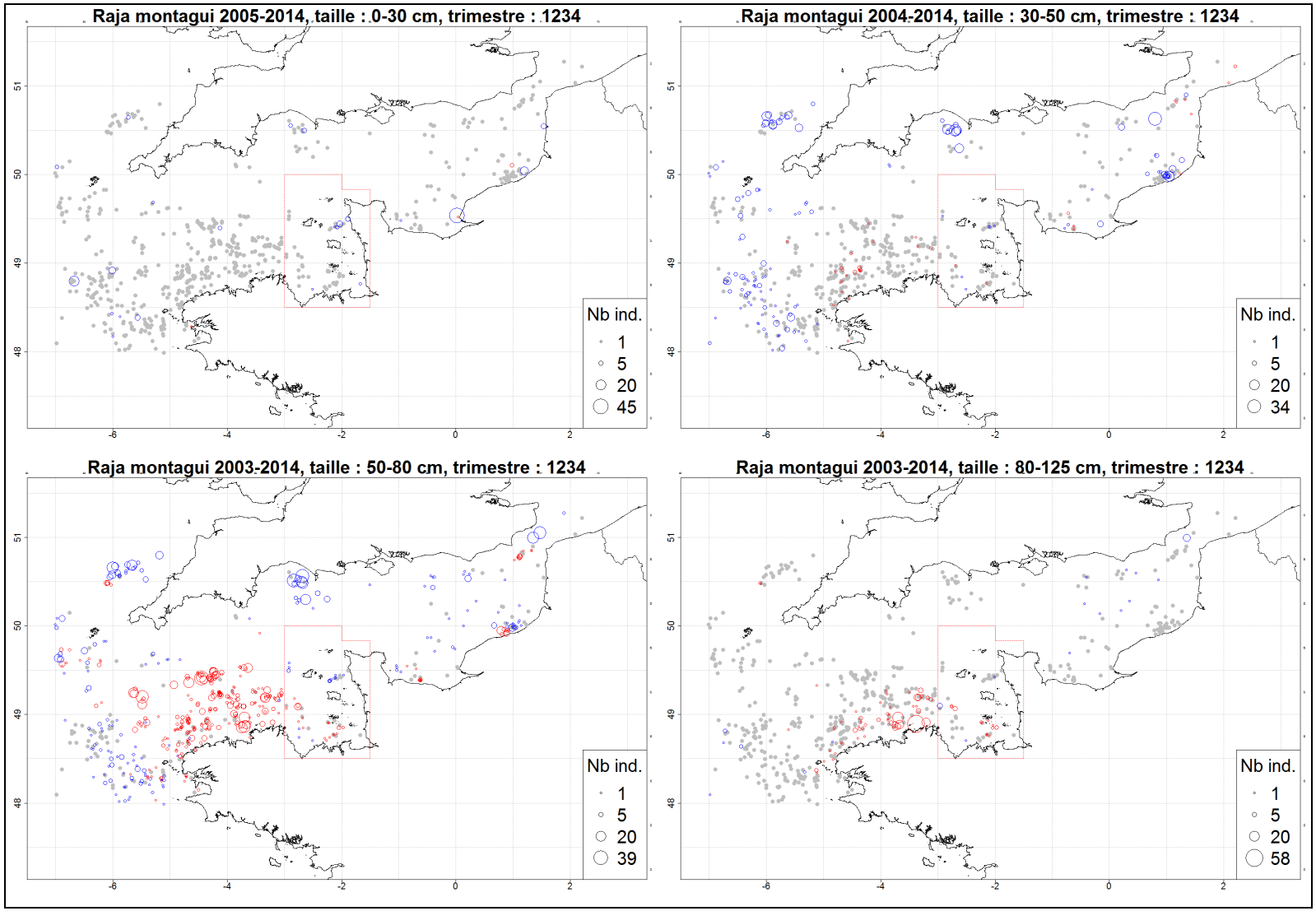


Figure 21: *R. montagui* catches (number of individuals) by total length category (0-30, 30-50, 50-80, >80 cm) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = sampling with catch of *R. montagui*, blue = active gears, red = passive gears).

