Supplementary Information for

Identifying the mechanisms behind the positive feedback loop between nitrogen cycling and algal blooms in a shallow eutrophic lake

from 0 to 3cm, XXX-2 mean the sediment at the middle layer of the sample sites from 3 to 6cm, and XXX-3 mean the sediment at the profundal layer of the sample sites from 6 to 9cm.

Figure S9. The comparison of the main fluorescent. The excitation (Ex) and emission (Em) wavelengths are A. Ex/Em=250/(380~480), B. Ex/Em=340/(420~480), C. Ex/Em=370/(450~500), D. Ex/Em=380/(310~435), E. Ex/Em=270/(320~350), F. Ex/Em=270/(300~320), respectively. In the group A, group C, group D and group F, the X-axis represents the wavelength range of emission, the Y-axis represents the sediments depth and the Z-axis represents the fluorescence intensity. In the group B and group E, the X-axis represents the sediments depth, the Y-axis represents the wavelength range of emission and the Z-axis represents the fluorescence intensity.

Figure S10. Concentration of NO_3^--N with OTU values of Sphingobium genus in profundal sediment (6-9cm).

Table S1. Geographic information of the sampling sites.

Table S2. *NosZ* primer base sequences and reaction compounds.

Table S3. qPCR conditions for nosZ gene regions.

Table S4. Vertical distribution characteristics of the DIN profiles as shown in Fig 3.

Table S5. Number of valid sequences, richness, and diversity of 6 sapling sites in Lake Taihu. XXX-1 mean the sediment at the surface layer of the sample sites from 0 to 3cm, XXX-2 mean the sediment at the middle layer of the sample sites from 3 to 6cm, and XXX-3 mean the sediment at the profundal layer of the sample sites from 6 to 9cm.

Table S6. Fluorescence components of DOM in sediments as shown in Fig S9.

Table S7. Environmental parameters of sediments of different depths in sample sites, and the value of the environment parameters is the average of the average of the measured value in the corresponding depth range. XXX-1 mean the sediment at the surface layer of the sample sites from 0 to 3cm, XXX-2 mean the sediment at the middle layer of the sample sites from 3 to 6cm, and XXX-3 mean the sediment at the profundal layer of the sample sites from 6 to 9cm.

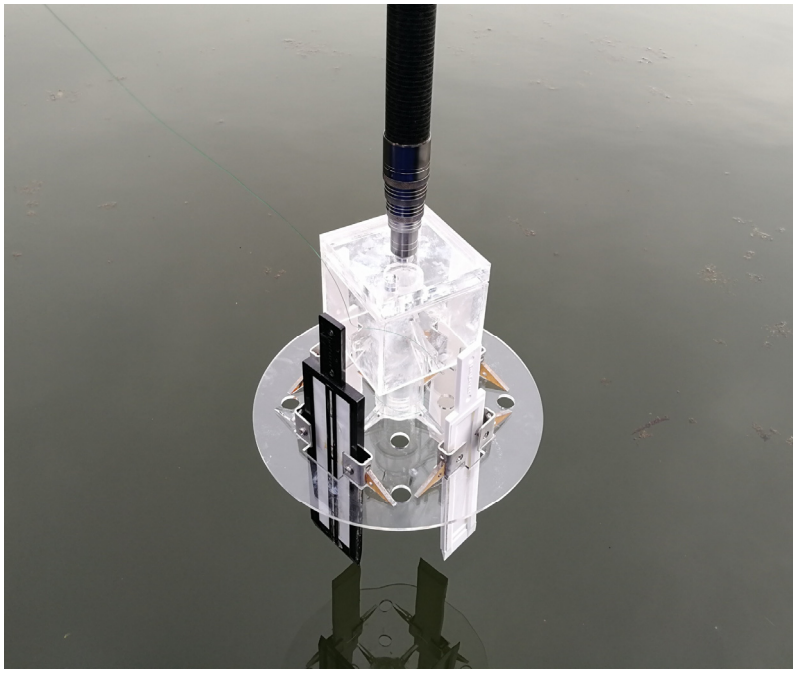


Figure S1. In-situ deployment device of DGT and HR-Peeper.

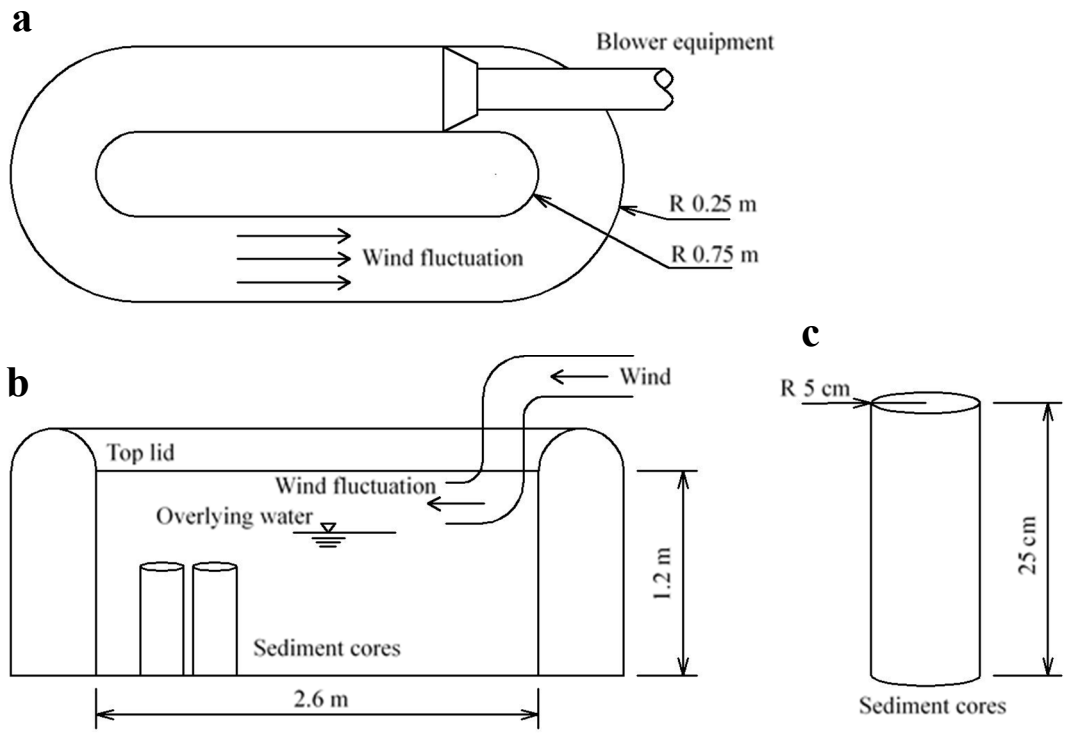


Figure S2. Schematic of the annular flume. (a) shows the plan form; (b) shows profiles of annular flume; (c) is a schematic of sediment cores. The present study examined 6 sediment cores. To avoid the excessive crosswise disturbance of the wind, the sediment cores were deployed in the annular flume which on the opposite side of the blower equipment.

