

## Supplementary Material 2

Table S1. Different functional forms of  $f(T)$  and their behavior along the ecosystem-size gradient.

| Case                 | $f(T)$   | Behavior of $f(T)$ for $T > T_1$   | $T$ values for $f(T) = 0$   |
|----------------------|--|------------------------------------|---|
| $T < M_1, M_2, M_3$  | $f_{(·123)} \equiv 1 - \frac{e}{s_1 T} - \frac{2s_2 e}{s_3^2 T}$           | Monotonic increase                 | $T_{(·123)} \equiv \frac{e}{s_1} + \frac{2s_2 e}{s_3^2}$  |
| $M_1 < T < M_2, M_3$ | $f_{(1·23)} \equiv 1 - \frac{e}{s_1 M_1} - \frac{2s_2 e}{s_3^2 T}$         | Monotonic increase                 | $T_{(1·23)} \equiv \frac{2s_2 e / s_3^2}{1 - e / (s_1 M_1)}$  |
| $M_2 < T < M_1, M_3$ | $f_{(2·13)} \equiv 1 - \frac{e}{s_1 T} - \frac{2s_2 M_2 e}{s_3^2 T^2}$     | Monotonic increase                 | $T_{(2·13)} \equiv \frac{e/s_1 + \sqrt{(e/s_1)^2 + 8s_2 M_2 e / s_3^2}}{2}$   |
| $M_3 < T < M_1, M_2$ | $f_{(3·12)} \equiv 1 - \frac{e}{s_1 T} - \frac{2s_2 T e}{s_3^2 M_3^2}$     | Quadratic increase and/or decrease | $T_{(3·12), \pm} \equiv \frac{1 \pm \sqrt{1 - 8s_2 e^2 / (s_1 s_3^2 M_3^2)}}{4s_2 e / (s_3^2 M_3^2)}$<br>$T_{(3·12), \text{mid}} \equiv \frac{1}{4s_2 e / (s_3^2 M_3^2)}$ |
| $M_1, M_2 < T < M_3$ | $f_{(12·3)} \equiv 1 - \frac{e}{s_1 M_1} - \frac{2s_2 M_2 e}{s_3^2 T^2}$   | Monotonic increase                 | $T_{(12·3)} \equiv \sqrt{\frac{2s_2 M_2 e / s_3^2}{1 - e / (s_1 M_1)}}$   |
| $M_1, M_3 < T < M_2$ | $f_{(13·2)} \equiv 1 - \frac{e}{s_1 M_1} - \frac{2s_2 T e}{s_3^2 M_3^2}$   | Monotonic decrease                 | $T_{(13·2)} \equiv \frac{1 - e / (s_1 M_1)}{2s_2 e / (s_3^2 M_3^2)}$  |
| $M_2, M_3 < T < M_1$ | $f_{(23·1)} \equiv 1 - \frac{e}{s_1 T} - \frac{2s_2 M_2 e}{s_3^2 M_3^2}$   | Monotonic increase                 | $T_{(23·1)} \equiv \frac{e / s_1}{\sqrt{1 - 2s_2 M_2 e / (s_3^2 M_3^2)}}$   |
| $M_1, M_2, M_3 < T$  | $f_{(123·)} \equiv 1 - \frac{e}{s_1 M_1} - \frac{2s_2 M_2 e}{s_3^2 M_3^2}$ | Constant                           | ---   |

Table S2. Sign of  $f(T)$  along the ecosystem-size gradient ( $M_1 < M_2 < M_3$ ).

| $T$                | $T_2$ or $T_3$ |                           | $M_1$                    | $M_2$                     | $M_3$                     |              |                         |             |
|--------------------|----------------|---------------------------|--------------------------|---------------------------|---------------------------|--------------|-------------------------|-------------|
| $f(T)$             | $f_{(-123)}$   | $f_{(-123)}$              | $f_{(-123)}, f_{(1-23)}$ | $f_{(1-23)}$              | $f_{(1-23)}, f_{(12-3)}$  | $f_{(12-3)}$ | $f_{(12-3)}, f_{(123)}$ | $f_{(123)}$ |
| -<br>( $T = T_3$ ) | -              | 0<br>( $T = T_{(-123)}$ ) | +                        | +                         | +                         | +            | +                       | +           |
| +<br>( $T = T_2$ ) | +              | +                         | +                        | +                         | +                         | +            | +                       | +           |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | 0<br>( $T = T_{(1-23)}$ ) | +                         | +            | +                       | +           |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | -                         | 0<br>( $T = T_{(12-3)}$ ) | +            | +                       | +           |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | -                         | -                         | -            | -                       | -           |

Table S3. Sign of  $f(T)$  along the ecosystem-size gradient ( $M_1 < M_3 < M_2$ ).

