Fishing intensity around the BBL pipeline

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Wageningen University &
Research Report C102/16

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Publication date: October 2016

Wageningen Marine Research
IJmuiden, October 2016

Wageningen Marine Research report C102/16

Niels Hintzen, 2016 Fishing intensity around the BBL pipeline,Wageningen, Wageningen Marine Research (University & Research centre), Wageningen Marine Research report C102/16.

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Wageningen Marine Research is ISO 9001:2008 certified.

Contents

1 Introduction

Wageningen Marine Research was requested by ACRB B.V. to investigate the fishing activities around the BBL pipeline. This gas pipeline crosses the southern North Sea from Balgzand (near Den Helder) in the Netherlands to Bacton in the UK (230km). This pipeline is abbreviated as the BBL pipeline. Part of the activities deployed by the owner of the BBL pipeline is to secure the integrity of the pipeline, which includes checking burial status, detecting free-spans and investigating internal and external threats to the integrity of the pipeline.

Fishing is considered as one of the external threats to the pipeline where a collision with fishing gear could damage the pipeline, the fishing gear, the vessel or the crew. Therefore in areas with substantial fishing activity, extra care should be taken. Such a risk inventory becomes more and more common day practice of submarine pipeline and cable owners where discussions now focus on how to best spend effort on protecting pipelines and where to relieve specific burial requirements.

In this research we investigate the fishing intensity by the Dutch bottom trawling fishing fleet around the BBL pipeline by the Dutch bottom trawling fishing fleet, visualize their seasonality and correlate the activity with seabed gradient and habitat type. The latter investigation could pinpoint generic areas that would have an increased risk to be fished at higher intensities, and could therefore serve as explanatory variables in a generic risk-based approach for pipeline integrity.

2 Assignment

The assignment consists of four activities:

1) Visualize the fishing intensity of the Dutch bottom fishing fleet around the BBL pipeline, within a 1 km radius;
2) Table the fishing intensities along the BBL pipeline, in blocks of 1 minute (degrees), distinguishing size fishing gear: traditional beamtrawl, sumwing beamtrawl, shrimp beamtrawl, dredge, flyshoot and otter trawling (a brief explanation of each of these fishing methods is included below);
3) Visualize the seasonality of the fishing activities around the BBL pipeline by showing fishing effort on a monthly basis;
4) Investigate the correlation between seabed depth-gradient (slope) and habitat with fishing activity around the BBL pipeline.

For all these activities, the chosen timeframe spans the years 2011-2015 and the spatial resolution is 1 minute by 1 minute [1], unless otherwise denoted in the results.

It should be noted that the study is limited to the Dutch registered fishing vessels. This means that fishermen registered in other countries, such as Denmark and the United Kingdom are not included. It also means that Dutch fishermen that have re-flagged their vessel to e.g. the United Kingdom, are not included.

[1] This means 1 minute Latitude by 1 minute Longitude, or 1852 m along the meridian and about 1100 m along the parallel (at 52 degrees N).

3 Materials and Methods

To analyse the fishing activity around the BBL pipeline, both VMS (Vessel Monitoring by Satellite) and Logbook data have been used. VMS is a GPS signal transmitted approximately every 2 hours and contains a date-time stamp, fishing speed and fishing direction information as well. Logbook data is compulsory for almost all commercial fishing vessels and contains information on fishing gear usage, engine power, fishing trip details (departure and arrival harbour) and the amount of fish per species caught on a daily basis.
The VMS system in the Netherlands is in use since 2001 and is controlled by the Dutch Food and Consumer Product Safety Authority (NVWA). The system was put into place for inspection purposes but can be used to study the spatial dynamics of the fishing fleet as well.

When VMS and logbook data are linked (they share a unique fishing vessel identification number), the spatio-temporal dynamics of the fishing fleet by fleet segment (since fishing gear is given in the logbooks) and location (since time-stamp and GPS position is given in the VMS data) can be studied.

Wageningen Marine Research has developed (1) state-of-the-art routines to process raw VMS and Logbook data, to correct errors contained in the source, and (2) analyses tools defining fishing activity, predicting gear width and linking catches in a fishing trip to the most likely geo-location. This process is described in Hintzen et al. (2013). The building blocks of the routine consist of:

1) Removing records with registrations on time, date, geo-location and heading outside their possible range (e.g. positions on land, heading outside compass range);
2) Remove trips that overlap in time or are duplicates;
3) Remove records that indicate a vessel is in harbour;
4) Detect fishing speed based on fitting a statistical mixture-model on speed-histograms by fishing metier;
5) Predict fishing gear width (for non-fixed width gears such as flyshoot or otter trawl) from a statistical model that links engine power to gear width (based on fishing fleet survey observations);
6) Dispatch catches by vessel, area and day to VMS positions.

In addition to these analyses, for this study gear depth, gradient and habitat were linked to the VMS data points. A 1 minute by 1 minute (degrees) depth layer, available from NOAA's (National Oceanic and Atmospheric Administration) national centers for environmental information, was used to link average depth to the VMS data. From the depth layer the slope at the specific location was calculated. A habitat layer was available for download from EMODnet Central Portal (http://www.emodnet.eu/seabed-habitats) and contains a modelled seabed habitat polygon based layer. Habitat is often defined as a combination of substrate, energetic state and depth. All three can be combined into a single indicator referred to as EUNIS (European Nature Information System). The EUNIS system for the marine environment contains six levels, of which level 3 is most informative given the combination of substrate, energy and depth. Level 3 is used in this study.

All VMS positions for the Dutch bottom fishing fleet in the year 2011-2015 have been used in this study. Gear codes representing bottom fishing are: TBB (beamtrawl), SSC (flyshoot), OTB (otterboard) and DRB/HMD (dredge). Wageningen Marine Research also holds a database in which finer gear characteristics are stored, such as the usage of a wing-design rather than the traditional beamtrawl. Combining the traditional gear codes with the Wageningen Marine Research innovative gear database resulted in six gear categories: traditional beamtrawl, wing beamtrawl, shrimp trawl, flyshoot, otterboard and dredge.

TBB: a beamtrawl vessel tows two nets on either side of the vessel along the seafloor, targeting especially sole and plaice. The net is kept open by a steal beam (usually 12m wide) which sits on two gliders on either side of the beam. In front of the net, attached behind the steel beam, are tickler

chains situated that plough the seabed to drive fish into the gear. A special case of the TBB is the shrimptrawl, named TBS. The gear setup is the same, except for the tickler chains which are replaced by lighter elements. The gear width is smaller than the larger beamtrawl and amounts to 9 meters on each side.
SSC: a flyshoot vessel is a hybrid between a seine vessel and an otterboard. The vessel moves forward while hauling a seine net, usually attached to a boy at the end of the net. A seine net is often between 4-6km long. The fishery targets usually round fish.
OTB: an otterboard is equipped with steel boards in front of the net that, through drag, move sideways and hereby keep the fishing net open. There is relatively little seafloor contact as only the boards penetrate the seafloor. Average gear width is around 130 meters but varies depending on fishing depth and speed. The fishery targets usually round fish.
DRB/HMD: This fishery is similar to the beamtrawl but has a substantial seafloor penetration. The gear has an average width of around 9 meters (both sides) and the fishery targets shellfish.

Surface area trawled by each of the fishing vessels is calculated as the speed of the vessel in km/h, the time-interval each VMS ping represents (usually 2 hours) and the width of the gear. To derive fishing intensity maps, one has to aggregate the surface area trawled in a spatial location, in our case a regular grid of 1 minute by 1 minute and divide by the surface area of the grid cell (~2km^2). I.e. fishing intensity is the ratio between summed swept area of all vessels in a specific grid cell and the surface area of the grid cell itself. We assume that if the surface area trawled equals the surface area of a specific grid cell, the whole grid cell is trawled once. This also implies that within a grid cell we assume no further aggregation of fishing effort. Each VMS ping can be associated with a certain amount of surface area trawled. This is calculated by multiplying the interval time of VMS (~2 hours) with recorded fishing speed and gear width. In units, this equals to: h * km/h * km, resulting in the unit km^2. To derive the number of times fishing vessels have actively passed the pipeline, we need to multiply the fishing intensity with the number of times a gear would fit into 1km pipeline section.