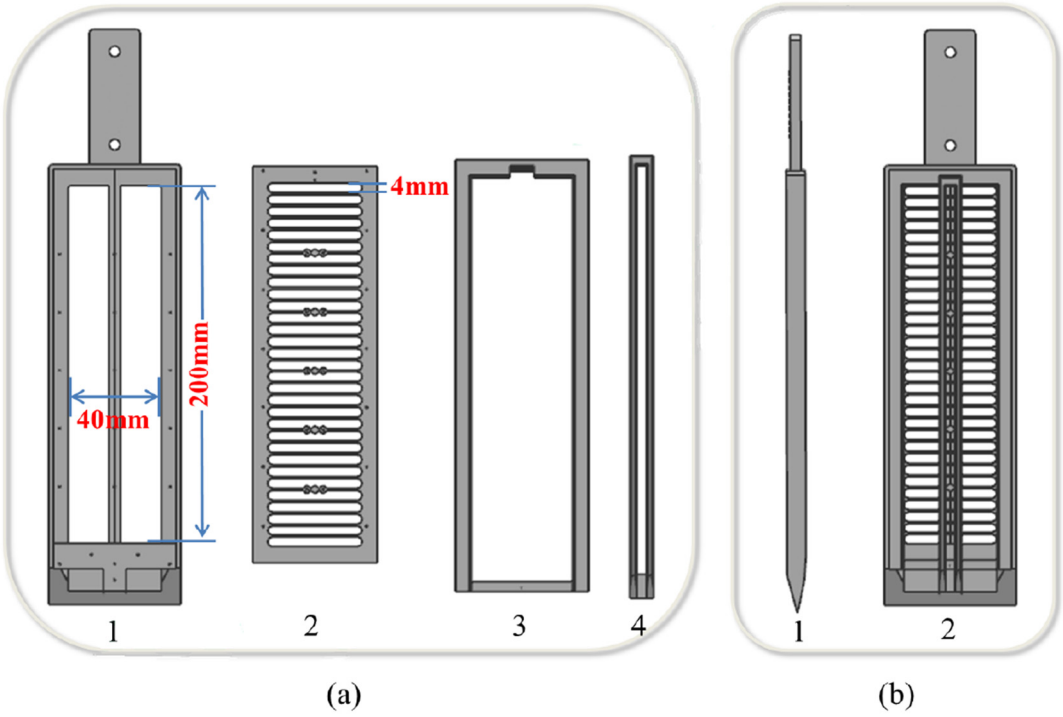
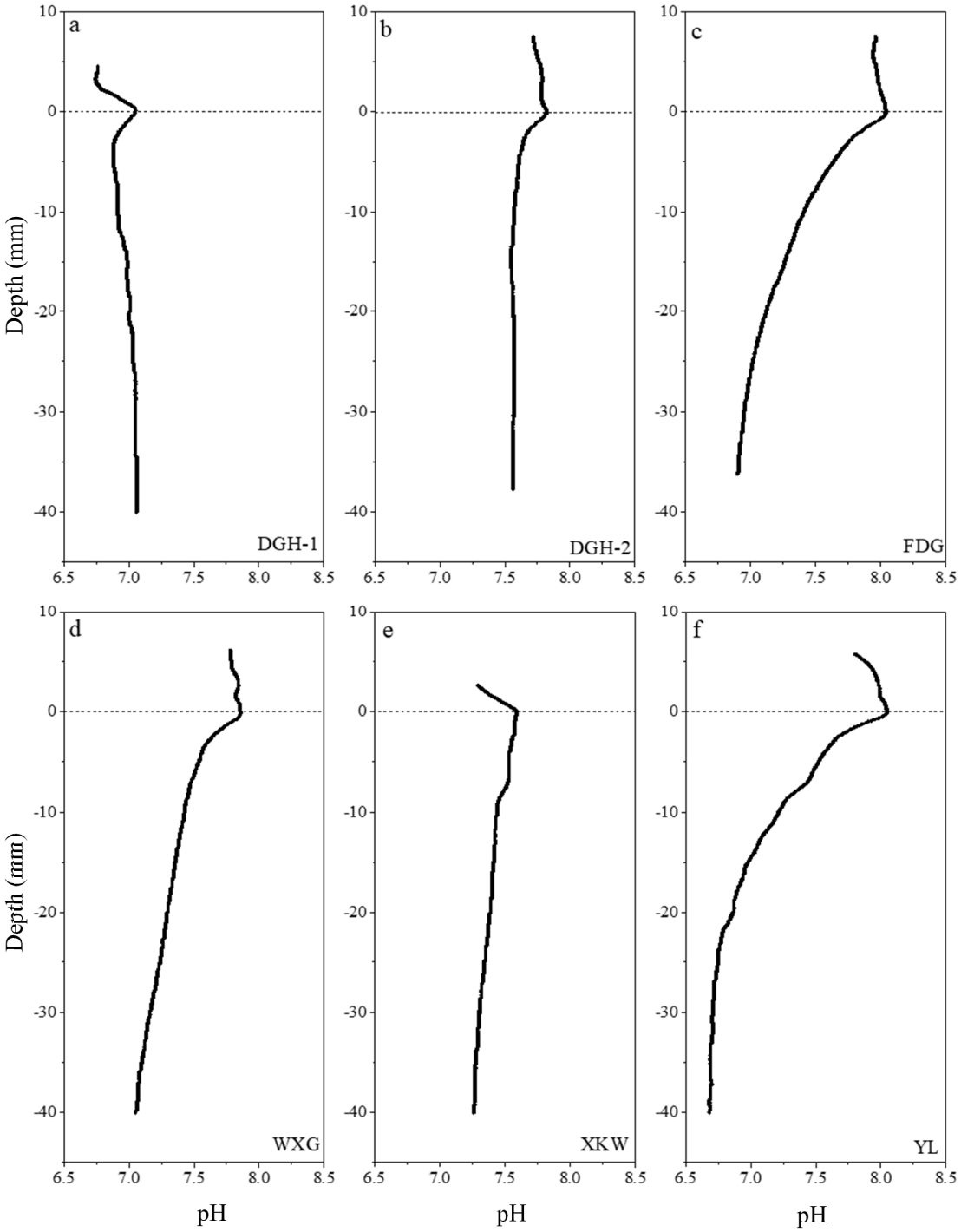


Figure S3. The structure of the HR-Peeper. a. the HR-Peeper was assembled by base plate (1), plastic window (2), outer frame (3) and inter frame (4), in the assembly of the HR-Peeper, the chambers were filled with deionized water and covered with a cellulose nitrate membrane (i.e., dialysis membrane; Whatman, 0.45μm pore size), all the components were bound together using plastic fastener. b. the lateral view and elevation view of HR-Peeper)

A


a
b
c
d
e
f
DGH-1
DGH-2
FDG
WXG
XKW
YL
Depth (mm)
pH
10
0
-10
-20
-30
-40
6.5
7.0
7.5
8.0
8.5