| $T$                | $T_2$ or $T_3$ |                           | $M_1$                    | $M_3$                     | $M_2$                    |                           |                         |             |
|--------------------|----------------|---------------------------|--------------------------|---------------------------|--------------------------|---------------------------|-------------------------|-------------|
| $f(T)$             | $f_{(-123)}$   | $f_{(-123)}$              | $f_{(-123)}, f_{(1-23)}$ | $f_{(1-23)}$              | $f_{(1-23)}, f_{(13-2)}$ | $f_{(13-2)}$              | $f_{(13-2)}, f_{(123)}$ | $f_{(123)}$ |
| -<br>( $T = T_3$ ) | -              | 0<br>( $T = T_{(-123)}$ ) | +                        | +                         | +                        | +                         | +                       | +           |
| +<br>( $T = T_2$ ) | +              | +                         | +                        | +                         | +                        | +                         | +                       | +           |
| -<br>( $T = T_3$ ) | -              | 0<br>( $T = T_{(-123)}$ ) | +                        | +                         | +                        | 0<br>( $T = T_{(13-2)}$ ) | -                       | -           |
| +<br>( $T = T_2$ ) | +              | +                         | +                        | +                         | +                        | 0<br>( $T = T_{(13-2)}$ ) | -                       | -           |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | 0<br>( $T = T_{(1-23)}$ ) | +                        | +                         | +                       | +           |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | 0<br>( $T = T_{(1-23)}$ ) | +                        | 0<br>( $T = T_{(13-2)}$ ) | -                       | -           |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | -                         | -                        | -                         | -                       | -           |

Table S4. Sign of  $f(T)$  along the ecosystem-size gradient ( $M_2 < M_1 < M_3$ ).

| $T$                | $T_2$ or $T_3$ | $M_2$                     |                          | $M_1$                     |                          | $M_3$                     |                          |              |
|--------------------|----------------|---------------------------|--------------------------|---------------------------|--------------------------|---------------------------|--------------------------|--------------|
| $f(T)$             | $f_{(-123)}$   | $f_{(-123)}$              | $f_{(-123)}, f_{(2-13)}$ | $f_{(2-13)}$              | $f_{(2-13)}, f_{(12-3)}$ | $f_{(12-3)}$              | $f_{(12-3)}, f_{(123-)}$ | $f_{(123-)}$ |
| -<br>( $T = T_3$ ) | -              | 0<br>( $T = T_{(-123)}$ ) | +                        | +                         | +                        | +                         | +                        | +            |
| +<br>( $T = T_2$ ) | +              | +                         | +                        | +                         | +                        | +                         | +                        | +            |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | 0<br>( $T = T_{(2-13)}$ ) | +                        | +                         | +                        | +            |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | -                         | -                        | 0<br>( $T = T_{(12-3)}$ ) | +                        | +            |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | -                         | -                        | -                         | -                        | -            |

Table S5. Sign of  $f(T)$  along the ecosystem-size gradient ( $M_2 < M_3 < M_1$ ).

| $T$                | $T_2$ or $T_3$ | $M_2$                     |                          | $M_3$                     |                          | $M_1$                     |                          |              |
|--------------------|----------------|---------------------------|--------------------------|---------------------------|--------------------------|---------------------------|--------------------------|--------------|
| $f(T)$             | $f_{(-123)}$   | $f_{(-123)}$              | $f_{(-123)}, f_{(2-13)}$ | $f_{(2-13)}$              | $f_{(2-13)}, f_{(23-1)}$ | $f_{(23-1)}$              | $f_{(23-1)}, f_{(123-)}$ | $f_{(123-)}$ |
| -<br>( $T = T_3$ ) | -              | 0<br>( $T = T_{(-123)}$ ) | +                        | +                         | +                        | +                         | +                        | +            |
| +<br>( $T = T_2$ ) | +              | +                         | +                        | +                         | +                        | +                         | +                        | +            |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | 0<br>( $T = T_{(2-13)}$ ) | +                        | +                         | +                        | +            |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | -                         | -                        | 0<br>( $T = T_{(23-1)}$ ) | +                        | +            |
| -<br>( $T = T_3$ ) | -              | -                         | -                        | -                         | -                        | -                         | -                        | -            |

Table S6. Sign of  $f(T)$  along the ecosystem-size gradient ( $M_3 < M_1 < M_2$ ).

