*Supplementary Material*

# Supplementary Figures and Tables

## Supplementary Figures



**Supplementary Figure 1.** Redundancy analysis ordination diagram of environmental factors and (A) coverage, (B) biomass of four lifeform aquatic plants. TN, WD, SS mean total nitrogen concentration, water depth, suspended solid respectively. And c.s, c.l, c.f, c.e mean coverage of submerged, floating-leaved, free floating and emergent plants.

## Supplementary Tables

**Supplementary Table 1.** List of the species and lifeform of aquatic macrophytes.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Family | Genus | Species | Abbreviation |
| Submerged species | Ceratophyllaceae | *Ceratophyllum* | *Ceratophyllum demersum* | CD |
|  | Haloragidaceae | *Myriophyllum* | *Myriophyllum spicatum* | MS |
|  | Najadaceae | *Najas* | *Najas marina* | NM1 |
|  | Najadaceae | *Najas* | *Najas minor* | NM2 |
|  | Hydrocharitaceae | *Ottelia* | *Ottelia alismoides* | OA |
|  | Hydrocharitaceae | *Vallisneria* | *Vallisneria natans* | VN |
|  | Hydrocharitaceae | *Hydrilla* | *Hydrilla verticillata* | HV |
|  | Potamogetonaceae | *Potamogeton* | *Potamogeton crispus* | PC |
|  | Potamogetonaceae | *Potamogeton* | *Potamogeton maackianus* | PM1 |
|  | Potamogetonaceae | *Potamogeton* | *Potamogeton malaianus* | PM2 |
|  | Lentibulariaceae | *Utricularia* | *Utricularia vulgaris* | UV |
|  | Characeae | *Chara* | *Chara* sp. | CV |
| Floating-leaved species | Nymphaeaceae | *Euryale* | *Euryale ferox* | EF |
|  | Nymphaeaceae | *Nelumbo* | *Nelumbo nucifera* | NN1 |
|  | Gentianaceae | *Nymphoides* | *Nymphoides indica* | NI |
|  | Gentianaceae | *Nymphoides* | *Nymphoides peltata* | NP |
|  | Pedaliaceae | *Trapella* | *Trapella sinensis* | TS |
|  | Trapaceae | *Trapa* | *Trapa* sp. | TN |
|  | Nymphaeaceae | *Nelumbo* | *Nelumbo sp.2* | NN2 |
| Free-floating species | Pontederiaceae | *Eichhornia* | *Eichhornia crassipes* | EC |
|  | Salviniaceae | *Salvinia* | *Salvinia natans* | SN |
| Emergent species | Amaranthaceae | *Alternanthera* | *Alternanthera philoxeroides* | AP |
|  | Cyperaceae | *Scirpus* | *Scirpus yagara* | SY |
|  | Cyperaceae | *Heleocharis* | *Heleocharis dulcis* | HD |
|  | Cyperaceae | *Heleocharis* | *Eleocharis yokoscensis* | EY |
|  | Gramineae | *Leersia* | *Leersia hexandra* | LH |
|  | Gramineae | *Phragmites* | *Phragmites australis* | PA |
|  | Gramineae | *Gramineae*  | *Gramineae* sp.1 | P1 |
|  | Gramineae | *Gramineae*  | *Gramineae* sp.2 | P2 |
|  | Polygonaceae | *Polygonum* | *Polygonum* sp. | PH |
|  | Alismataceae | *Sagittaria* | *Sagittaria* sp. | ST |
|  | Typhaceae | *Typha* | *Typha orientalis* | TO |
|  | Gramineae | *Zizania* | *Zizania latifolia* | ZL |

**Supplementary Table 2.** The extreme value and mean of the physico-chemical parameters and nutrition level monitored in Liangzi Lake

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | T (℃) | DO (mg·L-1) | Cond(us·cm-1) | TDS | SAL | pH | Turb(NTU) | SS(mg·L-1) | TN(mg·L-1) | TP(mg·L-1) | Kd |
| Maximum | 36.3 | 14.84 | 200.2 | 109.85 | 0.08 | 9.75 | 101 | 77 | 1.05 | 0.06 | 10.68  |
| Minimum | 30 | 2.29 | 157.3 | 86.45 | 0.06 | 7.3 | 4.88 | 0 | 0.363 | 0.005 | 0.77  |
| Mean | 32.9 | 7.83 | 170.2 | 96.47 | 0.07 | 8.61 | 21.37 | 24 | 0.554 | 0.024 | 3.33 |

# Supplementary Method

Full results for DI models comparing the contribution of species identity and interspecific interactions to BPR patterns in aquatic macrophyte communities.

