THÜNEN

Thünen-Institut für Seefischerei

Herwigstrasse 31, 27572 Bremerhaven Phone +49 471 94460-381 Fax: +49 471 94460 199

17.01.2020 Az.: Dr.Stelz/Grie/4371

Report

Cruise SO 765 of FRV „SOLEA“

25.07. –10.08.2019

Chief scientists: Dr. Vanessa Stelzenmüller & Jens Ulleweit

Objectives

1. Participation in the German Small-Scale Bottom Trawl Survey (GSBTS) to monitor the fish fauna in 6 out of 12 small areas (boxes),

2. Investigation of the hydrographical conditions within the boxes (vertical distribution of temperature, salinity and turbidity).

3. Experimental fisheries in the vicinity of two offshore windparks located in the German EEZ

Verteiler:
TI - Seefischerei

per E-Mail:
BMEL, Ref. 614
BMEL, Ref. 613
Bundesanstalt für Landwirtschaft und Ernährung, Hamburg
Schiffsführung FFS "
Präsidialbüro (Michael Welling)
Personalreferat Braunschweig
TI - Fischereiökologie
TI - Ostseefischerei Rostock
FIZ-Fischerei
TI - PR
MRI - BFEL HH, FB Fischqualität
Dr. Rohlf/SF - Reiseplanung Forschungsschiffe

Fahrtteilnehmer
Bundesamt für Seeschifffahrt und Hydrographie, Hamburg
Mecklenburger Hochseefischerei GmbH, Rostock
Doggerbank Seefischerei GmbH, Bremerhaven
Deutscher Fischerei - Verband e. V., Hamburg
Leibniz-Institut für Meereswissenschaften IFM-GEOMAR
H. Cammann-Oehne, BSH
Deutscher Hochseefischerei-Verband e.V.
DFFU

1. Narrative

FRV "Solea" left Cuxhaven on the 25nd of July 2019 and started its scientific program the following day in Box P (see Figure 1). In general, the scientific program consisted of three days with 7 hauls per day within each box. Each day at least two CTD casts were deployed. The scheduled personnel exchange was carried out around noon of the 4th of August in Esbjerg. The scientific program continued from the 25th of July until the 9th of August. The vessel returned to Cuxhaven on the 10th of August 2019.

During this year's survey a total of 92 hauls with the cod hopper trawl net and an additional 38 accompanying CTD casts were conducted in five boxes of the GSBTS assigned to FRV "Solea". In addition, an experimental box W and the vicinity of an offshore windfarm close to the island of Heligoland was sampled. Like in previous years the actual sequence of sampling in the boxes was adapted to the prevailing weather conditions (Box N (German EEZ; 5 days), Box W (German EEZ; 2 days), Box H (British EEZ; 2 days), Box K (Danish EEZ; 3 days), and Box P (German EEZ; 2 days)(Figure 1). Due to bad weather boxes E and F could not be sampled. Further, in the context of the project "Offshore wind farms in the context of ecosystem-based marine spatial management" 20 stations were sampled with strings of crab pots targeting brown crab (*Cancer pagurus*). A summary of the activities during SB765 within each box is given in Table 1 and a summary of the total sampling effort within the GSBTS survey program by box and year for the cod hopper is presented in Table 2.

Since 2017 the GSBTS sampling comprises the additional experimental box W (see Figure 1). Box W is similar in size of all the other standard GSBTS boxes and represents similar habitat conditions as box N. Box W is enclosing the offshore windfarm Butendiek, which is in operation since summer 2015. As shown in Table 1 a total number of 15 hauls were carried out in box W. The sampling procedure followed the GSBTS standard protocol. The setting positions were homogenously distributed across the main habitat types. In general, a distance of 500 m had to be kept to the windfarm boundary. The key question was if catches do significantly differ in composition, weight and numbers in the vicinity of the windfarm compared to box N. Four additional hauls were positioned in the proximity of the offshore windfarm Meerwind Süd/Ost, approx. 20 km off the Island of Heligoland. Keeping a minimum distance of 500 m to the east of the windfarm, five crab pots per station were positioned with a soaking time of 24h.

