Supplementary Material

Supplementary Table 1. Quantitative PCR primers and probes used in this study.

Species/clone	Forward primer	Probe	Reverse primer	Standard clone	References
Trichodesmium	GACGAAGTATTGAAGCCAGGTTTC	CATTAAGTGTGTTGAATCTGGTGGTCCTGAGC	CGGCCAGCGCAACCTA	AY528677	Church et al., 2005a
UCYN-A1	AGCTATAACAACGTTTTATGCGTTGA	TCTGGTGGTCCTGAGCCTGGA	ACCACGACCAGCACATCCA	AF059642	Church et al., 2005a
UCYN-A2/A3	GGTTACAACAACGTTTTATGTGTTGA	TCTGGTGGTCCTGAGCCCGGA	ACCACGACCAGCACATCCA	KF806604	Thompson et al., 2014
UCYN-B	TGGTCCTGAGCCTGGAGTTG	TGTGCTGGTCGTGGTAT	TCTTCTAGGAAGTTGATGGAGGTGAT	AF299418	Church et al., 2005a
het-1	CGGTTTCCGTGGTGTACGTT	TCCGGTGGTCCTGAGCCTGGTGT	AATACCACGACCCGCACAAC	AY706898	Church et al., 2005b
24774A11	CGGTAGAGGATCTTGAGCTTGAA	AAGTGCTTAAGGTTGGCTTTGGCGACA	CACCTGACTCCACGCACTTG	EU052413	Moisander et al., 2008

Supplementary Table 2. Pearson correlation coefficients (r) between paired variables including surface temperature (SST) and salinity (SSS), surface chlorophyll *a* concentration (Chl *a*), surface N_2 fixation rate (SNF), depth-integrated N_2 fixation rate (INF) and primary production (IPP), and total *nifH* gene abundance. Asterisks denote a significant correlation ($p < 0.05$).

