Spatial and temporal analysis of VMS data to provide standardised estimates of fishing effort in consultation with the fishing industry

Case Study: Fishing activity within proposed UK Natura 2000 area on Dogger Bank

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Introduction

Historically, the spatial distribution of fishing effort and hence commercial catch per unit effort (CPUE) has been difficult to quantify based on logbook or other data. Logbook effort (hours fished) is only recorded at the International Council for the Exploration of the Sea (ICES) rectangle level, and this is often too coarse for accurate spatial delineation of the fishing effort directed within fishing grounds. Vessel Monitoring System (VMS) data provides the potential for more resolved and accurate determination of the spatial distribution of fishing effort; however, the analysis of such data is still in its early stages of development.

Within the LOT 7 EU funded project "Joint data collection between the fishing sector and the scientific community in the North Sea" a collaborative study of VMS data was agreed with the North Sea Regional Advisory Council (NSRAC). The project was designed to improve scientific and user understanding of the analysis process conducted when mapping the spatial distribution of fishing activities and to demonstrate how such analysis could aid the NSRAC in the provision of spatially pertinent advice. It was agreed during discussions that the project would develop standardized methods for estimating effort from VMS data and to undertake an example study.

At the 2008 Brussels meeting of the NSRAC Demersal Working Group the latest UK draft proposal for offshore Natura 2000 sites, part of the 2008-09 offshore Special Areas of Conservation (SAC) consultation, was presented by the Joint Nature Conservation Committee (JNCC, the UK agency which advises on nature conservation for UK offshore waters). The Natura Directives aim to stop biodiversity loss within the European Union by protecting natural habitats and species. JNCC has proposed two Natura 2000 offshore SAC for consultation in 2009. One of these is on the Dogger Bank which has been proposed for the conservation of 'Sandbanks slightly covered by seawater all the time' and 'Harbour porpoise'. Consultation between the Lot 7 Project team and the NSRAC Spatial Planning Group Chair identified the Dogger Bank SAC as a suitable case study the fits the goals of the Lot 7 VMS analysis project.

VMS Analysis protocols

A workshop was held at Cefas, Lowestoft to bring together scientists from across Europe in order to evaluate existing methods, and begin the development of standardised protocols, for estimating fishing effort from VMS data and to discuss the analysis required for the Dogger Bank case study. Representatives from Imares (Netherlands), Ifremer (France), Cefas and Marine Scotland were present. The UK Joint Nature Conservation Committee (JNCC) presented and then participated in discussions concerning the proposed restriction of fishing activities within the Dogger Bank SAC; a study to which the standardised protocols developed by the LOT 7 project team could be applied. The protocols developed at the meeting and applied in the analysis of VMS and catch data are described elsewhere, this report details the results application and interpretation of the information extracted.

Collective summary

Figure 1 shows the ICES rectangles that intersect the proposed SAC. Four rectangles (39F1, 39F2, 38F1 and 38F2) cover the majority of the area with a further seven rectangles (40F1, 40F2, 40F3, 39F3, 38F3, 37F1, 37F2) contributing smaller proportions. Landings data from these rectangles are used in the species composition and value analysis, and VMS data are used to give a more detailed picture of vessel fishing activity.

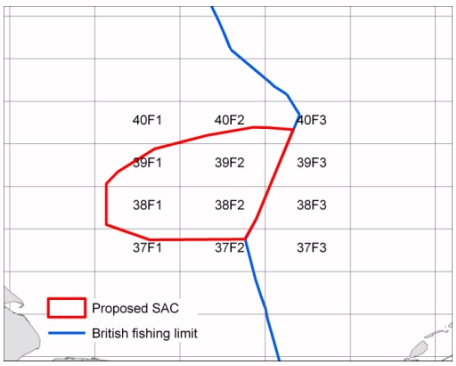

Figure 1. ICES rectangles intersecting the proposed SAC.

An initial analysis of patterns of fishing activity indicated that the majority of fishing effort deployed within this area was by Danish, Dutch and UK vessels. Unfortunately Danish analysts were not available within the project team for an analysis of their VMS, landings and value data and therefore only an analysis was conducted of their VMS data as part of 'other nations' VMS data recorded within UK waters. The main focus of this report is therefore a detailed analysis of UK and Dutch vessel activity within ICES regions IVb and IVc with particular focus on activity inside the proposed SAC area. Analysis is based upon EU logbook and VMS data for the years 2006 and 2007.

UK vessel activity within proposed SAC

Analysis of UK data for 2006 established that 21 beam trawlers, 6 otter trawlers and 3 Danish seine netters fished within the proposed SAC; in 2007, 23 beam trawlers, 8 otter trawlers and 2 Danish seine netters were active in the area. The total annual hours of fishing within the proposed SAC was estimated to be approximately 4700 for beam trawlers in both years, 400 and 1800 for otter trawlers in 2006 and 2007 and 1200 and 1000 for Danish seine netters. This represents approximately 11% of the beam trawl effort, 4% and 14% of the otter trawl effort and 94% and 79% of the Danish seine effort when compared with the total fishing effort of these vessels within ICES areas IVb & IVc. Maps derived from VMS data show that the beam trawl effort within the proposed SAC is greatest between April and September. Highest concentrations of otter trawl activity are noted around the periphery of the proposed SAC and again occur between April and September. The Danish seine effort occurs almost entirely within the proposed SAC area during the months of April to September with a small amount of activity being evident in the final quarter of 2007.

Analysis of the value of landings by UK vessels fishing within the four main ICES rectangles inside the SAC identified total catches, during the years 2006 and 2007, achieved 1.5 and 2.0 million pounds. Catch was dominated by flatfish (plaice, lemon sole, brill and turbot). Landings from the remaining six adjacent rectangles that the SAC covers to a lesser degree and which may be included within the Dogger Bank SAC of other nations achieved an additional 4 million pounds in both years

and were also dominated by flatfish but in addition comprised species (anglers, hake and nephrops) not usually associated with sand banks; illustrating the diversity of habitats available within the region.

The percentage of the revenue that the area represents for the UK fleets differs by gear type. Otter trawlers would be the least affected, with the four core rectangles representing <3% of their total revenue from ICES areas IVb and IVc in 2006 and 2007. Beam trawler catches from the core rectangles represented 5% and 7% of the IVb and IVc total revenue. UK vessels, using this gear type, would therefore be affected to a limited degree if forced to move to adjacent areas. Vessels fishing with Danish seine gear, although few in number, would have almost all (76% in 2006, 90% in 2007) of their revenue removed if they had not been permitted access to the four core rectangles and would therefore suffer the greatest disruption to income.

If the six adjacent areas are included within the SAC the percentage of revenue lost increases and could total 10% for the UK otter trawlers, 20% of the beam trawlers and 100% of the Danish seine netters.

Netherlands Vessels

Analysis of logbook and VMS data for Netherlands vessels in 2006 and 2007 showed that 24 beam trawlers and 2 otter trawlers fished in the proposed SAC. The total hours in two years of fishing within the proposed SAC was estimated to be 3380 for beam trawlers and 180 for otter trawlers. This represents less than 1% of the trawl effort when compared with the total fishing effort of these vessel types within ICES areas IVb & IVc. Only 2 vessels spend more than 5% of their effort within the SAC.

Maps derived from VMS data show that the beam trawl effort within the proposed SAC occurs throughout the year although little activity is evident between January and March. Most activity occurs around the periphery of the proposed SAC although between April and June there is an increase in activity within the SAC. Concentrations of otter trawl activity are low throughout the year and, when present, are noted around the periphery of the proposed SAC.

Analysis of the value of landings by Netherlands vessels fishing within the proposed SAC identified total catches, during the years 2006 and 2007 which achieved 0.88 and 2.1 million euros. Catch was dominated by flatfish (plaice, sole and turbot). The total value from the proposed SAC compared to that recorded in IVb,c was a low percentage; 0.8% in 2006 and 1.9% in 2007. Otter trawls recorded catch values of 29,400 euros in 2006 and 103,800 euro within the SAC in 2007, beam trawlers 0.85 and 2.0 million euros.

Danish Vessels

Analysis of UK recorded VMS data for Danish vessels for 2006 established that 18 gill netters, 64 otter trawlers and 11 Danish Danish seine netters fished within the proposed SAC; in 2007, 15 gill netters, 65 otter trawlers and 7 Danish seine netters were active in the area. Danish otter trawls showed the highest levels of activity in 2006 and 2007 with 16,700 and 7,600 hours fished respectively within the proposed SAC. Gill netters fished 1,600 hours in 2006 and 600 in 2007 and Danish seine netters 4,000 and 2,700 hours. The proportion of the Danish effort relative to the total for IVb and IVc, the species landed and their value was not available to the study.

Detailed analysis of UK activity

UK vessel activity from logbooks

UK Logbook data were extracted for the ICES regions IVb and IVc, which include the proposed SAC. The activity of UK vessels declaring landings within the eleven rectangles is shown in Table 1. These figures include activity in the areas outside of the proposed SAC. Most activity can be attributed to beam trawls, with some otter trawling and Danish seine netting. The majority of vessels for all gears are > 15m length and therefore provide information via the VMS.

Table 1. Proportion of fishing activity by UK vessels covered by VMS data.