The conversion factors to go from fishing intensity of 1 to number of pipeline crossings is given in the table below.

Gear	Average gear width	Average fishing speed	Average time interval in VMS	Surface associated with each VMS ping	Number of times average gear width fits in 1km pipeline section	Pipeline crossing with a fishing intensity of 1
Large beamtrawl	24m	5.2 knopen	2h	0.44km2	42	95
Sumwing	24m	5.0 knopen	2h	0.42km2	42	100
Shrimptrawl	18m	3.0 knopen	2h	0.19km2	56	295
Otterboard	130m (erg variabel)	3.0 knopen	2h	0.78km2	8	10
Flyshoot	-	2.1 knopen	2h	3.9km2	-	<1
Dredge	9m	3.6 knopen	2h	0.115km2	111	965

Seasonal trends are calculated by summing the fishing effort (each fishing VMS ping representing ~2 hours) by month by gear category.
Proportional fishing intensity per year by fishing category along the BBL pipeline is derived by creating ~1 km by ~1 km cells (on a non-regular grid, following the latitude of the pipeline) and matching the VMS positions to each of these cells. Thereafter, the calculation of fishing intensity is identical as described above.
Depth/gradient and habitat association is calculated as the observed swept area allocation in areas with a specific gradient (clustered in six categories) versus the expected swept area allocation if there was no preference (every gradient category would receive an equal amount of effort depending on the surface area that is represented by this area). All calculations are done based on grid cells of 1 minute latitude by 1 minute longitude within a 500m (1 km buffer) radius around the BBL pipeline.

4 Results

4.1 Study area and fishing intensity

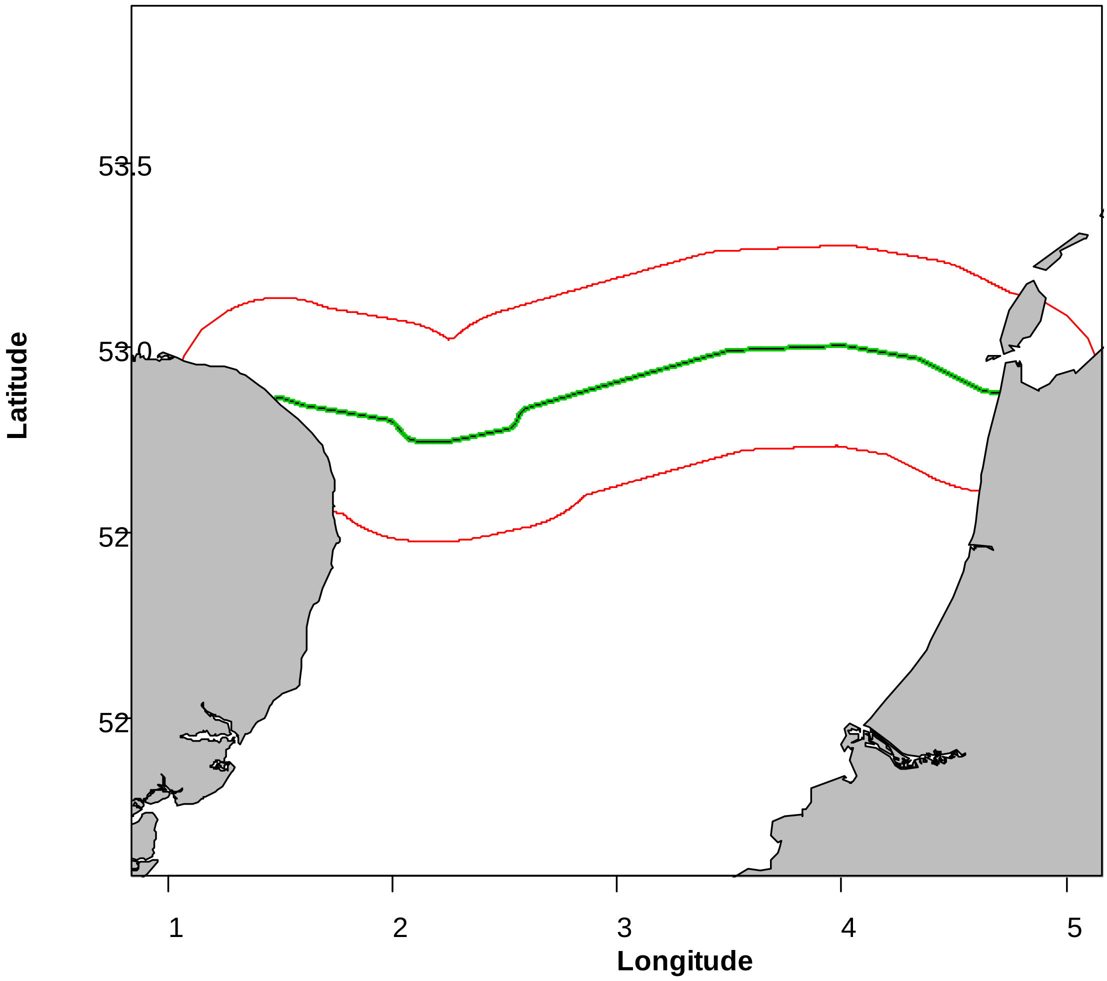

__Figure 4.1.1__ Study area. In black the BBL pipeline is shown (surrounded by green), in green a 1km buffer (500m on each side) and in red a 30km buffer area (30km each side) is shown. The green buffer is used to select VMS pings from vessels for the fishing intensity analyses and the red buffer is used for generic data extraction purposes.

