

Toxicity Tests for Various Habitats and Media

Test Species	Test Duration and Media	Endpoints	Advantages	Disadvantages	Other Remarks	Protocol Reference
Terrestrial						
Marsh Grass <i>Echinochloa crusgalli</i>	28 Days; soil	Survival Growth	Begun from seed, no culturing needed	Salinity inhibits growth	Alternative test species may be used if site-specific conditions (for example, soil salinity) preclude successful test completion with <i>E. crusgalli</i>	Walsh and others 1991 Walsh and others 1990
Lettuce <i>Lactuca sativa</i>	5 Days; aqueous solution of soil	Germination Root elongation	Begun from seed, no culturing needed; lettuce more sensitive than most terrestrial species (Keddy and others 1994)	A crop species and not a naturally occurring species	Media is actually soil solutions such as eluates, not soil; alternative test species may be used in place of lettuce (for example, ASTM E1598-94, ASTM 1997c)	(EPA 1989)
Lettuce <i>Lactuca sativa</i>	35 Days; soil	Germination Survival Bioaccumulation	Begun from seed, no culturing needed; lettuce more sensitive than most terrestrial species (Keddy and others 1994)	A crop species and not a naturally occurring species	Procedure can be used to test aqueous samples; alternative test species may be used in place of lettuce (Folsom and others 1991; WES 1989; ASTM E1598-94, ASTM 1997c)	(EPA 1989) Folsom and others 1991 WES 1989
Rye Grass <i>Lolium perenne</i>	2 Days; soil	Survival Growth	Begun from seed, no culturing needed; more sensitive than elongation test with same species	Existing seed bank may confound test result if weed seeds occurring in test soil include grasses	Alternative test species may be used in place of lettuce (Folsom and others 1991; WES 1989; ASTM E1598-94, ASTM 1997c)	ASTM E1598-94 (ASTM 1997c)
Earthworm <i>Eisenia foetida</i>	28 Days; soil	Survival Bioaccumulation	Species is cultured; can combine a chronic toxicity test with a bioaccumulation test; species is worldwide in distribution	Hydric soils may affect growth and survival; wetland soils (freshwater and estuarine) or high alkalinity soils may require testing alternative species (see Linder and others 1992)	Pathogenic organisms in soils may affect test organism; can be used to test aqueous samples as long as soils are not saturated; low dissolved oxygen concentrations or saturation of soils with water may mask the presence of toxic substances; addition of carbon is recommended for tested soils to complement this test	(EPA 1989) ASTM E1676-95 (ASTM 1997d)

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Aquatic - Freshwater						
Daphnid <i>Ceriodaphnia dubia</i>	8 Days or until 60 percent of survivors have three broods; water	Survival Reproduction	Species is cultured; important link in many food chains; species is as sensitive as fathead minnow; wide hardness tolerance; found throughout the United States		Applicable to testing effluents, leachates, and liquid phases of sediments	Test Method 1002.0 (EPA 1994c)
Amphipod <i>Hyalella azteca</i>	10 Days; sediment	Survival Growth	Species is cultured; most highly sensitive of the freshwater test organisms; tolerates wide range of sediment grain sizes	Alkalinity commonly encountered in sediment pore water is toxic (Lasier and others 1997; Duh and Myers 1997)	Tolerates salinities up to 15 ppt	Test Method 100.1 (EPA 1994a)
Amphipod <i>Hyalella azteca</i>	30 Days; sediment	Survival Reproduction	Species is cultured; most highly sensitive of the freshwater test organisms; tolerates wide range of sediment grain sizes		Can be used to evaluate the bioavailability of sediment associated contaminants; tolerates salinities up to 15 ppt	
Inland silverside <i>Menidia beryllina</i>	7 Days; water column	Survival	Species is cultured; occurs along both coasts of the United States; can tolerate freshwater to salinities of 35 ppt; can tolerate temperatures from 9.8 to 30 EC; sexually mature from March or April through July or August			Test Method 1006.0 (EPA 1994c)
African Clawed Frog (FETAX) <i>Xenopus laevis</i>	96 Hours; sediment	Development Teratogenesis	Time and cost-effective; technical ease in conducting test; versatile for testing various media; sensitive to low levels of developmental toxicants; extensive literature available; most predictive when compared to lettuce germination, earthworm survival, <i>Daphnia</i> survival, and fathead minnow survival (Fort and others 1995)		Can be used to test complex industrial mixtures; has been used to test surface water and aqueous extracts of soil; reference toxicant is 6-aminonicotinamide	ASTM E1439-91 (ASTM 1997a)

