Making the World Safe for Shrews:
Good Policy and Good Science or Unintended / Unconsidered Consequence of Conservatism?

Daniel Smith | GHD Exton, PA
## Current ESVs/PRGs Focus on Shrew Protection

<table>
<thead>
<tr>
<th>Source</th>
<th>% of ESVs due to Shrew</th>
<th>Shrew mass, g</th>
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Tens of Millions $ Spent for Coveted Triple S Status
Risk for Wildlife Occurs When

\[ TRV \ (\text{mg/kg/day}) < \frac{C_{\text{soil}} [IR_{\text{soil}} + (IR_{\text{food}} \times BCF)] \times AUF}{BW} \]

Where

- \( TRV \) = Toxicity reference value, safe dose (mg/kg/day)
- \( C_{\text{soil}} \) = Chemical and receptor-specific ESL in soil (mg/kg)
- \( BW \) = Receptor-specific body weight (kg)
- \( IR_{\text{soil}} \) = Receptor-specific soil ingestion rate (kg/day)
- \( IR_{\text{food}} \) = Receptor-specific food ingestion rate (kg/day)
- \( BCF \) = Soil-to-food bioconcentration factor (kg soil/kg food)
- \( AUF \) = Area Use Factor, % of Life Spent at Site
Why Do the Shrews Always Die?

Shrew Risk is a Positive Function of:

- Food consumption / body mass (usually highest)
- Incidental soil ingestion (very high)
- Food concentrations (usually highest)
- Site fidelity (usually highest)
- 1/TRV (usually not species dependent)
First Consider the Biology of the Shrew

Shrews are close to energetically impossible because:

- Very small homeotherms
- Smallest mammals – very high surface to volume ratio
- Common in colder climes
- Do not hibernate
- Do not have periods of torpor
- Very active predators

Metabolic rates / biomass highest of mammals

Often on edge of starvation

- Populations may be density dependent
Mammal Body Size vs Metabolic Rate

\[ y = 4.0041x^{0.6905} \]

Body Mass, grams ww

Basal Metab, ml O2/hr

Mammals

Soricid Shrews

Power (Mammals)

Power (Soricid Shrews)
Body Size vs Mass Specific Metabolic Rate

Metabolic Rate, ml O2/gram BW/hr vs Body Weight, grams ww

Species include:
- Shrew
- Harvest mouse
- Kangaroo mouse
- House mouse
- Ground squirrel
- Rat
- Cat
- Dog
- Sheep
- Lion
- Human
- Eland
- Elephant
- Blue whale

The graph shows a negative correlation between body weight and metabolic rate, with larger species having lower metabolic rates per unit body weight.
Good Assessment Endpoints Are

• Ecologically Important,
• Sensitive to Pollutant, AND
• Important to Society

“Three principal criteria are used to select ecological values that may be appropriate for assessment endpoints: (1) ecological relevance, (2) susceptibility to known or potential stressors, and (3) relevance to management goals. Of these, ecological relevance and susceptibility are essential for selecting assessment endpoints that are scientifically defensible. However, to increase the likelihood that the risk assessment will be used in management decisions, assessment endpoints are more effective when they also reflect societal values and management goals.”

EPA 1998 and Federal Register 1998
Are Shrews Ecologically Important? Maybe...

Importance to upper trophic levels uncertain
- Small % of prey biomass
- Mammals don’t like smell
- Readily taken by birds

Importance to lower trophic levels also uncertain
- 🔺 metabolism = 🔺 predation
  - % metab > % biomass
Are Shrews Sensitive to Pollutants? Maybe but...

Data show that shrews are highly exposed; however typical risk assessment method may exaggerate risks

- Food consumption rates may be too high
- % worms in diet much too high
  - Worms may be most efficient bioaccumulators
- Non-linear bioaccumulation makes small safety factors bigger
- Incidental soil ingestion often too high
  - Assumption of 100% RBA in soil too high
- Failure to consider high excretion rates
- Failure to consider density-dependent mortality
# Current ERA Methods May Exaggerate Risks

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Cadmium in Shrew and Vole vs. Soil

Animal Cd, mg/kg vs. Soil Cd, mg/kg

- Carnivorous Shrews
- Herbivorous Voles
## Metabolic TRV Scaling Factor from Lab Animal to Shrew

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<tr>
<td></td>
<td>0.75</td>
<td>0.67</td>
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<tr>
<td>From Mouse</td>
<td>1.1</td>
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</tr>
<tr>
<td>From Rat</td>
<td>1.8</td>
<td>2.2</td>
</tr>
<tr>
<td>From Mink</td>
<td>2.7</td>
<td>3.8</td>
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Are Shrews Important to Society? Probably not.
Why Are Shrews So Often Basis of EcoRisk and Remediation for EcoRisk?

- Not because they are important to society
- Probably not because they are important ecologically
- Probably because they appear to be at risk when assessed with conservative screening methods
This site is Sertified Shrew Safe