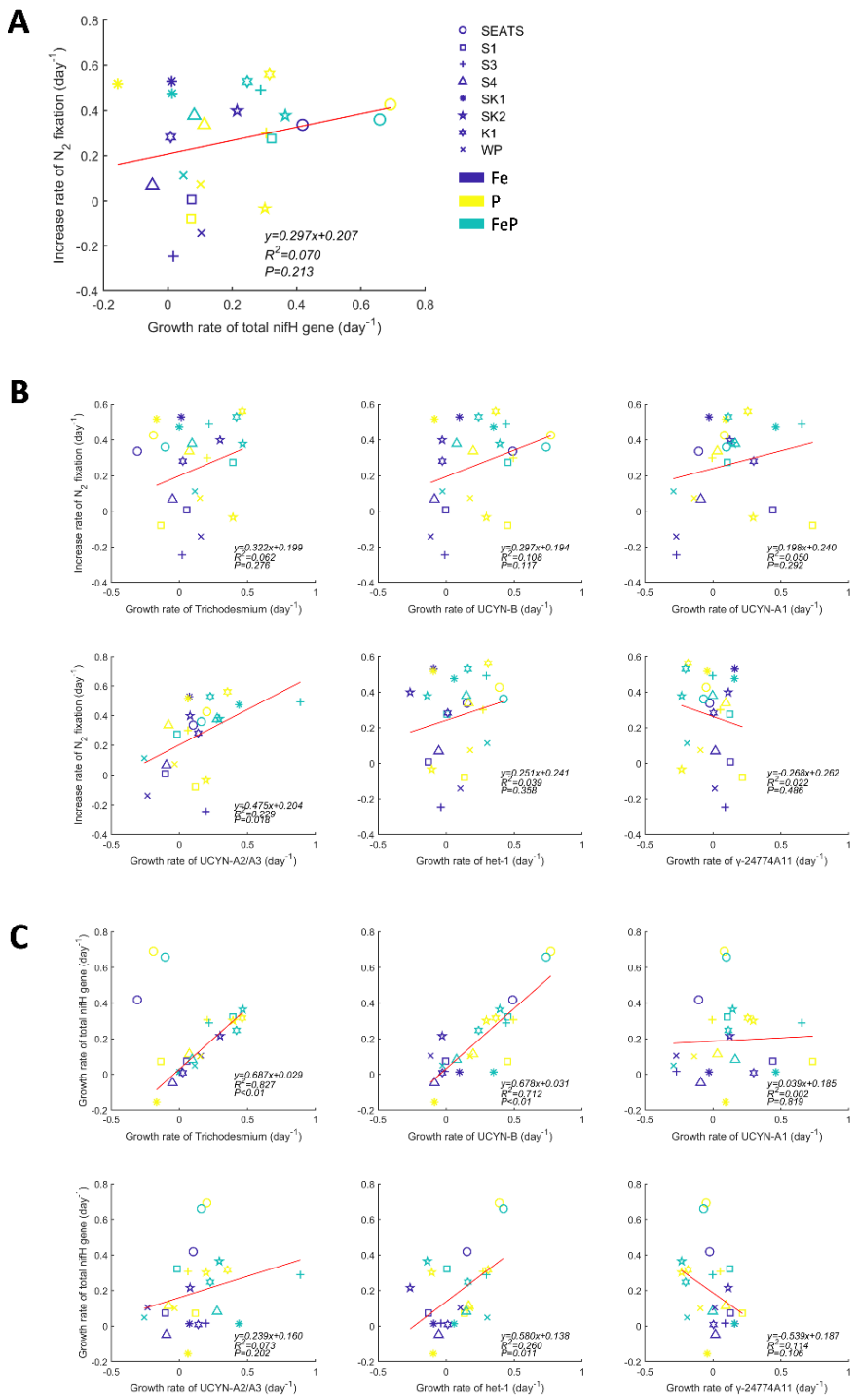
	SSS	**Chl *a***	**D_{Nitr}**	**SNF**	**INF**	**IPP**	***nifH***
SST	0.08	0.15	0.52	0.32	0.52	-0.67*	-0.05
SSS		-0.48	0.81*	-0.22	0.30	-0.47	0.75*
Chl *a*			-0.43	0.21	-0.10	0.21	-0.52
D_{Nitr}				0.15	0.62	-0.69*	0.74*
SNF					0.68*	-0.29	-0.01
INF						-0.32	0.72*
IPP							-0.04

Supplementary Table 3. Upper 150 m depth-integrated *nifH* gene abundance of six targeted diazotrophs. nd, no data.