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Aquatic - Estuarine and Marine						
Diatom <i>Thalassiosira pseudomona</i>	4 Days; water column	Growth	Represents aquatic primary producers			ASTM E1218-90 (ASTM 1997a)
Polychaete <i>Nereis (Neanthes) arenaceodentata</i>	20 Days; sediment	Growth Survival	Species is cultured; species can be tested at salinities less than 20 ppt; growth test is cost-effective; low cost; mortality has high dose response; mortality has high ecological relevance	Low to medium sensitivity; mortality has moderate dose responsiveness; growth has moderate ecological relevance	Test animal age, duration of exposure, food ration, and choice of endpoint affects the magnitude of the toxic response (Bridges and Farrar 1997; Bridges and others 1997); <i>N. arenaceodentata</i> biomass is more sensitive than <i>N. arenaceodentata</i> mortality	(EPA 1990)
Polychaete <i>Nereis virens</i>	28 Days; water column	Bioaccumulation	Species is cultured			Test Method 1005.0 (Chapman and others 1995)
Blue mussel <i>Mytilus edulis</i>	48 Hours; water column	Development	Species is cultured; high dose responsiveness	Moderate ecological relevance; does not spawn year-round	Less sensitive than <i>Strongylocentrotus purpuratus</i> to sulfides (complete inhibition at 8-FM total sulfide/L [Knezovich and others 1995])	Test Method 1005.0 (Chapman and others 1995)
Possum shrimp <i>Mysidopsis bahia</i>	7 Days; water column	Fecundity Survival Growth	Species is cultured	Very sensitive to changes in ionic balance in test solution	Laboratory success with the fecundity endpoint is rare (WSDE 1997)	Test Method 1007.0 (EPA 1994c)
Amphipod <i>Rhepoxynius abronius</i>	10 Days; sediment	Survival Reburial	Highly reliable test; most sensitive of amphipods usually tested; laboratory exposure analogous to field conditions; very useful in defining gradients of contamination; readily available species; test salinities from 25 to 32 ppt; directly exposed to sediment; high regulatory relevance; mortality endpoint has	Sensitive to high total organic content; sensitive to fine grained sediments; not as well distributed as <i>Leptocheirus plumulosus</i> and <i>Ampelisca abdita</i> ; species is field collected	<i>R. abronius</i> mortality as sensitive as <i>E. estuarius</i> mortality; <i>R. abronius</i> nonreburial is more sensitive than <i>E. estuarius</i> nonreburial; LC50 value for un-ionized ammonia is 1.59 mg/L (Kohn and others 1994); more sensitive to sulfides than <i>E. estuarius</i> (LC50 for total sulfides is 50 FM total sulfides/L [Knezovich and others 1995]); 10-day survival protocol using	Test Method 100.4 (EPA 1994b)

