

Figure S1. A map and photographs showing the sampling sites colonized with the eelgrass *Zostera marina* and the unvegetated sites in the shallow lagoon of Swan Lake, the Yellow Sea, Northern China.

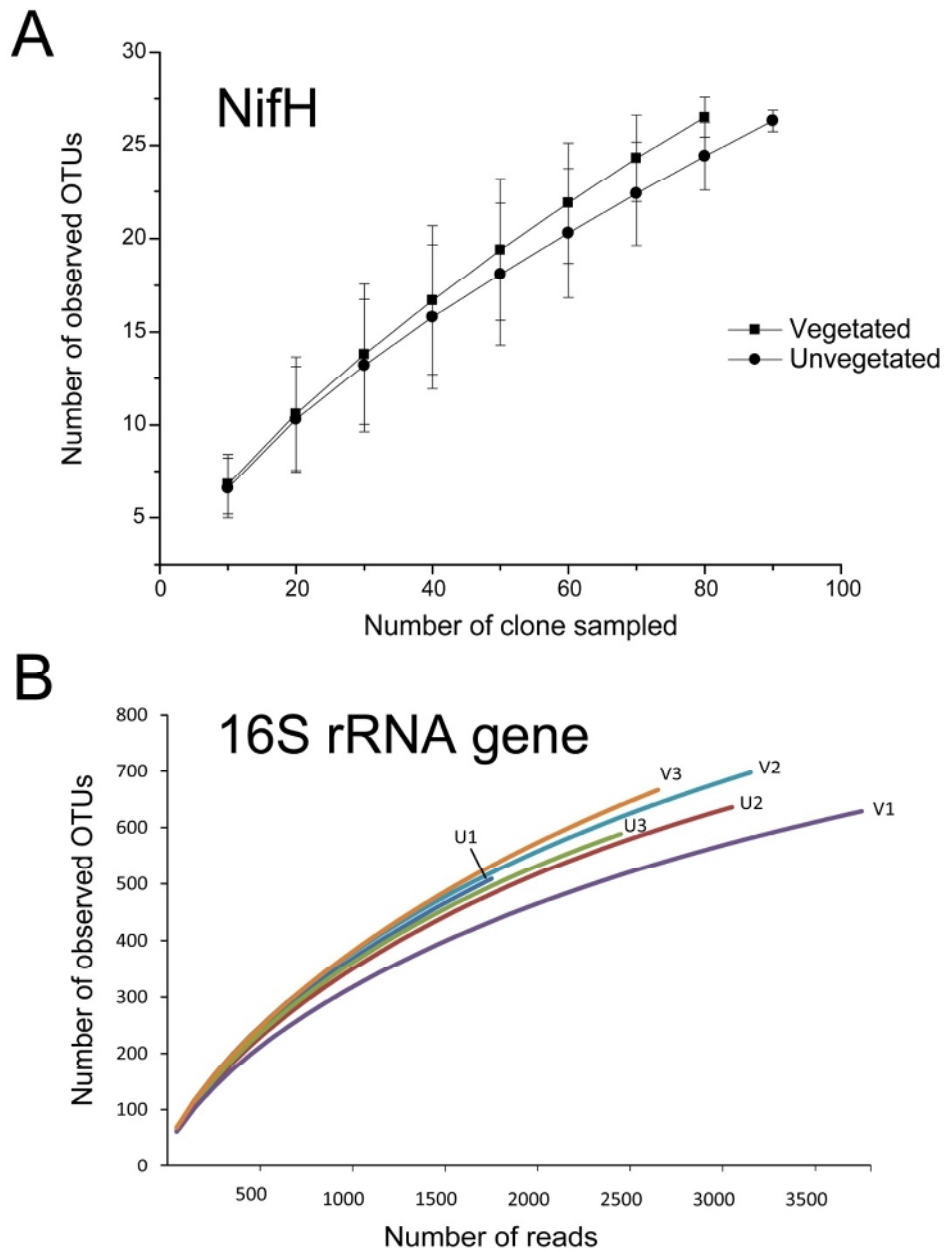
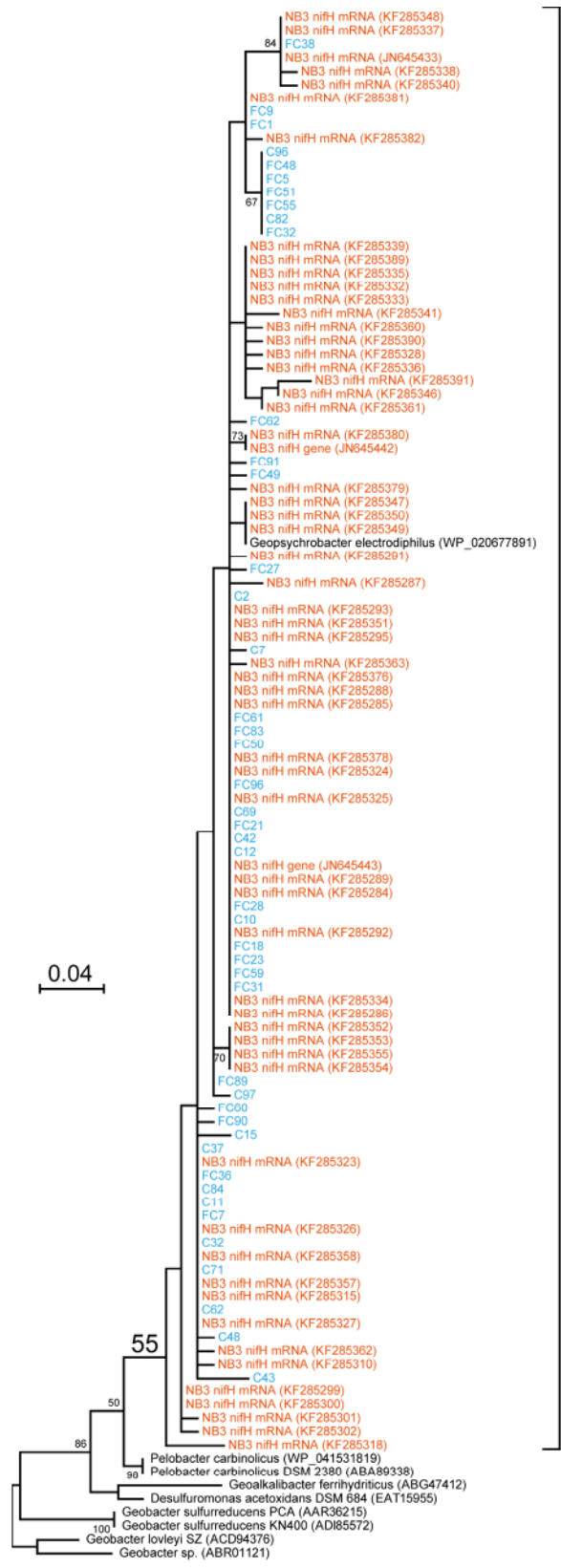