M0: Null model

**Table 1** ANOVA table for M0

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Df | Sum Sq | Mean Sq | F value | P |
| M | 1 | 1036386 | 1036386 | 10.426 | **0.0018** |
| Residuals | 76 | 7554699 | 99404 |  |  |

**Table 2** Parameter estimates for M0

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Estimate | Std. Error | t value | P |
| Intercept | 16.384 | 115.133 | 0.142 | 0.8872 |
| M | 3.591 | 1.112 | 3.229 | **0.0018** |

M1: Species identity model

**Table 3** Parameter estimates for M1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Estimate | Std. Error | t value | P |
| PM2 | 53.9 | 99.61 | 0.541 | 0.5911 |
| VN | -280.4 | 102.8 | -2.728 | **0.0091** |
| NP | -119.5 | 160.4 | -0.745 | 0.46 |
| HV | -152.4 | 140.4 | -1.085 | 0.2837 |
| NM1 | -286.7 | 154.3 | -1.858 | 0.0697 |
| MS | 13.17 | 85.44 | 0.154 | 0.8782 |
| PA | 40.88 | 197 | 0.208 | 0.8365 |
| CD | 213.5 | 127.5 | 1.674 | 0.1011 |
| ZL | 924.6 | 195.8 | 4.723 | **<0.001** |
| PH | 483.5 | 190.6 | 2.537 | **0.0147** |
| NM2 | -385 | 163.7 | -2.351 | **0.0232** |
| PC | -4954 | 8723 | -0.568 | 0.5729 |
| TN | 119.6 | 180.1 | 0.664 | 0.5102 |
| NI | -226.3 | 154.4 | -1.466 | 0.1497 |
| NN1 | -55.95 | 635.5 | -0.088 | 0.9302 |
| TS | -448.6 | 287.4 | -1.561 | 0.1255 |
| EF | -924.7 | 1783 | -0.519 | 0.6066 |
| PM1 | -2017 | 17400 | -0.116 | 0.9082 |
| TO | 1606 | 721 | 2.227 | **0.031** |
| HD | 361.5 | 490.8 | 0.737 | 0.4651 |
| SY | -18530 | 22930 | -0.808 | 0.4233 |
| LH | -4690 | 4295 | -1.092 | 0.2807 |
| UV | 98610 | 114700 | 0.86 | 0.3944 |
| ST | -1352 | 5217 | -0.259 | 0.7967 |
| P1 | 6563 | 4983 | 1.317 | 0.1945 |
| AP | -1001 | 1745 | -0.574 | 0.569 |
| NN2 | 106600 | 23970 | 4.448 | **<0.001** |
| EC | 1114 | 357.6 | 3.115 | **0.0032** |
| CV | 358.9 | 4480 | 0.08 | 0.9365 |
| OA | -1104 | 1629 | -0.678 | 0.5015 |
| EY | -2731 | 4018 | -0.68 | 0.5003 |
| P2 | -2308 | 2351 | -0.982 | 0.3316 |
| M | 4.181 | 0.8189 | 5.105 | **<0.001** |