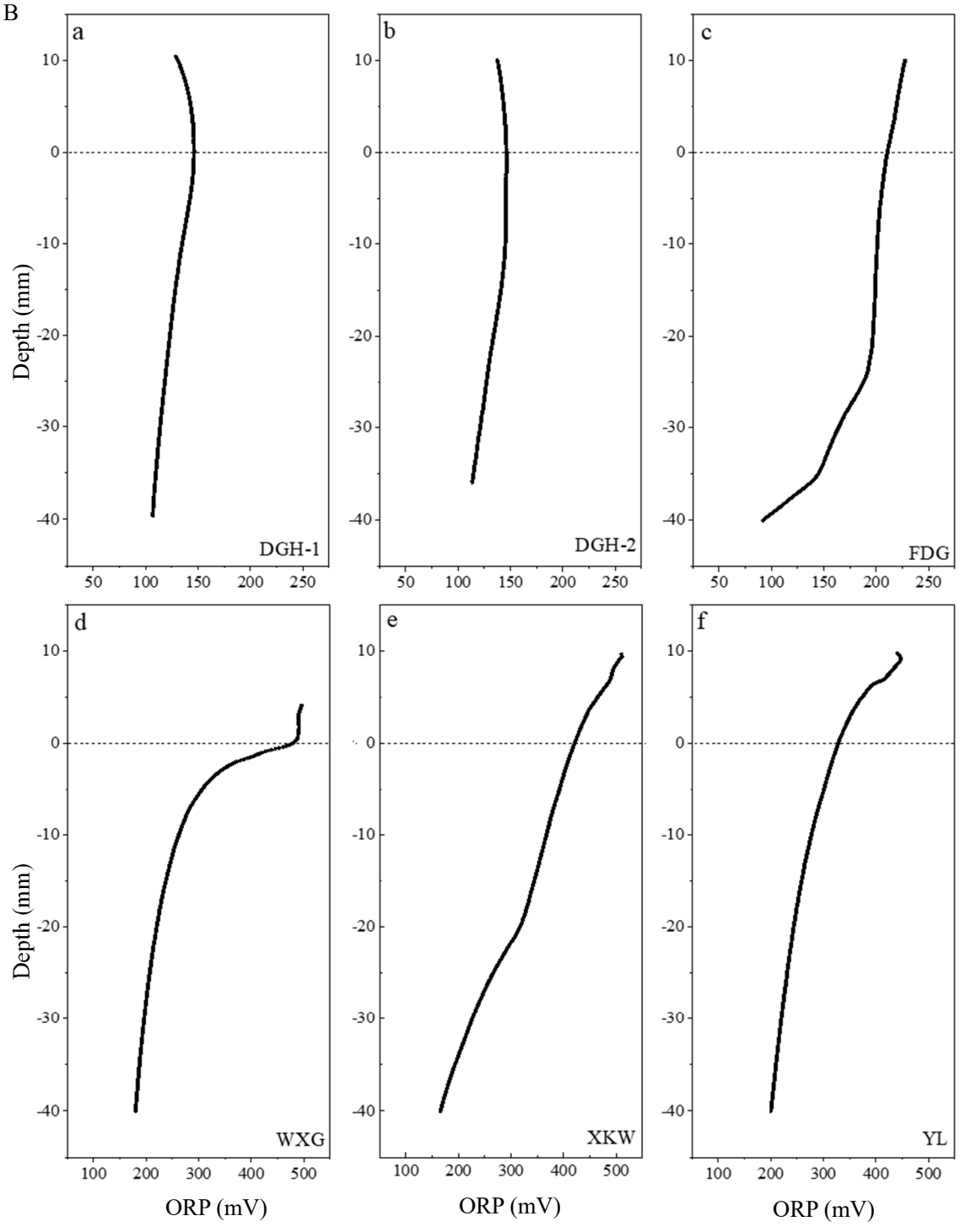
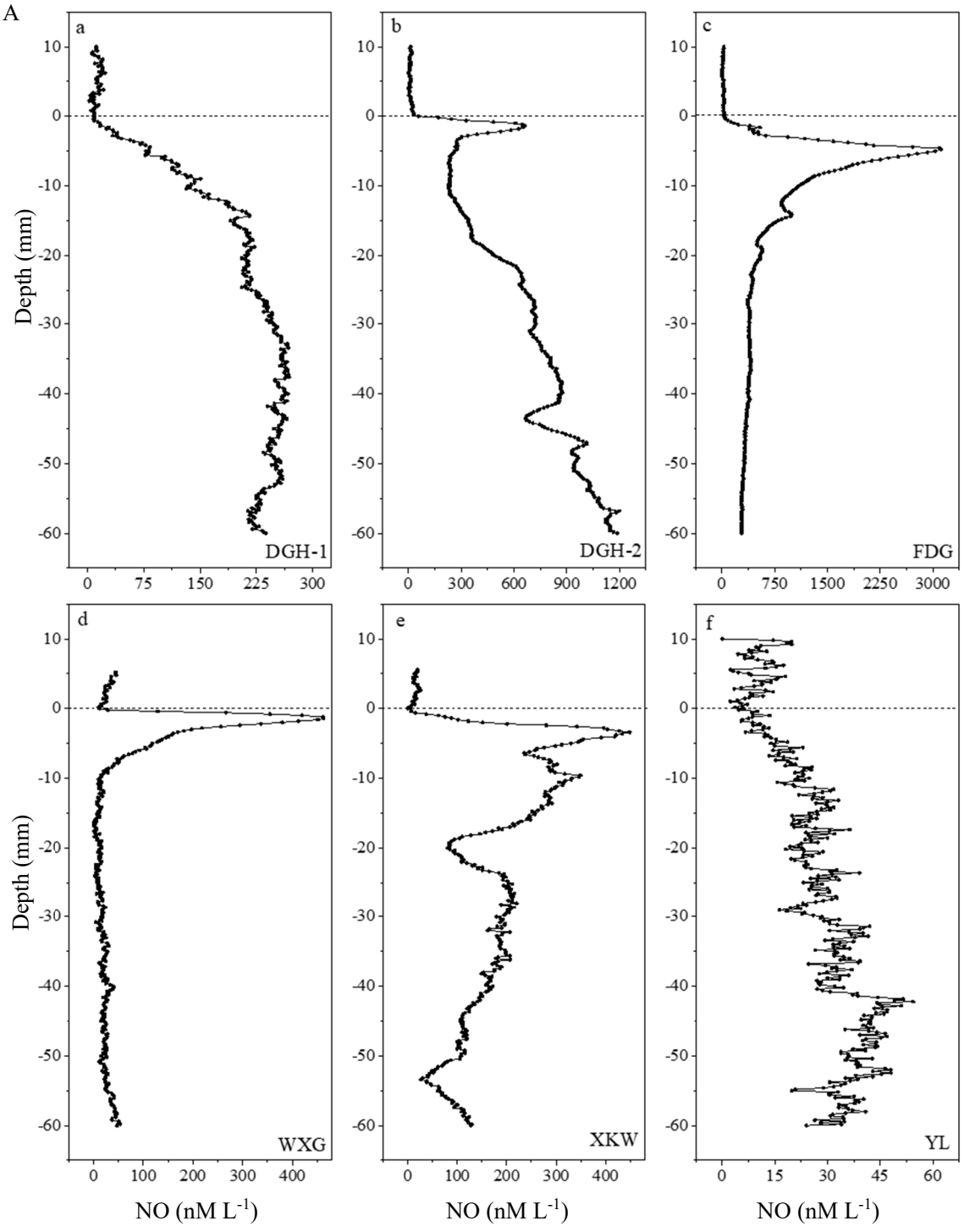


Figure S4. pH (A) and oxidation-reduction potential (ORP) (B) microprofiles of Lake Taihu sediment, from Jun 2019 to July 2019. Dashed lines indicated approximate positions of the sediment-water interface (SWI)


A
a
b
c
d
e
f
DGH-1
DGH-2
FDG
WXG
XKW
YL
Depth (mm)
NO (nM L-1)
NO (nM L-1)
NO (nM L-1)

