Other Underdogs

Mysid Shrimp, Grass Shrimp,

Ribbed Mussels, and Marsh Minnows

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Bioindicators

- Any species or groups of species whose function, population, or status can reveal the qualitative status of the environment

- Bioindicators can tell us about the cumulative effects of different pollutants in the ecosystem and about how long a problem may have been present
Bioindicator Attributes

- Wide distribution range
- Well known biology
- Immobility
- Ability to provide an early alert
- Key function in the ecosystem
- Homogeneous response to pollutants
- Existence of identifiable toxic effects with the degree of pollution

(Hilty and Merenlender, 2000; Goodsell et al., 2009). (Li et al. 2019)
Sentinel species

- Reliable sentinel species
  - Must be common
  - Easily handled
  - Consistent/regularly measurable responses to environmental changes
- Examples:
  - Canary – Coalmine
  - Trout – Great Lakes
Underdogs of Louisiana’s Bays & Estuaries

- Mysid Shrimp
- Grass Shrimp
- Mussels
- Marsh Minnows
Mysid Shrimp

*Americamysis bahia* (formerly *Mysidopsis bahia*)
Mysid Shrimp

- Small crustaceans (5–25 mm long)
- Abundant in shallow (<2 m) salt, brackish, and freshwater habitats (58 genera)
- Omnivore filter feeders (algae, detritus and zooplankton)
- Food source for many marine organisms
- Easily cultured and sensitive
- Used in toxicity test as bioindicators for water quality
Mysids and Toxicity Testing

- Used by EPA for more than two decades (Nimmo and Hamaker, 1982; Verslycke et al., 2004a)
- Determines toxicity by measuring endpoints (survival, growth, and fecundity)
- Dose-response information
- Expressed as the percent concentration that is lethal to 50% of the test organisms (LC50) within prescribed period of time (24-96 h) or the highest effluent concentration in which survival is not statistically significantly different from the control
Oil Effects on Mysids

- Cleveland et al. 2000
  - 7-day bioassay test with weathered crude oil
  - Exposed to Ultraviolet (UV) light treatments
  - Significant increase in mortality with UV exposure
  - Weathered oil and UV exposure will substantially increase the toxicity and reduce productivity (biomass)
Effects of Weathering on the Toxicity of Oil to Early Life-Stage Fish and Invertebrates (DWH-AR0280207)

- Certain PAHs are phototoxic
- These PAHs can cause severe tissue damage & mortality in semi-transparent organisms
- Short-exposure durations (e.g., hours; Willis and Oris, 2014) and are subsequently exposed to ultraviolet (UV) light.
- Weathered oil can cause photo-induced mortality of organisms at low concentrations (e.g., < 0.5 gg/L TPAH50; DWH Trustees, 2015, Section 4.3, Toxicity; Lay et al., 2015; Morris et al., 2015).
Grass Shrimp

*Palaemonetes pugio*
Grass Shrimp

- Small crustacean (~5 cm)
- ~1 year life span
- Abundant in fresh and brackish shallow water marshes
- Detritivores - can be primary or secondary consumers
- Aid in the breakdown of organic material as well as assimilate the associated microflaura, microfauna, and fungi.
- Attracted to plant stems and oyster reefs
Grass Shrimp

- Key link in food chain
- Support fishery stocks through the food chain (Rozas and Reed 1993)
- Instrumental in transporting energy
Oil Effects on Grass Shrimp

- Hydrocarbon concentrations could cause acute toxicity in sediments and water chronically exposed to oil or exposed during large oil spills.
- Metabolism, reproduction, and growth may be reduced or altered if oil concentrations persist near 1ppm.
- Tatem, H.E., 1975 - Exposure to PAHs may cause:
  - Altered respiratory rates, growth rates and behavior
  - Napthalene has narcotic effect
  - Detrimental effects to hatching larvae
  - Chronic exposure more harmful than acute high exposure
Ribbed Mussels