Abbreviations are as in Supplementary Tables 1

M2: Species identity model with all pairwise interactions

**Table 4** Parameter estimates for M2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Estimate | Std. Error | t value | P |
| PM2 | -71.59700818 | 261.465 | -0.27383 | 0.8099 |
| VN | -74968.69356 | 47436.73 | -1.58039 | 0.2548 |
| NP | 18802544467 | 1.17E+10 | 1.601935 | 0.2503 |
| HV | -9258.974891 | 5140.912 | -1.80104 | 0.2135 |
| NM1 | 830495.2579 | 817101.4 | 1.016392 | 0.4164 |
| MS | -292.2492056 | 238.9885 | -1.22286 | 0.3459 |
| PA | 0.900303902 | 280.289 | 0.003212 | 0.9977 |
| CD | 3.907568124 | 277.564 | 0.014078 | 0.99 |
| ZL | 7024993.064 | 4272702 | 1.644157 | 0.2419 |
| PH | 143.15326 | 379.474 | 0.377241 | 0.7423 |
| NM2 | -11866855.64 | 7426362 | -1.59794 | 0.2512 |
| PC | -9147372745 | 5.69E+09 | -1.60658 | 0.2494 |
| TN | -17563.64963 | 34575.26 | -0.50798 | 0.6619 |
| NI | -3224943.594 | 1965321 | -1.64092 | 0.2425 |
| NN1 | -1519.161186 | 149127.1 | -0.01019 | 0.9928 |
| TS | -466187750.1 | 2.91E+08 | -1.60192 | 0.2503 |
| EF | -7.41834E+12 | 4.63E+12 | -1.60239 | 0.2502 |
| PM1 | 41337512441 | 2.58E+10 | 1.601544 | 0.2504 |
| TO | -73931390.32 | 44945961 | -1.6449 | 0.2417 |
| HD | -72899749863 | 4.55E+10 | -1.60204 | 0.2503 |
| SY | 2.28991E+12 | 1.43E+12 | 1.601998 | 0.2503 |
| LH | -16953557028 | 1.05E+10 | -1.60708 | 0.2493 |
| UV | -1.14496E+13 | 7.15E+12 | -1.602 | 0.2503 |
| ST | 5.40459E+11 | 3.37E+11 | 1.60215 | 0.2503 |
| P1 | -48187294852 | 3.01E+10 | -1.60012 | 0.2507 |
| AP | -8.13142E+12 | 5.07E+12 | -1.60239 | 0.2502 |
| NN2 | 1017922.95 | 3290966 | 0.309308 | 0.7863 |
| EC | 8.56684E+11 | 5.35E+11 | 1.602397 | 0.2502 |
| CV | -7.69577E+11 | 4.81E+11 | -1.60146 | 0.2504 |
| OA | 7.03835E+14 | 4.39E+14 | 1.603018 | 0.2501 |
| EY | 14366553.14 | 8728007 | 1.646029 | 0.2415 |
| P2 | 1.56031E+14 | 9.74E+13 | 1.602352 | 0.2502 |
| M | 8.521722195 | 3.550088 | 2.400426 | 0.1384 |
| PM2\*VN | 77748.27701 | 53659.34 | 1.448923 | 0.2844 |
| PM2\*NP | 1.53802E+11 | 9.6E+10 | 1.601937 | 0.2503 |
| PM2\*HV | 11444.85768 | 7060.832 | 1.620894 | 0.2465 |
| PM2\*NM1 | 590118354 | 3.59E+08 | 1.645339 | 0.2416 |
| PM2\*MS | -29533.031 | 33925.89 | -0.87052 | 0.4758 |
| PM2\*CD | -64831.7419 | 37372.49 | -1.73475 | 0.2249 |
| PM2\*ZL | -639226000.4 | 3.89E+08 | -1.64406 | 0.2419 |
| PM2\*PH | 1.3402E+13 | 8.05E+12 | 1.664392 | 0.2379 |
| PM2\*NM2 | -1.06709E+11 | 6.68E+10 | -1.59847 | 0.2510 |
| PM2\*PC | 6.89739E+12 | 4.3E+12 | 1.6022 | 0.2503 |
| PM2\*TN | 1.06659E+11 | 6.67E+10 | 1.598471 | 0.251 |
| PM2\*NI | 32248332.52 | 19656132 | 1.640625 | 0.2426 |
| PM2\*NN1 | -3.27384E+14 | 2.04E+14 | -1.60239 | 0.2502 |
| PM2\*TS | -7.94568E+17 | 4.96E+17 | -1.60236 | 0.2502 |
| PM2\*TO | 303194367.1 | 1.84E+08 | 1.644308 | 0.2418 |
| PM2\*CV | -8.65445E+15 | 5.4E+15 | -1.60302 | 0.2501 |
| VN\*VP | -1.74686E+12 | 1.09E+12 | -1.60194 | 0.2503 |
| VN\*HV | 260372.6628 | 178105.8 | 1.461899 | 0.2813 |
| VN\*NM1 | -8669418.401 | 5452911 | -1.58987 | 0.2528 |
| VN\*MS | 4982562.405 | 3086027 | 1.614555 | 0.2478 |
| VN\*CD | 66688.98237 | 45940.47 | 1.451639 | 0.2837 |
| VN\*ZL | 1.57748E+16 | 9.84E+15 | 1.602352 | 0.2502 |
| VN\*PH | -1.32951E+11 | 7.99E+10 | -1.66488 | 0.2379 |
| VN\*NM2 | 16172166.34 | 10144038 | 1.594253 | 0.2519 |
| VN\*PC | -1.10961E+12 | 6.9E+11 | -1.60809 | 0.2491 |
| VN\*TN | 596307.7186 | 347736.9 | 1.714824 | 0.2285 |
| VN\*NI | 22617541162 | 1.41E+10 | 1.608072 | 0.2491 |
| VN\*NN1 | 3.27093E+14 | 2.04E+14 | 1.602392 | 0.2502 |
| VN\*P2 | -1.60711E+16 | 1E+16 | -1.60235 | 0.2502 |
| NP\*HV | 1.74787E+12 | 1.09E+12 | 1.602084 | 0.2503 |
| NP\*NM1 | -2.15294E+12 | 1.34E+12 | -1.60208 | 0.2503 |
| NP\*MS | -1.70995E+11 | 1.07E+11 | -1.60188 | 0.2503 |
| NP\*PH | -3.27792E+13 | 2.05E+13 | -1.60239 | 0.2502 |
| HV\*NM1 | -898038.2457 | 4444833 | -0.20204 | 0.8586 |
| HV\*MS | 12772.51177 | 6517.145 | 1.959832 | 0.1891 |
| HV\*CD | 784604.3635 | 1554029 | 0.504884 | 0.6638 |
| HV\*NM2 | 1198483796 | 7.5E+08 | 1.597814 | 0.2512 |
| HV\*PC | 66081755826 | 4.11E+10 | 1.608747 | 0.2489 |
| NM1\*MS | 76458563.3 | 45777581 | 1.670219 | 0.2368 |
| NM1\*NM2 | -263410262 | 1.63E+08 | -1.61932 | 0.2468 |
| NM1\*TN | -6676570.909 | 6983370 | -0.95607 | 0.4399 |
| MS\*CD | -674.5724513 | 2048.288 | -0.32933 | 0.7732 |
| MS\*NM2 | 22211292.55 | 13903005 | 1.597589 | 0.2512 |