Figure S2. Rarefaction curves of the numbers of observed NifH OTUs (cutoff = 5% dissimilarity) based on clone libraries (A) and bacterial 16S rRNA gene OTUs (cutoff = 3% dissimilarity) based on Ion Torrent sequencing dataset (B) of vegetated (V1-3) and unvegetated (U1-3) sediment samples.



NifH OTU from the Swan Lake: SL1
 = NB3 (originally defined by Fulweiler et al. 2013)
 = *Geopsychrobacter*-related (*Geobacteraceae*)
 NifH phylotypes

Figure S3. A maximum likelihood tree based on NifH protein sequences showing that SL1 sequences obtained in this study (in blue) and NB3 sequences (in orange) from Brown and Jenkins (2014) represent the same clade in which *Geopsychrobacter electrodiphilus* is included. Bootstrap values lower than 50% are not shown. The scale bar indicates 4 changes per 100 amino acids.

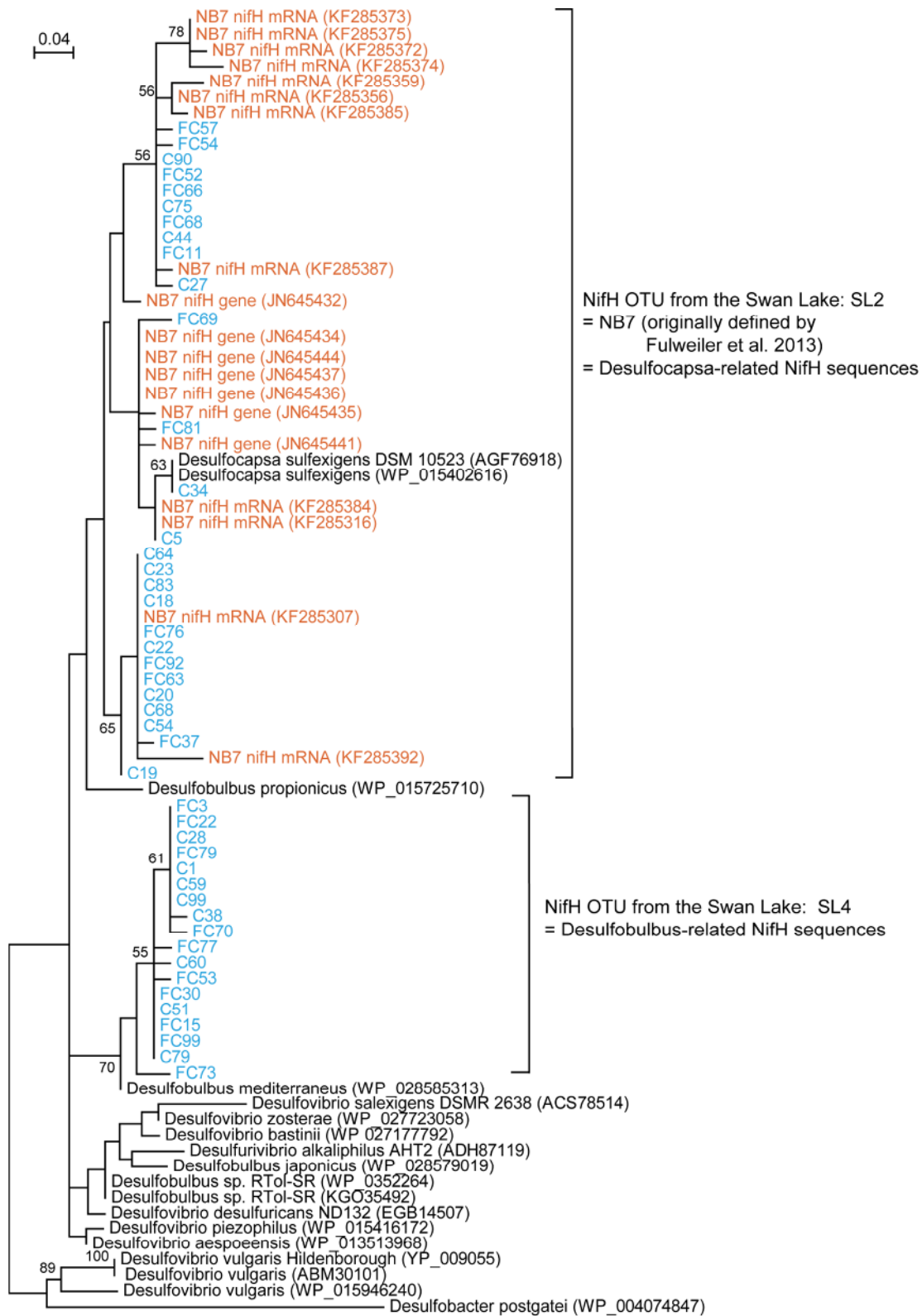


Figure S4. A maximum likelihood tree based on NifH protein sequences showing that SL2 sequences obtained in this study (in blue) cluster well with NB7 sequences (in orange) from Brown and Jenkins (2014), forming a clade that contains a cultured representative, *Desulfocapsa sulfexigens*. Bootstrap values lower than 50% are not shown. The scale bar indicates 4 changes per 100 amino acids.

Table S1. Environmental variables at sites vegetated with *Z. marina* and those unvegetated in the Swan Lake