	UK logbook activity days		**% of activity by vessels >15 m covered by VMS**	
	2006	**2007**	**2006**	**2007**
Otter trawls	221	432	94	100
Danish Seines	124	76	100	100
Beam trawls	1015	876	100	100

A summary of the fishing activity with ICES regions IVb and IVc and within the proposed SAC is provided in Table 2. More than half of the beam trawlers fishing within ICES regions IVb and IVc carry out some fishing activity within the proposed SAC area whereas only a small proportion (<5%) of otter trawlers fish inside the SAC. In contrast, nearly all of the activity by the (small number of) vessels employing Danish seines is carried out within the boundary of the proposed SAC. The majority of the fishing effort in terms of hours fished comes from the beam trawlers which contribute on average 77% of the total fishing hours in ICES regions IVb and IVc for the gears types under investigation and 69% of the effort within the SAC. Otter trawls represent 20% of the total fishing hours within ICES regions IVb and IVc and 15% of the effort within the SAC. Danish seines contribute the remaining 3% of effort within ICES regions IVb and IVc but represent 16% of the activity within the SAC.

Table 2. Fishing activity by UK vessels fishing within ICES regions IVb and IVc.

	Number of vessels in ICES regions IVb & IVc	**Number of vessels in proposed SAC**	**Proportion of vessels fishing within proposed SAC**	**Hours of activity by these vessels within ICES regions IVb & IVc**	**Hours of activity by these vessels in proposed SAC**	**Proportion of activity within proposed SAC**
Beam 2006	41	21	51	45,706	4,784	10
Beam 2007	34	23	68	37,933	4,726	12
Otter 2006	146	6	4	9,442	375	4
Otter 2007	153	8	5	12,670	1,787	14
Seine 2006	3	3	100	1,278	1,205	94
Seine 2007	2	2	100	1,267	1,000	79

Spatial distribution of activity from VMS

VMS data for the same area were extracted cleaned and processed. VMS locations sampled at 2-hour frequency and with a speed of between 1 and 6 knots were taken to represent 2 hours of fishing activity (as per the methodology described in the support methods document). Figures 2 to 4 show estimated hours of fishing activity within grid cells of 0.05 degrees (200 cells per ICES rectangle). The activity maps have been generated for quarterly data to show variation in patterns of activity throughout the year.

Maps of beam trawl activity in the North Sea (Figure 2) showed concentrations in ICES region IVc in the early months of the year with an increase in activity within the proposed SAC between April and September. Patterns of activity are similar in 2006 and 2007. Otter trawl activity by UK vessels (Figure 3) is most concentrated in the area to the west of in ICES region IVb with another broad swathe of less intense activity to the east of the proposed SAC. Activity within the SAC is concentrated around the boundary in particular to the south and southeast between April and September. The Danish seine activity (Figure 4) falls almost entirely within the proposed SAC and occurs between April and September.

Some vessels fished within in SAC in 2006 but not in 2007 and vice versa. Although more than 20 vessels engaged in some beam trawl activity within the SAC approximately half of those vessels spent a very small proportion of their fishing time in the area with no vessel spending more than 35% of their time there. Similarly the otter trawl effort within the SAC comprises activity from between 6 and 8 vessels however only two vessels in 2006 and three vessels in 2007 spent in excess of 15% of their time within the area. By contrast the vessels fishing Danish seines, although few in number, fish this year almost exclusively within the proposed SAC area with one vessel showing 100% of activity within the SAC in both 2006 and 2007.

There was little overlap in the gears being fished by vessels within ICES regions IVb and IVc although some vessels did fish different gears at different times of the year. Three of the beam trawlers fishing within the SAC in 2006 carried out some otter trawling activity within ICES regions IVb and IVc between the months of July and December. In 2007 four of the beam trawlers engaged in some level of otter trawl activity. Two of the otter trawlers fishing within the SAC in 2006 carried out some beam trawling activity within ICES regions IVb and IVc between January and June and one vessel employed nephrops trawl gear in December. In 2007, four of the vessels fishing otter trawls within the SAC were also engaged in beam trawling within ICES regions IVb and IVc during the year and one engaged in some nephrops trawling activity in September, November and December. Only one of the vessels fishing Danish seines within the SAC fished an alternative gear within ICES regions IVb and IVc during 2006 and 2007 using nephrops trawl gear (TBN) in January and between March and May.

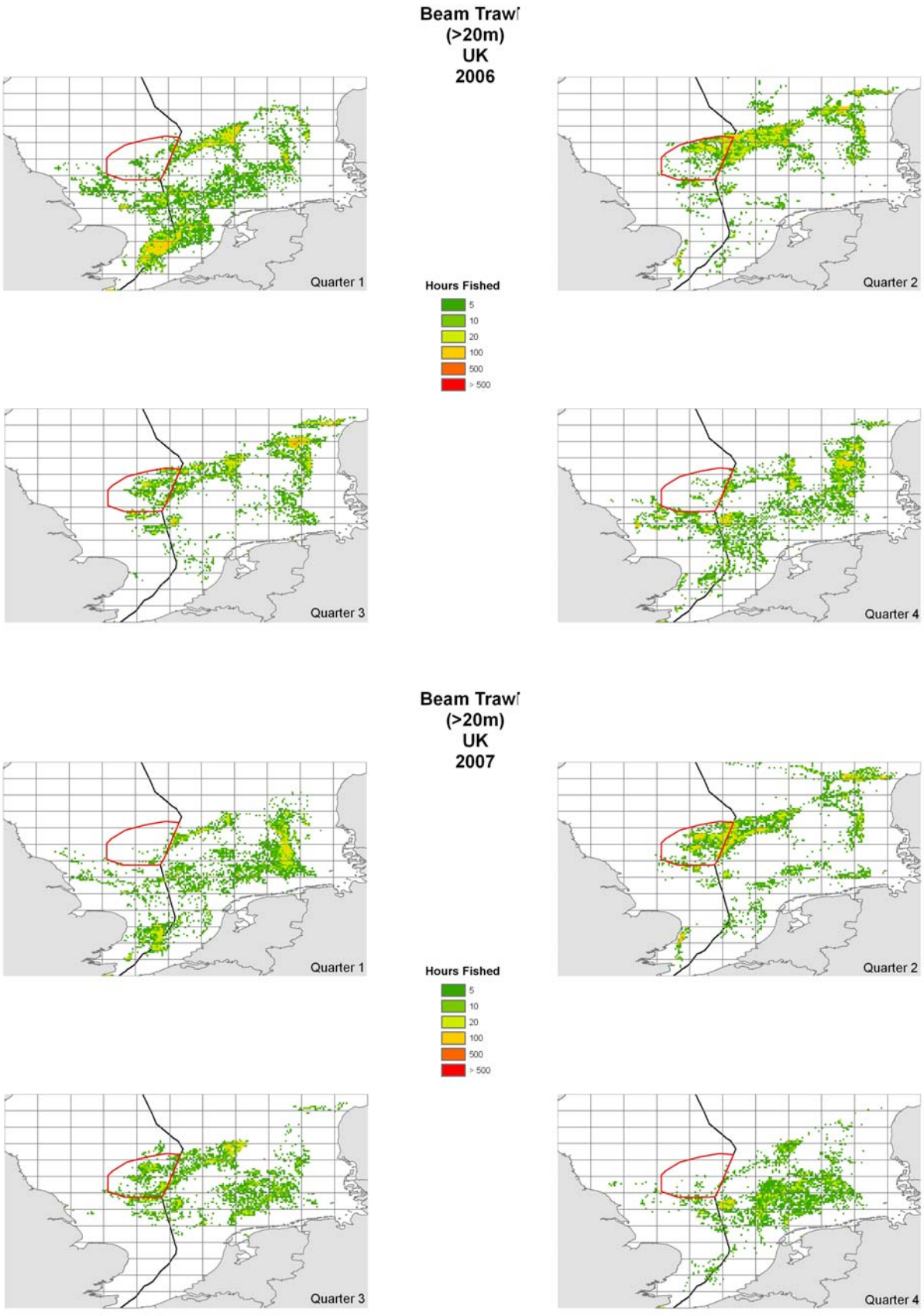

Figure 2. UK beam trawl activity for 2006 and 2007 estimated from VMS.

