

Effects of chronic bottom trawling on soft-seafloor macrofauna in the Kattegat

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Table S1. A. Faunal assemblage analysis. PERMANOVA for abundance of macrofauna as response to the fixed factors Trawling intensity (quartiles ≤ 0.4 , $> 0.4 - \leq 2.1$, $> 2.1 - \leq 4.6$, > 4.6), Year (2009, 2010, 2011, 2014), and Sampling station as random factor nested in Trawling intensity. B. Post-hoc comparison by pairwise PERMANOVA of Trawling intensity. Dependent variable was transformed by fourth root. Distance based test for homogeneity of multivariate dispersions (PERMDISP) did not indicate deviation from homogeneity (Group factor Year: $F = 1.02$, $df_1 = 3$, $df_2 = 228$, $p = 0.42$ Group factor Trawling intensity: $F = 1.77$, $df_1 = 3$, $df_2 = 228$, $p = 0.181$).

A.				
Source	df	MS	F	p
Trawling intensity	3	5985.9	3.01	0.0001
Year	3	4258.2	3.67	0.0001
Station (Trawling intensity)	99	2293.0	1.98	0.0001
Trawling intensity X Year	9	1353.1	1.17	0.0749
Residual	117	1160.3		
B.				
Groups (Trawling intensity)	t	p		
$>4.6, \leq 0.4$	2.23	0.0001		
$>4.6, >2.1 \leq 4.6$	0.81	0.8147		
$>4.6, >0.4 \leq 2.1$	1.86	0.0013		
$\leq 0.4, >2.1 \leq 4.6$	2.17	0.0003		
$\leq 0.4, >0.4 \leq 2.1$	1.17	0.1497		
$>2.1 \leq 4.6, >0.4 \leq 2.1$	1.82	0.0006		

Table S2. A. Faunal assemblage analysis. PERMANOVA for biomass of macrofauna excluding large bodied species as response to the fixed factors Trawling intensity (quartiles ≤ 0.4 , $> 0.4 - \leq 2.1$, $> 2.1 - \leq 4.6$, > 4.6), Year (2009, 2010, 2011, 2014), and Sampling station as random factor nested in Trawling intensity. B. Post-hoc comparison by pairwise PERMANOVA of Trawling intensity. Dependent variable was transformed by fourth root. Distance based test for homogeneity of multivariate dispersions (PERMDISP) did not indicate deviation from homogeneity (Group factor Year: $F = 0.10$, $df_1 = 3$, $df_2 = 228$, $p = 0.97$; Group factor Trawling intensity: $F = 2.12$, $df_1 = 3$, $df_2 = 228$, $p = 0.14$).

A.				
Source	df	MS	F	p
Trawling intensity	3	7336.2	2.89	0.0001
Year	3	3798.1	2.47	0.0001
Station (Trawling intensity)	99	2905.3	1.87	0.0001
Trawling intensity X Year	9	1724.8	1.12	0.1045
Residual	117	1540.3		
B.				
Groups (Trawling intensity)	t	p		
$>4.6, \leq 0.4$	2.20	0.0001		
$>4.6, >2.1 \leq 4.6$	0.82	0.8485		
$>4.6, >0.4 \leq 2.1$	1.90	0.0002		
$\leq 0.4, >2.1 \leq 4.6$	2.07	0.0001		
$\leq 0.4, >0.4 \leq 2.1$	1.08	0.2564		
$>2.1 \leq 4.6, >0.4 \leq 2.1$	1.76	0.0013		

Table S3. PERMANOVA for macrofaunal assemblage of abundance (A), biomass (B), species richness (C), total abundance (D) and total biomass (E) as response to the fixed factors Year (2009, 2010, 2011, 2014), Treatment (trawled versus closed area) and Sampling station as random factor nested in Treatment. Dependent variables were transformed by fourth root for abundance and biomass, and $\log x+1$ for species richness, total abundance and total biomass. Distance based test for homogeneity of multivariate dispersions (PERMDISP) did not indicate deviation from homogeneity:

A. Group factor Year: $F = 1.5$, $df_1 = 3$, $df_2 = 52$, $p = 0.66$; Group factor Treatment: $F = 0.89$, $df_1 = 1$, $df_2 = 54$, $p = 0.36$).

