Ecosystem services for aquatic macrophytes: linking ecology to risk assessment of chemicals

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Background
- Ecosystem services are the benefits people obtain from ecosystem structures and processes [1, 2];
- The potential impact of toxicants on ecosystem services was recognized 25 years ago [3], but the incorporation in risk assessment has only been considered recently [4];
- Risk assessment of chemicals could benefit from quantification of important ecosystem services;
- Here we focus on plants as important key service providing units (SPUs) [4];
- Aim: to collate quantitative information of ecosystem services from three different types of aquatic macrophyte vegetation:
  - seagrass beds as a representative of submerged macrophyte vegetation;
  - duckweed vegetation as a representative of floating macrophyte layers;
  - reed as a representative of emergent macrophyte stands.

Ecosystem services delivery by SPUs

<table>
<thead>
<tr>
<th>Service groups</th>
<th>Seagrass</th>
<th>Duckweed</th>
<th>Reed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning</td>
<td>mattress stuffing</td>
<td>proteins</td>
<td>thatching, litter, cover</td>
</tr>
<tr>
<td>Regulating: (g C/m² aboveground biomass)</td>
<td>Zostera marina:110; Z. noltii: 30</td>
<td>15.6</td>
<td>615</td>
</tr>
<tr>
<td>Regulating: C-fixation g C/m²/year</td>
<td>138</td>
<td>1.63</td>
<td></td>
</tr>
<tr>
<td>Regulating: erosion prevention g sediment/m²/day</td>
<td>0.1 – 116</td>
<td>12.5 – 25</td>
<td></td>
</tr>
<tr>
<td>Regulating: nutrient retention mg N or P/m²/day</td>
<td>69 - 140 (N)</td>
<td>120 – 590 (N)</td>
<td>63013 (N)</td>
</tr>
<tr>
<td>Regulating: nutrient retention mg N or P/m²/day</td>
<td>14 - 74 (P)</td>
<td>4383 (P)</td>
<td></td>
</tr>
<tr>
<td>Cultural</td>
<td>Low</td>
<td>Low to High</td>
<td>High</td>
</tr>
<tr>
<td>Supporting: primary production g above ground dry weight/m²/day</td>
<td>Zostera marina: 5.2</td>
<td>Lemna minor: 1.1</td>
<td>0.8-11.4</td>
</tr>
<tr>
<td>Supporting: primary production g above ground dry weight/m²/day</td>
<td>Z. noltii: 1.1</td>
<td>aboveground</td>
<td>7.7-30.6</td>
</tr>
</tbody>
</table>


Conclusions from Table 1
- Aquatic macrophytes are important SPUs in aquatic ecosystems;
- Provisioning services are common and were/are economically favourable;
- Regulating services include carbon fixation and storage, primary production and nutrient retention.

How to link ecosystem services to risk assessment quantitatively?
- Macrophyte assessment endpoints need to be linked to SPUs;
- Biomass seems to be a promising endpoint:
  - It is included as one of the assessment endpoints in the protection goals;
  - Can be linked to the ecosystem services provided by aquatic macrophytes;
  - Is an important output of macrophyte experimental studies and models assessing the effects of chemicals;
  - Approach needs further elaboration and quantification.
- Application in ecosystem services mapping and quantification of effects of chemicals on important ecosystem services;

References