3.6. Raja microocellata

3.6.1. Spatial distribution

Catches of *R. microocellata* in samplings at sea are very low and localised in particularly to the northeast of the Normand-Breton Gulf (Figure 23). The analysis of fishermen inquiries also indicated that this species occurs at a low density in this area (Figure 22). However, Ellis *et al.* (2011) indicated that Small-eyed ray was the main skate species caught to the north of Jersey.

3.6.2. Nursery area

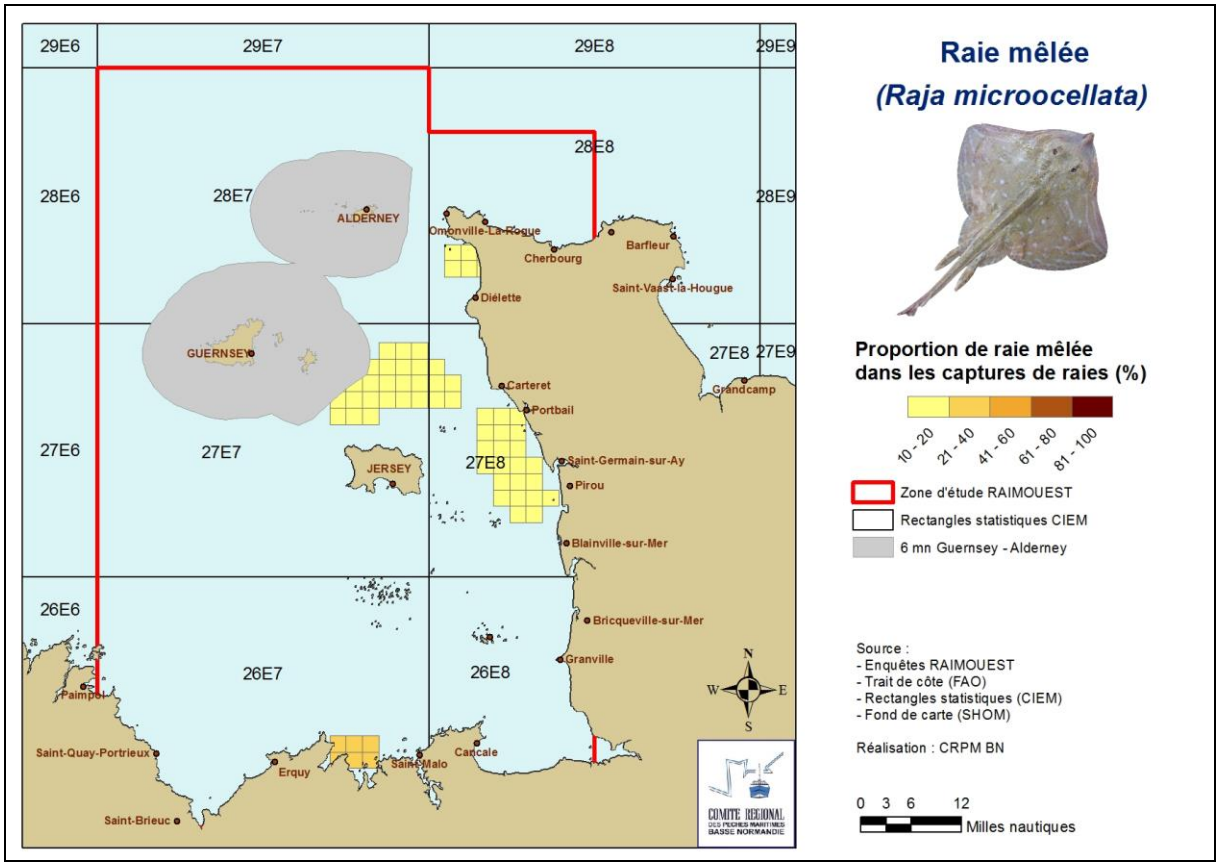


Figure 22: Proportion of R. microocellata in the total catch of rays in the Normand-Breton Gulf from inquiries. The red line depicts the limit of the study area in the GNB.