Abbreviations are as in Supplementary Tables 1

M3: Species identity model with average pairwise interactions

**Table 5** Parameter estimates for M3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Estimate | Std. Error | t value | P |
| PM2 | 62.88 | 99.23 | 0.634 | 0.5296 |
| VN | -254 | 104.3 | -2.435 | **0.019** |
| NP | -67.5 | 164.7 | -0.41 | 0.6838 |
| HV | -134.2 | 140.3 | -0.956 | 0.3441 |
| NM1 | -269.8 | 153.9 | -1.753 | 0.0866 |
| MS | 24.59 | 85.38 | 0.288 | 0.7747 |
| PA | 66.31 | 196.7 | 0.337 | 0.7377 |
| CD | 219.6 | 126.8 | 1.732 | 0.0903 |
| ZL | 905.4 | 195.1 | 4.641 | **<0.001** |
| PH | 464 | 190 | 2.443 | **0.0187** |
| NM2 | -342.6 | 166.1 | -2.062 | **0.0451** |
| PC | -2590 | 8869 | -0.292 | 0.7717 |
| TN | 161.1 | 182 | 0.885 | 0.3809 |
| NI | -187.3 | 156.6 | -1.197 | 0.2379 |
| NN1 | 52.96 | 637.4 | 0.083 | 0.9342 |
| TS | -371.7 | 292 | -1.273 | 0.2098 |
| EF | -870.3 | 1772 | -0.491 | 0.6258 |
| PM1 | 8.87 | 17360 | 0.001 | 0.9996 |
| TO | 1835 | 739.3 | 2.482 | **0.017** |
| HD | 433.9 | 491 | 0.884 | 0.3817 |
| SY | -16270 | 22860 | -0.712 | 0.4804 |
| LH | -4885 | 4271 | -1.144 | 0.2588 |
| UV | 87550 | 114300 | 0.766 | 0.4477 |
| ST | -180.8 | 5267 | -0.034 | 0.9728 |
| P1 | 6793 | 4955 | 1.371 | 0.1774 |
| AP | -750.1 | 1745 | -0.43 | 0.6694 |
| NN2 | 102100 | 24080 | 4.243 | **<0.001** |
| EC | 1106 | 355.4 | 3.113 | **0.0032** |
| CV | 1790 | 4595 | 0.39 | 0.6987 |
| OA | -1339 | 1629 | -0.822 | 0.4155 |
| EY | -2880 | 3995 | -0.721 | 0.4747 |
| P2 | -1503 | 2423 | -0.621 | 0.5381 |
| M | 4.426 | 0.8368 | 5.289 | **<0.001** |
| PPsum | -322.4 | 256.6 | -1.256 | 0.2157 |

Abbreviations are as in Supplementary Tables 1; PPsum is the sum of pairwise interactions.