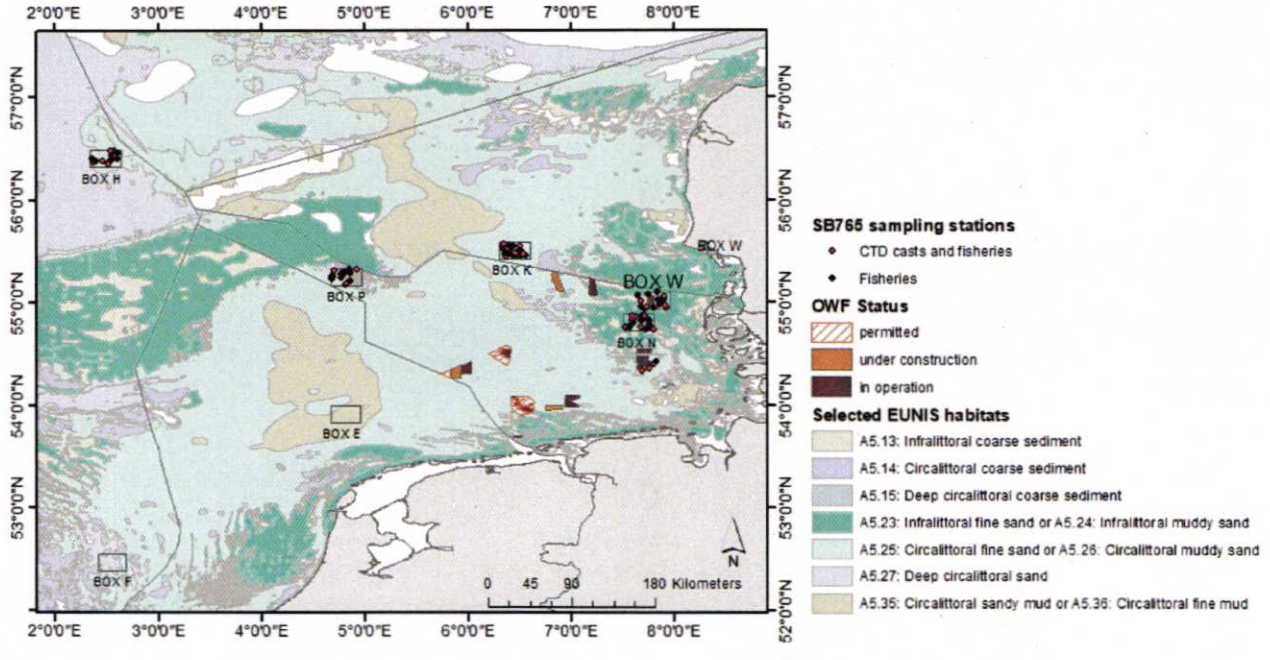

Figure 1: Positions of German small scale bottom trawl survey "boxes" (10 x 10 nm) monitored by the research vessel „Solea" during cruise no. 765 and sampling stations as mid positions indicating fishing activity (black dot) or fishing in combination with a CTD cast (red dot) per GSBTS box with intersecting EUNIS habitats categories.

Table 1. Total number of valid cod hopper (KJN) hauls and CTD casts during SO 765.

Box	KJH hauls	CTDs
BOX E	-	-
BOX F	-	-
BOX H	16	6
BOX K	21	8
BOX N	20	10
BOX P	16	6
BOX W	15	5
BOX M	4	3
Total	92	38

Table 2. Total sampling effort (cod hopper hauls) in the standard GSBTS boxes per survey year.

Year	BOX P	BOX H	BOX N	BOX K	BOX E	BOX F	Total
1990	-	-	-	-	8	28	36
1991	-	27	-	24	28	28	107
1992	-	23	-	19	28	21	91
1993	-	25	-	27	27	23	102
1995	-	26	-	24	21	25	96
1996	-	17	-	28	28	26	99
1997	-	25	-	26	6	18	75
1998	-	25	-	23	17	20	85
1999	-	17	-	30	10	27	84
2000	-	-	8	-	-	-	8
2002	-	17	-	9	15	17	58
2003	24	23	-	24	15	24	110
2004	16	23	15	17	19	17	107
2005	14	20	20	14	14	16	98
2006	-	16	19	24	-	-	59
2007	16	24	21	12	23	22	118
2008	18	21	21	18	21	22	121
2009	16	21	22	15	24	22	120
2010	14	21	21	16	21	21	114
2011	21	21	21	7	10	-	80
2012	18	21	21	7	21	-	88
2013	18	21	23	21	21	21	125
2014	24	23	17	18	21	21	124
2015	18	21	17	21	22	23	122
2016	18	21	16	14	12	12	93
2017	18	15	16	17	15	14	95
2018	15	14	21	21	21	-	92
2019	16	16	20	21	-	-	73
Total	284	544	319	497	468	468	2580

2. Results

2.1. Long-term trends in catch compositions

Trawl durations were constantly close to 30 min and the trawl speed ranged around 3.5 kn across all valid hols (Table 3). Mean depth between sampled boxes varies between 16.3 and 69.5 m.

Table 3. Summary of mean catch depth (m), mean vertical net opening (m), mean trawl duration (min), mean trawl speed (kn), mean length of trawl warp (m) and mean distance between trawl doors (m), and of all valid hols per box.

Box	mean depth (m)	mean vertical net opening (m)	mean trawl duration (min)	mean trawling speed (kn)	mean length trawl warp (m)	mean distance trawl doors (m)
BOX H	69.5	3.61	30.06	3.49	375.50	61.7
BOX K	38.2	3.38	30	3.42	222.95	55.1
BOX M	21.0	3.68	30.25	3.33	137.50	48.6
BOX N	20.6	3.43	30.05	3.54	115.70	45.6
BOX P	44.1	3.43	30	3.43	230.00	53.4
BOX W	16.3	3.45	30	3.47	111.93	43.9

In Figures 2 to 5 for each GSBTS box the annual catches (kg $30min^{-1}$) of the species contributing at least 0.5% to the cumulative total catch across all sampling years are displayed. Between a number of ten and thirteen species contributed the most to the overall biomass caught in the respective GSBTS boxes.

- In Box P cpue values (Fig. 2 top and bottom) were highest for dab (*Limanda limanda*) and grey gurnard (*Eutrigla gurnardus*). For the majority of the selected species mean cpue's were well below the median of the previous years. For European hake (*Merluccius merluccius*) and thorny skate (*Raja radiata*) only one individual was caught. Catches of plaice (*Pleuronectes platessa*) continued to decrease over the last five years.
- In Box H (Fig. 3 top and bottom) highest cupe values were detected for dab and haddock (*Melanogrammus aeglefinus*), whereby catches of haddock dropped from 30 to 40 kg per 30 min over the past years to approximately 10 kg per 30 min. Only one individual for each species was caught for starry ray, Norway pout (*Trisopterus esmarki*), poor cod (*Trisopterus minutus*) and tub gurnard (*Trigla lucerna*). Catches of haddock were slightly higher than the all-time median values.
- In Box N (Fig.4 top and bottom) cpue values were highest for dab and Atlantic mackerel (*Scomber scombrus*). The upward trend of catches continued in 2018 for dab and grey gurnard (*Eutrigla gurnadus*). In contrast, cat ches of Atlantic horse mackerel (*Trachurus trachurus*) continued to decrease. Only one individual was caught for solenette (*Buglossidium luteum*), snake pipefish (*Entelurus aequoreus*), European anchovy (*Engraulis encr asicolus*), brill (*Scophthalmus rhombus*), and common sole (*Solea vulgaris*).
- In Box K (Fig. 5 top and bottom) the catches of dab were highest in weight and numbers, while compared to p revious years' catches dropped below the median of the time series. Grey gurnard was the second abundant species in numbers and plaice had second highest cupe values. Only one individual per species was caught for Lesser weever (*Echiichthys vipera*), poor cod (*Trisopterus minutus*), Four-bearded rockling (*Rhinonemus cimbr ius*), brill, and starry smooth-hound (*Mustelus asterias*).