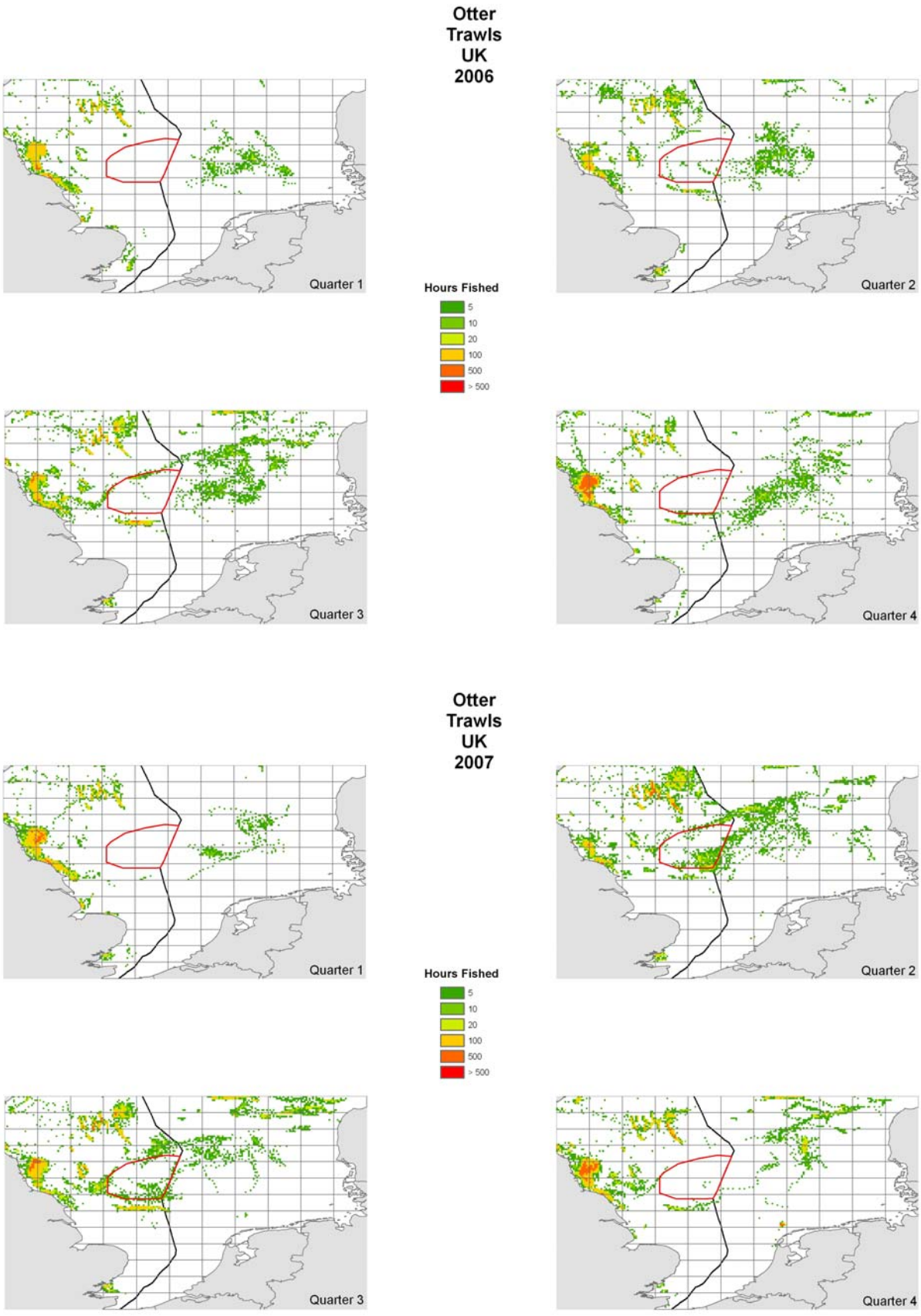

Figure 3. UK otter trawl activity for 2006 and 2007 estimated from VMS.

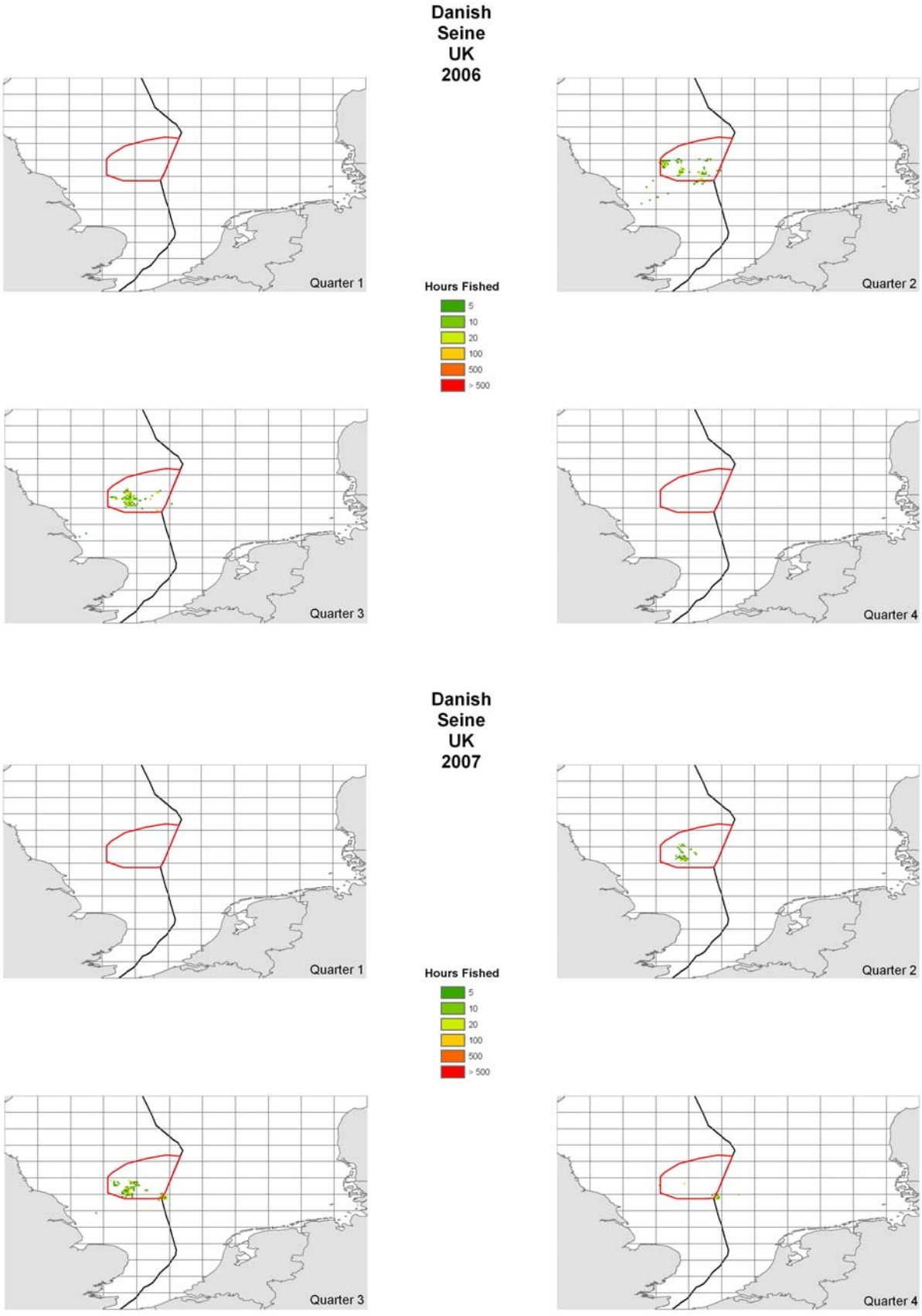

Figure 4. UK Danish seine activity for 2006 and 2007 estimated from VMS.

Landings within ICES regions IVb and IVc

Tables 3 - 6 present the summaries of the value of the landings by gear and species for the three classes of UK vessels fishing within the SAC while Table 7 lists the species codes used.

Table 3 presents the total value of the landings for each category of vessel by rectangle for the two years and the totals for the main core area and the adjacent rectangles. Total landings from the main area of the SAC achieved first sale values of 1.5 million pounds in 2007 and 2 million pounds in 2007. The majority of the revenue was achieved by beam trawls (~77%, £1.2m in 2006 and £1.6m in 2007), otter trawls and Danish seine comprised between 8 and 15% each (£0.16m to £0.3m).

Adjacent rectangles, parts of which are enclosed within the proposed UK SAC, realised just over 4 million pounds in both years with and similar proportions in 2006 but a higher proportion of otter trawling (35%) in 2007.

A comparison with the revenue achieved from the remainder of ICES areas IVb and IVc is presented in Table 4. The values achieved from the rectangles contained within the SAC represent 2% of the UK otter trawl landings in 2007, 7% of the beam trawl revenue and 76% of the Danish seine landings. Corresponding percentages for 2006 were (1% otter, 5% beam and 90% seine). Clearly this are represents the main area for Danish seine fishing in the southern and central North Sea. If the main and adjacent ICES rectangles are collated in the valuation the revenue comprises 10% of the otter, 19% of the beam and 100% of the seine revenue in 2007 and 5%, 21% and 98% in 2006.

Tables 5 and 6 present the break down of landings value by species for the core ICES rectangles and the main and adjacent rectangles for landings values greater than £1000. The two sets of data illustrate that for both years the main rectangle landings are dominated by flatfish (plaice, turbot, brill, sole, dab and lemon sole). The adjacent rectangles have differing compositions with cod, nephrops and skates having greater prominence to the south and megrim, hake and anglerfish increasing to the north and east, species which are not generally associated with the sandbanks that the SAC is designed to conserve.

Total landings values for eight of these species were mapped for each ICES rectangle and are shown in Figures 5 (2006) and 6 (2007).

Table 3. Total first sale value of landings from UK vessels fishing within the ICES rectangles contained in, and adjacent to, the UK proposed SAC.

2007	38F1	38F2	39F1	39F2	Main
All	£301,919	£902,101	£43,384	£808,096	£2,055,500
Otter	£71,651	£211,274	£26,740	£6,923	£316,588
Seine	£143,076	£9,862	£8,792		£161,730
Beam	£87,192	£680,965	£7,852	£801,173	£1,577,182

2007	37F1	37F2	38F3	39F3	40F2	40F3	Adjacent	All
All	£559,282	£1,349,795	£354,089	£1,245,086	£259,423	£574,089	£4,341,764	£6,397,264
Otter	£354,890	£535,047	£30,717	£135,418	£191,112	£254,187	£1,501,371	£1,817,959
Seine	£29,818	£21,009					£50,827	£212,557
Beam	£174,574	£793,739	£323,372	£1,109,668	£68,311	£319,902	£2,789,566	£4,366,748

2006	38F1	38F2	39F1	39F2	Main
All	£234,700	£376,249	£102,942	£815,757	£1,529,648
Otter	£12,872	£15,856	£74,514	£66,328	£169,570
Seine	£169,945	£17,377	£4,813	£7,653	£199,788
Beam	£51,883	£343,016	£23,615	£741,776	£1,160,290

2006	37F1	37F2	38F3	39F3	40F2	40F3	Adjacent	All
All	£667,463	£468,966	£218,299	£1,800,585	£144,061	£854,850	£4,154,224	£5,683,872
Otter	£368,029	£102,057	£18,442	£7,773	£42,872	£6,047	£545,220	£714,790
Seine		£18,147					£18,147	£217,935
Beam	£299,434	£348,762	£199,857	£1,792,812	£101,189	£848,803	£3,590,857	£4,751,147

Table 4. Total first sale value of landings from UK vessels fishing within the combined ICES rectangles contained in, and adjacent to, the UK proposed SAC and ICES Divisions IVb and IVc.