B

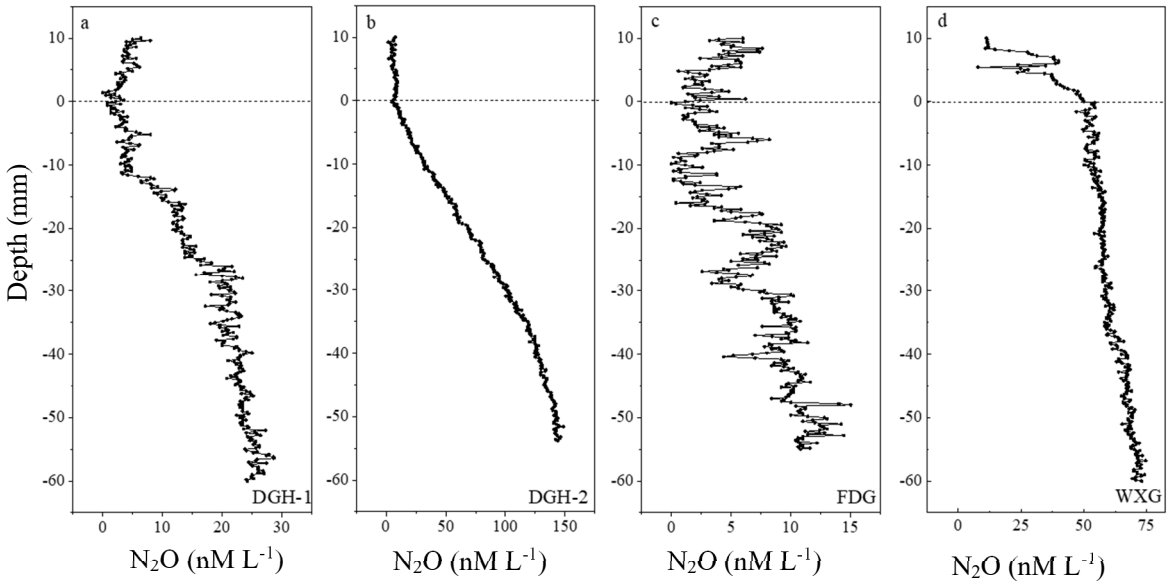


Figure S5. Vertical NO (A) and N_2O (B) microprofiles measured in Lake Taihu sediment using NO and N_2O microsensors, respectively. The N2O concentration of XKW and YL were not measured because of damage to the N2O microsensor during the measurement. Dashed lines represented approximate positions of the sediment-water interface (SWI). Note the different x-axis scaling in each of microprofiles.

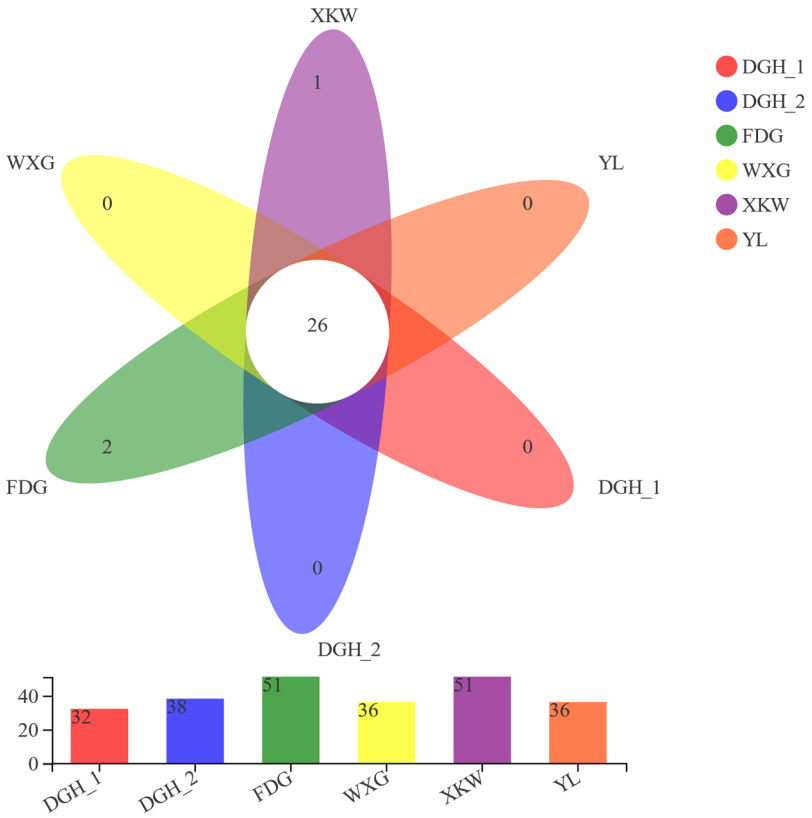


Figure S6. Venn diagram showing unique and shared operational taxonomic units (OTUs) among the sampling sites.

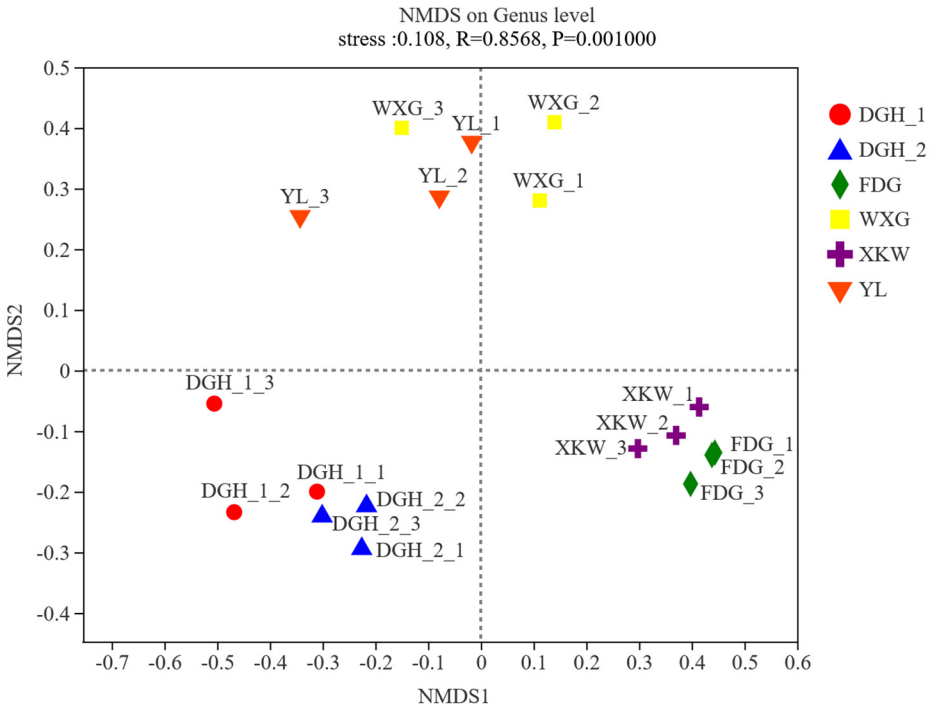


Figure S7. Non-metric multidimensional scaling (NMDS) analysis of microbial communities in Lake Taihu.

