Other Underdogs

Mysid Shrimp, Grass Shrimp,

Ribbed Mussels, and Marsh Minnows

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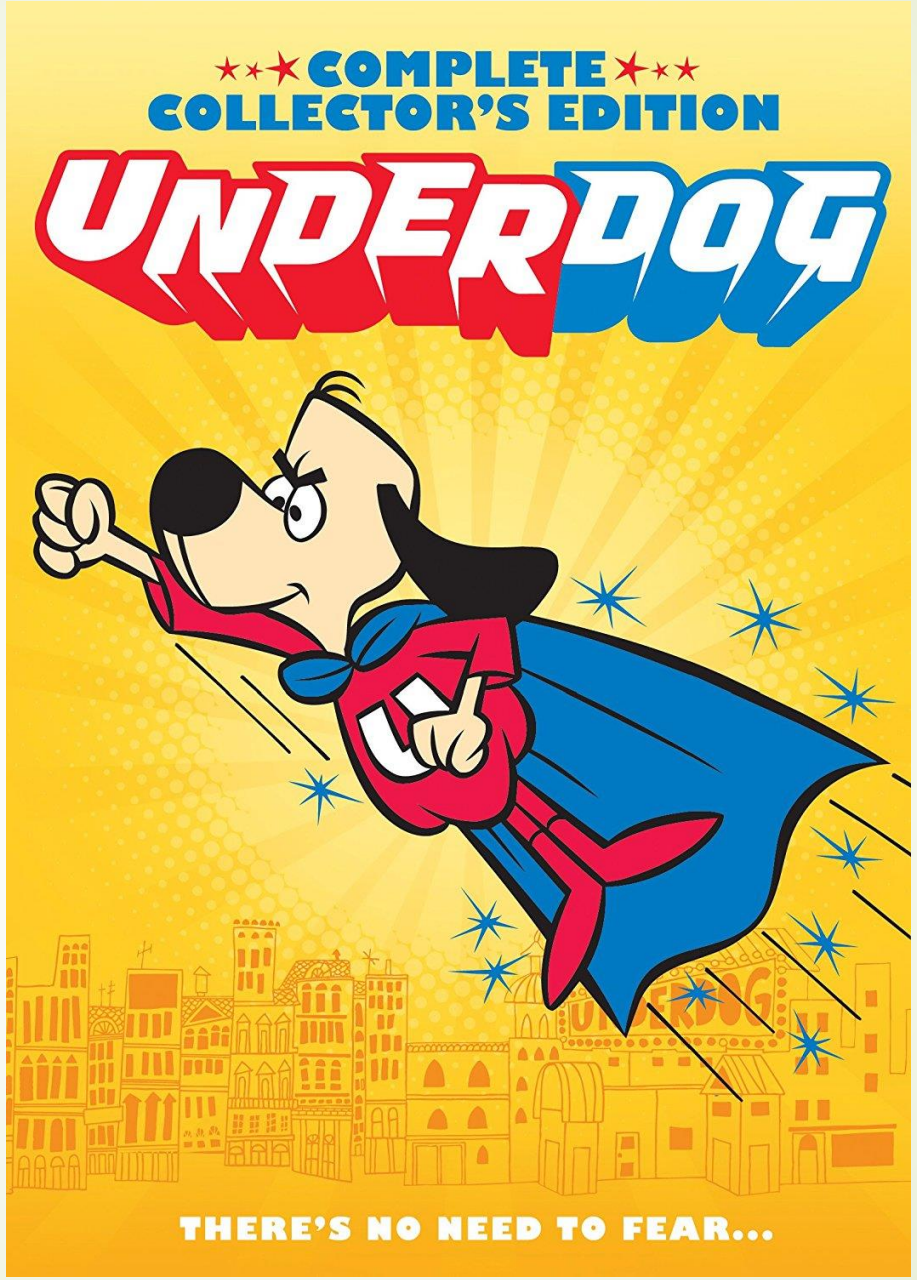

COMPLETE
COLLECTOR'S EDITION
UNDERDOG
THERE'S NO NEED TO FEAR...