B. Group factor Year: $F = 1.26$, $df_1 = 3$, $df_2 = 52$, $p = 0.59$; Group factor Treatment: $F = 0.01$, $df_1 = 1$, $df_2 = 54$, $p = 0.90$).

C. Group factor Year: $F = 0.38$, $df_1 = 3$, $df_2 = 52$, $p = 0.80$; Group factor Treatment: $F = 0.60$, $df_1 = 1$, $df_2 = 54$, $p = 0.46$).

D. Group factor Year: $F = 0.38$, $df_1 = 3$, $df_2 = 52$, $p = 0.80$; Group factor Treatment: $F = 0.02$, $df_1 = 1$, $df_2 = 54$, $p = 0.92$).

E. Group factor Year: $F = 0.60$, $df_1 = 3$, $df_2 = 52$, $p = 0.81$; Group factor Treatment: $F = 1.73$, $df_1 = 1$, $df_2 = 54$, $p = 0.31$).

A. Species abundance				
Source	df	MS	<i>F</i>	p
Year	3	2786.8	2.65	0.0001
Treatment	1	7415.5	3.67	0.0054
Station (Treatment)	12	2016.7	1.91	0.0001
Year X Treatment	3	1355.4	1.29	0.0872
Residual	36	1052.6		
B. Species biomass				
Source	df	MS	<i>F</i>	p
Year	3	2312.8	2.44	0.0002
Treatment	1	5753.6	3.11	0.0040
Station (Treatment)	12	1850.8	1.96	0.0001
Year X Treatment	3	1134.5	1.20	0.1823
Residual	36	945.8		
C. Species richness				
Source	df	MS	<i>F</i>	p
Year	3	140.3	1.21	0.3124
Treatment	1	1199.3	2.55	0.1377
Station (Treatment)	12	470.0	4.05	0.0006
Year X Treatment	3	129.7	1.12	0.3378
Residual	36	116.1		
D. Total abundance				
Source	df	MS	<i>F</i>	p
Year	3	385.8	1.45	0.2236
Treatment	1	108.4	0.18	0.7097
Station (Treatment)	12	595.0	2.24	0.0141
Year X Treatment	3	640.6	2.41	0.0605
Residual	36	266.2		
E. Total biomass				
Source	df	MS	<i>F</i>	p
Year	3	57.4	4.09	0.0129
Treatment	1	65.9	0.78	0.4639
Station (Treatment)	12	84.0	5.98	0.0001
Year X Treatment	3	23.8	1.70	0.1844
Residual	36	14.1		

Table S4. PERMANOVA for abundance of dominating species *Amphiura filiformis* and *Amphiura chiqjei* as response to the fixed factors Year (2009, 2010, 2011, 2014), Treatment (trawled versus closed area) and Sampling station as random factor nested in Treatment. Post-hoc comparison by pairwise PERMANOVA of the interaction (Yr X Tr) within levels “closed” (B) and “trawled” (C). Distance based test for homogeneity of multivariate dispersions (PERMDISP) did not indicate deviation from homogeneity (Group factor Year: $F = 1.5$, $df_1 = 3$, $df_2 = 52$, $p = 0.26$; Group factor Treatment: $F = 5.4$, $df_1 = 1$, $df_2 = 54$, $p = 0.06$).

A.				
Source	df	MS	<i>F</i>	p
Year	3	197.24	5.26	0.0014
Treatment	1	56.42	0.46	0.6480
Station (Treatment)	12	123.66	3.29	0.0006
Year X Treatment	3	100.04	2.67	0.0469
Residual	36	37.53		
B.				
Groups (Year) "closed"	t	p		
2009, 2010	1.86	0.0873		
2009, 2011	1.41	0.2484		
2009, 2014	2.66	0.0293		
2010, 2011	3.27	0.0156		
2010, 2014	6.68	0.0010		
2011, 2014	4.20	0.0061		
C.				
Groups (Year) "trawled"	t	p		
2009, 2010	1.10	0.3603		
2009, 2011	0.23	0.9075		
2009, 2014	0.76	0.5923		
2010, 2011	0.96	0.3835		
2010, 2014	1.65	0.0875		
2011, 2014	0.66	0.5891		