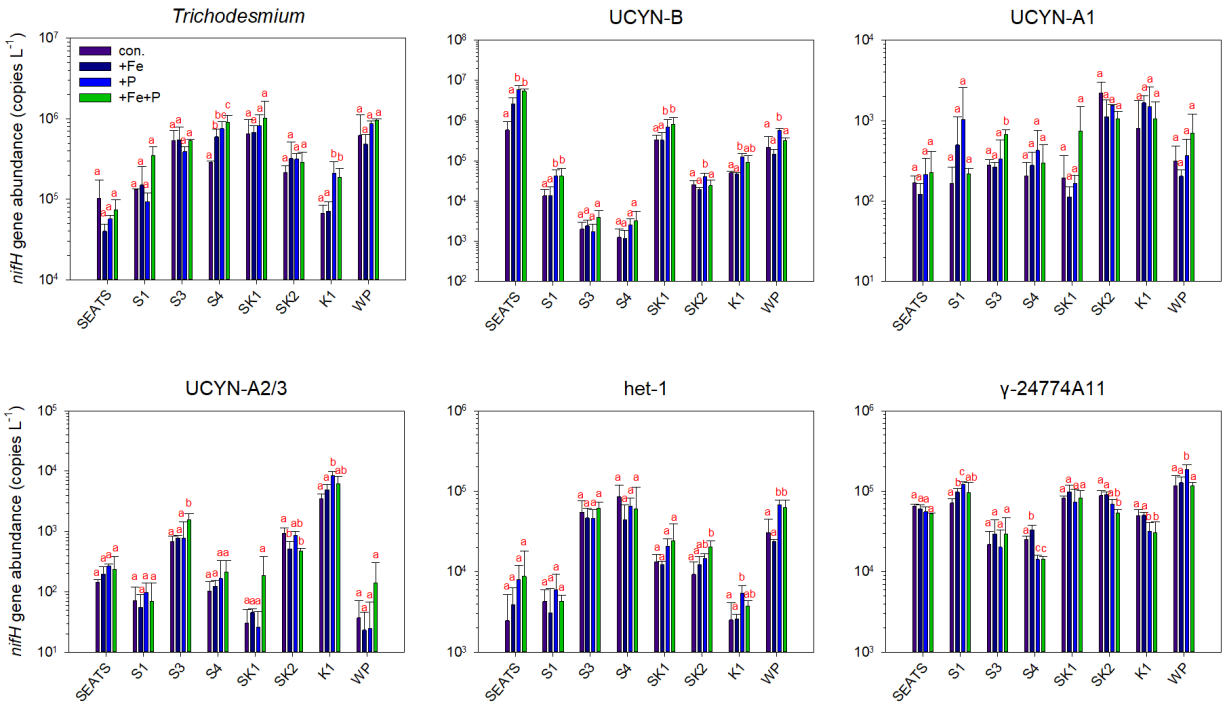
Station	Depth-integrated *nif*H gene abundance ($\times 10^9$ copies m^{-2})						
	Trichodesmium	**UCYN-A1**	**UCYN-A2/A3**	**UCYN-B**	**het-1**	**γ-24774A11**	**Total**
$SEATS_{2016}$	2.21	0.72	0.009	2.02	0.00	1.01	5.96
$SEATS_{2018}$	6.48	0.01	0.10	0.78	1.33	3.84	12.5
S1	3.43	0.06	0.005	3.25	0.16	0.18	7.08
S2	4.01	0.02	0.007	0.24	1.52	1.16	6.96
S3	35.4	0.05	0.005	0.16	0.08	0.99	36.7
S4	21.6	0.02	0.005	0.15	0.09	0.56	22.4
SK1	*nd*	*nd*	*nd*	*nd*	*nd*	*nd*	*nd*
SK2	*nd*	*nd*	*nd*	*nd*	*nd*	*nd*	*nd*
K1	10.2	17.3	1.09	12.0	0.23	3.14	44.0
WP	1.73	5.63	0.23	66.0	0.42	0.80	74.8

Supplementary Table 4. Intracellular particulate Fe (PFe_{intra}), total particulate Fe (PFe_{total}) and particulate organic carbon (POC) concentrations, and particulate Fe to POC ratios in surface waters of the NSCS and the Kuroshio during 2018 cruise.

Station	**PFe_{intra} (nM)**	**PFe_{total} (nM)**	**POC (μM)**	**PFe_{intra}:POC (nmol Fe μmol C^{-1})**	**PFe_{total}:POC (nmol Fe μmol C^{-1})**
$SEATS_{2018}$	1.16	1.10	2.31	0.50	0.48
S2	0.34	0.86	2.28	0.15	0.38
S3	0.70	0.71	2.70	0.26	0.26
S4	0.45	1.00	3.03	0.15	0.33
SK2	1.34	2.40	2.46	0.54	0.98
K1	0.62	0.94	2.14	0.29	0.44



Supplementary Figure 1. Correlations of response rates between (A) total *nifH* gene abundances and N_2 fixation rates, (B) individual diazotroph abundances and N_2 fixation rates, and (C) individual diazotroph abundances and total *nifH* gene abundances.