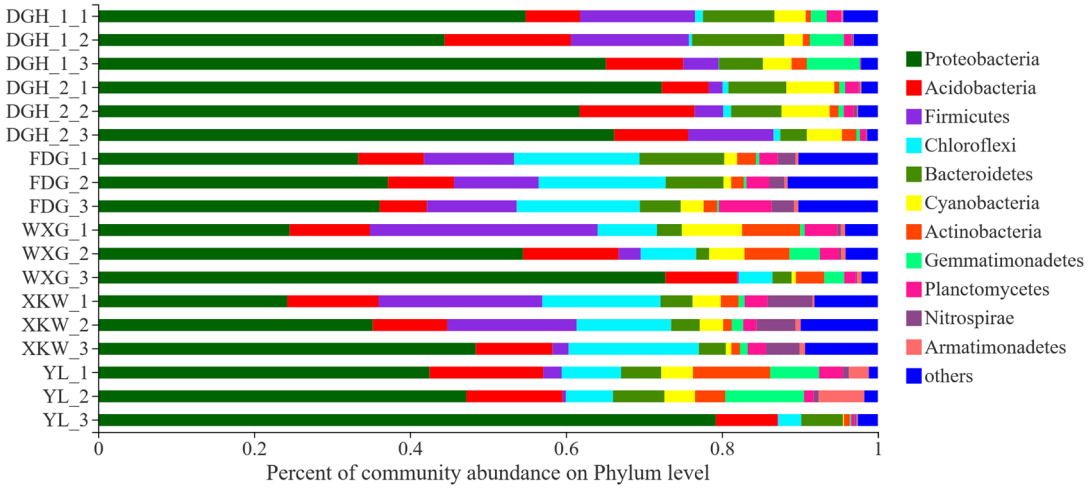
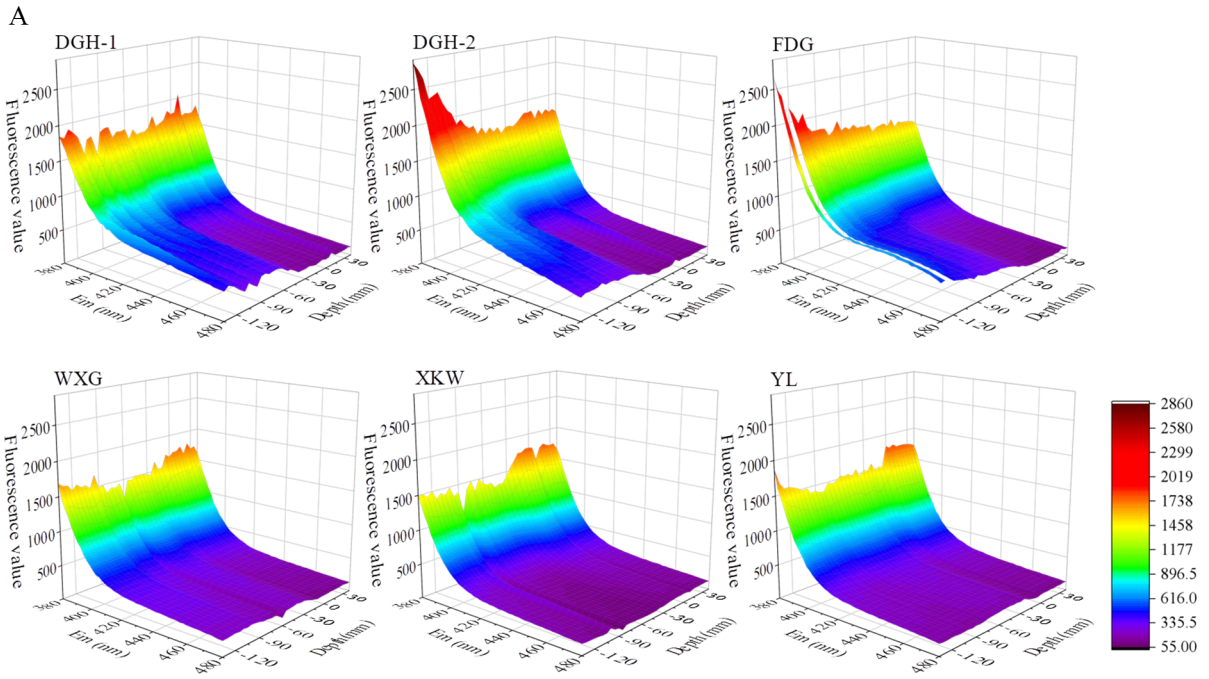
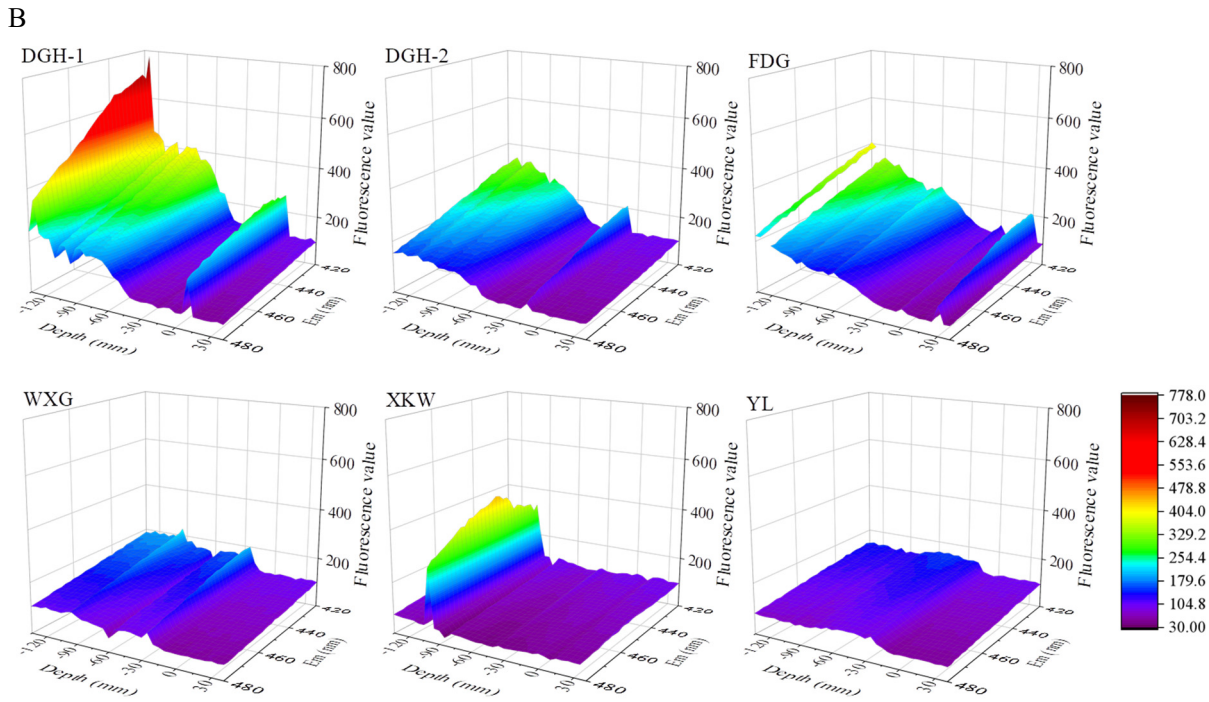
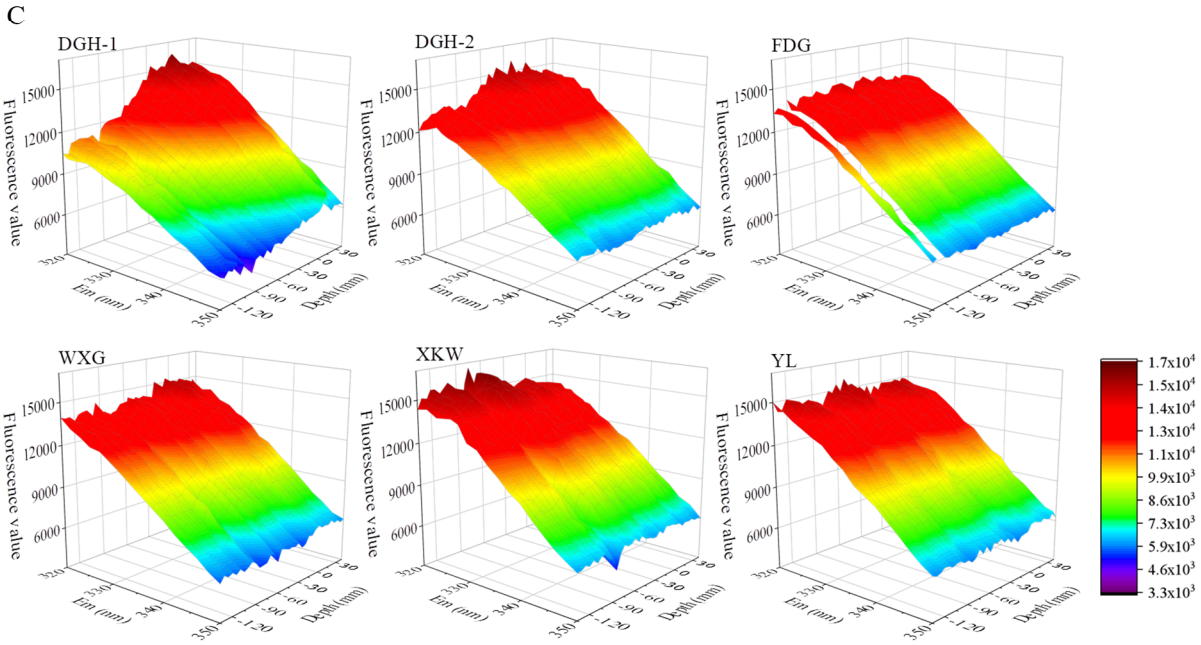
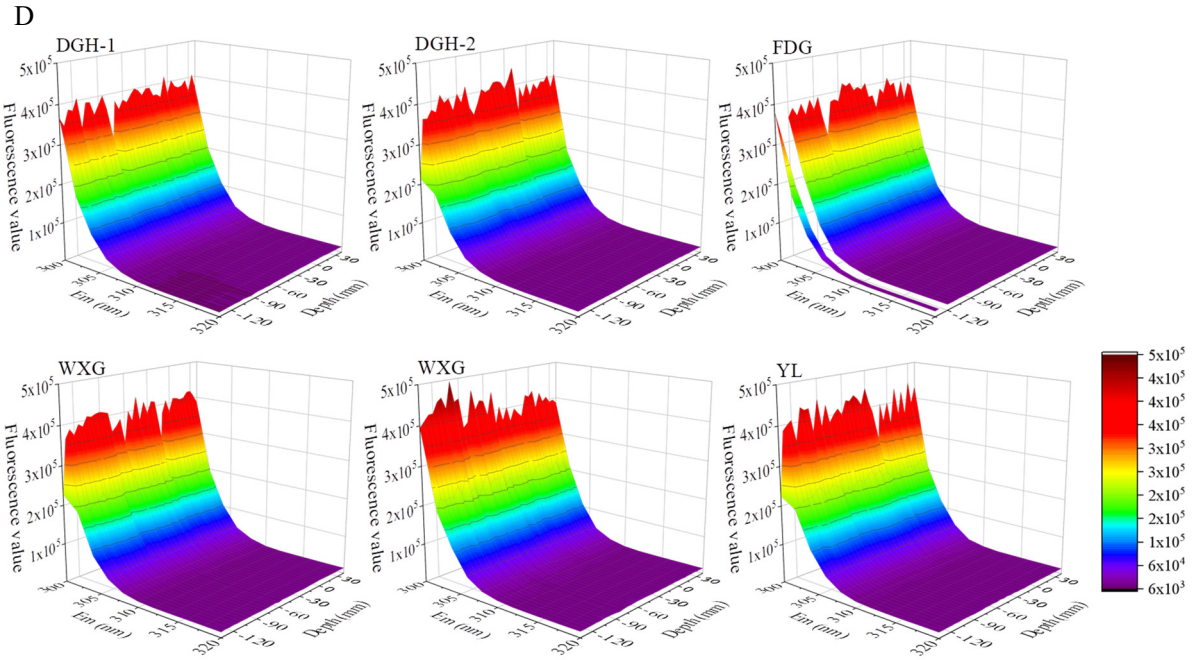


