WATER TOXICOLOGY

Sediment Toxicity Tests

- Can provide rapid information on the potential toxicity of contaminants to benthic organisms,
- Can be used to determine the relationship toxicity and bioavailability,
- Investigate interactions among contaminants,
- Determine the saptio-temporal distributions of contaminants,
- Evaluate hazards of dredge material,
- Estimate the effectiveness of management facilities.

Sediment toxicity tests have limitations

- Collection, handling and storage may alter bioavailability,
- Depletion of sediment sorbed contaminants and kinetics may reduce bioavailability,
- Natural characteristics of sediment may influence the responce of test organisms,
- Chronic testing methods of sublethal effects are not available for evaluating contaminant sediment.

Water and sediment quality criteria for toxic compounds

Water quality criteria (WQC) and sediment quality criteria (SQC) reported in draft EPA documents (U.S. EPA, 1991a–e).

Compound	log K_{oc} (L/kg$_{oc}$)	WQC (µg/L)	SQC_{oc} (µg/g$_{oc}$)	SQC at 1% OC (µg/g)
Dieldrin				
Freshwater	5.16	0.0625	9.03[a]	0.0903
Salt water	5.16	0.1147	16.6	0.166
Endrin				
Freshwater	4.82	0.061	4.03	0.0403
Salt water	4.82	0.011	0.73	0.0073
Acenaphthene				
Freshwater	3.78	23.0	138	1.38
Salt water	3.78	40.4	243	2.43
Fluoranthene				
Freshwater	5.10	8.12	1022	10.22
Salt water	5.10	10.65	1341	13.41
Phenanthrene				
Freshwater	4.36	6.32	123	1.23
Salt water	4.36	8.26	161	1.61

[a] $SQC_{oc} = K_{oc} \cdot WQC$

$= (10^{5.16}$ L/kg$_{oc}$) $\cdot$ (10^{-3} kg$_{oc}$/g$_{oc}$) (0.0625 µg dieldrin/L)

$= 9.03$ µg dieldrin/g$_{oc}$.

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Commonly used species for whole-sediment toxicity testing

Organism	End point[m]	Test duration (d)[n]	Habitat	Feeding habit
Freshwater				
Hyalella azteca (amphipod)[a]	S, G, R	28	Burrow, epibenthic	Deposit feeder
Diporeia sp. (amphipod)[b]	S	28	Burrow, infaunal	Deposit feeder
Chironomus riparius (midge)[a]	S, G, E	14	Tube dweller	Suspension and deposit feeder
Chironomus tentans (midge)[a]	S, G	10	Tube dweller	Suspension and deposit feeder
Hexagenia limbata (mayfly)[c]	S, G, M	10	Tube dweller	Suspension and deposit feeder
Ceriodaphnia dubia (cladoceran)[a,d]	S, R	7	Water column	Suspension feeder
Daphnia magna (cladoceran)[c]	S, G, R	10	Water column	Suspension feeder
Lumbriculus variegatus[e]	S, G, R	28	Burrow, infaunal/ epibenthic	Deposit feeder
Tubifex tubifex[f]	S	28	Burrow, infaunal/ epibenthic	Deposit feeder
Salt water				
Rhepoxynius abronius (amphipod)[g]	S	10	Burrow, infaunal	Deposit feeder, predator
Eohaustorius estaurius (amphipod)[g]	S	10	Burrow, infaunal	Deposit feeder
Ampelisca abdita (amphipod)[g]	S, G, R	20	Tube dweller	Suspension and deposit feeder
Grandidierella japonica (amphipod)[g]	S, G	10	Tube dweller	Deposit feeder
Hyalella azteca (amphipod)[h]	S, G, R	28	Burrow, epibenthic	Deposit feeder
Leptocheirus plumulosus (amphipod)[i]	S, G, R	28	Burrow, infaunal	Deposit feeder
Neanthes sp. (polychaete)[j]	S, G, R	85	Tube dweller	Deposit feeder
Capitella capitata (polychaete)[k]	S, G	35	Tube dweller	Deposit feeder
Nereis virens (polychaete)[l]	S	12	Tube dweller	Deposit feeder

[a] ASTM (1995a); Ingersoll and Nelson (1990).
[b] Landrum (1989); Landrum et al. (1989); ASTM (1995a); formerly *Pontoporeia hoyi*.
[c] Nebeker et al. (1984a); ASTM (1995a); Bahnick et al. (1981).
[d] Burton et al. (1989); ASTM (1995a).
[e] Phipps et al. (1992); ASTM (1995a).
[f] Reynoldson et al. (1991); ASTM (1995a).
[g] ASTM (1992), Swartz et al. (1985).
[h] Nebeker and Miller (1988b); U.S. EPA (1994a).
[i] ASTM (1992), Schlekat et al. (1991).
[j] Johns and Ginn (1990), Pesch (1979), ASTM (1994e).
[k] Chapman and Fink (1984).
[l] McLeese et al. (1982); ASTM (1994e).
[m] S = survival, G = growth, R = reproduction, M = molting frequency, E = adult emergence.
[n] Maximum duration of tests.

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Advantages and limitations of sediment toxicity tests

Advantages

- Provide a direct measure of benthic effects.
- Limited special equipment is required.
- Methods are rapid and inexpensive.
- Legal and scientific precedence exist for use; ASTM standards are available.
- Tests with spiked chemicals provide data on cause-effect relationships.
- Sediment toxicity tests can be applied to all chemicals of concern.
- Tests applied to field samples reflect cumulative effects of all contaminants and contaminant interactions.
- Toxicity tests are amenable to field validation.

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Advantages and limitations of sediment toxicity tests

Limitations

- Sediment collection, handling, and storage may alter bioavailability.
- Spiked sediment may not be representative of field-contaminated sediment.
- Natural geochemical characteristics of sediment may affect the response of test organisms.
- Indigenous animals may be present in field-collected sediments.
- Route of exposure may be uncertain and data generated in sediment toxicity tests may be difficult to interpret if factors controlling the bioavailability of contaminants in sediment are unknown.
- Tests applied to field samples cannot discriminate effects of individual chemicals.
- Few comparisons have been made of methods or species.
- Only a few chronic methods for measuring sublethal effects have been developed or extensively evaluated.
- Laboratory tests have inherent limitations in predicting ecological effects.
- Tests do not directly address human health effects.

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