Further at three stations in boxes K (1) and H (2) one indiviual of blackbelly rosefish (*Helicolenus dactylopterus*) was caught. The three specimens had a length of 12.5 to 14.5 cm with a wet weight varying between 34 and 58 g. This reflects an excepitional catch, since this is a deep sea species. In the years 1995, 1996 and 1997 at total of 5 blackbelly rosefish have been caught by GSBTS survey in the central and southern North Sea.

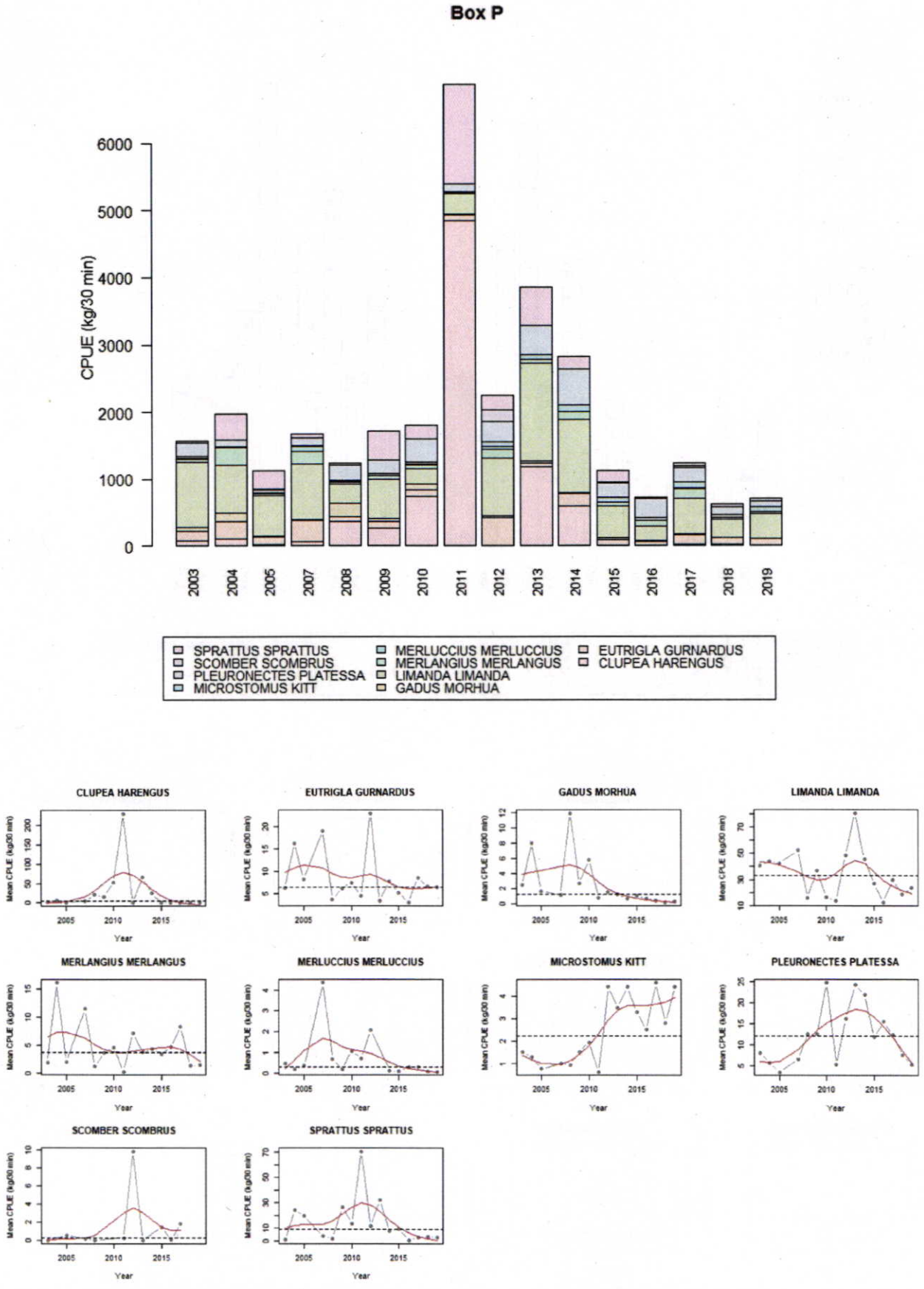

Figure 2: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box P. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box P, with indicated median CPUE per haul value over all sampling years (dashed line).