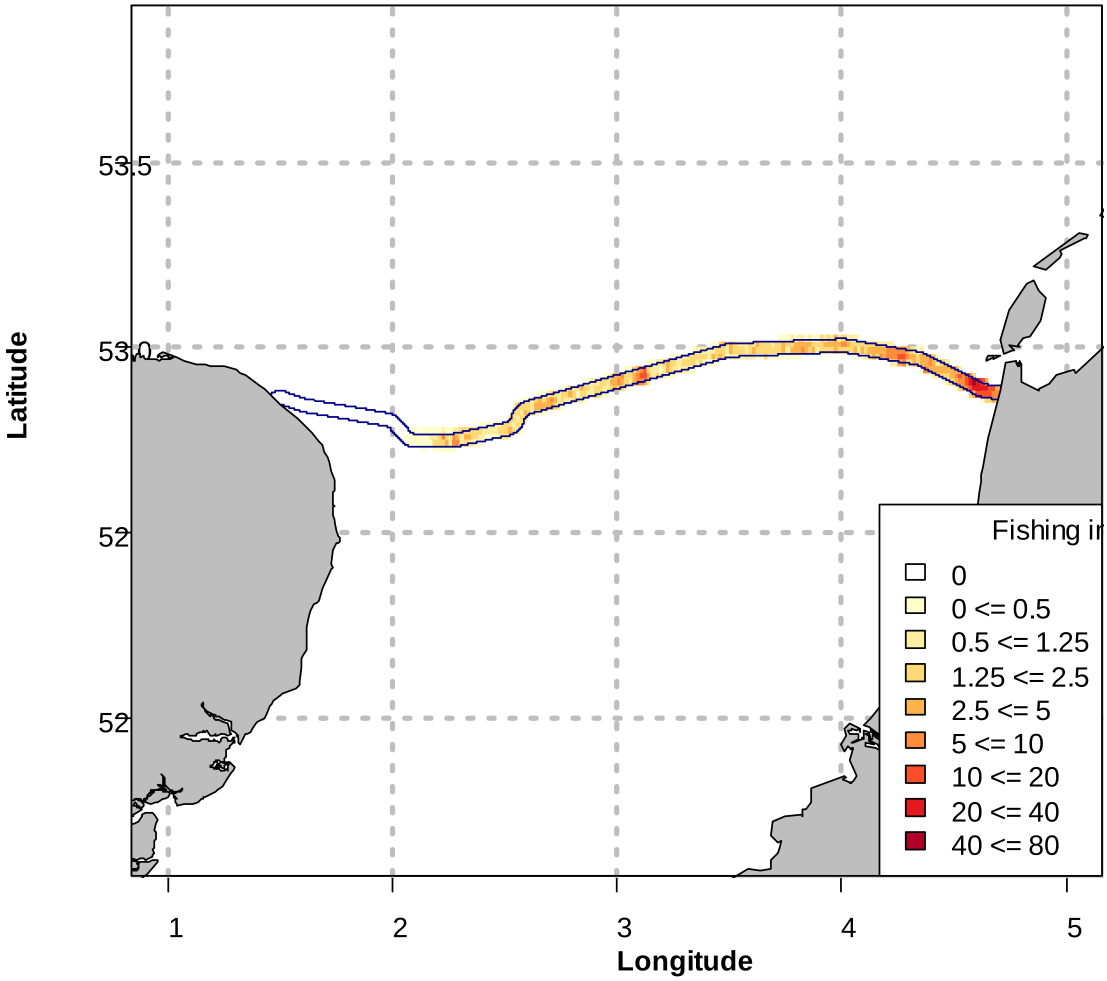

Figure 4.1.2 *Average fishing intensity of the entire Dutch bottom fishing fleet over the years 2011-2015 around the BBL pipeline. Fishing intensity is given at a 1minute by 1minute grid cell scale (~1km^2). Darker colours denote higher fishing intensities. Fishing intensities span about 2 orders of magnitude from very low (<1) times fishing an entire 1x1 minute grid cell to ~50 times.*

Results show that especially close to the Dutch coastline fishing activity is high. This is caused by the shrimp trawl fleet (see also section 4.2) that trawl small subsections of the Dutch EEZ with high intensity. Further offshore, there is moderate to high fishing activity up till ~2 degrees longitude where fishing activity reduces to zero. Part of this section receives no fishing activity given that it is located inside the UK 12 mile zone where Dutch fishing is not allowed. Though just right of the 2 degree meridian, fishing is allowed but intensities as between 0 and 0.5 are common in that region. Whether there is a relationship between depth gradient and habitat is shown in 4.4. Just right (East) of the 3 degree meridian, there is a fishing hotspot where both flyshoot and sumwing are especially active.

4.2 Fishing intensity by metier

Table 4.2.1 shows the fishing intensities by metier along the BBL pipeline. The coordinates listed, each ~1km apart, show the midpoint of each of the 1km blocks.

Table 4.2.1. *Fraction of fishing intensity by 1km subsection of the BBL pipeline. Coordinates [2] denote the midpoint of the 1km subsection. Empty cells indicate no fishing activity. The pipeline is shown from Bacton (top) to Balgzand (bottom).*

Beamtrawl	Dredge	Flyshoot	Otterboard	Shrimp	Sumwing	Longitude	Latitude
						1.465929506	52.85877868
						1.471279852	52.8595226
						1.479576053	52.86207381
						1.493378919	52.86520461
						1.508036949	52.86508294
						1.5221763	52.86240974
						1.536189852	52.85941842
						1.550220717	52.8564552
						1.564242142	52.85347959
						1.578234015	52.85047343
						1.592257689	52.84752133
						1.606410013	52.84486434
						1.620985719	52.84320799
						1.63560719	52.84170021
						1.650223278	52.84018137
						1.664865779	52.83870858
						1.679487207	52.83718115
						1.694117793	52.83568727
						1.708754527	52.83416263
						1.72338885	52.83263618
						1.738028349	52.83113269
						1.75266082	52.82960027
						1.767295903	52.82810611
						1.781907332	52.82656274
						1.79651878	52.8250457
						1.811145825	52.82353137
						1.825775947	52.82197542
						1.840415737	52.82045422
						1.855047762	52.81893468
						1.869652709	52.81740118
						1.884241164	52.81586511
						1.898834733	52.81434811
						1.913413702	52.81281082
						1.928005377	52.81129297
						1.94259226	52.80970757
						1.957224229	52.80819588
						1.971820138	52.80659993
						1.986072623	52.80419878
						1.999260056	52.80004914
						2.01088062	52.79434959

[2] Coordinates are in WGS84 decimal geographical degrees.

				2.020833421	52.78787618
				2.030313626	52.78103175
				2.039799024	52.77415359
				2.04929633	52.76736302
				2.059452025	52.76098884
			1.000	2.071365633	52.75557389
			1.000	2.08477965	52.75176345
			1.000	2.099168366	52.74970805
			1.000	2.113937606	52.74921665
			1.000	2.128737691	52.74924367
				2.143544478	52.74923611
			1.000	2.158388023	52.74922316
			1.000	2.173232041	52.74923994
0.068			0.932	2.188061223	52.74924726
0.540			0.460	2.202866315	52.74925863
0.306			0.694	2.217673355	52.74921314
0.111			0.889	2.23250241	52.74924057
0.040			0.960	2.247338567	52.74921249
0.474			0.526	2.262161884	52.74936973
0.094			0.906	2.276809096	52.75067567
0.069			0.931	2.291328468	52.75248542
0.035			0.965	2.305784052	52.75441447
0.037			0.963	2.320279152	52.75625466
0.177			0.823	2.334773271	52.75813938
0.071			0.929	2.3492645	52.75999359
0.099			0.901	2.363750874	52.76186335
0.016			0.984	2.378243428	52.76372146
0.029			0.971	2.392738733	52.76556984
0.047			0.953	2.407217974	52.76744104
0.158			0.842	2.421700556	52.76924177
				2.425161747	52.76508756
0.790			0.210	2.436144216	52.7711333
0.130			0.870	2.450645427	52.77294933
0.118			0.882	2.465144723	52.77481488
0.334			0.666	2.47965193	52.77664403
0.045			0.955	2.494169193	52.77850429
0.496			0.504	2.508680295	52.78041197
0.665			0.335	2.522599431	52.78351551
0.356			0.644	2.535048871	52.78844984
0.380			0.620	2.545507764	52.79535043
0.125			0.875	2.553248291	52.80371418
0.370			0.630	2.558834989	52.81018604
0.321			0.679	2.56461247	52.81701142
0.301			0.699	2.572786875	52.825383
0.024			0.976	2.583595336	52.83198
		0.032	0.968	2.596300781	52.83666817
0.191			0.809	2.610337988	52.83963015
0.096			0.904	2.624584868	52.84219282
0.233			0.767	2.638868342	52.84469899
0.029	0.537		0.434	2.653135618	52.84723768
0.045			0.955	2.667401855	52.84976549
0.098	0.871		0.032	2.681692714	52.85223266
0.086	0.766		0.149	2.695941389	52.85477746
0.058	0.833		0.109	2.71019903	52.85730748
0.241	0.043		0.715	2.724472404	52.85979221

