Illustrative Example for Bioconcentration, Bioaccumulation and Biomagnification Assessment: Cobalt

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Context

- Four cobalt substances were assessed in 2010 under the Government of Canada’s Challenge initiative: elemental cobalt, cobalt chloride, sulfuric acid cobalt salts (n = 2)
- Since these substances are inorganic water soluble salts, the bioconcentration, bioaccumulation and biomagnification assessment was actually conducted for the cobalt element.
- The assessment was submitted at SIAM 31 in October 2010.
Methodology

• Literature review of studies on cobalt bioconcentration, bioaccumulation and biomagnification (BCF/BAF/BSAF/BMF/TMF);
• Selection of studies based on a set of criteria developed by Environment Canada (outlined in next slides) – novel approach used for the first time;
• Further assessment of the reliability of selected studies using Robust Study Summaries (RSS);
• Compilation and analysis of results;
• Consideration of several lines of evidence.
Methodology (continued)

• Definition of acronyms:
  – BCF: Bioconcentration Factor
  – BAF: Bioaccumulation Factor
  – BSAF: Biota to Soil or Sediment Accumulation Factor
  – BMF: Biomagnification Factor
  – TMF: Trophic Magnification Factor
10 main considerations for determining the reliability of BCF/BAF/BSAF/BMF/TMF studies for metals

1) Steady-state is reached;
2) Field BAFs are preferred over laboratory-derived BCFs;
3) Metal concentration (\([M]\)) in test organism and in water are measured simultaneously;
4) \([M]\) in water is low in order to (1) minimize BCF/BAF decreases with increases in exposure concentration; (2) be well below levels causing chronic toxicity; and (3) metal concentration in water and tissue must exceed detection limits;
10 main considerations for determining the reliability of BCF/BAF/BSAF/BMF/TMF studies for metals (continued)

5) Key methodological details are provided in the study;
6) QA/QC checks are reported;
7) BCFs, BAFs are expressed on a wet weight basis; when possible, ratios are corrected for background [M] in test organism and water; when possible body [M] are corrected for [M] in gut contents for BCFs and BAFs;
8) Consideration is given to degree of essentiality of the metal;
10 main considerations for determining the reliability of BCF/BAF/BSAF/BMF/TMF studies for metals (continued)

9) Consideration is given to detoxification mechanisms (e.g. BCFs and BAFs less meaningful for hyper accumulators and regulators, hence some studies may not be used);

10) Studies conducted before 1977–1978 generally considered of uncertain quality because of numerous analytical difficulties for metals at that time.
Results for cobalt

• Cobalt is an essential micro-nutrient element for bacteria, algae and animals; to some extent, homeostatic mechanisms exist to regulate internal cobalt levels including uptake

• 38 studies were considered; 20 of these were used for this bioconcentration/bioaccumulation/biomagnification assessment

• 18 studies were rejected; most common reasons include:
  – [M] in organisms or water not adequately measured or reported;
  – Hyperaccumulator species used;
  – Metal chemical analyses performed prior to 1977;
  – Lack of sufficient information (methodological/results).
### Results for cobalt (continued)

<table>
<thead>
<tr>
<th>Number of values</th>
<th>Type of ratio</th>
<th>Average</th>
<th>Range</th>
<th>Taxonomic group(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>BCF/BAF</td>
<td>878 L/kg</td>
<td>7.4-3110 L/kg</td>
<td>algae, invertebrates, fish</td>
</tr>
<tr>
<td>4</td>
<td>BSAF-sed.</td>
<td>0.232</td>
<td>0.091-0.645</td>
<td>invertebrates</td>
</tr>
<tr>
<td>4</td>
<td>BSAF-soil</td>
<td>0.155</td>
<td>0.078-15</td>
<td>terrestrial plants</td>
</tr>
<tr>
<td>4</td>
<td>BMF</td>
<td>0.030</td>
<td>0.004-0.087</td>
<td>invertebrates, fish</td>
</tr>
<tr>
<td>5</td>
<td>TMF</td>
<td>1.03</td>
<td>0.71-1.45</td>
<td>algae, invertebrates, fish, birds, mammals</td>
</tr>
</tbody>
</table>
Results for cobalt (continued)

• Conclusion: the 4 substances were not found to meet the bioaccumulation criteria (BAF or BCF > 5000) as set out in the Persistence and Bioaccumulation Regulations (CEPA 1999), on the basis of the cobalt element.
Status of the approach to assess Bioconcentration, Bioaccumulation and Biomagnification for metals

- The approach (i.e. 10 main considerations) has been peer-reviewed by metal experts (academics) in Canada.
- As part of the draft Challenge assessment report (4 cobalt substances), the approach was published for a 60-day public comment period in Canada; no objections were noted.
- The approach was presented to SIAM 31 in October 2010; no objections noted.
- The approach has also been applied in the Challenge assessments of vanadium pentoxide and antimony oxide.
- Canada plans to continue with this approach in the future.
For more information on the Canadian cobalt assessment:
www.chemicalsubstanceschimiques.gc.ca/challenge-defi/batch-lot-10/index-eng.php#a5

Thank you!
Merci!