Ecological Risk Assessment of Dioxins on Common Cormorant Populations

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We estimated the risk of dioxin exposure in Tokyo Bay sediment via fish ingestion onto common cormorant (Phalacrocorax carbo) populations, in reference to the egg mortality.

Exposure via contaminated fish was estimated using the next equation.

\[ TEQ_{\text{egg}} = \sum_{\text{congener}} C_{\text{sed}} \times BSAF \times BMF \times EBR \times TEF / L_{\text{egg}} \]

Where, \( TEQ_{\text{egg}} \)=Total toxic equivalency quantity in egg (pg TEQ/g egg wet weight basis), \( C_{\text{sed}} \)=Organic carbon-normalized concentration of each congener (12 congeners; 2378TCDD, 12378PeCDF, 234678HxCDF, PCB81, 77, 126, 104, 105, 118, 156 and 157) in sediment (pg/g sediment OC weight basis), \( BSAF \)=Lipid- and organic carbon-normalized concentration ratio between fish and sediment, \( BMF \)=Lipid-normalized concentration ratio between cormorant and fish, \( EBR \)= Lipid-normalized concentration ratio between egg and parent body, \( TEF \)=Toxic equivalency factor (WHO-bird), \( L_{\text{egg}} \)=Lipid content in cormorant egg. The parameters in the right side of the equation, except for TEF, were assigned to probability distributions, respectively. Then, Monte-Carlo simulations were performed using the software package Crystal Ball 4.0 (Decisioneering, Inc., USA). As a result, the probability distribution of \( TEQ_{\text{egg}} \) was obtained (Fig. 1).

Effects characterization was conducted on the basis of the toxicity data that was derived 2378TCDD egg injection test on double-crested cormorant (Phalacrocorax auritus) (Powell et al., 1998). On the assumption that the base-10 logarithms of tolerances are assumed to have a normal distribution with parameters: mean=\( \log (LC50) \); standard deviation=1/slope, from the probit model, a random tolerance is generated as follows (ECOFRAM; USEPA, 1999).

\[ \text{Random tolerance} = LD_{50} \times 10^{(Z/slope)} \]

\( Z \) = standard normal distribution (m=0, \( \delta =1 \))

Risk characterization is a stage where results of exposure and effects analyses are integrated to evaluate the likelihood of adverse effects occurring. The mortality probability function is a quantal response, and for a given exposure and sensitivity, an individual either dies (where the tolerance of the individual is less than the exposure received) or survives.

If exposure>tolerance then morality, if exposure<tolerance then survival

Consequently, the probability distribution of egg mortality was estimated (Fig.2).

In the next phase, we will evaluate the risk in terms of population-level effects.