0.177				0.823	2.738760209	52.86227002
0.100	0.478			0.422	2.752995803	52.86482796
				1.000	2.767295945	52.86725515
0.205				0.795	2.781534484	52.86981714
0.193				0.807	2.795828109	52.87226016
0.025	0.595			0.379	2.810084841	52.87477235
				1.000	2.824326703	52.87730438
0.046				0.954	2.838619505	52.87976627
0.020	0.343			0.637	2.852892862	52.88228612
0.119			0.076	0.804	2.867179164	52.88476151
				1.000	2.881450747	52.88726431
				1.000	2.895739315	52.8897423
				1.000	2.910035737	52.89221595
0.238				0.762	2.924312397	52.89471257
0.327				0.673	2.938599941	52.89718102
0.266				0.734	2.952889207	52.899677
0.267				0.733	2.967195251	52.90213828
0.273	0.348			0.379	2.98147489	52.90462445
0.009	0.671			0.320	2.995759656	52.90708569
0.004	0.793			0.204	3.010042762	52.90955425
0.035	0.803			0.161	3.024331587	52.91204101
	0.811			0.189	3.038650285	52.91450001
0.062	0.858			0.081	3.052961024	52.91697691
0.058	0.382			0.560	3.067276278	52.9194485
0.068	0.549			0.383	3.081591638	52.92189348
0.031	0.753			0.216	3.095872958	52.92438742
0.013	0.885	0.014		0.088	3.110193544	52.92682118
0.016	0.903			0.081	3.124504956	52.9293053
	0.880			0.120	3.13885356	52.93172834
	0.253			0.747	3.153174719	52.93419065
0.239		0.375		0.386	3.167562961	52.93649397
0.358		0.167		0.476	3.181812572	52.93903701
				1.000	3.196099413	52.94153253
0.149				0.851	3.210434777	52.9439958
0.174				0.826	3.224764799	52.94646838
0.241				0.759	3.239101703	52.94887909
0.088				0.912	3.25340181	52.95136768
0.099				0.901	3.267759418	52.95377455
0.069				0.931	3.282089933	52.95624101
0.669				0.331	3.296439788	52.9586644
0.177				0.823	3.310790171	52.96110098
0.208				0.792	3.325137257	52.96355086
0.193				0.807	3.339500928	52.96595492
0.339				0.661	3.353821623	52.96844229
0.418				0.582	3.368201544	52.9708296
0.164	0.420			0.416	3.382542692	52.97329736
0.294				0.706	3.396911825	52.97569209
0.093	0.407			0.500	3.411260312	52.97814673
0.273	0.366			0.360	3.42562932	52.98056464
0.140	0.509			0.352	3.439996527	52.98298405
0.044	0.589			0.367	3.454354827	52.98542171
				1.000	3.46874259	52.98781704
0.240				0.760	3.483099992	52.9902499
0.229				0.771	3.497595328	52.99229296
0.257				0.743	3.512423487	52.99314526

0.395				0.605	3.527328379	52.99354963
0.084	0.617			0.300	3.542223874	52.99397646
0.195				0.805	3.55711797	52.99443035
0.204				0.796	3.572019808	52.9947906
0.230				0.770	3.586915259	52.99525123
0.127	0.372			0.500	3.601802275	52.99561573
0.194				0.806	3.616690537	52.99604269
0.068		0.491		0.441	3.631598062	52.99642523
0.344				0.656	3.646494769	52.99685542
0.272				0.728	3.661402366	52.99723722
0.210		0.047		0.743	3.676309435	52.99765585
0.018				0.982	3.691216617	52.99806258
0.115				0.885	3.706121401	52.99847771
0.219				0.781	3.721021899	52.99885896
0.249				0.751	3.735928048	52.99927435
0.000				1.000	3.750837781	52.99964685
0.285				0.715	3.765729902	53.00005992
0.164		0.136		0.700	3.780624006	53.00043235
0.267		0.047		0.686	3.795532663	53.00080884
0.261		0.057		0.682	3.810441768	53.00120226
0.092	0.226			0.682	3.825337675	53.00156724
0.181	0.255	0.162		0.402	3.8402398	53.00195039
0.245		0.113		0.642	3.855149307	53.00232555
0.144		0.238		0.618	3.870050868	53.00270636
0.130		0.183		0.687	3.884963099	53.00305728
0.313		0.123		0.565	3.899872646	53.00343944
0.124				0.876	3.914751884	53.00384205
0.022		0.240		0.738	3.92963428	53.0041945
0.170		0.442		0.388	3.944545054	53.00456742
0.300		0.051		0.649	3.959456561	53.00493197
0.290		0.301		0.409	3.974366096	53.00532846
0.119		0.038		0.843	3.989279911	53.0056621
0.119	0.484	0.044		0.353	4.00417507	53.00579066
0.068	0.607	0.126		0.199	4.018980245	53.00495988
0.080	0.235	0.367		0.319	4.033695191	53.00349578
0.170				0.830	4.048382707	53.00190021
0.004		0.856		0.140	4.063063836	53.00035887
0.110	0.569	0.203		0.118	4.077747526	52.99883082
0.075		0.490		0.435	4.092435479	52.99724053
0.276	0.121			0.604	4.107149707	52.99574625
0.136	0.508	0.052		0.304	4.121825372	52.99415508
0.107	0.281	0.215		0.398	4.136522069	52.99260095
0.187		0.302		0.511	4.151228769	52.99109253
0.083	0.264	0.090		0.564	4.165907386	52.9894829
0.133		0.340		0.528	4.180610451	52.98795767
0.203		0.363	0.011	0.423	4.195291083	52.98636021
0.091	0.598	0.128		0.184	4.209976911	52.98482013
0.094	0.351	0.228		0.327	4.224633134	52.98323922
0.137	0.252	0.096		0.515	4.239311597	52.9817156
0.058	0.474	0.147	0.003	0.318	4.253970935	52.98011693
0.063	0.609	0.130	0.007	0.191	4.268645573	52.97855798
0.039	0.498	0.199		0.264	4.283303289	52.97699645
	0.540	0.145		0.315	4.297964379	52.97540143
0.038	0.482	0.127		0.353	4.312653474	52.97384583
0.076	0.505	0.260		0.160	4.327319086	52.97224092

0.128		0.718	0.087		0.067	4.341873085	52.97031937
0.313		0.382	0.025		0.280	4.355797095	52.96716227
0.118		0.558	0.174		0.149	4.369154129	52.96319988
0.172		0.602	0.104		0.121	4.38245317	52.95916017
0.035		0.692	0.249	0.009	0.015	4.39574071	52.95509012
0.107		0.405	0.283	0.013	0.192	4.409031691	52.95101807
0.073			0.197	0.121	0.609	4.4223184	52.94697432
0.057			0.531	0.009	0.403	4.435544927	52.9428992
0.125			0.565	0.056	0.254	4.448855184	52.93888169
0.024			0.526	0.096	0.354	4.462220482	52.9349114
0.028			0.124	0.334	0.513	4.475534853	52.9309189
0.091			0.128	0.158	0.623	4.488814166	52.9269075
0.074		0.349	0.165	0.103	0.310	4.502093586	52.9228625
0.072			0.381	0.360	0.186	4.515352783	52.91877784
0.130	0.005	0.091	0.384	0.125	0.264	4.528644733	52.91470604
0.065	0.008	0.056	0.249	0.256	0.367	4.541908028	52.91062722
0.085	0.007		0.249	0.273	0.386	4.555167228	52.90655708
0.092		0.038	0.304	0.271	0.295	4.568465962	52.90253982
0.030	0.003	0.080	0.352	0.288	0.247	4.581725403	52.89852991
0.032	0.006		0.393	0.460	0.108	4.594690362	52.89428541
0.037	0.015	0.045	0.198	0.607	0.097	4.607858916	52.89013981
0.030	0.006	0.110	0.139	0.597	0.118	4.62160523	52.88669426
0.007	0.004		0.147	0.808	0.035	4.635843954	52.88407263
	0.002			0.998		4.650388805	52.88218195
	0.091			0.909		4.66515776	52.88109884
	0.089			0.911		4.680006405	52.88049328
0.000	0.012			0.987		4.694877765	52.88018428
				1.000		4.70937015	52.88016855
						4.71948156	52.88066142

Sumwing activity dominates the area closest to Bacton and maintains to be the most dominant gear type up till ~50km to the Dutch coast where otterboard and flyshoot become more apparent. Closest to shore, it is shrimp trawling that dominates the fishing activity together with a fraction of dredging. Traditional beamtrawling is relatively stable along the entire pipeline with an average fraction of 20% (although minor close to the Dutch coast).