2007	All	Main	Adjacent	4b, 4c	All	Main	Adjacent
All	£6,397,264	£2,055,500	£4,341,764	£41,856,446	15%	5%	10%
Otter	£1,817,959	£316,588	£1,501,371	£18,107,383	10%	2%	8%
Seine	£212,557	£161,730	£50,827	£213,058	100%	76%	24%
Beam	£4,366,748	£1,577,182	£2,789,566	£23,536,005	19%	7%	12%

2006	All	Main	Adjacent	4b, 4c	All	Main	Adjacent
All	£5,683,872	£1,529,648	£4,154,224	£37,338,605	15%	4%	11%
Otter	£714,790	£169,570	£545,220	£14,031,451	5%	1%	4%
Seine	£217,935	£199,788	£18,147	£222,532	98%	90%	8%
Beam	£4,751,147	£1,160,290	£3,590,857	£23,084,622	21%	5%	16%

Table 5. The "Top 30" individual species landings values of commercial species recorded by UK England & Wales vessels in 2007 from the four ICES rectangles containing the majority of the UK proposed Natura 2000 site and the six adjacent rectangles.

2007	Main				
Species	38F1	38F2	39F1	39F2	Total
PLE	£247,892	£590,047	£23,566	£540,614	£1,402,119
TUR	£11,771	£134,261	£3,216	£62,879	£212,127
LEM	£18,235	£58,260	£9,625	£125,217	£211,337
SOL	£1,723	£72,282	£67	£17,539	£91,611
DAB	£5,758	£34,550	£930	£36,470	£77,708
ANF	£4,157	£1,692	£886	£10,527	£17,262
BLL	£954	£1,472	£721	£5,447	£8,594
COD	£2,901	£1,190	£1,538	£1,359	£6,988
CRE	£303	£2,046	£36	£4,255	£6,640
HAD	£1,719	£114	£1,187	£102	£3,122
SQC	£267	£1,234	£228	£1,085	£2,814
SAN	£2,715	£0	£0	£0	£2,715
GUX	£347	£1,125	£67	£465	£2,004
DGS	£833	£850	£14	£177	£1,874
HAL	£1,008	£68	£296	£30	£1,402
JOD	£13	£658	£12	£152	£835
GRO	£96	£250	£3	£367	£716
HKE	£160	£95	£145	£309	£709
WHG	£375	£56	£184	£92	£707
CRA	£57	£137	£0	£443	£637
SKA	£180	£389	£46	£10	£625
NEP	£65	£4	£433	£1	£503
WHE	£53	£216	£53	£144	£466
MAC	£0	£370	£0	£0	£370
GUR	£8	£223	£0	£47	£278
GUG	£55	£86	£0	£126	£267
MUR	£63	£114	£17	£29	£223
JAX	£39	£179	£0	£0	£218
LBE	£85	£49	£13	£50	£197
WIT	£52	£2	£54	£0	£108
All spp	£301,919	£902,101	£43,384	£808,096	£2,055,500

2007	Adjacent						
Species	37F1	37F2	38F3	39F3	40F2	40F3	Total
PLE	£229,178	£637,604	£224,562	£820,786	£60,958	£322,761	£2,295,849
LEM	£39,217	£36,999	£12,389	£95,691	£157,704	£152,132	£494,132
TUR	£33,629	£192,113	£47,503	£171,784	£8,563	£40,391	£493,983
NEP	£111,255	£225,587	£211	£0	£1,703	£324	£339,080
SOL	£18,971	£168,102	£44,628	£35,580	£161	£4,883	£272,325
DAB	£12,232	£29,830	£14,979	£90,952	£2,431	£19,951	£170,375
COD	£56,355	£16,155	£2,147	£3,592	£1,025	£2,824	£82,098
ANF	£5,981	£3,514	£689	£7,782	£10,363	£12,231	£40,560
BLL	£6,113	£10,495	£3,056	£8,619	£300	£6,348	£34,931
SKA	£14,369	£8,411	£748	£32	£0	£1	£23,561
HAL	£2,533	£1,251	£125	£239	£6,936	£3,270	£14,354
SQC	£6,179	£2,563	£456	£2,071	£280	£1,132	£12,681
HAD	£4,604	£692	£6	£25	£1,799	£1,172	£8,298
WHE	£335	£3,972	£997	£1,804	£58	£272	£7,438
LBE	£6,205	£277	£277	£40	£4	£5	£6,808
WHG	£3,010	£2,017	£63	£187	£835	£571	£6,683
LEZ	£14	£0	£4	£1	£4,381	£1,199	£5,599
MAC	£2,793	£2,468	£6	£0	£0	£0	£5,267
CRE	£1,006	£1,990	£282	£1,409	£46	£525	£5,258
DGS	£1,867	£917	£116	£192	£59	£928	£4,079
GUX	£393	£1,219	£325	£922	£24	£84	£2,967
MUR	£1,796	£897	£4	£77	£26	£56	£2,856
HKE	£123	£59	£76	£1,039	£191	£987	£2,475
WIT	£22	£107	£2	£1	£1,138	£900	£2,170
GRO	£152	£551	£68	£487	£155	£305	£1,718
JOD	£85	£569	£100	£550	£54	£129	£1,487
GUR	£40	£338	£92	£603	£1	£87	£1,161
LIN	£456	£110	£17	£44	£67	£148	£842
GUG	£74	£536	£12	£90	£0	£63	£775
POK	£61	£15	£1	£41	£66	£169	£353
All spp	£559,282	£1,349,795	£354,089	£1,245,086	£259,423	£574,089	£4,341,764

Total	
Species	Value
PLE	£3,697,968
TUR	£706,110
LEM	£705,469
SOL	£363,936
NEP	£339,583
DAB	£248,083
COD	£89,086
ANF	£57,822
BLL	£43,525
SKA	£24,186
HAL	£15,756
SQC	£15,495
CRE	£11,898
HAD	£11,420
WHE	£7,904
WHG	£7,390
LBE	£7,005
DGS	£5,953
LEZ	£5,674
MAC	£5,637
GUX	£4,971
HKE	£3,184
MUR	£3,079
SAN	£2,715
GRO	£2,434
JOD	£2,322
WIT	£2,278
GUR	£1,439
GUG	£1,042
LIN	£904
All spp	£6,397,264

Table 6. The "Top 30" individual species landings values of commercial species recorded by UK England & Wales vessels in 2006 from the four ICES rectangles containing the majority of the UK proposed Natura 2000 site and the six adjacent rectangles.

2006	Main				
Species	38F1	38F2	39F1	39F2	Total
PLE	£190,911	£265,632	£27,907	£499,277	£983,727
LEM	£12,848	£19,615	£29,935	£157,148	£219,546
TUR	£6,049	£35,518	£3,748	£52,735	£98,050
SOL	£4,685	£38,724	£595	£30,274	£74,278
DAB	£1,707	£8,020	£934	£26,697	£37,358
NEP	£1,452	£0	£31,662	£16	£33,130
WHE	£719	£1,577	£244	£14,547	£17,087
BLL	£719	£2,334	£416	£13,502	£16,971
ANF	£1,029	£1,272	£1,774	£8,760	£12,835
SAN	£8,357	£0	£0	£0	£8,357
COD	£1,490	£1,092	£745	£2,361	£5,688
HAD	£1,149	£32	£1,486	£907	£3,574
DGS	£1,377	£196	£1	£1,726	£3,300
WHG	£546	£73	£1,339	£313	£2,271
SQC	£652	£342	£243	£953	£2,190
CRE	£172	£465	£198	£1,204	£2,039
LEZ	£100	£0	£797	£639	£1,536
HAL	£95	£69	£668	£516	£1,348
SKH	£0	£0	£0	£1,167	£1,167
SKA	£373	£92	£12	£653	£1,130
GRO	£33	£193	£61	£774	£1,061
GUX	£48	£424	£3	£463	£938
HKE	£46	£105	£64	£535	£750
JOD	£31	£89	£29	£295	£444
GUR	£1	£165	£0	£31	£197
LBE	£0	£169	£0	£6	£175
LIN	£8	£14	£13	£56	£91
MUR	£69	£6	£5	£6	£86
WIT	£3	£0	£44	£20	£67
POK	£0	£3	£0	£54	£57
All spp	£234,700	£376,249	£102,942	£815,757	£1,529,648