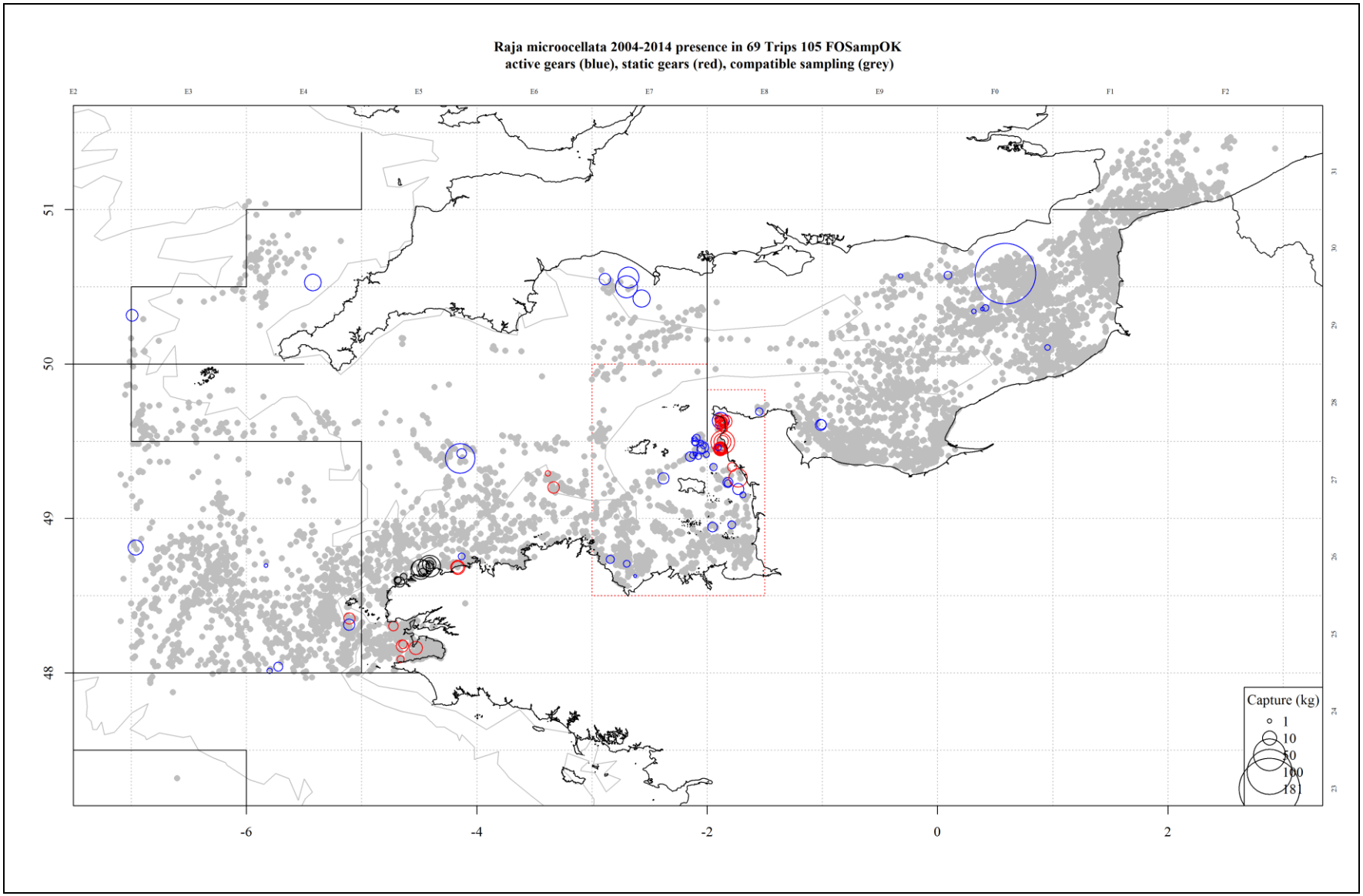


Figure 23: R. microocellata catches (Kg) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = compatible sampling, blue = active gears, red = passive gears)