Environmental variable	Vegetated site						Unvegetated site						P
	V1	V2	V3	V4	V5	Mean	U1	U2	U3	U4	U5	Mean	
Overlying water													
Dissolved oxygen (mg L ⁻¹)	8.28	8.31	8.28	8.00	7.75	8.1	7.83	8.27	7.9	8.19	8.23	8.1	0.79
Salinity (PSU)	31.22	31.27	31.25	31.24	31.24	31.2	31.23	31.19	31.22	31.31	31.48	31.3	0.45
Temperature (°C)	15.58	15.50	15.54	15.5	15.48	15.5	15.49	15.58	15.32	14.68	14.17	15.1	0.12
Chlorophyll <i>a</i> (µg L ⁻¹)	11.97	12.03	12.1	12.11	12.05	12.1	5.13	4.94	5.18	4.93	4.98	5.0	<0.01
pH	8.23	8.23	8.23	8.22	8.20	8.22	8.21	8.23	8.2	8.08	8.09	8.16	0.10
Sediment pore water													
NO ₃ ⁻ -N (µM)	33.06	46.07	28.047	32.69	39.64	35.9	68.69	20.70	34.56	18.36	23.41	33.1	0.79
NO ₂ ⁻ -N (µM)	0.56	0.52	1.27	0.46	1.37	0.8	8.35	0.93	2.72	1.07	4.40	3.5	0.09
NH ₄ ⁺ -N (µM)	448.6	386.4	420.0	390.7	407.1	410.6	977.1	957.1	1093.6	1040.0	1175.0	1048.6	<0.01
DIN (µM)	512.2	433.0	449.3	393.9	1148.1	587.3	924.2	978.8	1130.9	1059.4	1302.8	1079.2	0.01
PO ₄ ³⁻ -P (µM)	18.42	25.22	36.19	27.56	92.84	40.1	43.64	22.33	50.6	26.76	101.09	48.9	0.66
N:P	27.80	17.17	12.42	14.29	12.37	16.8	21.18	43.828	22.35	39.60	12.89	28.0	0.13
Sediment													
Grain size (µm)	41.55	63.565	51.795	55.37	59.40	55.3	472.6	339.3	293.0	313.0	154.0	314.4	<0.01
TOC (%)	1.13	0.84	2.48	0.47	0.11	1.0	1.32	0.812	0.94	1.23	1.91	1.2	0.61
TON (%)	0.10	0.09	0.42	0.09	0.08	0.2	0.13	0.10	0.08	0.09	0.16	0.1	0.53
TOC:TON	10.94	9.63	5.94	4.98	1.42	6.6	10.30	8.41	12.46	13.37	12.14	11.3	0.04
Pb (mg kg ⁻¹)	11.37	7.79	6.03	6.45	4.93	7.3	4.18	1.74	3.38	3.19	3.12	3.1	<0.01
Cr (mg kg ⁻¹)	8.58	5.53	4.52	4.89	3.80	5.5	2.96	1.23	2.68	2.37	2.27	2.3	<0.01
Mn (mg kg ⁻¹)	166.1	107.8	68.0	96.4	58.4	99.3	80.8	40.80	50.4	59.2	50.6	56.4	0.07
Fe (mg kg ⁻¹)	6617.5	4701.0	3533.7	4026.6	3035.6	4382.9	2720.2	1418.0	2404.4	2218.6	2205.8	2193.4	0.01
Co (mg kg ⁻¹)	4.64	3.22	2.36	2.63	2.00	3.0	1.51	0.61	1.28	1.18	1.22	1.2	<0.01
Ni (mg kg ⁻¹)	9.34	6.35	4.86	5.52	4.08	6.0	3.42	1.17	2.65	2.27	2.49	2.4	<0.01
Cu (mg kg ⁻¹)	8.97	6.79	5.40	5.20	4.31	6.1	3.37	1.26	2.89	2.59	2.44	2.5	<0.01
Zn (mg kg ⁻¹)	26.41	19.30	15.12	14.32	11.76	17.4	9.38	3.16	7.99	6.86	18.76	9.2	0.06
As (mg kg ⁻¹)	2.52	1.82	1.41	1.73	1.48	1.8	1.58	0.60	0.85	0.81	1.29	1.0	0.02
Cd (mg kg ⁻¹)	1.66	0.17	0.17	0.11	0.12	0.45	0.06	0.02	0.05	0.04	0.05	0.04	0.22

The significant differences between vegetated and unvegetated sites ($P < 0.05$) are highlighted in bold (t -test, $n = 5$).

Table S2. Spearman's rank correlations between relative abundance of dominant *nifH* T-RFs and environmental variables measured in this study ($n = 10$). The corresponding OTUs in clone libraries and their phylogenetic affiliations are also provided.