2006	Adjacent						
Species	37F1	37F2	38F3	39F3	40F2	40F3	Total
PLE	£153,584	£204,157	£140,632	£1,269,235	£71,242	£541,354	£2,380,204
LEM	£32,801	£13,622	£9,560	£123,136	£47,352	£150,625	£377,096
TUR	£33,381	£35,247	£29,104	£186,013	£7,337	£58,838	£349,920
SOL	£106,664	£89,477	£21,791	£66,259	£393	£11,611	£296,195
NEP	£182,950	£74,162	£3	£22	£571	£2	£257,710
DAB	£7,134	£9,486	£9,183	£100,168	£1,962	£31,569	£159,502
BLL	£25,367	£9,217	£2,880	£19,325	£4,202	£21,895	£82,886
COD	£32,779	£12,537	£1,660	£5,018	£1,160	£4,656	£57,810
WHE	£6,578	£8,119	£1,722	£17,996	£3,614	£18,519	£56,548
SAN	£33,153	£0	£0	£0	£0	£0	£33,153
ANF	£7,233	£1,325	£590	£7,329	£1,837	£10,690	£29,004
DGS	£17,637	£1,383	£16	£97	£92	£114	£19,339
SKA	£11,858	£3,709	£42	£421	£0	£18	£16,048
SQC	£3,582	£1,863	£142	£676	£40	£286	£6,589
WHG	£2,598	£978	£181	£167	£143	£957	£5,024
HAL	£2,584	£802	£77	£283	£620	£401	£4,767
LBE	£3,752	£277	£2	£32	£0	£9	£4,072
CRE	£476	£715	£240	£841	£66	£522	£2,860
HKE	£47	£46	£136	£947	£99	£854	£2,129
GRO	£162	£129	£58	£725	£139	£910	£2,123
GUX	£316	£251	£51	£728	£297	£309	£1,952
HAD	£866	£113	£4	£47	£426	£146	£1,602
LEZ	£29	£8	£0	£9	£1,355	£22	£1,423
GUR	£430	£341	£5	£265	£10	£20	£1,071
MUR	£819	£129	£0	£2	£0	£5	£955
GUG	£48	£278	£22	£216	£0	£166	£730
WIT	£21	£4	£0	£0	£628	£23	£676
LIN	£244	£60	£17	£100	£32	£164	£617
JOD	£4	£70	£107	£369	£0	£58	£608
FLE	£16	£304	£32	£9	£0	£0	£361
All spp	£667,463	£468,966	£218,299	£1,800,585	£144,061	£854,850	£4,154,224

Total	
Species	Value
PLE	£3,363,931
LEM	£596,642
TUR	£447,970
SOL	£370,473
NEP	£290,840
DAB	£196,860
BLL	£99,857
WHE	£73,635
COD	£63,498
ANF	£41,839
SAN	£41,510
DGS	£22,639
SKA	£17,178
SQC	£8,779
WHG	£7,295
HAL	£6,115
HAD	£5,176
CRE	£4,899
LBE	£4,247
GRO	£3,184
LEZ	£2,959
GUX	£2,890
HKE	£2,879
GUR	£1,268
SKH	£1,198
JOD	£1,052
MUR	£1,041
GUG	£781
WIT	£743
LIN	£708
All spp	£5,683,872

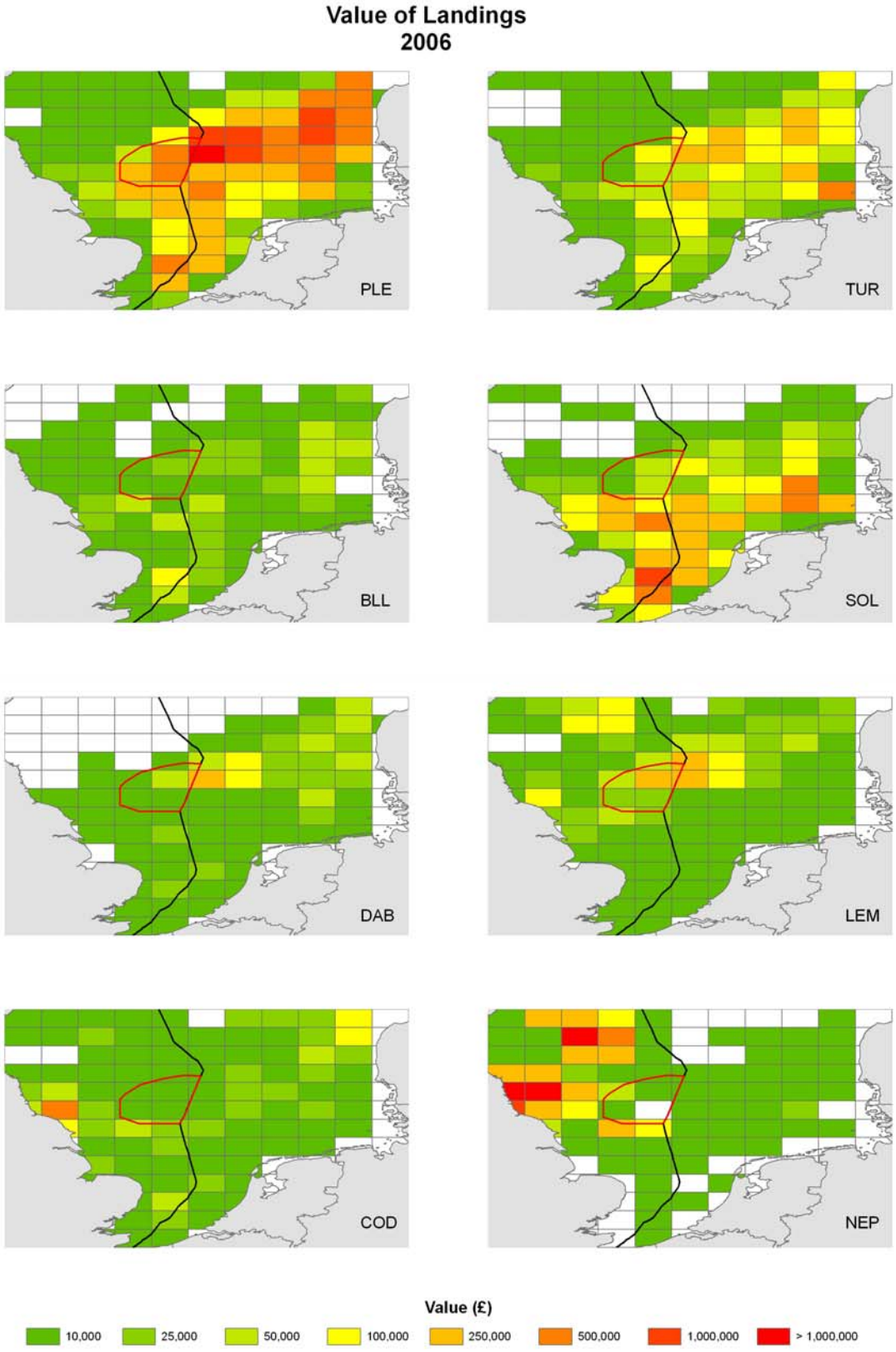

Figure 5. Value of UK landings by species, 2006.

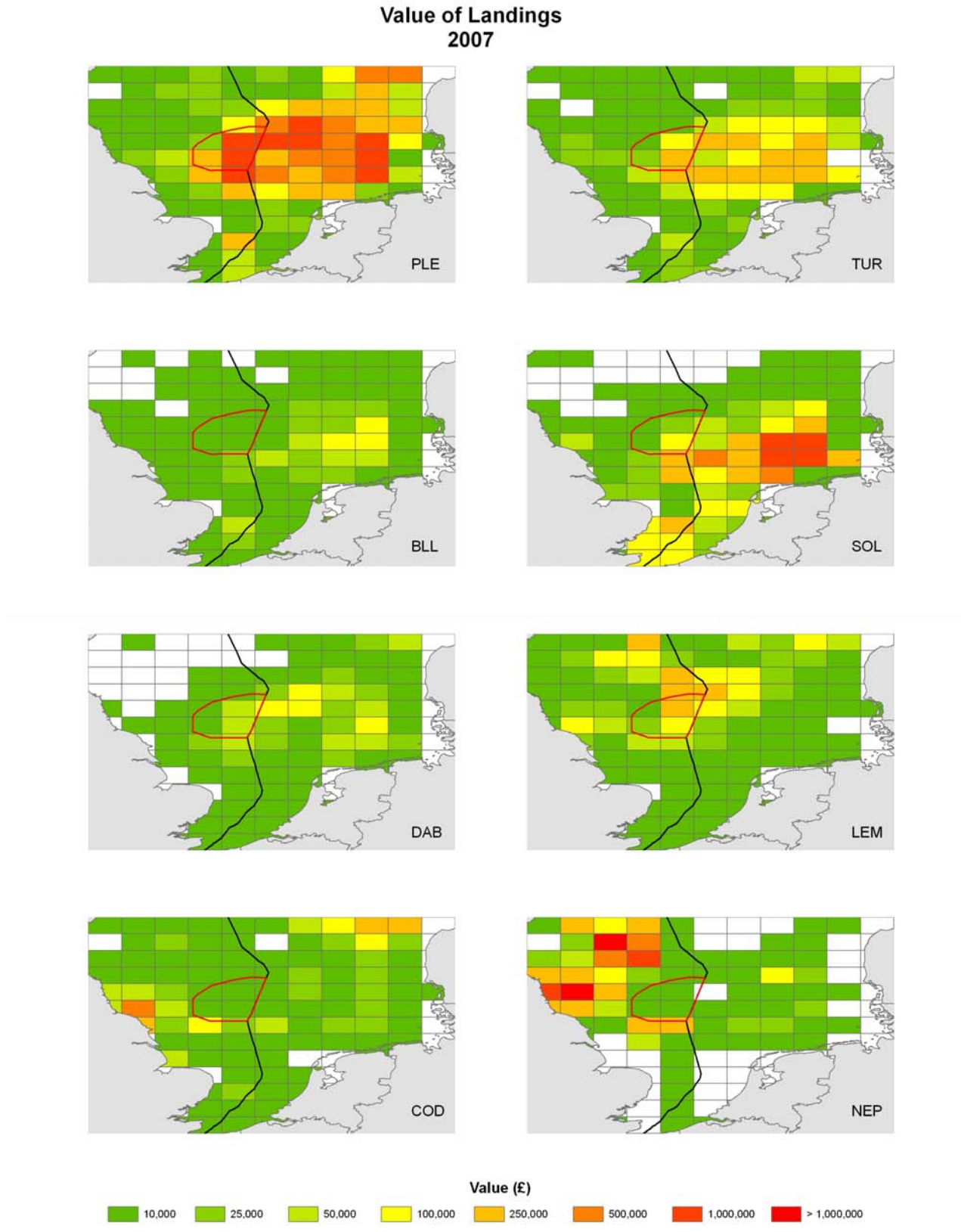

Figure 6. Value of UK landings by species, 2007.