Geukensia granosissima
Ribbed Mussels

- Intertidal, filter feeding, benthic bivalve (~8 cm)
- Abundant along salt & brackish marsh vegetation
- Attach to the base of plant stem with byssal threads
- Mutualistic relationship with marsh grass
- Deposit fecal matter on the surrounding sediment which stimulates the grass to grow by increasing the soil nitrogen
- Increase marsh net primary production and stability
- Few studies in Mississippi River deltaic marshes
- NOAA’s Mussel Watch Program in Atlantic region
- 2000 individuals/m² in New England salt marshes (Chintala et al. 2006).
Ribbed Mussels

- Significant in affecting the physical structure of the marsh (Bertness, 1985)
- Jordan and Valiela 1982, Culbertson et al. 2008 (Atlantic species)
  - Provide important ecosystem services
  - Critical nutrient cycling
  - Estuarine filtration
  - Fertilization of host vegetation
  - soil strengthening
- Changes that impact bivalve populations and distribution may lead to trophic cascades with large ecosystem consequences (Jordan and Valiela 1982, Bertness 1984)
Oil Effects on Ribbed Mussels

- Readily bioaccumulate pollutants in their tissues
- Potentially more sensitive to pollutants than oysters (Coen and Walters 2005)
- Through filtering large quantities of water, mussels are exposed to lipophilic PAHs, which are known to bioconcentrate by 2-5 orders of magnitude within mussel tissue (Neff 2002).
- This exposure to hydrocarbons can decrease population (Peteiro et al., 2006)
- Decrease growth rates (Stromgren et al., 1986; LeFloch et al., 2003)
- Lower feeding rates (Widdows et al., 1981; Widdows et al., 1987; Widdows et al., 1996) (Culbertson et al. 2008)
Marsh Minnows

*Cyprinodon variegatus* – Sheepshad minnow
Marsh Minnows
*Fundulus grandis* - Gulf killifish

Male

Female
Small abundant minnows (~4.6 cm -18cm)
- Live in fresh, brackish, and salt marshes
- Attracted to marsh plant stems, oyster beds, pilings and seagrasses
- Omnivores (organic detritus, algae, and small crustaceans)
- Tough/hardy - low oxygen, wide salinity ranges
- Spawn spring to fall months (Nordlie 2006; Brown et al. 2012, 2011).
- Eggs stick to plants stems, bay bottom, oyster shells, and each other
Marsh Minnows

- Important prey for fish, birds, and mammals
- High site fidelity with small-scale movements (Vastano et al. 2017)
- Popular live bait
- *Fundulus heteroclitus* long term toxicology model for genetic and genomic response to pollutants at Superfund sites across the northeastern US.
- Could become the marine science equivalent of the white mouse used in medical science. – Dr. Stephen “Ash” Bullard, Auburn University Gulf of Mexico Research Initiative
Effects of Oil on Marsh Minnows

- Dubansky et al. 2013
  - PAHs elicited genomic and physiological effects in Gulf killifish
  - Expression of molecular biomarkers (cytochrome p450 [cyp] transcripts)
  - Changes in gill histology and (Whitehead et al. 2012)
  - Embryonic exposure to oiled sediments had negative impacts on health (reduced hatching, increased mortality, and developmental abnormalities)
  - Cardiovascular defects, delayed hatching, and reduced hatching success
  - Potential long-term effects at the population level for marsh minnows and other biota that live or spawn in similar habitats.
  - Weathered crude imparts significant biological impacts in marshes for more than 2 months following initial exposures

- Hedgpeth B.M. and Griffitt R.J. 2015
  - Exposure to oil or dispersed oil and hypoxia - significant decrease in egg production, egg hatch, and larval survival in sheepshead minnow
Mysid References

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Grass Shrimp References

Mussel References


Mussel References

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Mussel References

Marsh Minnow References


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Conclusion

- Underdogs or Heroes?
- Similar species in other areas are well documented
- Species well documented for other pollutants
- Louisiana specific research
  - Marshes and species
  - Oil, temperature, salinity, and other environmental factors
  - Spills of opportunity
Thank you

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