Supplementary Figure 2. Responses of different diazotroph phylotypes to nutrient amendment. The data are mean + SD (n = 2 or 3). Different letters indicate statistically significant difference ($p < 0.05$) among treatments (ANOVA followed by Fisher PLSD test).

Parameters involved in nitrogen fixation rate calculation

Cruise	Date	Station	Long	Lat	Depth	SST
NSCS_2016	5/22/16	SEATS_2016	116.067	18.017	5	30.26
NSCS_2016	5/22/16	SEATS_2016	116.067	18.017	15	30.25
NSCS_2016	5/22/16	SEATS_2016	116.067	18.017	25	29.34
NSCS_2016	5/22/16	SEATS_2016	116.067	18.017	50	23.31
NSCS_2016	5/22/16	SEATS_2016	116.067	18.017	75	20.91
NSCS_2016	5/22/16	SEATS_2016	116.067	18.017	100	19.14
NSCS_2016	5/22/16	SEATS_2016	116.067	18.017	130	17.09
NSCS_2017	7/23/17	S1	116.503	19.502	5	29.46
NSCS_2017	7/23/17	S1	116.503	19.502	25	29.35
NSCS_2017	7/23/17	S1	116.503	19.502	50	24.92
NSCS_2017	7/23/17	S1	116.503	19.502	65	22.78
NSCS_2017	7/23/17	S1	116.503	19.502	100	18.48
NSCS_2017	7/13/17	SK1	120.413	21.03	5	30.45
NSCS_2017	7/13/17	SK1	120.413	21.03	25	30.25
NSCS_2017	7/13/17	SK1	120.413	21.03	50	29.17
NSCS_2017	7/13/17	SK1	120.413	21.03	75	28.06
NSCS_2017	7/13/17	SK1	120.413	21.03	100	25.17
NSCS_2017	7/14/17	WP	123	22	5	30.86
NSCS_2017	7/14/17	WP	123	22	25	30.7
NSCS_2017	7/14/17	WP	123	22	50	29.8
NSCS_2017	7/14/17	WP	123	22	75	27.32
NSCS_2017	7/14/17	WP	123	22	100	26.37
NSCS_2018	7/6/18	SEATS_2018	116.046	17.978	5	30.27
NSCS_2018	7/6/18	SEATS_2018	116.046	17.978	25	29.34
NSCS_2018	7/6/18	SEATS_2018	116.046	17.978	75	20.91
NSCS_2018	7/6/18	SEATS_2018	116.046	17.978	88	20.05
NSCS_2018	7/6/18	SEATS_2018	116.046	17.978	100	19.14
NSCS_2018	7/6/18	SEATS_2018	116.046	17.978	150	16.34
NSCS_2018	7/1/18	S2	117.94	19.57	5	29.38
NSCS_2018	7/1/18	S2	117.94	19.57	25	29.38
NSCS_2018	7/1/18	S2	117.94	19.57	50	27.26
NSCS_2018	7/1/18	S2	117.94	19.57	95	20.69
NSCS_2018	7/1/18	S2	117.94	19.57	100	20.13
NSCS_2018	7/1/18	S2	117.94	19.57	150	16.02
NSCS_2018	6/23/18	S3	119.34	20.86	5	28.65
NSCS_2018	6/23/18	S3	119.34	20.86	25	27.44
NSCS_2018	6/23/18	S3	119.34	20.86	50	25.73
NSCS_2018	6/23/18	S3	119.34	20.86	75	21.97
NSCS_2018	6/23/18	S3	119.34	20.86	100	19.87
NSCS_2018	6/23/18	S3	119.34	20.86	150	17.66
NSCS_2018	6/25/18	S4	120.05	21.54	5	29.47
NSCS_2018	6/25/18	S4	120.05	21.54	25	29.22
NSCS_2018	6/25/18	S4	120.05	21.54	50	27.93
NSCS_2018	6/25/18	S4	120.05	21.54	62	26.87
NSCS_2018	6/25/18	S4	120.05	21.54	100	23.04
NSCS_2018	6/25/18	K1	122.5	22	5	29.1189
NSCS_2018	6/25/18	K1	122.5	22	25	28.5271
NSCS_2018	6/25/18	K1	122.5	22	50	26.3913
NSCS_2018	6/25/18	K1	122.5	22	75	25.264
NSCS_2018	6/25/18	K1	122.5	22	100	23.2653
NSCS_2018	6/25/18	K1	122.5	22	150	22.36
NSCS_2018	6/28/18	SK2	121.27	21.31	5	no data