4.3 Seasonality by metier

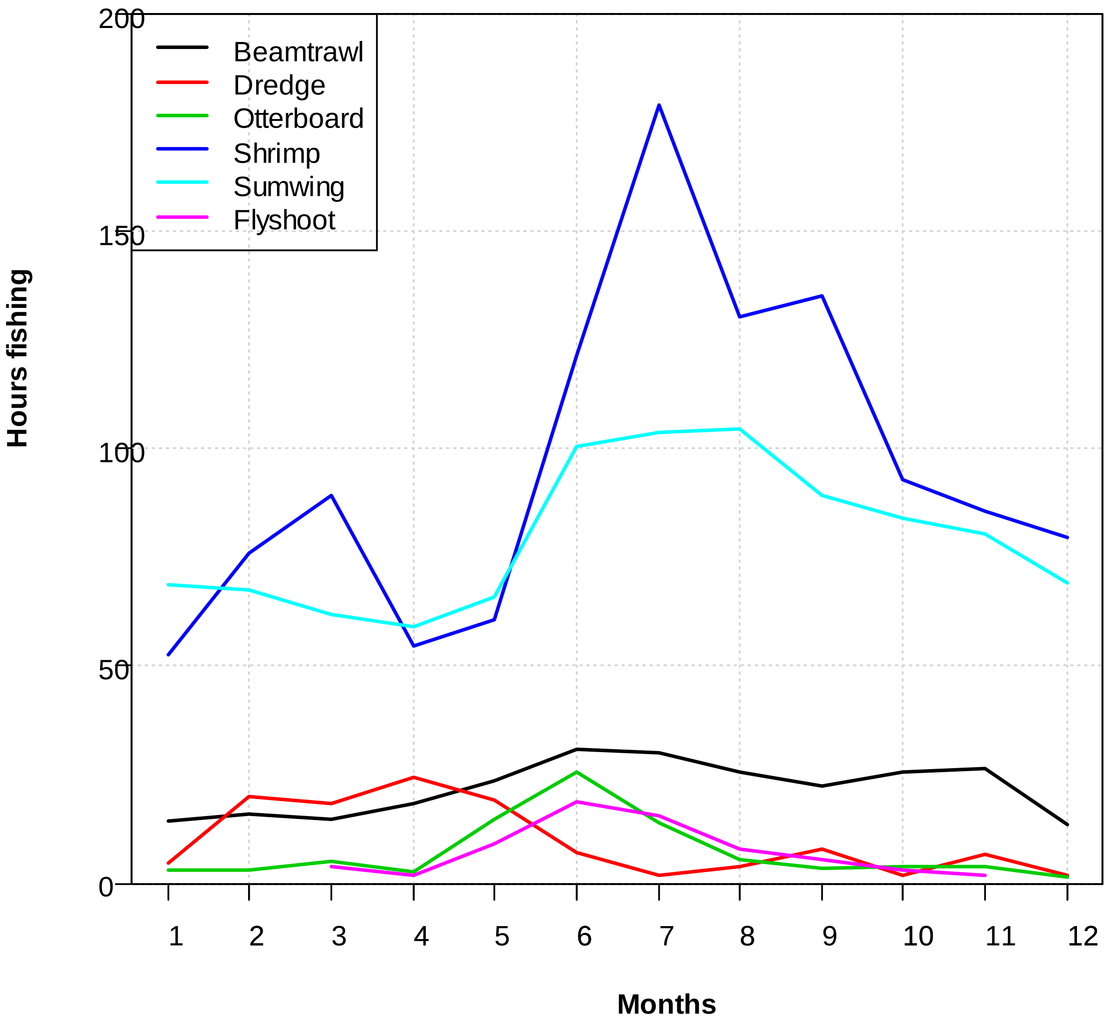

Figure 4.3.1 *Average fishing effort by month by metier over the years 2011-2015.*

Nearly all fishing metier categories show some degree of seasonality. Shrimp are caught typically over the summer months, similarly to flyshoot and otterboarding. Dredging takes place especially late winter and early spring while the traditional beamtrawl and sumwing show some seasonality (drop around December / January) but less pronounced than the other gear types. The seasonality of these fleets coincides with the biology of the target species (migration and spawning).

4.4 Fishing intensity and depth-gradient / habitat association

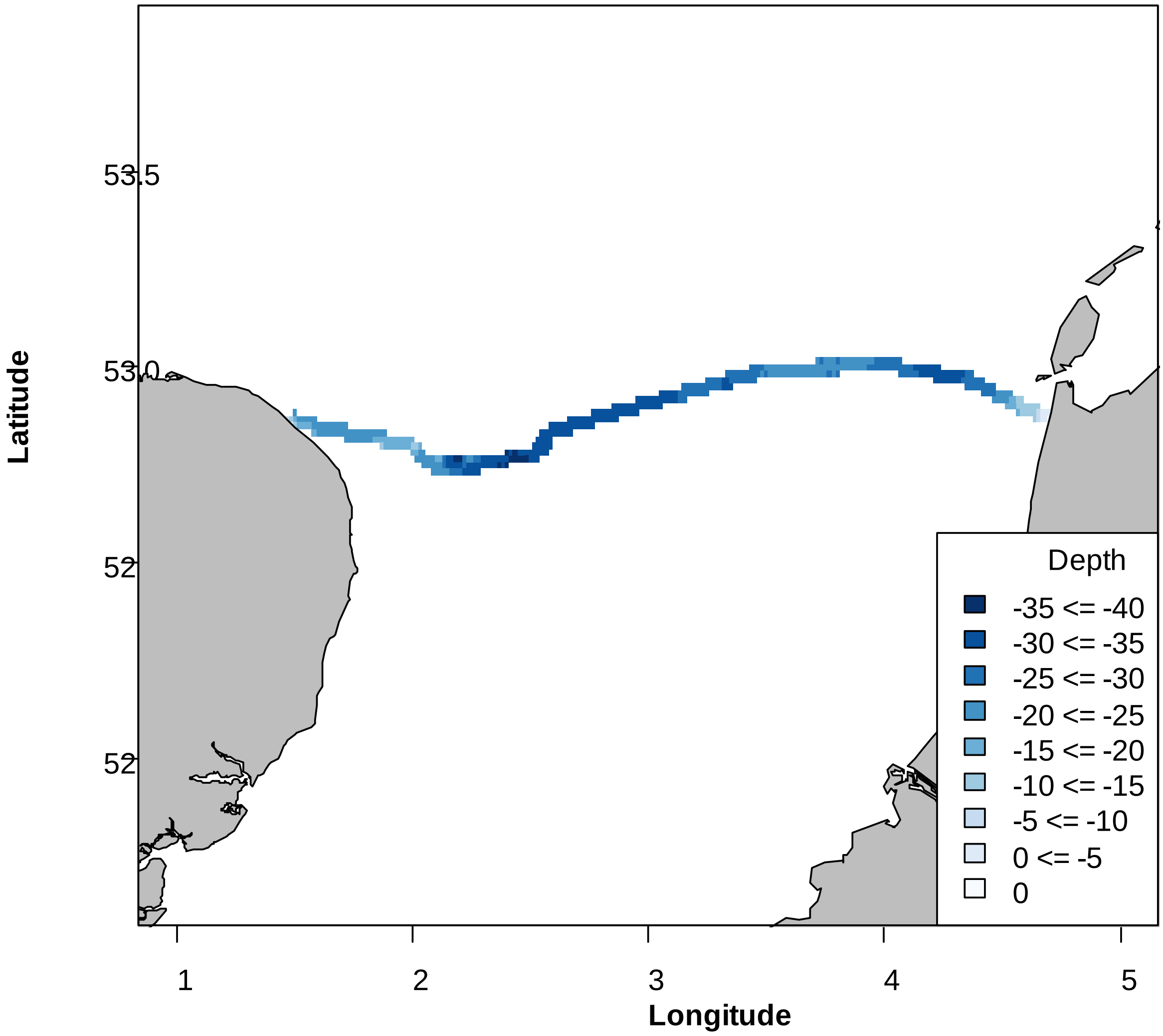

Figure 4.4.1 *Average depth (m) per 1minute x 1minute grid cell in a buffer area around the BBL pipeline. Darker blue areas denote deeper areas while lighter blue areas denote shallower areas.*