T-RF length (bp)	44/45		61 - 63		151/152		175/177/178		183	356/358		
Corresponding	SL1		Unidentified		SL2, SL4		SL4		SL3	SL2		
OUT	<i>Geobacteraceae</i>		Unclassified		<i>Desulfobulbaceae</i>		<i>Desulfobulbus</i>		<i>Pseudomonas</i>	<i>Desulfocapsa</i>		
Classification							-related		-related	-related		
	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>	
DO	-0.34	0.34	0.37	0.29	0.11	0.76	0.22	0.54	-0.09	0.80	0.29	0.42
Salinity	0.00	1.00	0.14	0.70	0.02	0.96	-0.31	0.39	0.01	0.97	-0.04	0.91
Temperature	0.16	0.65	-0.20	0.59	0.32	0.36	0.48	0.16	0.05	0.88	0.29	0.41
Chl- <i>a</i>	0.62	0.05	-0.42	0.23	0.45	0.19	0.07	0.85	-0.02	0.96	-0.09	0.80
pH	0.18	0.61	-0.21	0.55	0.45	0.19	0.57	0.08	0.20	0.58	0.41	0.23
NO ₃ ⁻ -N	0.24	0.51	-0.39	0.26	0.30	0.40	0.20	0.58	0.45	0.19	-0.09	0.80
NO ₂ ⁻ -N	-0.05	0.88	-0.20	0.58	-0.09	0.80	0.06	0.88	0.26	0.47	0.10	0.78
NH ₄ ⁺ -N	-0.55	0.10	0.39	0.26	-0.61	0.06	-0.30	0.40	-0.22	0.53	-0.03	0.93
DIN	-0.30	0.40	0.28	0.43	-0.35	0.33	-0.19	0.59	-0.03	0.93	-0.26	0.47
PO ₄ ³⁻ -P	0.31	0.38	-0.25	0.49	0.03	0.93	-0.14	0.69	0.20	0.58	-0.04	0.91
N:P	-0.62	0.05	0.42	0.23	-0.42	0.23	-0.02	0.96	-0.24	0.51	0.02	0.96
Grain size	-0.12	0.75	-0.15	0.68	-0.03	0.93	0.24	0.50	0.47	0.17	0.39	0.26
TOC	-0.35	0.33	0.09	0.80	-0.18	0.63	-0.04	0.90	-0.10	0.78	0.27	0.45
TON	0.08	0.83	-0.13	0.73	-0.04	0.91	0.09	0.81	0.10	0.78	0.47	0.17
TOC:TON	-0.88	<0.01	0.67	0.03	-0.68	0.03	-0.44	0.21	-0.41	0.24	-0.24	0.51
Pb	0.12	0.75	-0.05	0.88	0.15	0.68	-0.11	0.76	-0.18	0.63	-0.33	0.35
Cr	0.12	0.75	-0.05	0.88	0.15	0.68	-0.11	0.76	-0.18	0.63	-0.33	0.35
Mn	-0.01	0.99	0.01	0.99	-0.02	0.96	-0.23	0.52	-0.12	0.75	-0.25	0.49
Fe	0.12	0.75	-0.05	0.88	0.15	0.68	-0.11	0.76	-0.18	0.63	-0.33	0.35
Co	0.14	0.70	-0.04	0.91	-0.04	0.91	-0.11	0.76	-0.13	0.73	-0.30	0.40
Ni	0.14	0.70	-0.04	0.91	0.14	0.70	-0.11	0.76	-0.13	0.73	-0.30	0.40
Cu	0.09	0.80	-0.08	0.83	0.21	0.56	-0.03	0.93	-0.16	0.65	-0.28	0.43
Zn	-0.09	0.80	0.27	0.45	-0.08	0.83	-0.24	0.50	-0.10	0.78	-0.22	0.53
As	0.13	0.73	-0.04	0.91	0.02	0.96	-0.19	0.59	0.03	0.93	-0.30	0.40
Cd	0.12	0.75	-0.05	0.88	0.21	0.56	-0.02	0.96	-0.04	0.91	-0.26	0.47

The significant differences ($P < 0.05$) are highlighted in bold.

DO = dissolved oxygen; Chl-*a* = chlorophyll *a*; DIN = dissolved inorganic nitrogen; N:P = ratio of DIN to PO₄³⁻-P; TOC = total organic carbon; TON = total organic nitrogen.

Table S3. Summary of Ion Torrent Sequencing of bacterial communities and alpha diversities in vegetated (V1-3) and unvegetated sediments (U1-3) of Swan Lake

Sample ID	No. of raw reads	No. of reads after quality filtering	No. of reads after removing the unaligned, chimeras, and singletons	No. of reads after removing non-bacteria	No. of reads assigned to Chloroplast	No. of OTUs (per 1813 reads)	Shannon (per 1813 reads)	Chao1 (per 1813 reads)
V1	9326	5241	4184	4144	257	430	6.77	783
V2	8916	4427	3397	3350	53	507	7.33	912
V3	10195	3648	2855	2811	78	534	7.46	1016
U1	7965	2445	1878	1859	46	511	7.49	960
U2	4326	4326	3199	3166	33	490	7.19	904
U3	5709	3823	2611	2585	39	502	7.03	921

REFERENCES

- Fulweiler RW, Brown SM, Nixon SW, Jenkins BD.** 2013. Evidence and a conceptual model for the co-occurrence of nitrogen fixation and denitrification in heterotrophic marine sediments. *Mar. Ecol. Prog. Ser.* **482**:57–68.
- Brown SM, Jenkins BD.** 2014. Profiling gene expression to distinguish the likely active diazotrophs from a sea of genetic potential in marine sediments. *Environ. Microbiol.* **16**:3128–3142.