SSS	Chla	PON_0	15N atom% enrichment of PON_0	PON_{24h} concentration (µM)	15N atom% enrichment of PON_{24h}	NFR
33.46	0.26	no data	no data	0.38	0.3816805	1.1
33.46	0.26	no data	no data	0.37	0.3798570	2.0
33.62	0.30	no data	no data	0.33	0.3708272	0.5
34.36	0.45	no data	no data	0.31	0.3750863	0.3
34.56	0.61	no data	no data	0.64	0.3674203	0.2
34.65	0.31	no data	no data	0.17	0.3701849	0.2
34.64	no data	no data	no data	0.10	0.3741270	0.3
33.73	0.24	0.33	0.3668207	0.43	0.3767814	0.8
33.71	0.37	0.42	0.3669390	0.58	0.3686309	0.8
34.44	0.84	0.67	0.3674356	0.88	0.3683459	0.6
34.54	0.98	0.48	0.3669079	no data	no data	no data
34.66	0.15	0.19	0.3680782	0.20	0.3677434	0.0
33.62	0.22	no data	no data	0.33	0.3943007	10.4
33.75	0.21	no data	no data	0.34	0.3799960	3.5
34.11	no data	no data	no data	0.57	0.3893380	5.4
34.32	no data	no data	no data	0.63	0.4776194	2.6
34.57	no data	no data	no data	0.66	0.3688654	0.2
34.47	0.11	0.23	0.36781801	0.37	0.382999743	1.9
34.41	0.11	0.23	0.36801961	0.24	0.440051932	3.3
34.53	0.13	0.25	0.36856696	0.28	0.438787892	7.9
34.89	0.17	0.18	0.36801961	0.21	0.467344503	4.0
34.96	0.29	0.21	0.37211872	0.24	0.373643014	0.1
33.46	0.11	0.25	0.36588618	0.27	0.376683576	1.8
33.62	0.13	0.29	0.36654193	0.29	0.376494591	2.1
34.56	0.65	0.47	0.36696012	0.42	0.367307142	0.3
34.61	0.60	0.28	0.36504468	0.30	0.366694829	0.3
34.65	0.51	0.37	0.36525123	0.25	0.366694099	0.3
34.62	0.07	0.11	0.36663827	0.10	0.368374111	0.1
33.75	0.10	0.25	0.36629562	0.26	0.385884928	3.0
33.78	0.12	0.25	0.36631459	0.32	0.380279581	2.1
33.98	0.27	0.32	0.36698311	0.36	0.367273154	0.0
34.67	0.53	0.22	0.36589932	0.30	0.366632742	0.2
34.7	0.35	0.19	0.36612192	0.22	0.367169886	0.1
34.61	0.05	0.13	0.36758702	0.10	0.367449038	0.0
33.53	0.15	0.41	0.36610039	0.56	0.371222007	2.4
33.73	0.17	0.41	0.36840695	0.29	0.385794335	5.9
34.05	0.78	0.50	0.36706959	0.48	0.3679406	0.5
34.58	0.79	0.47	0.37048536	0.66	0.371195082	0.0
34.77	0.26	0.21	0.36691706	0.21	0.366320972	0.0
34.72	0.07	0.09	0.36833251	0.09	0.366939499	0.0
33.74	0.17	0.56	0.36740275	0.43	0.371252697	1.8
33.74	0.13	nd	0.36662075	0.38	0.38311794	6.1
33.92	0.50	0.59	0.36729218	0.42	0.376236431	4.4
33.88	0.59	0.40	0.37216232	0.42	0.3759452	0.0
34.45	0.21	0.32	0.36821392	0.26	0.367758162	0.0
34.4468	0.11	0.21	0.36537165	0.28	0.368736205	0.8
34.5194	0.10	0.27	0.36547419	0.27	0.372847664	1.9
34.6763	0.12	0.28	0.36515927	0.29	0.373097594	2.2
34.7557	0.34	0.33	0.36576248	0.29	0.366441681	0.3
34.8755	0.07	0.29	0.36573036	0.27	0.365967681	0.1
34.902	0.20	0.14	0.3675166	0.14	0.366298654	0.0
no data	0.11	0.28	0.36665797	0.19	0.375381825	2.0