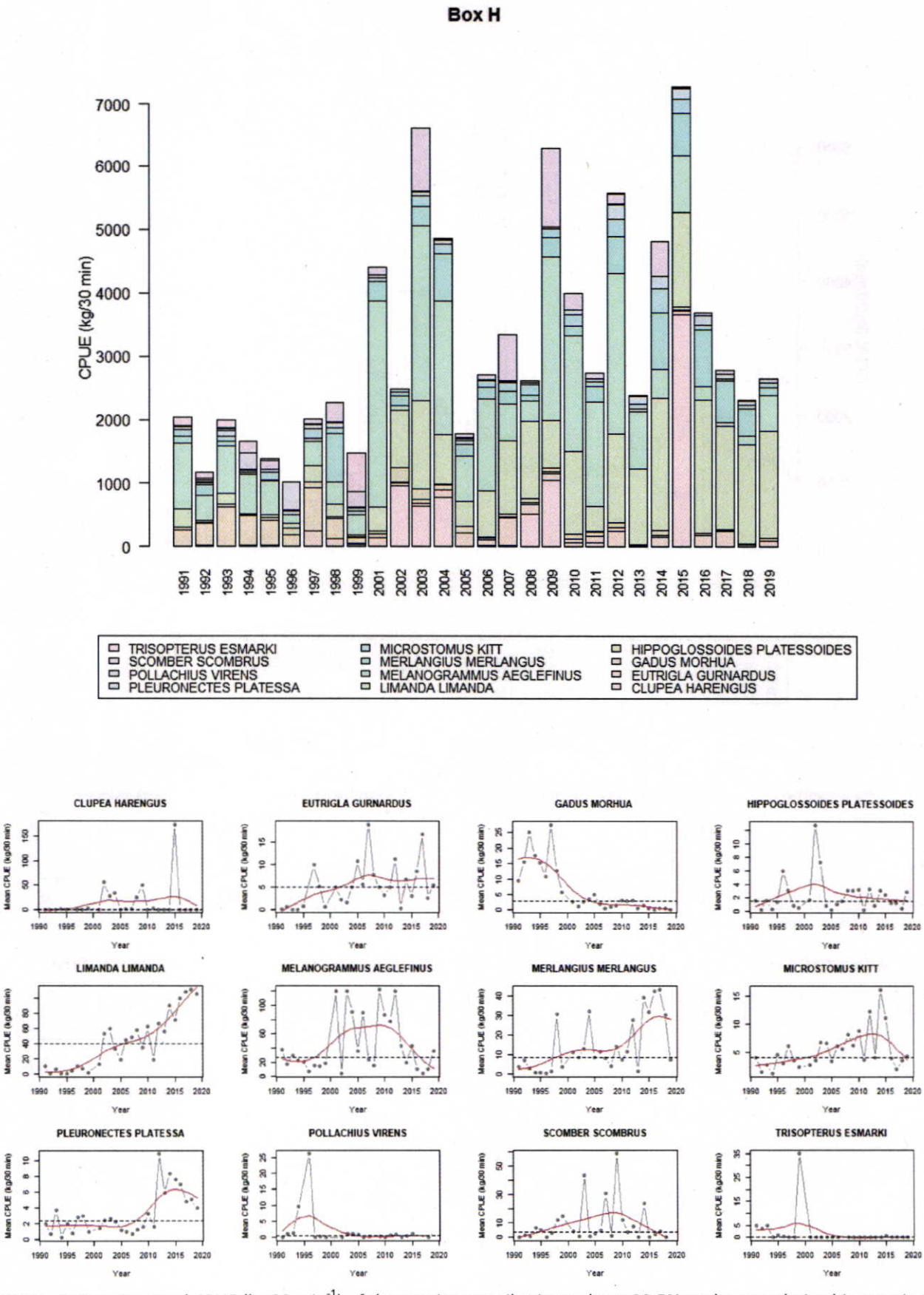

Figure 3: Top: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box H. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box H, with indicated median CPUE per haul value over all sampling years (dashed line).