Figure S8. Relative abundances of sequences at the phylum level. Groups with <5% abundance were summarized as "Other". XXX-1 mean the sediment at the surface layer of the sample sites from 0 to 3cm, XXX-2 mean the sediment at the middle layer of the sample sites from 3 to 6cm, and XXX-3 mean the sediment at the profundal layer of the sample sites from 6 to 9cm.


A
DGH-1
DGH-2
FDG
WXG
XKW
YL
Fluorescence value
Depth (mm)
Em (nm)
2860
2580
2299
2019
1738
1458
1177
896.5
616.0
335.5
55.00


B
DGH-1
DGH-2
FDG
WXG
XKW
YL
Fluorescence value
Depth (mm)
Em (nm)
778.0
703.2
628.4
553.6
478.8
404.0
329.2
254.4
179.6
104.8
30.00


C
DGH-1
DGH-2
FDG
WXG
XKW
YL
Fluorescence value
Em (nm)
Depth (mm)
1.7x10⁴
1.5x10⁴
1.4x10⁴
1.3x10⁴
1.1x10⁴
9.9x10³
8.6x10³
7.3x10³
5.9x10³
4.6x10³
3.3x10³


D
DGH-1
DGH-2
FDG
WXG
WXG
YL
Fluorescence value
Em (nm)
Depth (mm)
5x10⁵
4x10⁵
4x10⁵
4x10⁵
3x10⁵
3x10⁵
2x10⁵
2x10⁵
1x10⁵
6x10⁴
6x10³