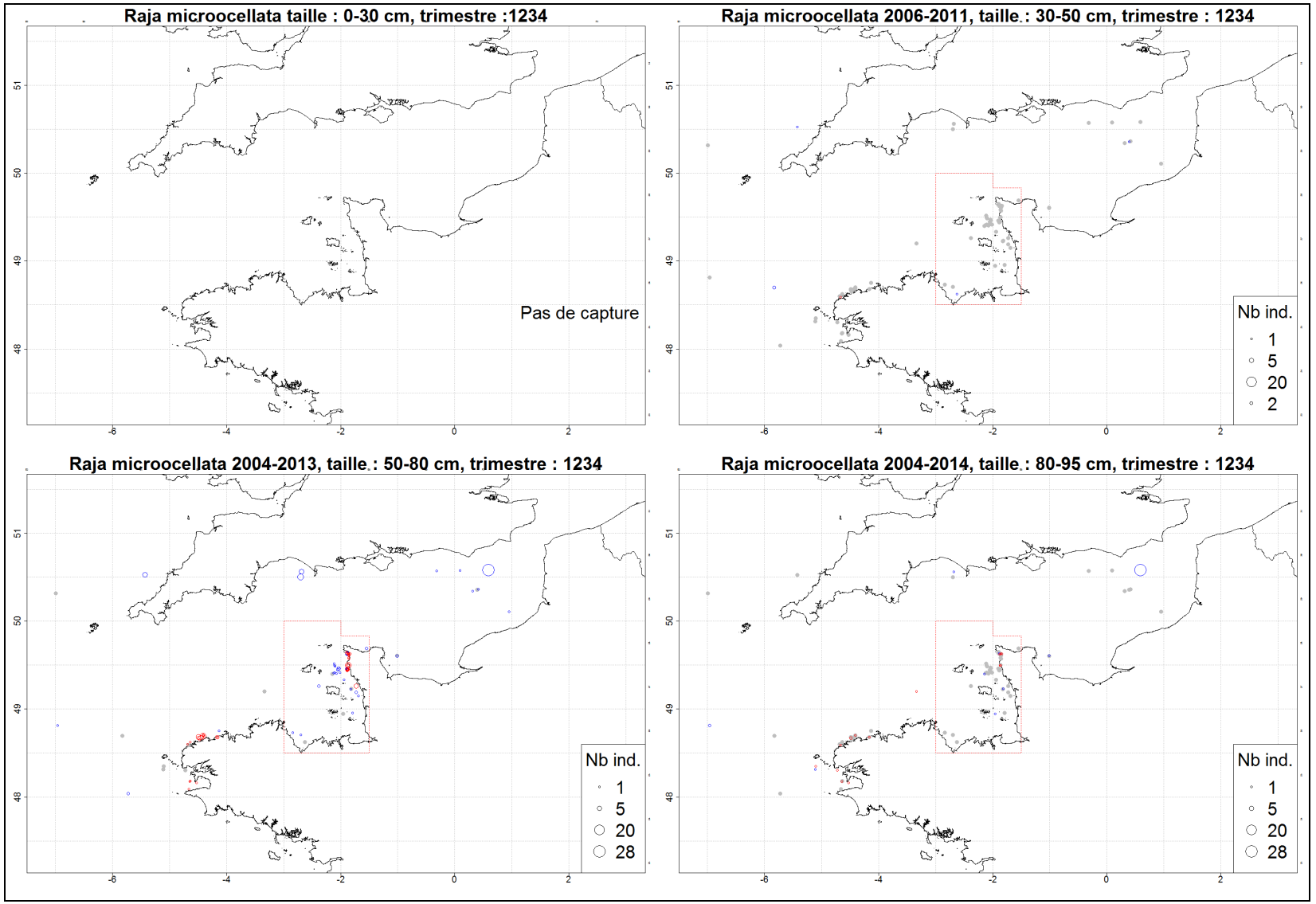


Figure 24: R. microocellata catches (number of individuals) by total length category (0-30, 30-50, 50-80, >80 cm) in samplings at sea in the English Channel from 2003 to the first quarter 2014 (grey = sampling with catch of R. microocellata, blue = active gears, red = passive gears)..