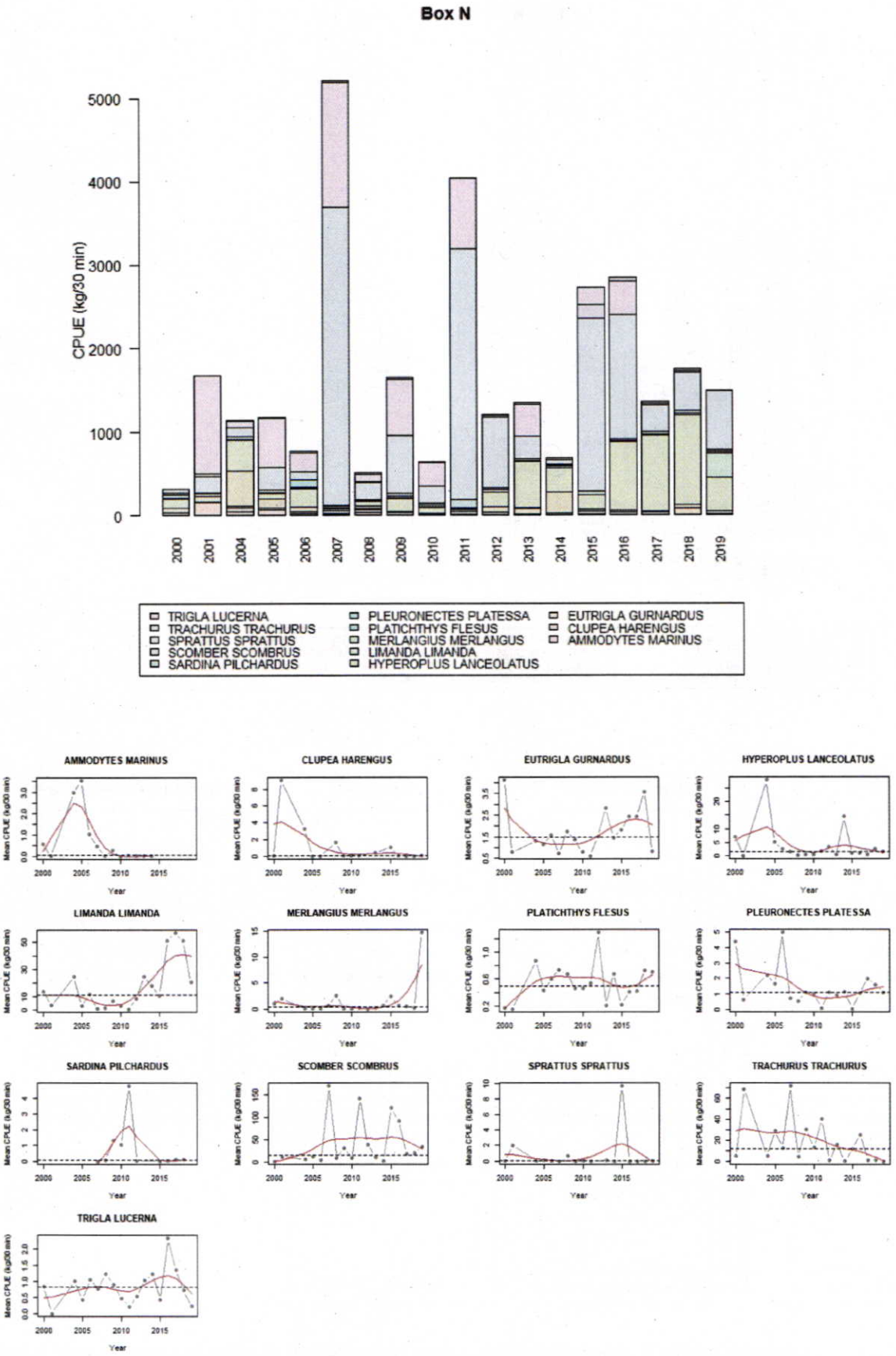

Figure 4: Top: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box N. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box N, with indicated median CPUE per haul value over all sampling years (dashed line).

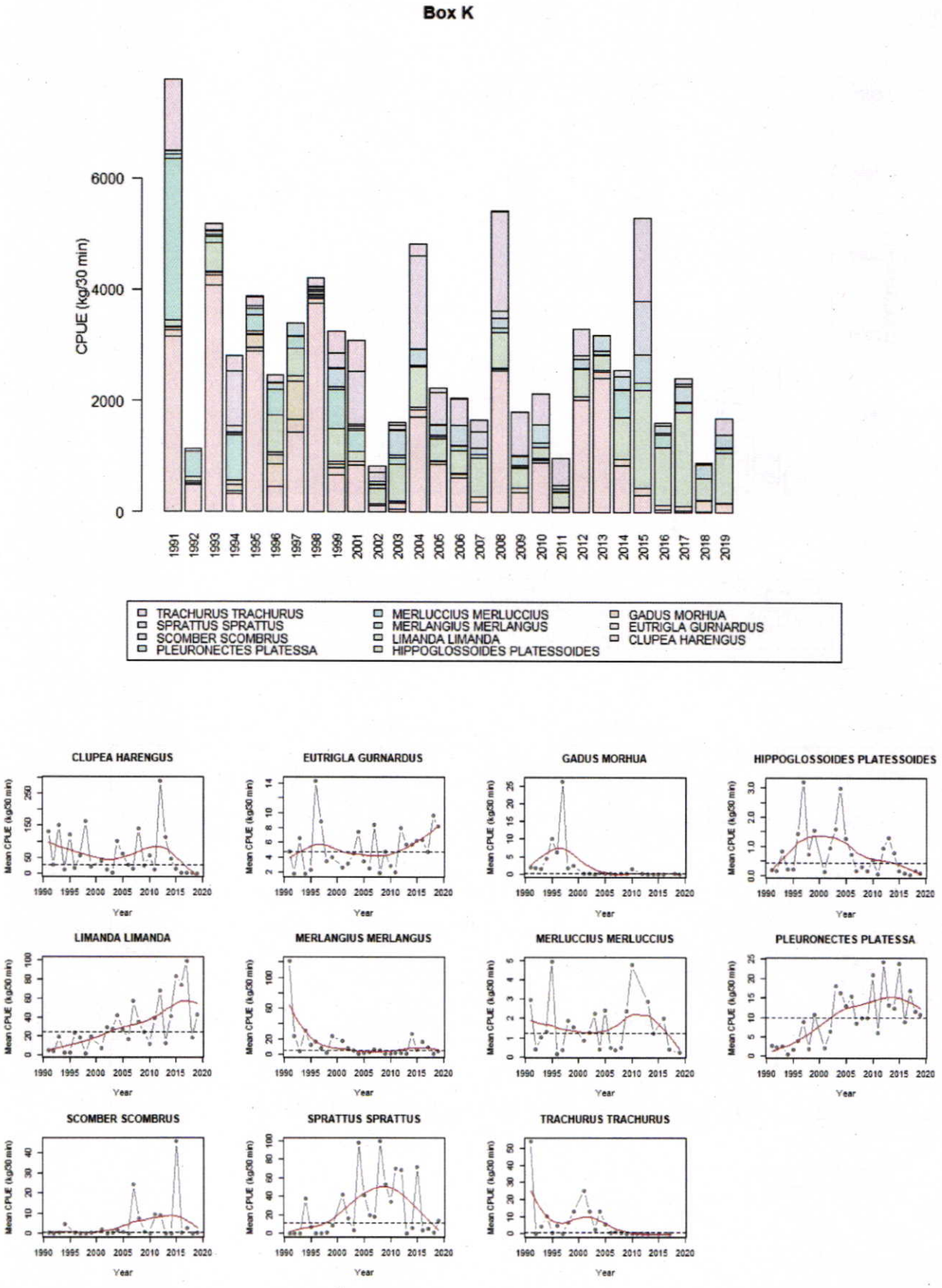

Figure 5: Top: Summed CPUE (kg 30 min^{-1}) of the species contributing to least 99.5% to the cumulative biomass in Box K. Bottom: Long-term trends in mean CPUE per haul (kg 30 min^{-1}) of the selected species in Box K, with indicated median CPUE per haul value over all sampling years (dashed line).

