BIOMONITORING OF TERRESTRIAL VERTEBRATES IN ATLANTIC COAST ESTUARIES: UTLITY AND VULNERABILITY INDICES

Nancy H. Golden1,2, Barnett A. Rattner1, and Mary Ann Ottinger2
1USGS Patuxent Wildlife Research Center, Laurel, MD., 2University of Maryland, College Park, MD. Park.

Abstract

As part of the Biomonitoring of Environmental Status and Trends program of USGS, the threat of contaminants to terrestrial vertebrates residing in or near coastal estuarine ecosystems is being evaluated by data synthesis and field studies. As one objective, the utility of various wildlife species for contaminant monitoring is evaluated on the Atlantic Coast being evaluated. Two sets of indices have been developed to assist decision makers in risk assessment of persistent organic pollutants, cholinesterase-inhibiting pesticides, mercury, lead, oil, and petroleum-the crude of contamination. The "Utility Index" ranks terrestrial vertebrate species as potential biomonitoring of these chemicals based upon exposure potential, geographic occurrence, habitat vulnerability, and health utility. The "Vulnerability Index" ranks terrestrial vertebrates in terms of their sensitivity, individual resilience, and population resilience. Though several indices have been primarily evaluated the utility of each index, these tests have been limited to assess the utility of other terrestrial vertebrates to those chosen. For 25 species commonly found in estuaries habitats, a set of indices was developed to rank species from the Atlantic Coast for their vulnerability to contaminants and their utility in monitoring pollution in Atlantic Coast estuaries. The indices can be utilized in the creation of a high-scope monitoring program for this region, or indices can be used by resource managers in the creation of local monitoring programs.

Methods

Two indices were developed to rank terrestrial vertebrate species:
- The Utility Index ranks the suitability of a species as a biomonitor of exposure to a contaminant.
- The Vulnerability Index ranks susceptibility of populations upon exposure.

Indices were developed for 5 contaminants or contaminant classes:
- Persistent Organic Pollutants (POPs)
- Mercury
- Chlorinated (C3)-Inhibiting Pesticides

Mercury Utility Index Score =
(A1 + A2 + A3) + (B1 + B2) + (C1 + C2 + C3 + C4 + C5) + (D)

Mercury Vulnerability Index Score =
2(1 + A1 + A2 + A3 + A5 + A6) + (B1) + (C1 + C2 + C3 + C4 + C5)

Conclusions

Rankings presented apply only to terrestrial vertebrates residing in Atlantic Coast estuaries, and only when considering the entire coast as the intended study area. However, the indices are designed to be generic, and thus may be utilized in their present form to rank any species in any habitat.

In general, high ranks for vulnerability were not necessarily predictive of utility, and vice versa.

Though birds are overwhelmingly used for terrestrial vertebrates contaminant monitoring, mammals and reptiles consistently ranked among the top species as biomonitor of environmental pollution.

Inter-species sensitivity is often poorly chackecl, and hinders the assessment of vulnerability.

Some species, such as the turtles, ranked high in vulnerability to contaminants from fish, and low in utility, due to their phylogeny of contamination exposure and effects data available.

Results and Discussion

Sample: MERCURY UTILITY INDEX

A. EXPOSURE POTENTIAL

1. Dietary Potential
- Fish
- Terrestrial vertebrates or aquatic invertebrates
- Both terrestrial vertebrates and aquatic (invertebrates)

2. Longevity
- Short-lived (<5 years)
- Medium-lived (5-15 years)
- Long-lived (>15 years)

3. Accessibility of sampling unit
- Difficult to access
- Moderately accessible
- Easily accessible

4. Social structure
- Solitary
- Semi-colonial or semi-gregarious
- Total gregarious

5. Residency
- Permanent resident (does not migrate)
- Migrates beyond study area (present winter season)
- Present during migration only

6. Range
- Abundant (Numerous in suitable habitat)
- Common (Certain to be in suitable habitat)
- Uncommon (Presence is expected, but not a certainty)
- Occasional (Presence is possible, but not expected)
- Rare (Not normally present)

7. Maturity
- Adult
- Immature

8. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

C. CASE OF COLLECTION

1. Physical characteristics
- Short
- Moderate
- Tall

2. Behaviour
- Rushes or nerves available
- Independent-foraging young
- Nestbound young or eggs available

3. Accessibility of sampling unit
- High
- Moderate
- Low

4. Individual
- Accessible
- Moderately accessible
- Difficult to access

5. Year-round resident (does not migrate)
- Migrates beyond study area (present winter season)
- Present during migration only

6. Monitoring
- Present
- Not present

D. QUANTITY OF EXISTING EXPOSURE AND EFFECT DATA

1. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

2. Distribution outside of study area
- Endemic to study area
- Present outside of study area, but not abundant
- Abundant outside of study area

3. Longevity
- Short-lived (<5 years)
- Medium-lived (5-15 years)
- Long-lived (>15 years)

4. Residency
- Permanent resident (does not migrate)
- Migrates beyond study area (present winter season)
- Present during migration only

5. Monitoring
- Present
- Not present

Sample: MERCURY VULNERABILITY INDEX

A. EXPOSURE POTENTIAL

1. Dietary Potential
- Fish
- Terrestrial vertebrates or aquatic invertebrates
- Both terrestrial vertebrates and aquatic (invertebrates)
- Both terrestrial vertebrates and aquatic (invertebrates)
- Both terrestrial vertebrates and aquatic (invertebrates)
- Vegetables

2. Social structure
- Solitary
- Semi-colonial or semi-gregarious
- Total gregarious

3. Residency
- Permanent resident (does not migrate)
- Migrates beyond study area (present winter season)
- Present during migration only

4. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

5. Maturity
- Adult
- Immature

6. Range
- Abundant (Numerous in suitable habitat)
- Common (Certain to be in suitable habitat)
- Uncommon (Presence is expected, but not a certainty)
- Occasional (Presence is possible, but not expected)
- Rare (Not normally present)

7. Longevity
- Short-lived (<5 years)
- Medium-lived (5-15 years)
- Long-lived (>15 years)

8. Monitoring
- Present
- Not present

B. GEOGRAPHIC OCCURRENCE

1. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

2. Distribution outside of study area
- Endemic to study area
- Present outside of study area, but not abundant
- Abundant outside of study area

3. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

C. CASE OF COLLECTION

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- Avoids these areas

F. Use of industrial or urbanized areas
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- Will occasionally utilize these areas
- Avoids these areas

G. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
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H. Use of industrial or urbanized areas
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- Will occasionally utilize these areas
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I. Use of industrial or urbanized areas
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- Will occasionally utilize these areas
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J. Use of industrial or urbanized areas
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- Will occasionally utilize these areas
- Avoids these areas

K. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

L. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

M. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

N. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

O. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

P. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

Q. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

R. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

S. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

T. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

U. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

V. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

W. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

X. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

Y. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
- Avoids these areas

Z. Use of industrial or urbanized areas
- Readily inhabits or forages in these areas
- Will occasionally utilize these areas
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Some species, such as the turtles, ranked high in vulnerability to contaminants as a precautionary measure due to the paucity of contaminant exposure and effects data available.