4. CONCLUSIONS

63 % of the French fleet operating in the Normand-Breton Gulf in 2012 was concerned by ray fishing (catching or having caught rays before the *R. undulata* landing ban). This fleet of 289 vessels was composed of half of vessels mainly using active gears (essentially coastal trawlers/dredgers) and half of vessels mainly using passive gears (principally coastal netters of small length size, 9 m on average).

Both inquiries, observation at sea and sales by species at Cherbourg auction data indicate that *R. undulata* is the main species caught (50-75 % of the ray catch), followed by *R. brachyura* (17-30 %), *R. clavata* (5 %), *R. montagui* and *R. microocellata*.

Consequently, *R. undulata* landing ban since 2009 has induced an important impact on the ray fisheries fleet, directly by the decrease of the ray landings (at least -160 tons at the Normand-Breton Gulf level and -300 tons at the western English Channel level) and indirectly by changes in fishing practises (abandon of fishing areas where *R. undulata* is very abundant and fishing strategies unviable without this species). Another impact of this ban has been the absence of landings and sales at auctions data for this species since 2009 which has led to significant issues when trying diagnostic its stock.

To provide information likely to improve the diagnostic of *R. undulata*, RAIMOUEST has used inquiries and analysed sales and landing data available, as well as observations at sea in which this species has been sampled in discards since 2009.

Analysis of inquiries and sampling at sea data were coherent and complementary, they seem to indicate that *R. undulata* forms a local stock in the Normand-Breton Gulf and that there are some continuity with the Eastern English Channel and the Western part of the Western English Channel. The RECOAM tagging/recapture operation carried out in the Normand-Breton Gulf seems to show high site fidelity (Stéphan *et al.*, 2014).

Based on the decrease of the ray landings from SIH data, the annual French landings of *R. undulata* before 2009 were estimated at least at 300 tons in the Western English Channel (VIIe) and 160 tons in the Normand-Breton Gulf. This value could be considered underestimated because of report of the fishing activities on other ray species and the underrepresentation of small coastal netters and longliners in this data. Sales of *R. undulata* at auctions for the Basse-Normandie fleet before 2009 were estimated at 270 tons (235 tons in the western English Channel and 35 tons in the eastern English Channel) but the total ray sales of this fleet is higher than this value because it did not include a part of netters and longliners which sold rays out of the auction. Discards estimate of *R. undulata* by the French bottom trawl fleet in ICES Division VIIe in 2012 and 2013 are coherent and indicate around 750 tons. These three analyses give an indicative level of the *R. undulata* stock.

The location of the other ray species catches in the samplings at sea provides information on their spatial distribution in the English Channel which could be useful to define stocks units. In example, *R. clavata* is abundant in all the Eastern English Channel and at least in the Southern statistic rectangles of the North Sea while it is scarce in the western English Channel. This suggests that the stock diagnostic of this species in the western English Channel might be attached to the eastern English Channel stock unit diagnostic.

Inquiries and the location of the main ray species catches by total length categories in the samplings at sea highlights the coastal localisation of nursery for *R. undulata* and *R. clavata*.

The contrasted geographical distribution of the different species suggest that if one species appeared to be exploited at higher level than others it could be envisaged to reduce effort of the fishing gears that catch that species in areas where it is most abundant. The ban of *R. undulata* probably resulted in such a spatial effect as fishers stopped fishing in areas where *R. undulata* was their primary target. The likely increase in abundant of the species suggests that the reduction of fishing mortality for a few years allow a stock biomass increase. The accumulation of knowledge over years may allow the development of a more accurate management of rays where habitats of species that are subject of concern could be subject to fishing restriction in order to lift fishing mortality of those species.