2.2. Long-term trends in elasmobranch catches

An overview of the total elasmobranch catches in 2019 as kg per 30 min and numbers per 30 min for each box are given in Table 4. Overall, most elasmobranches are generally caught in box K. In Figure 6 the decreasing trend of catches of thorny skate is shown for box H while in box K the catches of lesser spotted dogfish (*Scyliorhinus canicula*) seem to slightly increase over the last decade.

Table 4. Overview of elasmobranch catches in the 2019 GSBTS.

Box	Species	Total catch (kg)	Total catch (n)
BOX H	RAJA RADIATA	0.24	1
BOX K	RAJA CLAVATA	3.85	3
BOX K	SCYLIORHINUS CANICULA	3.11	6
BOX P	RAJA RADIATA	0.63	1

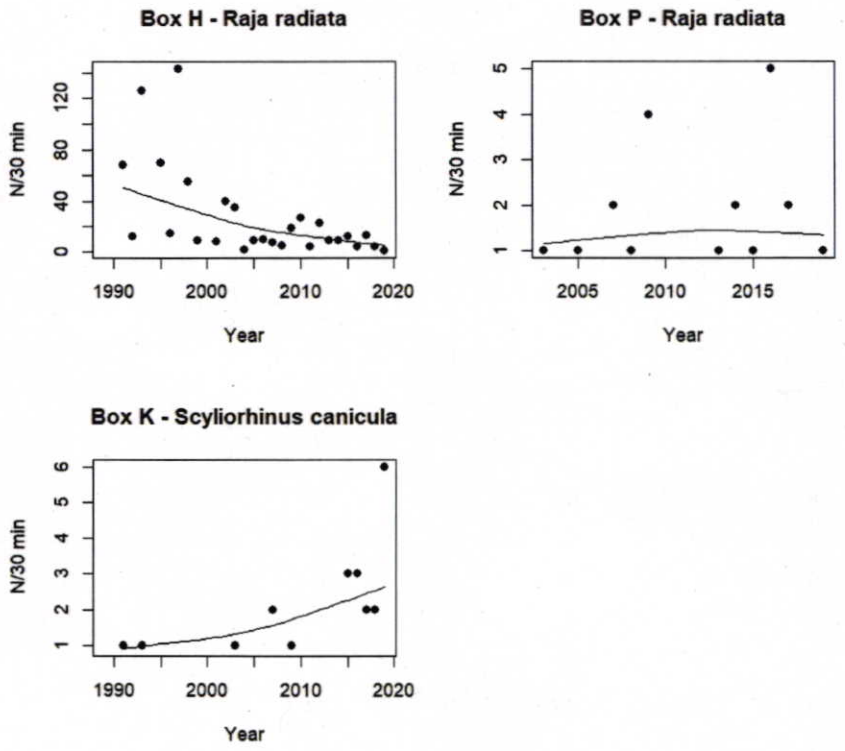

Figure 6: Long-term trends of the two more frequently caught elasmobranchii thorny skate (*Raja radiata*) and lesser spotted dogfish (*Scyliorhinus canicula*) as total numbers 30 min^{-1}.

2.3. Experimental fisheries in the vicinity of an offshore windpark

In 2019 the 15 fixed stations have been sampled. Thus, trawl tracks have been almost identical for the three subsequent years. Across the three sampling years (GSBTS 737, 751, 765) a total number of 35 species were caught in the GSBTS boxes N and W (see Table 5). In all years dab dominated the catches in the two boxes.

Table 5: Overview of the mean catches (N 30min^{-1}) of commonly caught species in boxes N and W in 2017, 2018 and 2019.

	2017		2018		2019	
Species	**Box N**	**Box W**	**Box N**	**Box W**	**Box N**	**Box W**
AGONUS CATAPHRACTUS	1	1	1	1	1	1
ALOSA FALLAX	0	0	0	0	2	9
AMMODYTES MARINUS	0	3	0	0	0	0
AMMODYTES TOBIANUS	21	19	99	104	65	8
ARNOGLOSSUS LATERNA	1	2	2	2	1	1
BUGLOSSIDIUM LUTEUM	0	0	1	0	0	0
CALLIONYMUS LYRA	1	2	2	2	1	4
CALLIONYMUS MACULATUS	0	0	0	0	0	1
CANCER PAGURUS	1	2	2	2	2	2
CLUPEA HARENGUS	1	1	2	1	1	1
ECHIICHTHYS VIPERA	24	1	4	2	7	2
ENGRAULIS ENCRASICOLUS	0	0	1	1	0	0
ENTELURUS AEQUOREUS	0	0	1	1	1	0
EUTRIGLA GURNARDUS	37	44	61	131	10	13
GADUS MORHUA	0	0	0	1	11	1
HOMARUS VULGARIS	0	0	0	0	1	0
HYPEROPLUS LANCEOLATUS	43	182	209	185	105	93
LIMANDA LIMANDA	789	363	736	552	295	151
MELANOGRAMMUS AEGLEFINUS	0	0	0	0	2	1
MERLANGIUS MERLANGUS	17	8	62	10	665	25
MICROSTOMUS KITT	0	0	1	0	1	1
MULLUS SURMULETUS	4	0	2	0	12	2
MYOXOCEPHALUS SCORPIUS	1	1	2	1	1	1
PLATICHTHYS FLESUS	3	15	5	9	3	4
PLEURONECTES PLATESSA	27	43	32	37	16	12
PSETTA MAXIMA	1	1	1	2	0	0
SARDINA PILCHARDUS	6	3	5	0	0	0
SCOMBER SCOMBRUS	206	304	227	155	196	160
SCOPHTHALMUS RHOMBUS	1	0	1	0	0	0
SCYLIORHINUS CANICULA	0	0	0	1	0	0
SOLEA VULGARIS	0	0	1	0	0	1
SPRATTUS SPRATTUS	1	2	2	3	4	1
SYNGNATHUS ROSTELLATUS	0	0	0	0	2	1
TRACHURUS TRACHURUS	28	74	30	6	6	37
TRIGLA LUCERNA	5	7	3	2	2	3

ANOVA results (Table 6) showed that the factor "Box" was only significant for European flounder (*Platichthys flesus*) and dab, with significant more catches (N 30min^{-1}) of European flounder in box W and more catches of dab in box N. In contrast, the mean length (cm) of European flounder, plaice and dab were significantly larger in box N. While the mean length of whiting and tub gurnard (*Trigla lucerna*) were significantly greater in box W.