Table 7. Species landings codes used within Tables 5 and 6.

Code	Species
PLE	Plaice
TUR	Turbot
NEP	Nephrops
LEM	Lemon sole
SOL	Sole
DAB	Dab
COD	Cod
ANF	Anglerfish
BLL	Brill
SKA	Skate and rays
SKH	Sharks
SQC	Squid
CRE	Crab
HAD	Haddock
LBE	Lobster
WHG	Whiting
MAC	Mackerel
HAL	Hallibut
WHE	Whelk
DGS	Spurdog
GUX	Gurnard and latchet
MUR	Mullet red
SAN	Sandeel
JOD	John Dory
LEZ	Megrim
GRO	Other mixed demersal

Detailed analysis of Danish activity, based on UK VMS records

Table 8 shows the main gears and fishing activity by the Danish fleet based on an analysis of UK recorded VMS data. In 2006, 18 gill netters, 64 otter trawlers and 11 Danish Danish seine netters fished within the proposed SAC; in 2007, 15 gill netters, 65 otter trawlers and 7 Danish seine netters were active in the area. Danish otter trawls showed the highest levels of activity in 2006 and 2007 with more effort allocated in 2006 than in 2007 by all gear types.

Table 8. Activity of Danish vessels fishing within the proposed SAC within UK waters.

	2006		2007	
	Hours	Vessels	Hours	Vessels
Gillnets	1,587	18	643	15
Otter trawls	16,722	64	7,610	65
Danish seines	3,963	11	2,664	7

The maps in Figure 7 show the pattern of activity for gillnets, otter trawls and Danish seines from the Danish fleet. Otter trawl activity is distributed to the west and south of the SAC, although there is activity throughout the area. The activity is considered to be characteristic of the sandeel industrial fishery. VMS data from UK waters on Danish gill netters indicates activity spread across IVb and IVc with no particular concentration within the SAC. In contrast the Danish Danish seine activity is almost exclusively within the SAC showing a similar spatial allegiance to that of the UK vessels fishing with this gear type.

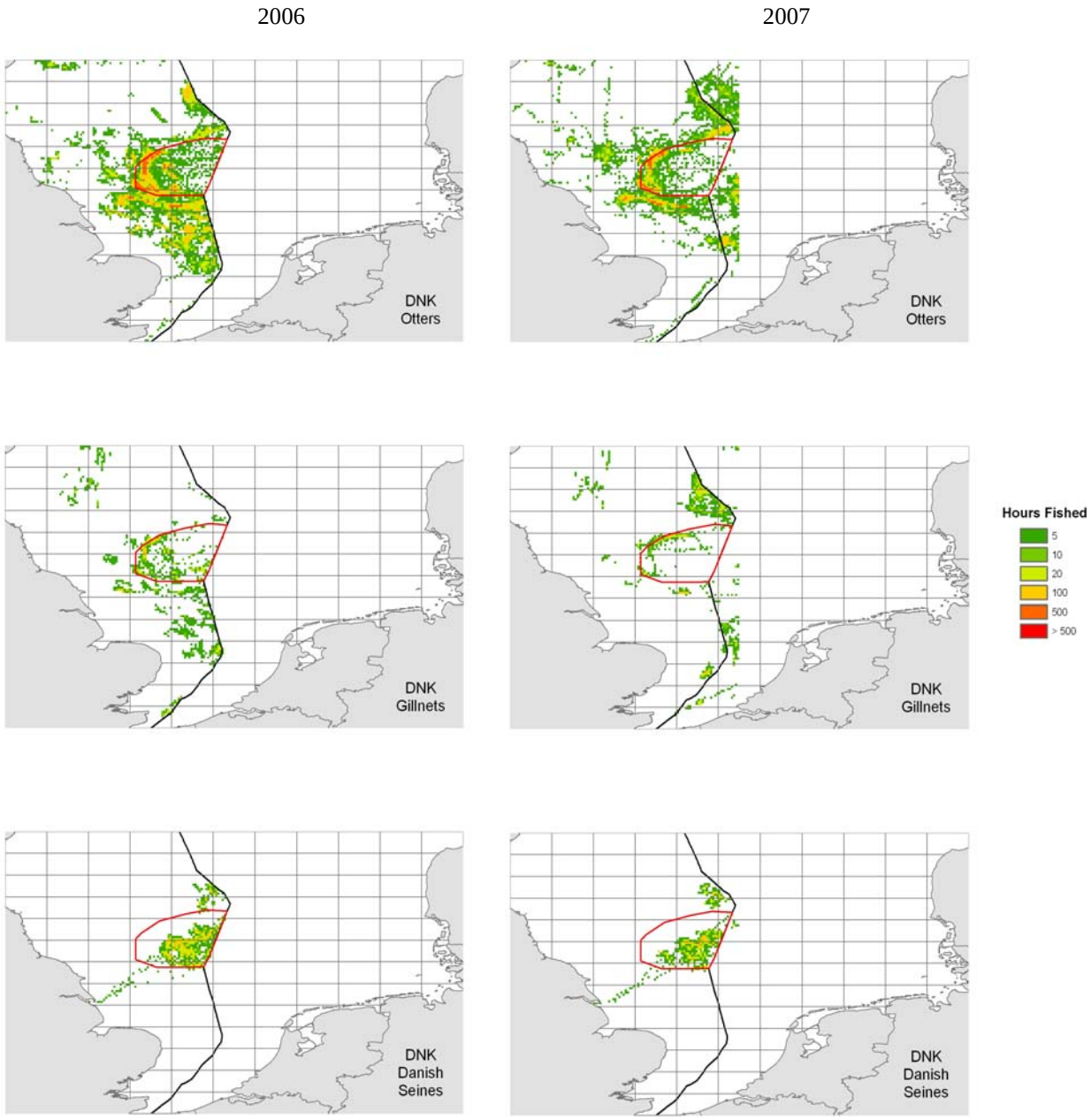

Figure 7. Fishing activity for Danish vessels for 2006 and 2007 estimated from VMS.

Detailed analysis of Netherlands activity

Methods

Logbook data were extracted for the ICES regions IVb and IVc, which include the proposed SAC. VMS data for the same area were extracted cleaned and processed. VMS locations sampled at 2-hour frequency within a speed range depending on the type of gear used represent hours of fishing. Hours of fishing depend on the total effort allocated by the fisheries, distributed over the number of VMS records where vessels are fishing. Since routines have only been developed for the gear types otter trawl, shrimp beam trawl and beam trawl to distinguish fishing activities from steaming, effort allocations to VMS records can only be accomplished for these gear types. However, as only two VMS records with one other gear type (Scottish seine) have been recorded in the SAC area, the omission made by not accounting for other gear types is not significant. Values for landings are obtained from auction data, provided by the Dutch Ministry. These data are aggregated and averaged on a monthly basis. Catches obtained from logbook data are multiplied with the average monthly price of the species to compute landings value.

Results

The total number of vessels within the proposed SAC area is limited. Only two types of gears can be distinguished, otter trawls and beam trawls. During 2006 and 2007, 2 otter trawls and 24 beam trawls fished within the proposed SAC area (Table 9). The total effort allocated in ICES regions IVb and IVc by the otter trawlers is 34,895 hours of which 178 hours (0.51%) were spent within the proposed SAC. The beam trawler activity was 543,319 hours within ICES regions IVb and IVc with 3,384 hours (0.62%) spent within the proposed SAC. A spatial overview of allocated effort in 2006 and 2007 by quarter for these otter and beam vessels is given in Figures 8 and 9.

Table 9. NLD vessels fishing within proposed SAC.

	Number of vessels fishing in proposed SAC, 2006-2007	**Effort within SAC, hours fished 2006-2007 (hours fished)**	**Proportion of effort in ICES areas IVb & IVc (%)**
Otter trawls	2	178	0.51
Beam trawls	24	3384	0.62

The largest fishery in terms of effort in ICES areas IVb & IVc is the large beam trawl fishery. The shrimp trawl fishery is considerably smaller, followed by the otter trawling effort which is only 5% of the total effort allocated by these three types of fisheries (Table 10). Note however that as only these three gear types have been investigated, in reality these figures might be different for IVb&c. An overview of the effort allocated by vessel within and without the proposed SAC area is provided as Table 11.

Table 10. Proportion of effort in ICES IVb and IVc (NLD vessels) within proposed SAC.

	Effort in ICES areas IVb & IVc (hours fished)	**Proportion of all fishery activity (%)**
Otter trawls	34,895	5.0
Beam trawls	543,319	77.4
Shrimp trawls	123,518	17.6

The values of the landings are based upon monthly averaged prices obtained from auction data. The effort allocated by the otter boards and beam trawling can be expressed in a monetary value when merged with monthly averaged prices (Table 12). From the species caught by these fisheries, both in 2006 and 2007, the top 3 species by value are represented by sole (*Solea solea*), plaice (*Pleuronectes platessa*) and turbot (*Psetta maxima*) (Table 13). However, these values compared to the values outside the proposed SAC are small. Hence, based upon these analyses, the major part of the catch value is taken outside the proposed SAC area. Figures 10 and 11 represent the spatial distribution of landings value per ICES rectangle for eight main commercial species for 2006 and 2007. These figures indicate where effort, expressed as a value measure, has been allocated in these years. Only 26 of the 131 (20%) vessels fish inside the SAC and of these vessels only 2 spend more than 5% of their effort within the SAC.