Acknowledgements

We thank the Système d'Information Halieutique (SIH) database held at Ifremer for the fishery-dependent data.

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We thank fishermen and at sea observers involved in the sampling at sea aboard professional fishing vessels (ObsMer and RAIMOUEST), and the Lycée Maritime et Aquacole de Cherbourg (LMA) for their additional samplings.

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Annex 1: Samplings at sea in the English Channel (VIIde) in trips and in fishing operation samplings numbers by DCF métier, by year and by quarter.

Année	Trimestre	Nombre de marées	Nombre d'opérations de pêche échantillonnées	Nombre d'opération de pêche échantillonnées par métier																	
				DRB_MOL	GNS_CRU	GNS_DEF	GTN_DEF	GTR_CEP	GTR_CRU	GTR_DEF<220	GTR_DEF>=220	LLS_DEF	OTB_CEP	OTB_DEF	OTB_MOL	OTB_SPF	OTT_CEP	OTT_DEF	SDN_DEF	TBB_DEF	Autres métiers
2003	1																				
	2	4	24							11	2		1	6							4
	3	13	83							40	1		21	11		3				5	2
	4	10	53							14			20	12						7	
2004	1																				
	2	7	40							23	4			5		1		7			
	3	16	139			12				11	4		83	22						6	1
	4	12	81			4				8	8		7	42		1					11
2005	1																				
	2	6	32							24				8							
	3	15	114							9			55	41	3	2					4
	4	10	89			8				4			45	19						13	
2006	1	2	20											20							
	2	6	58							12			5	40	1						
	3	8	39							5	16		5	12		1					
	4	6	36		3								17	10							6
2007	1	28	172		4	6				5				1		1					155
	2	16	41			5					10			9		5	5				7
	3	43	119			14			1	22	29			33	2	10	5				3
	4	35	112		11					41			38	16		2					4
2008	1	30	67		21									4							42
	2	43	182		10	7					19		15	48		5					78
	3	45	93			41				4			7	16		3		3			19
	4	59	130		18	3				4			12	76				1			16
2009	1	91	337	8	24	2				38	15		26	141							83
	2	127	413		30	17				59	57	42	22	153		1				7	25
	3	147	401		11	57			8	130	43	42	1	79		7		4		7	12
	4	134	259	4	30	25				39	36	9	24	65				1		6	20
2010	1	124	316		25	17			8	107	20		50	38						2	49
	2	139	338		37	18			8	37	53		8	54		7	2	5			109
	3	112	288		18	19			5	37	26		27	64		3		3			86
	4	74	188	28	14	8			2	11	20			42		7				1	55
2011	1	58	217	94		8				27	8		9	22							49
	2	65	175		2	1		1		44	20		8	65		7	6	4		6	11
	3	81	241		2	10				55	23	9	8	90	2	11		5		9	17
	4	73	247		1	36			1	69	9	27	2	76		3			15	3	5
2012	1	93	344			63		3	1	108	13	16		90		6				6	38
	2	98	352			23		6	3	112	46	57	5	49		8	3	4			36
	3	111	453		3	34			4	104	27	76	11	84	3	13	6	6	46	7	29
	4	62	186	3	1	20			5	49	7	4	2	26				4	29	6	30
2013	1	68	186		5	6	1			65	15			46		10			3	3	32
	2	92	232		2	15				60	22		13	56		15	5	2		16	26
	3	122	300		1	22			4	74	13	2	15	96		15	2	5	11	3	37
	4	57	124	1	2	8				31	17	1	8	28		2		3			23
2014	1	32	75			2			1	18				44							10
Total		**2374**	**7396**	**138**	**275**	**511**	**1**	**10**	**51**	**1511**	**583**	**285**	**570**	**1859**	**11**	**149**	**34**	**57**	**104**	**113**	**1134**