Table 6: ANOVA results of twenty-seven species which were commonly caught in boxes N and W during GSBTS 737, 751 and 765, where significant results are highlighted in bold.

Species	Df	MeanSq	ErrorVar	F ratio	p-value
AGONUS CATAPHRACTUS	28	0.09	0.15	0.65	0.43
ALOSA FALLAX	3	64.53	42.89	1.50	0.31
AMMODYTES TOBIANUS	60	4924.26	11217.29	0.44	0.51
ARNOGLOSSUS LATERNA	25	0.01	1.23	0.00	0.95
CALLIONYMUS LYRA	54	8.52	5.17	1.65	0.20
CANCER PAGURUS	57	0.81	0.61	1.33	0.25
CLUPEA HARENGUS	13	0.25	0.39	0.63	0.44
ECHIICHTHYS VIPERA	34	377.16	133.93	2.82	0.10
ENTELURUS AEQUOREUS	1	0.00	0.00	NA	NA
EUTRIGLA GURNARDUS	92	25184.01	7569.37	3.33	0.07
GADUS MORHUA	7	224.45	180.22	1.25	0.30
HYPEROPLUS LANCEOLATUS	73	10717.99	53503.10	0.20	0.66
LIMANDA LIMANDA	100	1453961.43	301550.37	4.82	**0.03**
MELANOGRAMMUS AEGLEFINUS	3	1.25	1.58	0.79	0.44
MERLANGIUS MERLANGUS	96	1459651.78	793885.29	1.84	0.18
MICROSTOMUS KITT	1	0.00	0.00	NA	NA
MULLUS SURMULETUS	21	192.35	269.31	0.71	0.41
MYOXOCEPHALUS SCORPIUS	9	0.30	0.37	0.82	0.39
PLATICHTHYS FLESUS	87	702.75	33.53	20.96	**0.00**
PLEURONECTES PLATESSA	98	737.20	566.90	1.30	0.26
PSETTA MAXIMA	4	0.17	0.17	1.00	0.37
SARDINA PILCHARDUS	12	21.43	19.67	1.09	0.32
SCOMBER SCOMBRUS	100	407.42	66910.13	0.01	0.94
SPRATTUS SPRATTUS	21	2.75	7.13	0.39	0.54
SYNGNATHUS ROSTELLATUS	1	0.17	0.50	0.33	0.67
TRACHURUS TRACHURUS	76	2540.44	2888.81	0.88	0.35
TRIGLA LUCERNA	69	18.19	26.02	0.70	0.41

For each mid positions of the stations sampled in box W the distance (m; DistTurb) to the nearest wind turbine of the Butendiek windfarm was calculated. Adjacent to the north-eastern corner of Butendiek an area with glacial boulders is located. Traditionally fishing activities around these boulders are limited due to an increased risk of fishing gear loss. Since this is a unique habitat feature which could also attract the aggregation of fish, the nearest distance (m; DistBold) to this area was also calculated for each trawling mid-position. In Figure 9 the log-transformed cpues (N 30 min^{-1}) of 18 in box W abundant species (2017 to 2019) were plotted against both the log transformed distances to the nearest wind turbine of Butendiek and the area with glacial boulders. In box W distances to the area with boulders ranged from 500 m to 15000 m, while the distances to the nearest wind turbine ranged between 500 m to 6500 m. Overall no clear linear trends of increasing or decreasing abundances in the close proximity of Butendiek and the boulders could be observed.

A comparison of the catches between the boxes N and W in relation to the distance to the two spatial features is shown in Figure 10. Thus, the log transformed cpues (2017 and 2018) of both boxes are plotted against log transformed distances to the nearest wind turbine of Butendiek and the area with boulders. In box W and N distances to the nearest wind turbine and area with boulders ranged from 500 m to 28000 m. Figure 10 shows on this lager

spatial scale the significant differences of catches of European flounder between box N and W. Also it seems that plaice catches were slightly increased close to the glacial boulders where fishing activities are limited. In box N and therefore with greatest distances to the two spatial features catches of dab were clearly increased. In Figure 11 the log-transformed mean length (cm) of 18 abundant species in box W and N (2017 and 2018) were plotted against the log-transformed distances to the nearest wind turbine of Butendiek. Again there were no clear trends in the relationship between mean sizes and the distances to the spatial features observed.

For brown crab we found a degreasing trend in the size ranges of the carapax width (cm) (difference between max and min length) with increasing distance to the wind turbines (Figure 10). This indicates that closer to the wind turbines catches composed of smaller and greater individuals, while sizes were more uniformly distributed at greater distances.

In summary, the experimental fishing in box W revealed some differences in catches between boxes W and N besides similar substrates in both boxes. For some species such European flounder catches were clearly increased in box W, while habitat features were almost identical across the sampled stations in both boxes.