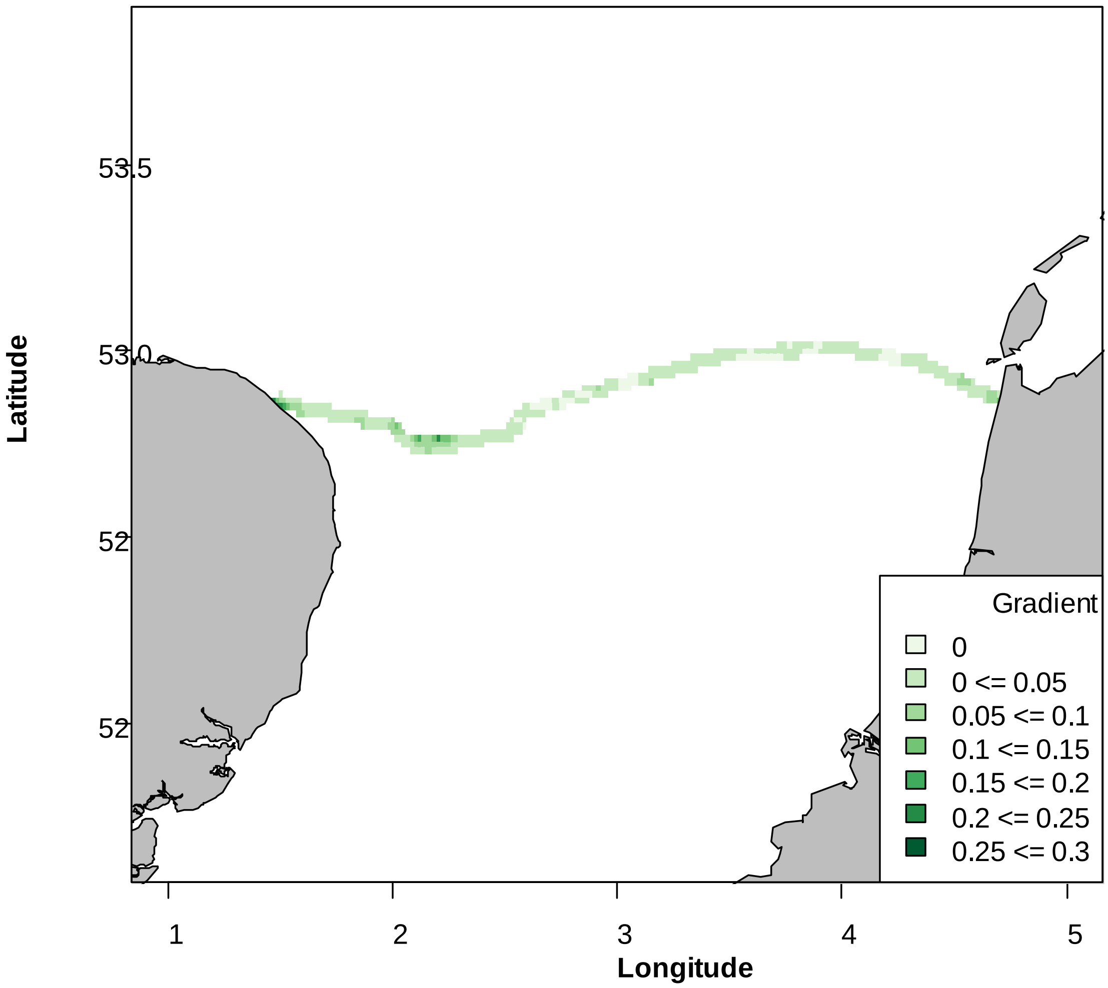

Figure 4.4.2 *Average gradient per 1minute x 1minute grid cell in a buffer area around the BBL pipeline. Darker green denotes areas with steeper gradients while lighter green denotes areas with less height difference.*

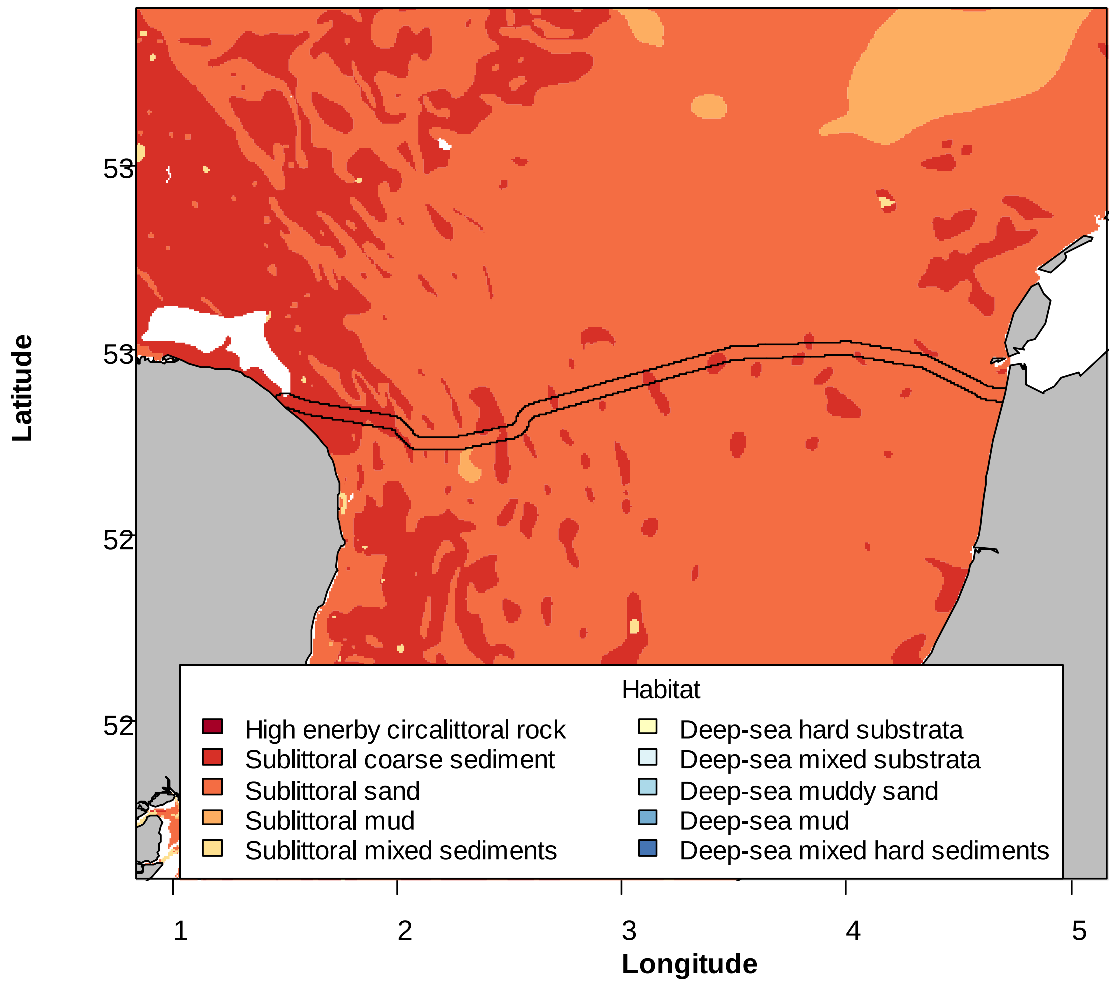

Figure 4.4.3 *Habitat types of a broad area around the BBL pipeline as obtained from the EMODnet modelled seabed habitat, EUNIS level 3.*

Figure 4.4.3 shows the modelled seabed habitats around the BBL pipeline. Only two types of habitat can be distinguished within the BBL buffer area: sublittoral coarse sediment, especially closer to the UK coast, and sublittoral sand, one of the main habitat types in the southern North Sea.

