A Risk Assessment of Methylmercury to Fish in South Florida

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ABSTRACT

A list of fish species has been evaluated based on methylmercury (MeHg) toxicity. The range of lowest effect residue reported was 470 ng/g wet weight (ww) in largemouth bass and 959 ng/g ww (wet weight) in bluegill sunfish. The seasonal variations in water temperature and solar UV radiation can be expected to impose dramatic changes in the exposure and hence observed effect levels. Based on the relationship between tissue THg and MeHg concentrations, it is assumed that the majority of the mercury detected in fish is comprised by methylmercury. The MeHg concentrations in tissues are compared to thresholds that were derived from a Monte Carlo simulation, which incorporates Monte Carlo sampling of the variability of fish effects and among studies, subject to a lognormal distribution. Based on tissue THg, the risk to fish from mercury will also vary spatially and temporally.

METHODS

The effect of MeHg exposure was evaluated by overlaying the literature for species that showed fish with MeHg and documented statistically significant effects. Ideally, each individual tissue level from each study was accepted into the model if it was greater than the 95% confidence level, but due to the limited number of data sets, the threshold for each analysis was set at 95%. A lognormal distribution was assumed for both residue data sets. Risk probability was determined using the Monte Carlo sampling capability of Crystal Ball®. It was assumed that the risk was uniform across the entire range of concentrations of residues in fish tissues. Risk probabilities were based on an average of 2,737 samples, and were based protection levels while the "dietary effect residue" values establish a consumption based protection level. The risk threshold for whole fish was based on the "dietary effect residue" values as reported for all locations and species.

It is evident from the effects data that sufficient biological effects have been observed at levels above the current USEPA and state guidelines.

DISCUSSION

Table 3. Risk Probabilities Based on Monte Carlo Sampling

<table>
<thead>
<tr>
<th>Organism Level</th>
<th>Largemouth Bass, All Locations Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival</td>
<td>0.750</td>
</tr>
<tr>
<td>Growth</td>
<td>0.667</td>
</tr>
<tr>
<td>Reproduction</td>
<td>0.500</td>
</tr>
</tbody>
</table>

Table 1. Lowest Effect Residue Levels Reported in Literature

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Organism</th>
<th>Location</th>
<th>Primates</th>
<th>Lower Confidence Bound</th>
<th>Upper Confidence Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>Methylmercury</td>
<td>Largemouth Bass</td>
<td>750 ng/g ww</td>
<td>500 ng/g ww</td>
<td>1000 ng/g ww</td>
</tr>
<tr>
<td>Kidney</td>
<td>Methylmercury</td>
<td>Bluegill</td>
<td>2000 ng/g ww</td>
<td>1500 ng/g ww</td>
<td>2500 ng/g ww</td>
</tr>
</tbody>
</table>

Figure 1. Total Mercury in All Fish Species Related to Threshold Effect Levels

Figure 2. Total Mercury in Fish by Species Related to Threshold Effect Levels

Figure 3. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 4. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 5. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 6. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 7. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 8. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 9. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 10. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 11. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 12. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass

Figure 13. Temporal Threshold Levels in Relation to Spatial and Temporal Variations of Total Mercury burdens in Largemouth Bass