Table S5. ANOVA for abundance and biomass of dominating species *Amphiura filiformis* and *Amphiura chiajei* as response to the fixed factors Year (2009, 2010, 2011, 2014), Treatment (trawled versus closed area) and Sampling station as random factor nested in Treatment. Post-hoc comparison of the interaction (Yr X Tr) within levels “closed” (B) and “trawled” (C). Abundances were transformed by log X+1. Welch’s test did not indicate unequal variances:

(A. $F_{7, 20.5} = 1.81$, $p = 0.1388$, B. $F_{7, 20.5} = 2.32$, $p = 0.0655$).

A. <i>Amphiura filiformis</i> abundance				
Source	df	MS	<i>F</i>	p
Year	3	0.65	3.34	0.0295
Treatment	1	0.26	0.43	0.5236
Station (Treatment)	12	0.61	3.12	0.0040
Year X Treatment	3	0.53	2.73	0.0581
Residual	36			
B. <i>Amphiura chiajei</i> abundance				
Source	df	MS	<i>F</i>	p
Year	3	2.2	6.62	0.0011
Treatment	1	0.81	0.6	0.4545
Station (Treatment)	12	1.35	4.06	0.0005
Year X Treatment	3	0.87	2.63	0.0647
Residual	36			

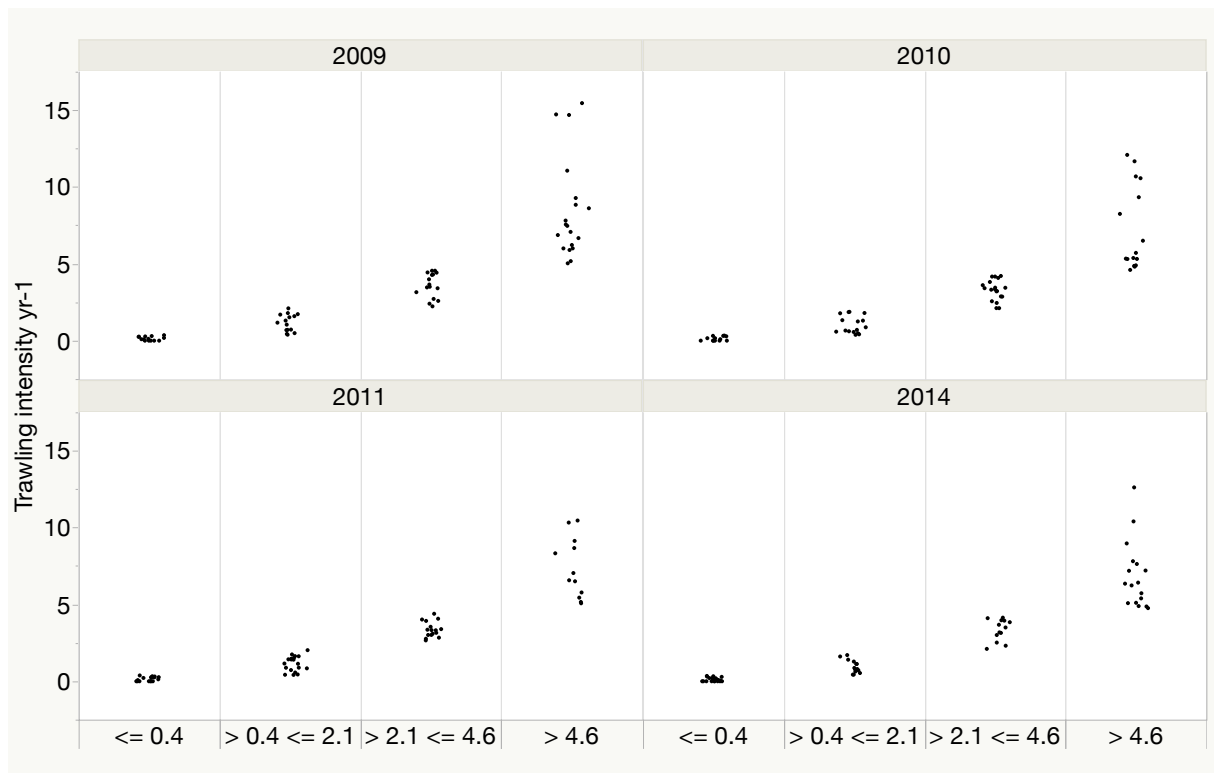


Fig. S1. Ranges of trawling intensity grouped in quartiles 2009, 2010, 2011 and 2014. The statistical quartiles of the x-axis are calculated over all four years.