| $T$                | $T_2$ or $T_3$            | $M_3$        |                             |              |              | $M_1$                         |                          |                           | $M_2$                    |              |
|--------------------|---------------------------|--------------|-----------------------------|--------------|--------------|-------------------------------|--------------------------|---------------------------|--------------------------|--------------|
| $f(T)$             | $f_{(-123)}$              | $f_{(-123)}$ | $f_{(-123)}, f_{(3-12)}$    | $f_{(3-12)}$ | $f_{(3-12)}$ | $f_{(3-12)}$                  | $f_{(3-12)}, f_{(13-2)}$ | $f_{(13-2)}$              | $f_{(13-2)}, f_{(123-)}$ | $f_{(123-)}$ |
| -<br>( $T = T_3$ ) | 0<br>( $T = T_{(-123)}$ ) | +            | +                           | +            | +            | +                             | +                        | +                         | +                        | +            |
| +<br>( $T = T_2$ ) | +                         | +            | +                           | +            | +            | +                             | +                        | +                         | +                        | +            |
| -<br>( $T = T_3$ ) | 0<br>( $T = T_{(-123)}$ ) | +            | +                           | +            | +            | +                             | +                        | 0<br>( $T = T_{(13-2)}$ ) | -                        | -            |
| +<br>( $T = T_2$ ) | +                         | +            | +                           | +            | +            | +                             | +                        | 0<br>( $T = T_{(13-2)}$ ) | -                        | -            |
| -<br>( $T = T_3$ ) | 0<br>( $T = T_{(-123)}$ ) | +            | +                           | +            | +            | 0<br>( $T = T_{(3-12),+}$ )   | -                        | -                         | +                        | +            |
| +<br>( $T = T_2$ ) | +                         | +            | +                           | +            | +            | 0<br>( $T = T_{(3-12),+}$ )   | -                        | -                         | +                        | +            |
| -<br>( $T = T_3$ ) | -                         | -            | 0<br>( $T = T_{(3-12),-}$ ) | +            | +            | +                             | +                        | +                         | +                        | +            |
| -<br>( $T = T_3$ ) | -                         | -            | 0<br>( $T = T_{(3-12),-}$ ) | +            | +            | +                             | +                        | 0<br>( $T = T_{(13-2)}$ ) | -                        | -            |
| -<br>( $T = T_3$ ) | -                         | -            | 0<br>( $T = T_{(3-12),-}$ ) | +            | +            | 0<br>( $T = T_{(3-12),mid}$ ) | +                        | -                         | -                        | -            |
| -<br>( $T = T_3$ ) | -                         | -            | -                           | -            | -            | -                             | -                        | -                         | -                        | -            |

Table S7. Sign of  $f(T)$  along the ecosystem-size gradient ( $M_3 < M_2 < M_1$ ).

| $T$                | $T_2$ or $T_3$            |              | $M_3$                    |                             |              | $M_2$                         |                          | $M_1$                     |                         |             |
|--------------------|---------------------------|--------------|--------------------------|-----------------------------|--------------|-------------------------------|--------------------------|---------------------------|-------------------------|-------------|
| $f(T)$             | $f_{(-123)}$              | $f_{(-123)}$ | $f_{(-123)}, f_{(3-12)}$ | $f_{(3-12)}$                | $f_{(3-12)}$ | $f_{(3-12)}$                  | $f_{(3-12)}, f_{(23-1)}$ | $f_{(23-1)}$              | $f_{(23-1)}, f_{(123)}$ | $f_{(123)}$ |
| -<br>( $T = T_3$ ) | 0<br>( $T = T_{(-123)}$ ) | 0            | +                        | +                           | +            | +                             | +                        | +                         | +                       | +           |
| +<br>( $T = T_2$ ) | +                         | +            | +                        | +                           | +            | +                             | +                        | +                         | +                       | +           |
| -<br>( $T = T_3$ ) | 0<br>( $T = T_{(-123)}$ ) | 0            | +                        | +                           | +            | 0<br>( $T = T_{(3-12),+}$ )   | -                        | -                         | -                       | -           |
| +<br>( $T = T_2$ ) | +                         | +            | +                        | +                           | +            | 0<br>( $T = T_{(3-12),+}$ )   | -                        | -                         | -                       | -           |
| -<br>( $T = T_3$ ) | 0<br>( $T = T_{(-123)}$ ) | 0            | +                        | +                           | +            | 0<br>( $T = T_{(3-12),+}$ )   | -                        | 0<br>( $T = T_{(23-1)}$ ) | +                       | +           |
| +<br>( $T = T_2$ ) | +                         | +            | +                        | +                           | +            | 0<br>( $T = T_{(3-12),+}$ )   | -                        | 0<br>( $T = T_{(23-1)}$ ) | +                       | +           |
| -<br>( $T = T_3$ ) | -                         | -            | -                        | 0<br>( $T = T_{(3-12),-}$ ) | +            | 0<br>( $T = T_{(3-12),+}$ )   | -                        | -                         | -                       | -           |
| -<br>( $T = T_3$ ) | -                         | -            | -                        | 0<br>( $T = T_{(3-12),-}$ ) | +            | 0<br>( $T = T_{(3-12),mid}$ ) | -                        | 0<br>( $T = T_{(23-1)}$ ) | +                       | +           |
| -<br>( $T = T_3$ ) | -                         | -            | -                        | 0<br>( $T = T_{(3-12),-}$ ) | +            | 0<br>( $T = T_{(3-12),mid}$ ) | -                        | 0<br>( $T = T_{(23-1)}$ ) | +                       | +           |
| -<br>( $T = T_3$ ) | -                         | -            | -                        | 0<br>( $T = T_{(3-12),-}$ ) | +            | +                             | +                        | +                         | +                       | +           |
| -<br>( $T = T_3$ ) | -                         | -            | -                        | -                           | -            | -                             | -                        | 0<br>( $T = T_{(23-1)}$ ) | +                       | +           |
| -<br>( $T = T_3$ ) | -                         | -            | -                        | -                           | -            | -                             | -                        | -                         | -                       | -           |