SD_{NFR}	NFR_LOD [nmol N L^{-1} d^{-1}]	PP	SD_{PP} [µmol C L-1 d-1]	Trichodesmium
	0.23	0.59	0.00	5.57E+04
0.04	0.23	0.48	0.02	6.60E+04
0.34	0.20	0.25	0.02	5.68E+04
	0.14	0.38	0.05	0.00E+00
0.03	0.39	0.01	0.00	0.00E+00
0.05	0.10	0.01	0.00	0.00E+00
0.17	0.06	0.00	0.00	0.00E+00
0.00	0.54	0.37	0.03	1.97E+05
0.05	0.71	0.48	0.01	1.98E+04
0.32	0.99	0.69	0.04	9.48E+02
no data	no data	no data	no data	2.31E+02
0.00	0.48	0.02	0.00	2.97E+02
0.01	0.29	0.08	0.01	no data
0.00	0.22	0.09	0.01	no data
0.00	0.36	0.11	0.12	no data
0.00	0.40	0.16	0.01	no data
0.17	0.42	0.05	0.02	no data
0.74	0.19	0.12	0.02	1.02E+03
0.00	0.15	0.09	0.01	1.19E+03
0.43	0.17	0.11	0.01	4.30E+03
0.00	0.12	0.07	0.00	3.28E+03
0.00	0.14	0.06	0.02	1.20E+05
0.11	0.23	0.30	0.01	1.76E+05
0.40	0.26	0.29	0.01	1.09E+05
0.25	0.40	0.14	0.02	7.46E+02
0.05	0.26	0.11	0.02	2.20E+02
0.02	0.28	0.10	0.02	0.00E+00
0.02	0.10	0.01	0.00	no data
0.01	0.23	0.22	0.01	1.78E+05
0.33	0.25	0.26	0.01	5.73E+04
0.02	0.30	0.27	0.04	1.02E+03
0.06	0.23	0.11	0.00	5.16E+02
0.01	0.19	0.07	0.00	0.00E+00
0.04	0.10	0.01	0.00	no data
1.20	0.69	0.61	0.09	8.00E+05
1.23	0.50	0.39	0.09	9.07E+05
0.67	0.69	1.04	0.01	9.54E+04
0.00	0.76	1.71	0.10	2.63E+04
0.02	0.30	0.28	0.02	0.00E+00
0.00	0.13	0.03	0.00	no data
0.31	0.70	0.41	0.03	4.22E+05
0.38	0.54	0.80	0.11	4.95E+05
1.50	0.72	0.85	0.11	2.01E+05
0.00	0.58	0.66	0.01	1.53E+04
0.00	0.41	0.11	0.04	0.00E+00
0.21	0.34	0.20	0.01	1.29E+05
0.13	0.38	0.18	0.00	2.23E+05
0.23	0.40	0.21	0.00	1.18E+05
0.48	0.44	0.22	0.01	1.18E+04
0.06	0.39	0.09	0.00	8.93E+02
0.00	0.20	0.02	0.00	2.11E+02
0.00	0.34	0.26	0.00	1.37E+05