Table 11. Proportion of effort in ICES IVb and IVc (individual NLD vessels) within proposed SAC.

Vessel	Effort in SAC	Effort outside SAC	% in SAC		Vessel	Effort in SAC	Effort outside SAC	% in SAC		Vessel	Effort in SAC	Effort outside SAC	% in SAC
1		7622			45	142	6500	2.1		89		7604	
2		7307			46		7			90		5543	
3		6568			47		8845			91	58	1613	3.5
4		6887			48		8603			92		6918	
5		4221			49		6263			93	15	7756	0.2
6		3724			50		7346			94		856	
7		6642			51		1317			95		7532	
8	113	6565	1.7		52		1986			96		4368	
9		5323			53		5522			97		5870	
10	119	6777	1.7		54		2			98	67	7576	0.9
11	79	4681	1.7		55		7632			99		5172	
12	57	6787	0.8		56		5265			100		7729	
13		6600			57		5752			101		3226	
14		6744			58		3308			102		7006	
15		634			59		7027			103		6636	
16		7296			60	2	7534			104		3554	
17	515	6458	7.4		61	232	6845	3.3		105		2888	
18		7033			62	179	7220	2.4		106		480	
19		7509			63		2518			107		1998	
20		7409			64	109	6504	1.6		108		4111	
21		7918			65		4337			109		5402	
22		8248			66	46	7011	0.7		110		3051	
23		3620			67		6801			111		3081	
24		6445			68	133	7043	1.8		112		3573	
25		2297			69		7076			113		594	
26		728			70		6608			114		5192	
27		3694			71	22	5938	0.4		115		1376	
28		933			72		7353			116		4336	
29		895			73	497	7203	6.5		117		2723	
30		10472			74	288	6647	4.2		118		1353	
31		8549			75		6628			119		3289	
32		5568			76		1306			120		8145	
33		7063			77		5696			121		870	
34		7438			78	15	7623	0.2		122		4031	
35	2	9986			79		5583			123		2152	
36		6299			80		7213			124		4315	
37		9268			81		7001			125		2312	
38		6667			82		4092			126		4144	
39	36	6722	0.5		83		7593			127		4923	
40	157	7206	2.1		84		7146			128		3651	
41	24	7547	0.3		85	120	4018	2.9		129		2499	
42	270	8389	3.1		86		7077			130		1577	
43		4085			87		5963			131		6080	
44	265	6608	3.9		88		2684						

Table 12. Proportion of catch (NLD vessels) within proposed SAC.

	Value of catch within proposed SAC, euros		**Percentage of total catch**	
	2006	2007	2006	2007
Otter trawls	29,480	103,804	0.25	0.59
Beam trawls	846,952	2,014,520	0.56	1.31

Table 13. Catch value by species (NLD vessels) within proposed SAC.

	2006		**2007**	
Position	**Main Species caught within SAC**	**Value of landings within SAC in euros**	**Main Species caught within SAC**	**Value of landings within SAC in euros**
1	SOL	341,047	SOL	997,140
2	PLE	313,259	PLE	651,374
3	TUR	76,275	TUR	211,064
4	LEM	49,057	LEM	71,247
5	BLL	22,140	DAB	37,605
6	DAB	20,721	BLL	31,711
7	COD	11,600	NEP	27,707
8	NEP	7,379	COD	20,010
9	GUU	6,353	SRX	16,449
10	SRX	5,396	GUU	13,699

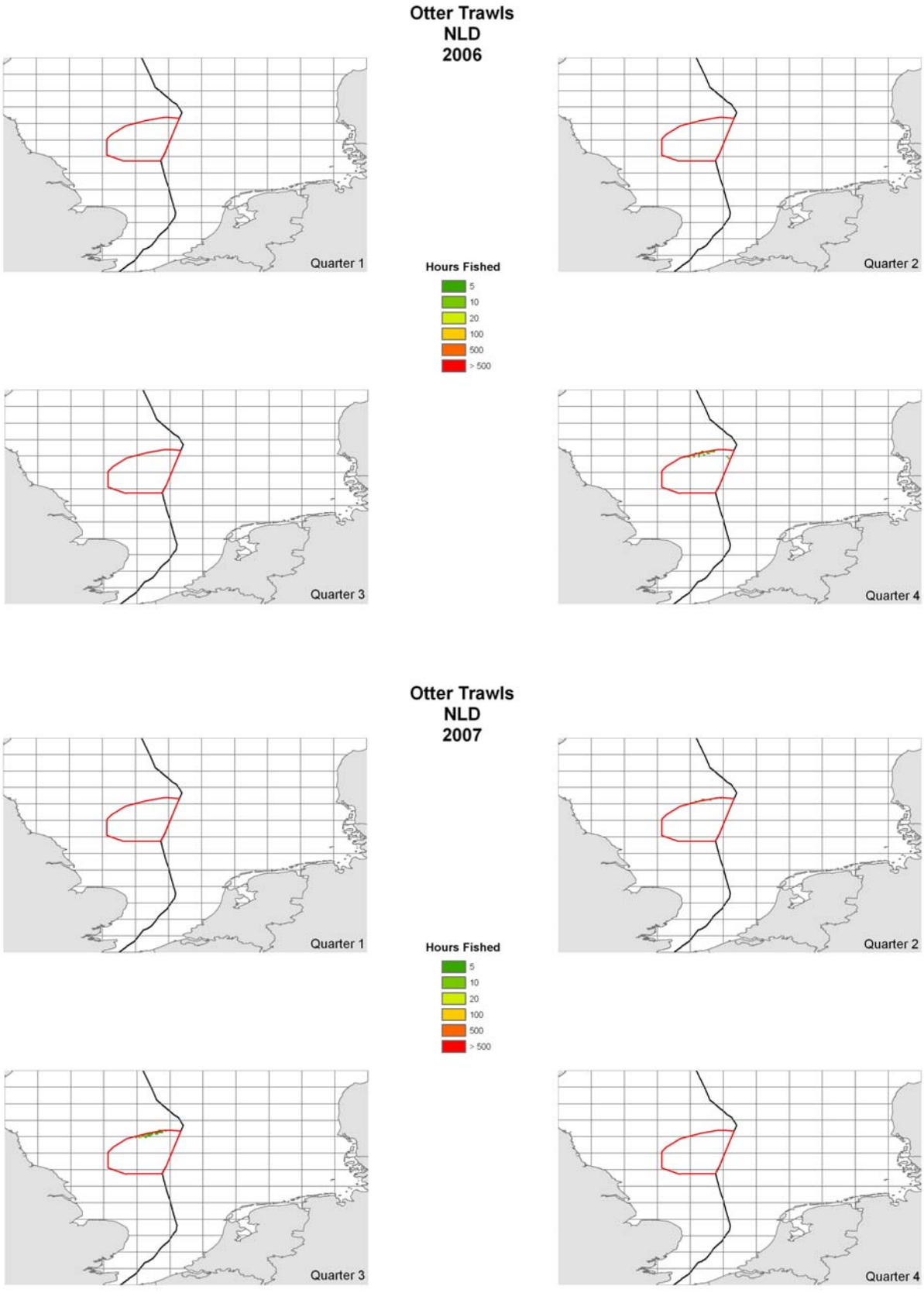

Figure 8. Netherlands otter trawl activity (2006-7) for vessels operating within the proposed SAC.