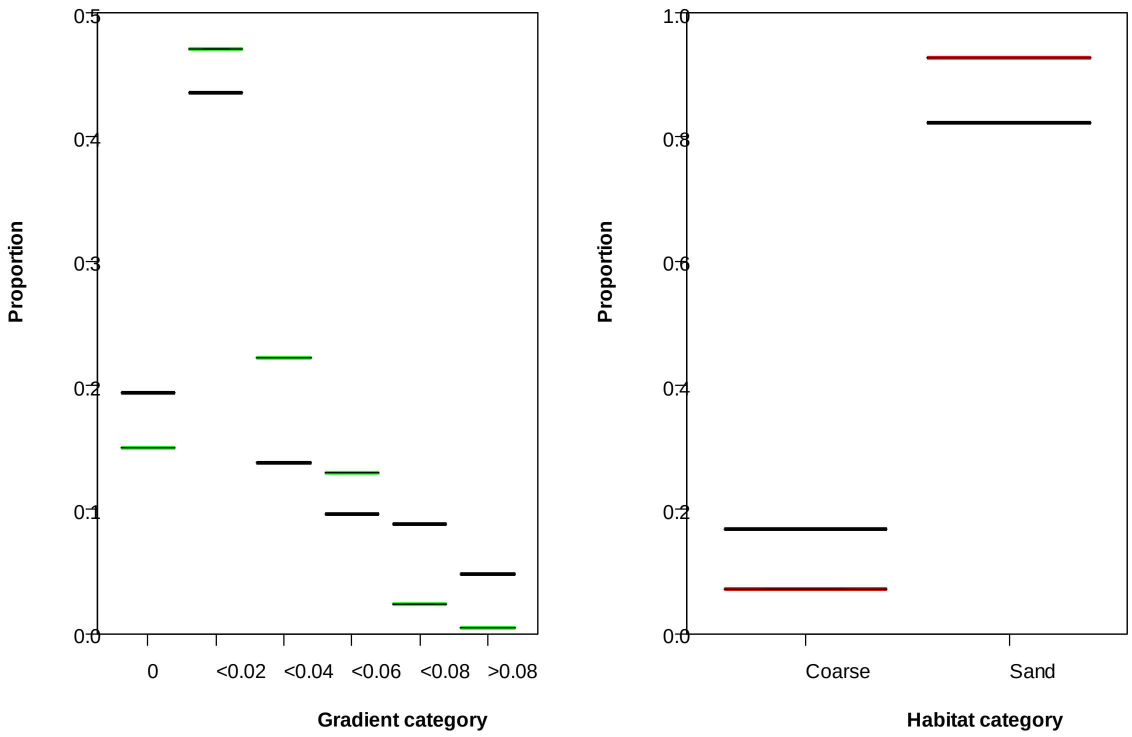

Figure 4.4.4 *Left: Proportion of area per gradient category for the entire BBL buffer area (reference area, in black) and the proportional swept area allocation per gradient category (as observed from VMS, green). Right: Proportion of area per habitat category for the entire BBL buffer area (reference area, in black) and the proportional swept area allocation per habitat category (as observed from VMS, red).*

Overall, without distinguishing gear types, the moderately steep areas receive a higher preference from the bottom fishing fleet. Those areas with relatively steep slopes (high gradients) are less visited by the fishing fleet; some of these areas appear inside the 12 mile zone of the UK however and are therefore not accessible for the fishing fleet. There is a higher preference for sandy habitat over coarser sediment habitat. This observation is confirmed by observations from the whole fleet in its entire distribution area, mainly owing to the inability to operate heavy gear (such as beamtrawls) on coarse sediment habitat. In addition, a substantial part of the coarse habitat is situated inside the UK 12 mile zone and therefore not accessible either.

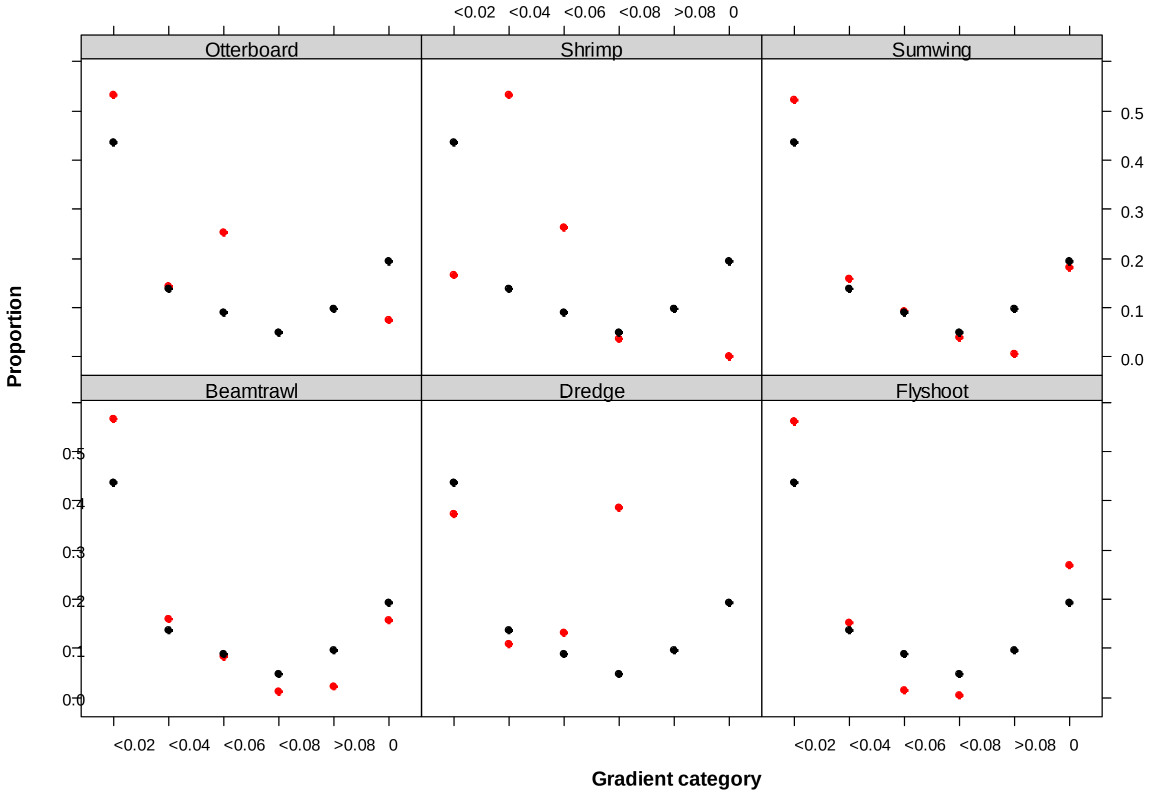

Figure 4.4.5 *Proportion of area per gradient category and fleet metier for the entire BBL buffer area (reference area, in black) and the proportional swept area allocation per gradient category (as observed from VMS, red).*

Sumwing, beamtrawl and flyshoot all have a very similar preference from low gradient while dredge seems to favour higher gradients. A clear pattern is lacking for otterboards and shrimp. The clear preference for moderate gradients as was observed in Figure 4.4.4 left seems to be dominated by the moderate gradient preference by shrimpers, while the all score low preference for high gradients. Ony dredge seems to have a low preference for low gradient and a higher preference for higher gradients. The results are influenced by the distribution of the target species, but it cannot be tested here whether their distribution depends on the gradient or different co-variets.