UCYN-B	UCYN-A1	UCYN-A2/A3	het-1	γ-24774A11
4.16E+04	6.34E+02	8.93E+02	0.00E+00	1.26E+04
5.42E+04	0.00E+00	0.00E+00	0.00E+00	3.45E+04
6.04E+04	8.71E+03	0.00E+00	0.00E+00	0.00E+00
0.00E+00	2.23E+04	0.00E+00	0.00E+00	1.75E+03
0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E+04
0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.25E+03
0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.08E+03
2.11E+05	2.94E+02	9.83E+01	1.15E+03	5.63E+03
1.13E+03	4.87E+02	2.64E+01	4.83E+02	2.23E+03
4.61E+02	4.91E+02	3.70E+01	5.75E+03	7.96E+02
1.09E+03	5.54E+02	3.65E+01	3.23E+02	4.12E+02
1.23E+03	1.17E+03	6.50E+01	4.48E+02	1.00E+03
no data	no data	no data	no data	no data
no data	no data	no data	no data	no data
no data	no data	no data	no data	no data
no data	no data	no data	no data	no data
no data	no data	no data	no data	no data
8.67E+05	7.80E+02	3.93E+01	9.00E+01	6.70E+03
9.52E+05	3.97E+03	1.09E+03	2.76E+02	3.73E+03
7.99E+05	2.62E+04	5.38E+02	1.17E+04	9.91E+03
4.54E+05	1.58E+05	6.87E+03	4.67E+03	1.07E+04
2.17E+04	7.52E+04	1.73E+03	3.69E+02	7.61E+03
5.77E+03	1.51E+02	4.53E+02	1.80E+04	7.17E+04
1.81E+04	1.67E+02	2.75E+03	2.96E+04	7.79E+04
1.58E+03	8.94E+01	1.48E+01	5.76E+02	8.01E+02
5.10E+02	1.68E+01	0.00E+00	1.54E-01	6.66E+02
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
no data	no data	no data	no data	no data
8.25E+03	7.71E+02	2.79E+02	7.61E+04	3.79E+04
3.73E+03	1.40E+02	3.71E+01	1.62E+04	1.97E+04
6.28E+02	3.91E+01	3.62E+01	2.93E+02	3.98E+03
3.59E+02	2.08E+02	3.35E+01	2.93E+02	3.07E+02
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
no data	no data	no data	no data	no data
7.30E+02	4.24E+01	6.43E+01	1.65E+03	1.28E+04
4.39E+03	5.02E+02	1.26E+02	1.29E+03	1.56E+04
1.14E+03	7.85E+02	1.57E+01	6.34E+02	5.54E+03
9.42E+02	8.44E+02	3.42E+01	2.70E+02	1.23E+04
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
no data	no data	no data	no data	no data
2.30E+02	5.67E+01	2.96E+01	1.09E+03	1.17E+04
4.45E+03	4.87E+01	1.34E+02	2.45E+03	1.11E+04
1.81E+03	2.63E+02	5.39E+01	8.28E+02	4.05E+03
5.33E+02	6.09E+02	2.24E+00	1.38E+02	2.53E+03
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6.55E+04	2.30E+03	1.55E+03	2.44E+03	4.39E+04
2.64E+05	8.55E+04	1.46E+04	4.53E+03	5.61E+04
1.94E+05	6.09E+05	2.95E+04	2.04E+03	4.51E+04
5.99E+03	5.27E+03	1.06E+02	6.17E+02	3.18E+03
2.77E+03	2.39E+03	6.83E+01	1.58E+03	6.86E+02
2.76E+03	8.90E+02	7.58E+01	8.16E+02	3.84E+02
2.24E+04	5.72E+02	2.81E+02	1.69E+04	1.96E+04

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