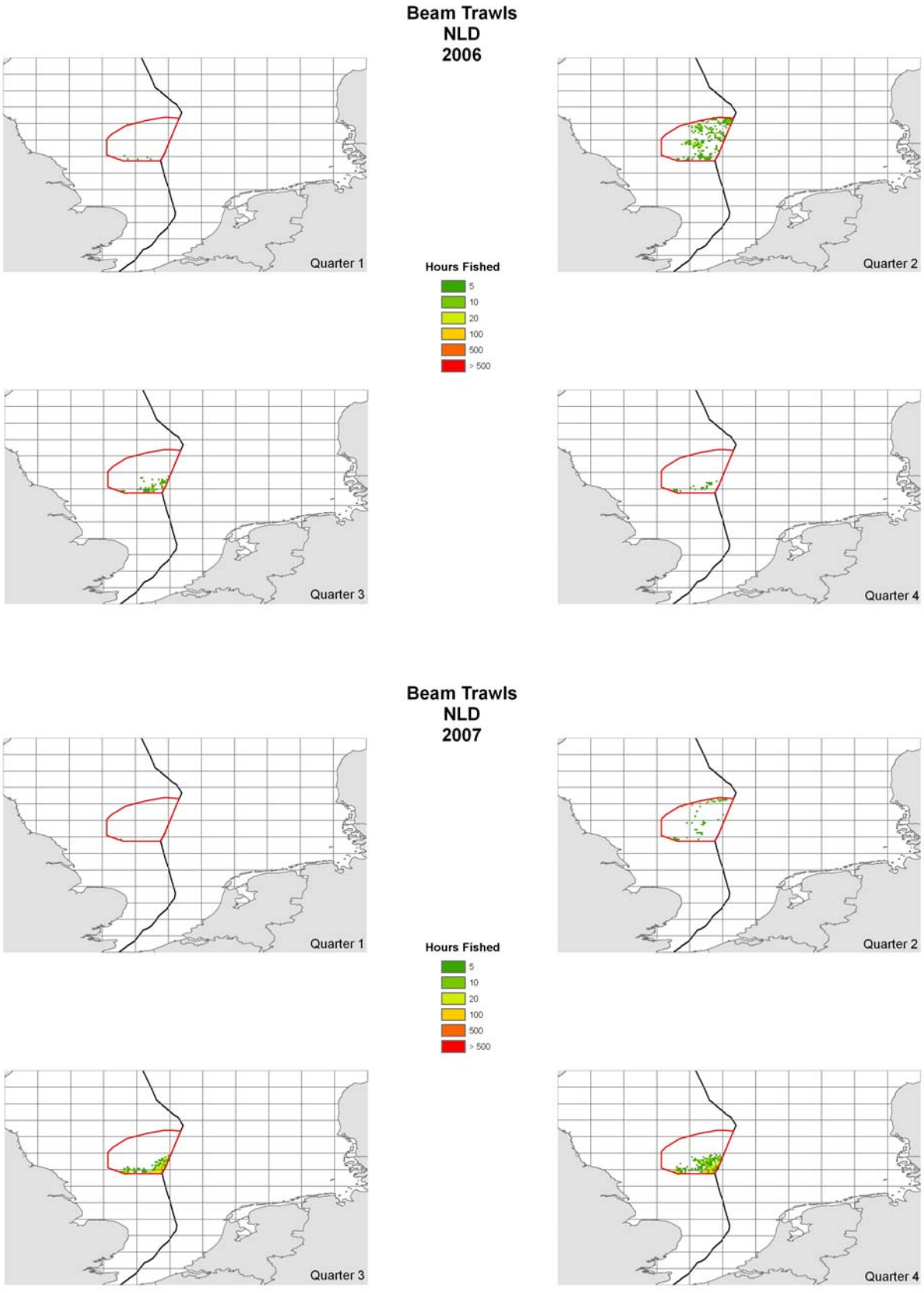

Figure 9. Netherlands beam trawl activity (2006-7) for vessels operating within the proposed SAC.

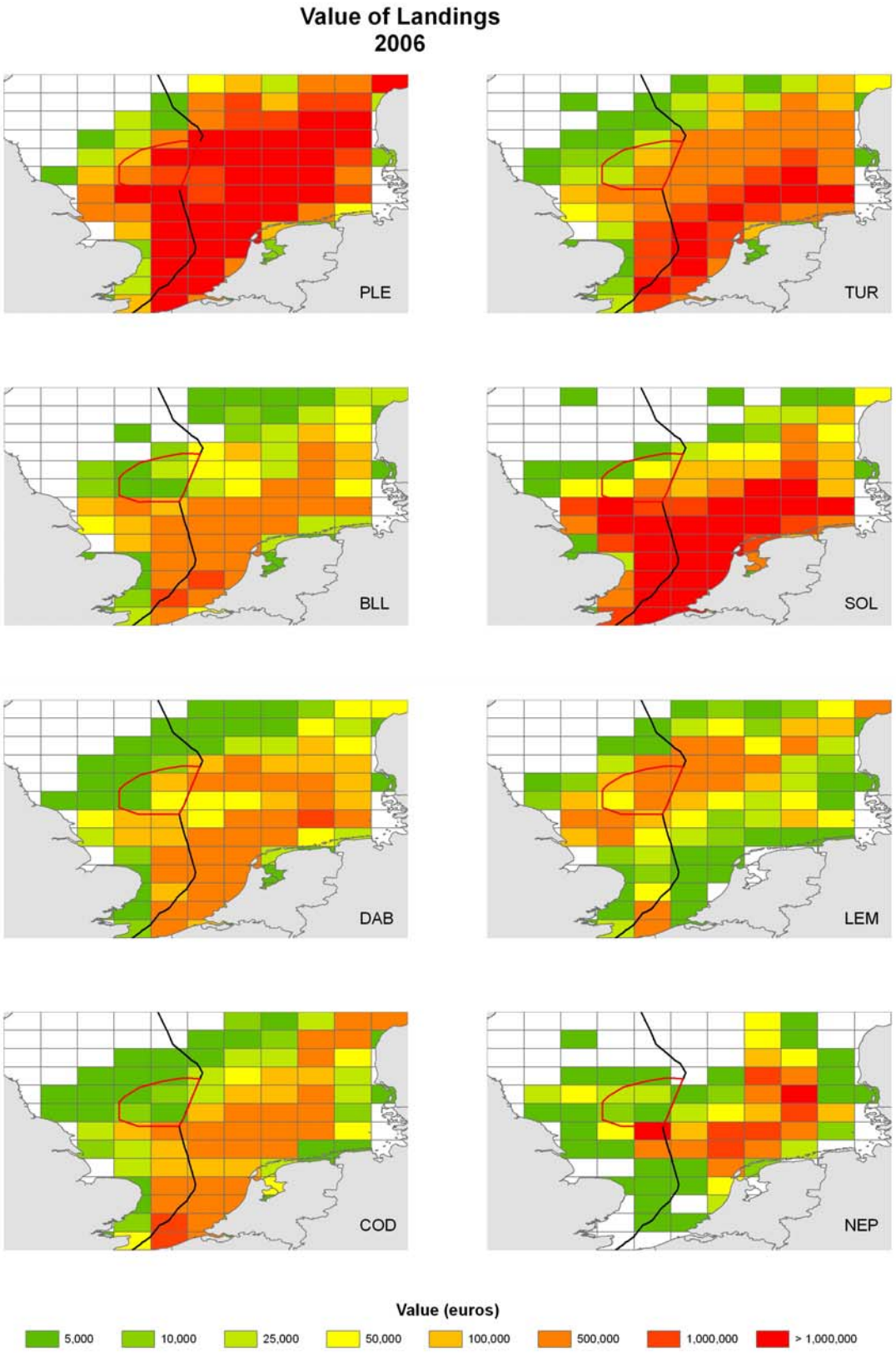

Figure 10. Value of NLD landings by species, 2006.

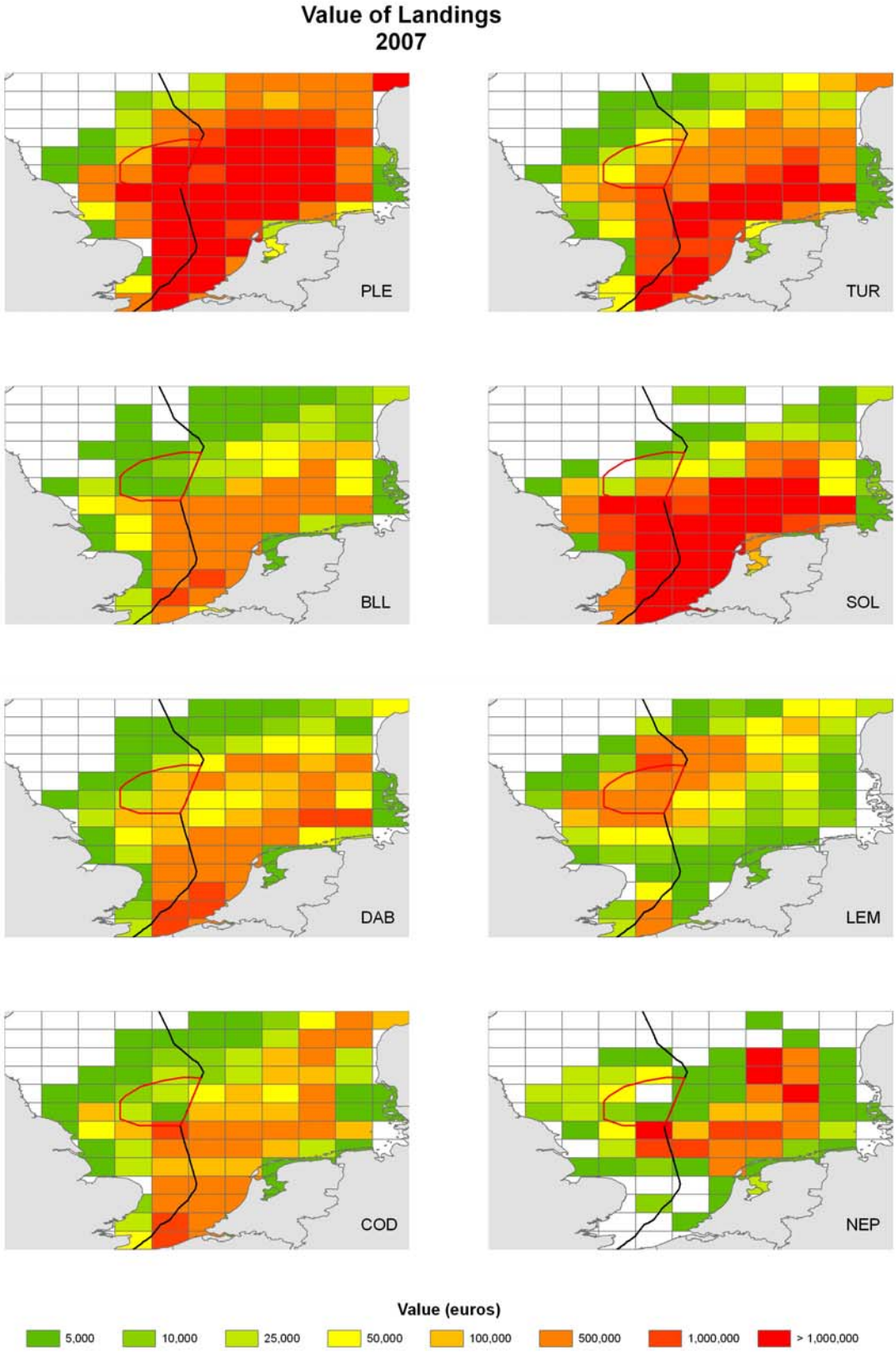

Figure 11. Value of NLD landings by species, 2007