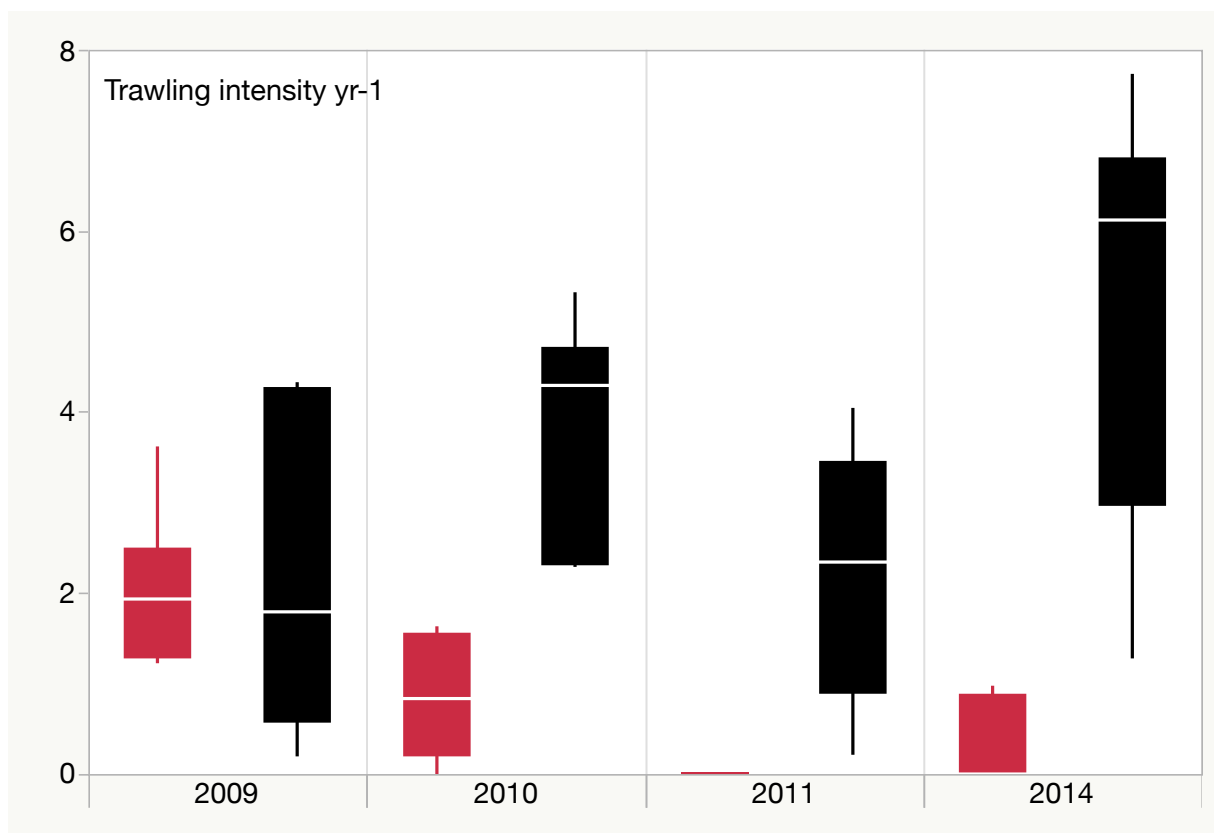


Fig. S2. Boxplot with median and quartiles of trawling intensity for the year previous to the sampling for benthic macrofauna at stations inside the MPA established in 2009 (red, n=7) and stations outside where trawling continued (black, n=7).