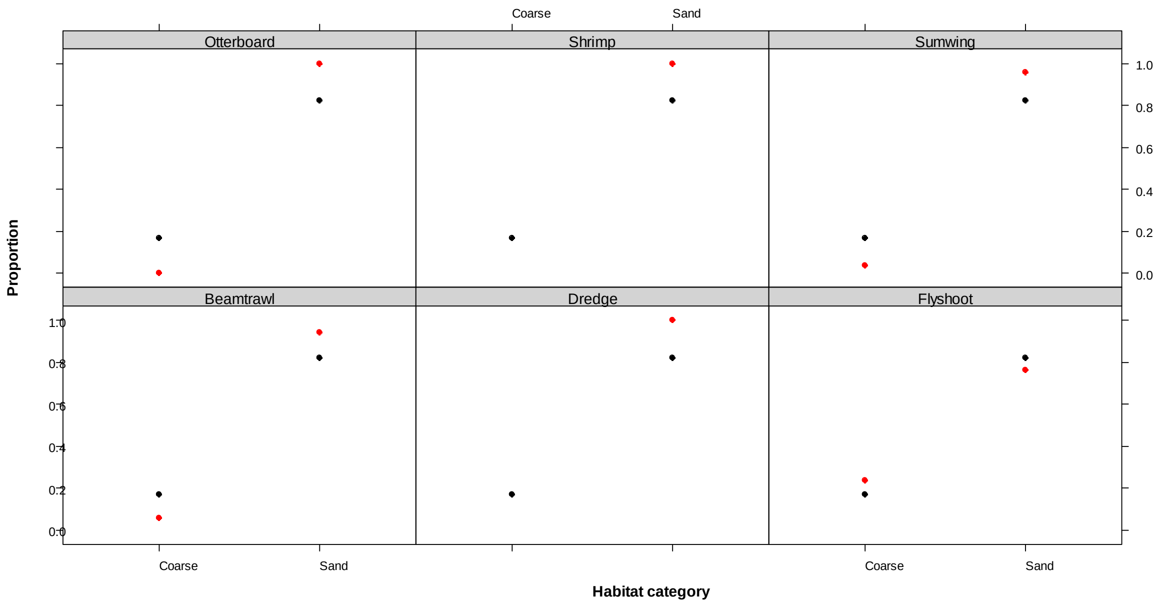

Figure 4.4.6 *Proportion of area that per habitat category and fleet metier for the entire BBL buffer area (reference area, in black) and the proportional swept area allocation per habitat category (as observed from VMS, red).*

All fleet metiers, except flyshoot, prefer a sandy habitat over a coarse habitat. In case of shrimp and dredge, no activity takes place on coarse habitat. Flyshoot is a relatively light gear (with a clump that is dragged across the seabottom) and may therefore operate well in coarse habitat where heavier gear has more problems to be operated without risking gear to get stuck.

5 Conclusions and recommendations

We conclude that especially near the Dutch coast, along the BBL pipeline, there is high fishing intensity of especially shrimp vessels. Fishing intensities amount up to 50 times per year in an area of ~1km^2 (equalling to ~200 trawls). In the less frequently trawled areas, in the middle of the pipeline, fishing intensities span 0 – 5 times a year, equalling in the upper range to ~10 trawls a year.

The results only represent the fishing intensities of the Dutch fishing vessels. A number of beamtrawlers are flagged to the UK which could not be analysed as data is not freely available, and neither are otterboarders and flyshooters from other nations represented. This implies that fishing intensities in reality are higher than reported. It is yet unknown by what factor these intensities should be raised, and collaboration with sister institutes is necessary to achieve an all-comprising map.

The results furthermore show a clear spatial segregation of fleet metiers, where the shrimpers and dredging vessel are abundant in the coastal areas of the Netherlands and the more traditional beamtrawlers and sumwing vessels operate further out at sea while flyshoot vessels focus on coarse habitat patches. Their activities have a strong seasonal pattern, with exception from beamtrawlers (including sumwing) that are known to operate all year round following the availability to their target species year round as well. Only in the winter months, when both plaice and sole spawn, less fishing takes place as the kg price of the resource drops.

Habitat association follows earlier studies where the majority of fishing vessels are known to fish on sandy habitats, mainly because these vessels cannot operate their gear on coarse substrate, such as rock. With the introduction of lighter gears however, including the pulse gear, rocky areas now become accessible. Overall however, the shift takes place on small patches leaving the majority of the fishing effort spatial allocation untouched.

Anecdotal information from beamtrawl fishers indicates the preference to fish on the edges of sand dunes. This information is confirmed by our results but also shows that the steeper areas are left aside, likely because the gear is more difficult to manoeuvre in these areas.

The interpretation of fishing intensity related to risk should be taken with care. No causal relationship between fishing effort and pipeline damages can be identified based on this type of data analyses. Even though it is likely that both relate, VMS or other spatial data such as AIS cannot be used to link vessel presence to pipeline damages as other (environmental or human) factors may have an effect as well. The low temporal resolution provided by VMS (one ping every two hours) does limited the accuracy of our analyses, but provides a useful insight in the spatio-temporal distribution of fishing. Using interpolation and confidence interval techniques to increase the temporal resolution of VMS will improve the understanding of fishing activity around pipelines.

It should be noted that the fishing fleet distribution changes by season and by year, owing to seasonal changes in fish availability and changes in what types of gears are being used by fishers. Especially fishers who used to fish with large beam-trawls are known to have switched to new innovative gear types which weigh less and partially hoover over the seabed (pulse trawl, sumwing). These gears have only recently been introduced and new fishing grounds are still explored by these fishers. Therefore, maps based on only a few years of data may not accurately represent fishing activity in upcoming years. Repeating this exercise for a larger number of years is recommended to improve predictive accuracy of fishing activity in the vicinity of pipelines.

To work towards a full risk assessment of the pipelines in relation to fisheries the knowledge base on fishing activity and pipeliens needs to be extended with studies focussing among others on: i) attrativeness of pipelines to fishers, through statistical testing whether fishing intensity around pipelines is greater than elsewhere, ii) the physical impact a gear can have on an exposed pipeline (in terms of force by the part of the gear that interacts with the pipeline and penetration depth, iii) avoidance behavior of fishers when vulnerable pipeline sections are communicated (willingness to collaborate) and iv) the seasonal variability in burial depth in relation to fishing intensity.

6 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

Furthermore, the chemical laboratory at IJmuiden has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation. The chemical laboratory at IJmuiden has thus demonstrated its ability to provide valid results according a technically competent manner and to work according to the ISO 17025 standard. The scope (L097) of de accredited analytical methods can be found at the website of the Council for Accreditation (www.rva.nl).

7 References

Hintzen, NT, A Coers and KG Hamon (2013), a collaborative approach to mapping values of fisheries resources in the North Sea (part 1: Methodology). IMARES report C001/13. (available at: edepot.wur.nl/248628)]

Justification

Report C102/16
Project Number: 4311000001-39

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Dr. R.H. Jongbloed
Onderzoeker

Signature:

Date: 27 October 2016

Approved: Drs. J. Asjes
Integration Manager

Signature:

Date: 27 October 2016

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The Wageningen Marine Research mission

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