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

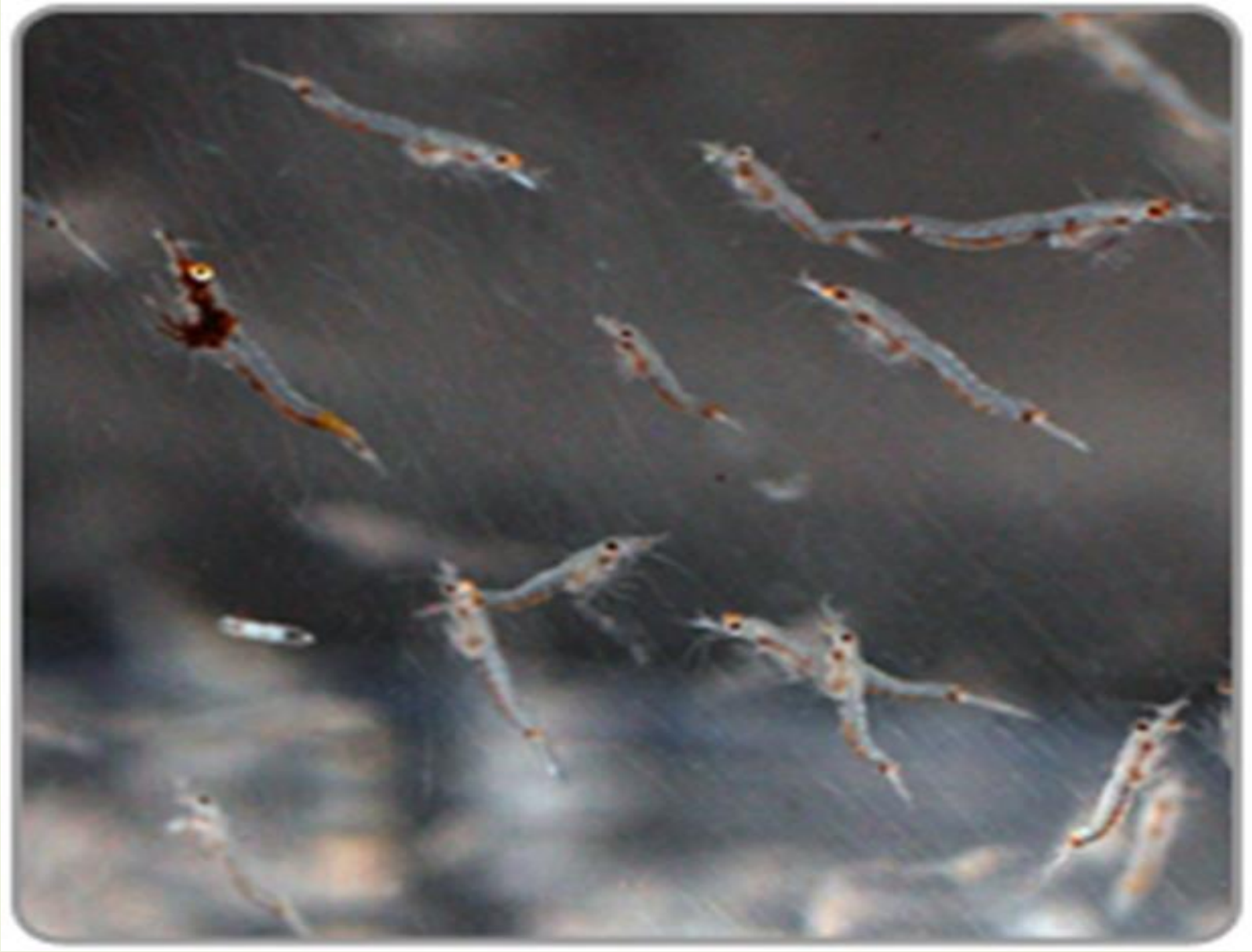
- **Reliable sentinel species**
  - **Must be common**
  - **Easily handled**
  - **Consistent/regularly measurable responses to environmental changes**
- **Examples:**
  - **Canary – Coalmine**
  - **Trout – Great Lakes**

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)

Oil Effects on Mysids cont.

- 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

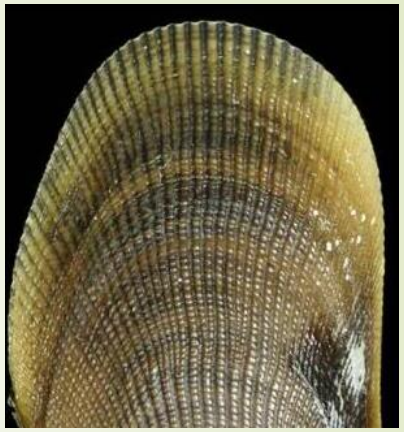
Oil Effects on Grass Shrimp

- 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/m^2 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 – Sheepshead minnow

Marsh Minnows

Fundulus grandis - Gulf killifish

Male

Female

Marsh Minnows

- 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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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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