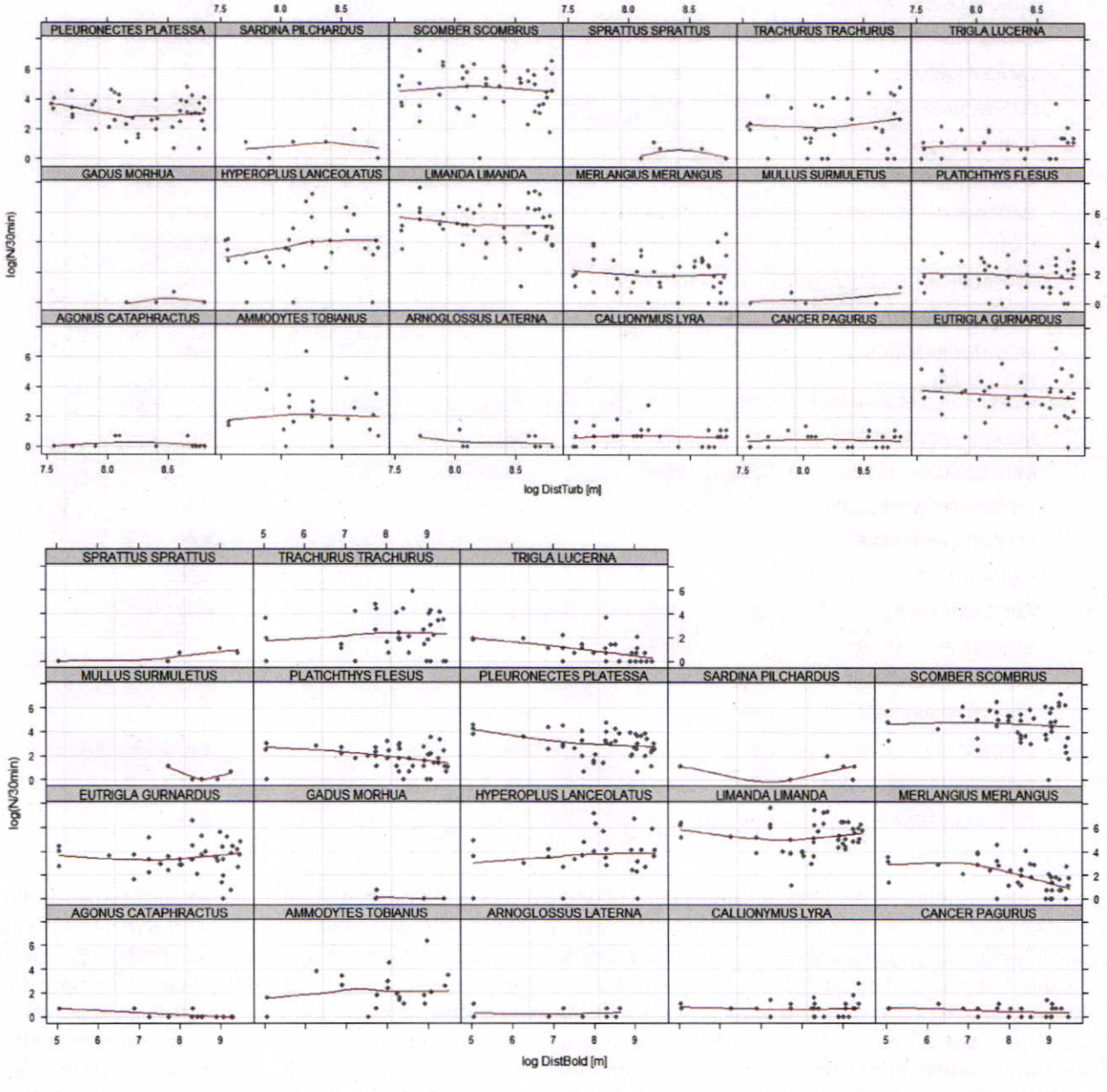

Figure 9: Trends in catches of 18 more abundant species caught in 2017, 2018 and 2019 in box W with increasing log transformed distances (m) to the nearest wind turbine of Butendiek (DistTurb; top) and to the area containing boulders (DistBoulders; bottom).

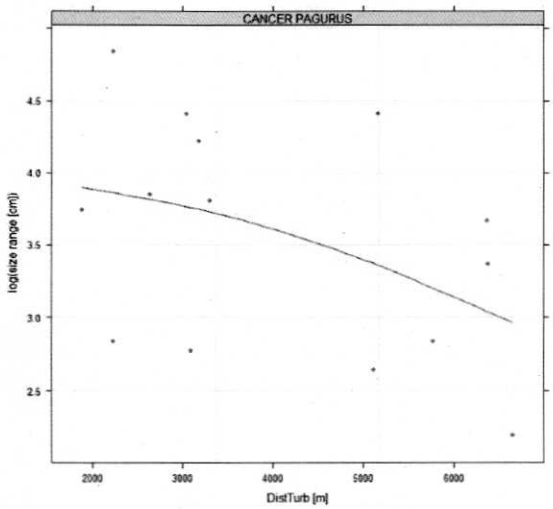

Figure 10: Spatial trend of size ranges of the carapax width (cm) (difference between max and min length) of brown crab (*Cancer pagurus*).

Personnel

Name	Role	Affiliation
Dr. Vanessa Stelzenmüller	Scientist in charge/CTD (Second part)	TI - SF
Jens Ulleweit	Scientist in charge/CTD (First part)	TI - SF
Dr. Antje Gimpel	Fisheries biology (First part)	TI - SF
Jana Bäger	Fisheries biology	TI - SF
Annika Elsheimer	Fisheries biology/database	TI - SF
Dr. Jörg Berkenhagen	Fisheries biology (Second part)	TI - SF
Merle Twesten	Fisheries biology	TI - SF
Contanze Hammerl	Fisheries biology	TI_SF
Simon Wieser	Fisheries biology	TI - SF

Acknowledgements

We thank Captain Stefan Meier as well as the crew of FRV "Solea" and all members of the scientific team for their cooperation and outstanding commitment that allowed the successful accomplishment of the survey.

Dr. Vanessa Stelzenmüller

Jens Ulleweit