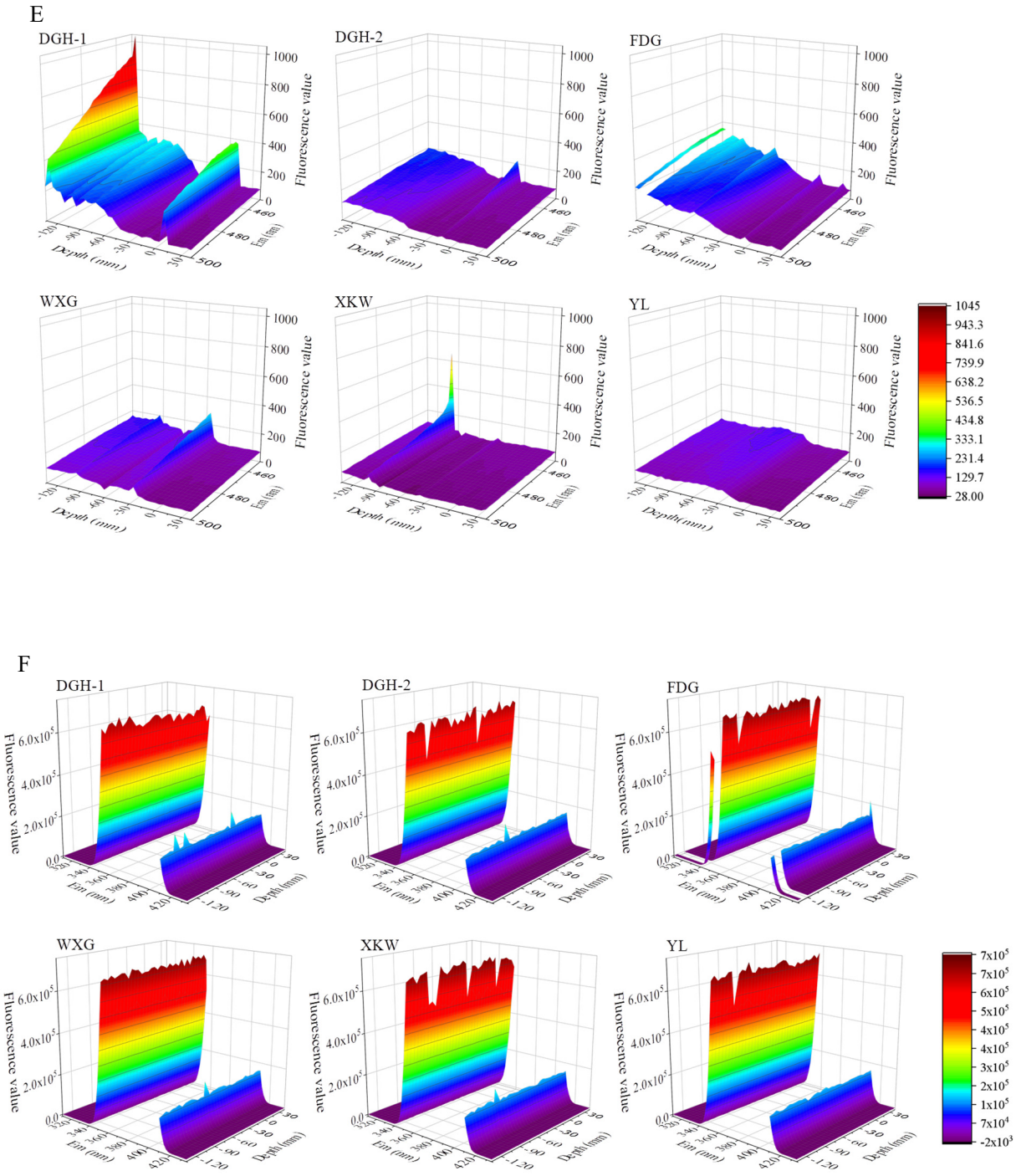


Figure S9. The comparison of the main fluorescent. The excitation (Ex) and emission (Em) wavelengths are A. Ex/Em=250/(380~480), B. Ex/Em=340/(420~480), C. Ex/Em=370/(450~500), D. Ex/Em=380/(310~435), E. Ex/Em=270/(320~350), F. Ex/Em=270/(300~320), respectively. In the group A, group C, group D and group F, the X-axis represents the wavelength range of emission, the Y-axis represents the sediments depth and the Z-axis represents the fluorescence intensity. In the group B and group E, the X-axis represents the sediments depth, the Y-axis represents the

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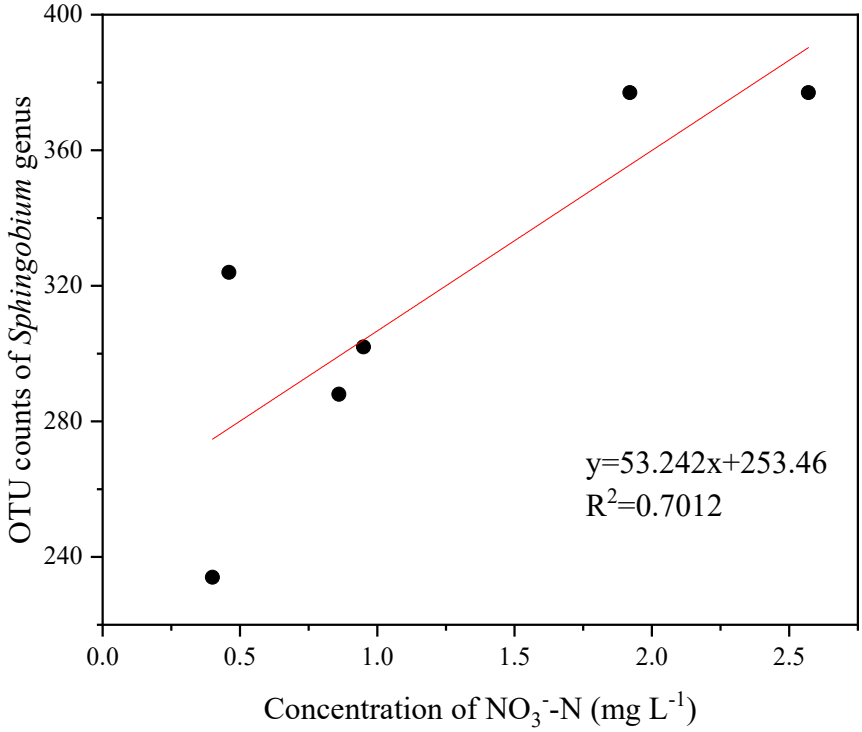

Figure S10. Concentration of NO_3^--N with OTU values of *Sphingobium* genus in profundal sediment (6-9cm).

Table S1. Geographic information of the sampling sites.

Core	**the north of Taihu Lake**		**the east of Taihu Lake**			**the west of Taihu Lake**
	YL	FDG	WXG	DGH-1	DGH-2	XKW
Latitude	N 31°23′12″	N 31°24′44″	N 31°15′10″	N 31°11′13″	N 31°9′41″	N 31°12′59″
Longitude	E 120°7′45″	E 120°0′59″	E 119°58′40″	E 119°57′15″	E 120°4′4″	E 120°27′39″
Sampling time	Jun 2019	Jul 2019	Jun 2019	Jun 2019	Jun 2019	Jul 2019

Table S2. *NosZ* primer base sequences and reaction compounds.

	Primer 5'→3'	
nosZ2F	CGCRACGGCAASAAGGTSMSSGT	
nosZ2R	CAKRTGCAKSGCRTGGCAGAA	
Reaction compounds	**Concentration**	**Volume (μl)**
ChamQ SYBR Color qPCR Master Mix	2X	16.4
nosZ2F	5 μM	0.8
nosZ2R	5 μM	0.8
Template (DNA)		2
Total		20

Table S3. qPCR conditions for *nosZ* gene regions.

Thermal Cycler	**Times and Temperatures**			
	Initial Steps	Each of 40 cycles		
		Melt	Anneal	Extend
ABI 7300 qPCR Instrument	HOLD 95℃-5 min	CYCLE 95℃-5 sec	60℃-30 sec	72℃ 40 sec

Table S4. Vertical distribution characteristics of the DIN profiles as shown in Figure 3

Sample sites	NH_3-N			NO_3^--N			NO_2^--N		
	$\bar{C}^a$ mg/L	${C_{max}}^b$ mg/L	${D_{max}}^c$ (mm)	$\bar{C}^a$ mg/L	${C_{max}}^b$ mg/L	${D_{max}}^c$ (mm)	$\bar{C}^a$ mg/L	${C_{max}}^b$ mg/L	${D_{max}}^c$ (mm)
DGH-1	0.33	1.06	-36	0.62	4.02	0	0.34	1.23	0
DGH-2	0.21	0.43	-100	1.14	3.97	0	0.31	1.27	0
FDG	0.39	1.37	-108	0.74	3.25	0	0.20	1.23	0
WXG	0.22	0.82	-104	0.97	3.50	0	1.90	4.79	-135
XKW	0.24	0.97	-96	2.28	8.83	-98	0.15	1.34	0
YL	0.19	0.52	-58	1.65	4.30	0	0.34	1.27	0

[a] The mean concentration in each sediment profile.