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			high ecological relevance; moderately cost-effective		<i>R abronius</i> was a more sensitive indicator of toxicity than 20-day test with <i>N. arenaceodentata</i> based on statistical power of the test and not greater sensitivity of the organisms or endpoints (Anderson and others 1998)	
Amphipod <i>Eohaustorius estuarius</i>	10 Days; sediment	Survival Reburial	Highly reliable test; laboratory exposure analogous to field conditions; very useful in defining gradients of sediment toxicity; readily available species; test salinities from 2 to 28 ppt; tolerant of fine sediments; directly exposed to sediments; high regulatory relevance; mortality endpoint has high ecological relevance; moderately cost-effective	Less sensitive than <i>R. abronius</i> ; potential sediment interferences; not as well distributed as <i>L. plummulosus</i> or <i>A. abdita</i> ; species is field collected	Remove potential predators from sediment before testing; less sensitive to sulfide than <i>R. abronius</i> (LC50 = 104 FM total sulfides/L [Knezovich and others 1995]); <i>E. estuarius</i> mortality as sensitive as <i>R. abronius</i> mortality; <i>R. abronius</i> nonreburial is more sensitive than <i>E. estuarius</i> nonreburial; <i>E. estuarius</i> mortality more sensitive than <i>N. arenaceodentata</i> biomass, which is more sensitive than <i>N. arenaceodentata</i> mortality; mortality endpoint more sensitive than reburial; LC50 value for total ammonia is 125.5 mg/L and unionized ammonia is 2.49 mg/L (Kohn and others 1994)	Test Method 100.4 (EPA 1994b)
Amphipod <i>Ampelisca abdita</i>	10 Days; sediment	Survival	Highly reliable test; laboratory exposure analogous to field conditions; very useful in defining gradients of sediment toxicity; readily available species and widely distributed species; test salinities from 10 to 35 ppt; tolerant of fine sediments; high regulatory relevance; mortality endpoint has high ecological relevance; moderately cost-effective	Tube dweller, not in direct contact with sediment; sensitive to coarse grained sediments; species is field collected	Less sensitive than <i>E. estuarius</i> and <i>R. abronius</i> ; LC50 value for un-ionized ammonia is 0.83 mg/L (Kohn and others 1994)	Test Method 100.4 (EPA 1994b)
Amphipod <i>Leptocheirus</i>	10 Days; sediment	Survival Reburial	Species is cultured; salinity range of 1.5 to 32 ppt (pore water)	Tube dweller - not in direct contact with sediment		Test Method 100.4 (EPA 1994b)

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<i>plumulosus</i>			salinities of less than 1 to 35 ppt [Niewolny and others 1997]); tolerates full range of grain sizes (except sandy sediments with less than 5 percent silt/clay [Niewolny and others 1997]); tolerant of fine sediments; highly reliable test; high ecological relevance; laboratory exposure analogous to field conditions; widely distributed and cultured			
Purple sea urchin <i>Strongylocentrotus purpuratus</i>	72 Hours; water column	Development Survival	Highly sensitive; early-life stage toxicity test	Species is field collected; not recommended for sediments with a pore water salinity less than 10 ppt; Does not spawn year-round; does not directly live in sediments; moderate ecological relevance	Highly susceptible to unionized ammonia toxicity when testing sediment pore water (EC50 for unionized ammonia was 0.057 mg/L [Greenstein and others 1996]); total inhibition from sulfides at 20-FM total sulfide/L [Knezovich and others 1995])	Test Method 1008.0 (Chapman and others 1995)
Sand dollar <i>Dendraster excentricus</i>	72 Hours; water column	Development Survival	Highly sensitive; early-life stage toxicity test; gravid adults can be obtained year-round (EPA 1993b)	Species is field collected; medium dose responsiveness; moderately cost-effective; moderate ecological relevance	Can be induced to spawn but with reduced gamete viability; proposed echinoderm effect threshold for unionized ammonia is 0.04 mg/L (EPA 1993b)	Test Method 1008.0 (Chapman and others 1995)
Topsmelt <i>Atherinops affinis</i>	12 Days; sediment-water interface	Percent hatched	Most appropriate for testing early life stage fishes; can tolerate salinities from 2 to 60 ppt; can tolerate wide range in temperature with a preference of 19 to 23 EC; reproductive season from early March to July or August depending upon latitude		Suggested test instead of using sediment pore water where fish are receptors of concern; numerically abundant in California estuaries	(Protocol based on Anderson and others 1996)

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Notes:

ASTM	American Society for Testing and Materials
EC 50	Effects concentration fifty
EPA	U.S. Environmental Protection Agency
L	Liter
LC50	Lethal concentration fifty
ppt	Parts per thousand
FM	Micro moles
WES	U.S. Army Corps of Engineers Waterways Experiment Station
WSDE	Washington State Department of Ecology

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