[b] The maximum concentration in each sediment profile.

[c] Depth showing the maximum concentration in each sediment profile.

Table S5. Number of valid sequences, richness, and diversity of 6 sapling sites in Lake Taihu. XXX-1 mean the sediment at the surface layer of the sample sites from 0 to 3cm, XXX-2 mean the sediment at the middle layer of the sample sites from 3 to 6cm, and XXX-3 mean the sediment at the profundal layer of the sample sites from 6 to 9cm.

Sampling sites	Sobs	Shannon	Simpson	Ace	Chao1	Coverage
DGH-1-1	978	4.521441	0.042706	1298.317	1295.24	0.988898
DGH-1-2	666	4.000748	0.040994	1071.993	914.4434	0.991736
DGH-1-3	302	3.458799	0.069245	405.0537	397.3571	0.996766
DGH-2-1	1128	3.968926	0.114318	1967.954	1652.922	0.984406
DGH-2-2	1318	4.584223	0.043581	1915.711	1871.235	0.982215
DGH-2-3	1028	4.246019	0.042383	1848.36	1485.644	0.98552
FDG-1	2407	6.338434	0.007576	3123.194	2943.281	0.974095
FDG-2	2363	6.347213	0.007395	2972.714	2859.165	0.975999
FDG-3	2096	6.123897	0.006851	2733.078	2591.8	0.977185
WXG-1	1666	5.350756	0.025878	2230.427	2160	0.980849
WXG-2	1344	4.735857	0.075122	1832.024	1816.679	0.984011
WXG-3	866	4.293516	0.048324	1148.44	1149.42	0.990191
XKW-1	2458	6.031448	0.016801	3231.562	3149.715	0.971759
XKW-2	2389	6.004805	0.011679	3131.496	3068.803	0.972478
XKW-3	2185	6.013773	0.010682	2807.489	2692.235	0.976753
YL-1	1127	5.227672	0.01239	1512.844	1523.442	0.987065
YL-2	1006	4.967666	0.018499	1342.084	1342.582	0.988718
YL-3	607	3.189854	0.19412	836.4631	808.0306	0.99285

Table S6. Fluorescence components of DOM in sediments as shown in Fig S9.

Region	Fluorescence integral region		Fluorescence substance
	λ_{Ex} (nm)	λ_{Em} (nm)	
I	250	380~480	Fulvic-like acid
II	340	420~480	
III	370	450~500	Humic-like acid
IV	380	310~435	
V	270	320~350	Soluble microbial by-products
VI	270	300~320	

Table S7. Environmental parameters of sediments of different depths in sample sites, and the value of the environment parameters is the average of the average of the measured value in the corresponding depth range. XXX-1 mean the sediment at the surface layer of the sample sites from 0 to 3cm, XXX-2 mean the sediment at the middle layer of the sample sites from 3 to 6cm, and XXX-3 mean the sediment at the profundal layer of the sample sites from 6 to 9cm.

Sampling sites	pH	ORP	DO	H_2S	NO	N_2O	S (-II)
		mV	μM/L	μM/L	nM/L	nM/L	mg/L
DGH-1-1	6.98	126.98	12.33	0.39	178.45	11.57	0.13
DGH-1-2	7.06	109.91	0.11	0.55	248.78	23.16	0.14
DGH-1-3	7.06*	109.91*	0.11*	0.55*	248.78*	23.16	0.15
DGH-2-1	7.58	134.92	21.33	0.57	474.75	58.90	0.07
DGH-2-2	7.56	116.00	0.26	0.92	901.67	130.90	0.09
DGH-2-3	7.56*	116.00*	0.26*	0.92*	901.67*	130.90	0.10
FDG-1	7.29	190.27	19.85	10.79	799.11	4.98	0.16
FDG-2	6.92	137.37	0.59	10.60	339.87	10.15	0.19
FDG-3	6.92*	137.37*	0.59*	10.60*	339.87*	10.15	0.23
WXG-1	7.35	248.06	32.09	1.59	51.61	56.13	0.13
WXG-2	7.10	187.48	0.09	0.41	24.82	65.98	0.16
WXG-3	7.10*	187.48*	0.09*	0.41*	24.82*	65.98	0.18
XKW-1	7.41	317.16	23.57	1.72	216.52	0.00**	0.01
XKW-2	7.28	194.40	0.26	1.23	128.57	0.00**	0.01
XKW-3	7.28*	194.40*	0.26*	1.23*	128.57*	0.00**	0.01
YL-1	7.05	256.91	92.61	0.48	23.79	0.00**	0.02
YL-2	6.69	209.87	0.47	0.65	36.69	0.00**	0.01
YL-3	6.69*	209.87*	0.47*	0.65*	36.69*	0.00**	0.02

* If the environment parameters is missing measurements in the corresponding depth range, the measurements closest to the depth range will be used instead.

** The N_2O concentration of XKW and YL were not measured because of damage to the N_2O microelectrode during the measurement.

Table S7 (Contd.)

Sampling sites	Fe (II) mg/L	DRP mg/L	FI	α(254) m^{-1}	NH_3-N mg/L	NO_3^--N mg/L	NO_2^--N mg/L
DGH-1-1	0.47	0.86	1.62	28.33	0.36	1.54	0.95
DGH-1-2	0.52	1.16	1.50	34.47	0.45	0.52	0.38
DGH-1-3	0.15	2.48	1.50	56.98	0.31	0.46	0.06
DGH-2-1	0.33	1.88	1.92	25.32	0.17	1.40	0.87
DGH-2-2	0.21	1.77	1.52	23.72	0.21	1.28	0.25
DGH-2-3	0.24	1.56	1.51	36.39	0.24	0.86	0.08
FDG-1	7.19	7.05	1.57	24.06	0.31	1.39	0.71
FDG-2	8.53	7.82	1.59	25.88	0.20	0.46	0.06
FDG-3	7.14	8.84	1.62	31.28	0.40	0.40	0.03
WXG-1	2.71	0.66	1.66	24.20	0.21	0.92	0.48
WXG-2	4.97	0.64	1.54	24.06	0.21	0.71	0.61
WXG-3	6.27	0.96	1.59	26.52	0.22	0.95	1.77
XKW-1	0.12	2.74	1.57	23.97	0.18	0.95	0.40
XKW-2	0.06	2.02	1.65	13.40	0.18	0.40	0.07
XKW-3	0.35	2.16	1.65	15.37	0.28	2.57	0.07
YL-1	0.23	0.72	1.58	25.18	0.35	1.27	1.06
YL-2	0.16	0.53	1.56	24.95	0.26	1.18	0.27
YL-3	0.21	0.67	1.55	22.36	0.08	1.92	0.07

DRP: dissolved reactive phosphorus; FI: fluorescence index.