An integrated health assessment of fish populations exposed to fly ash releases at the TVA Kingston facility

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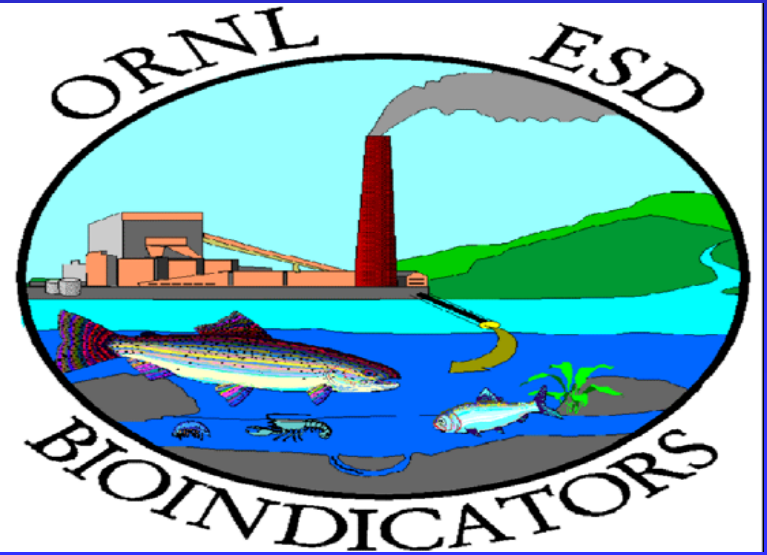


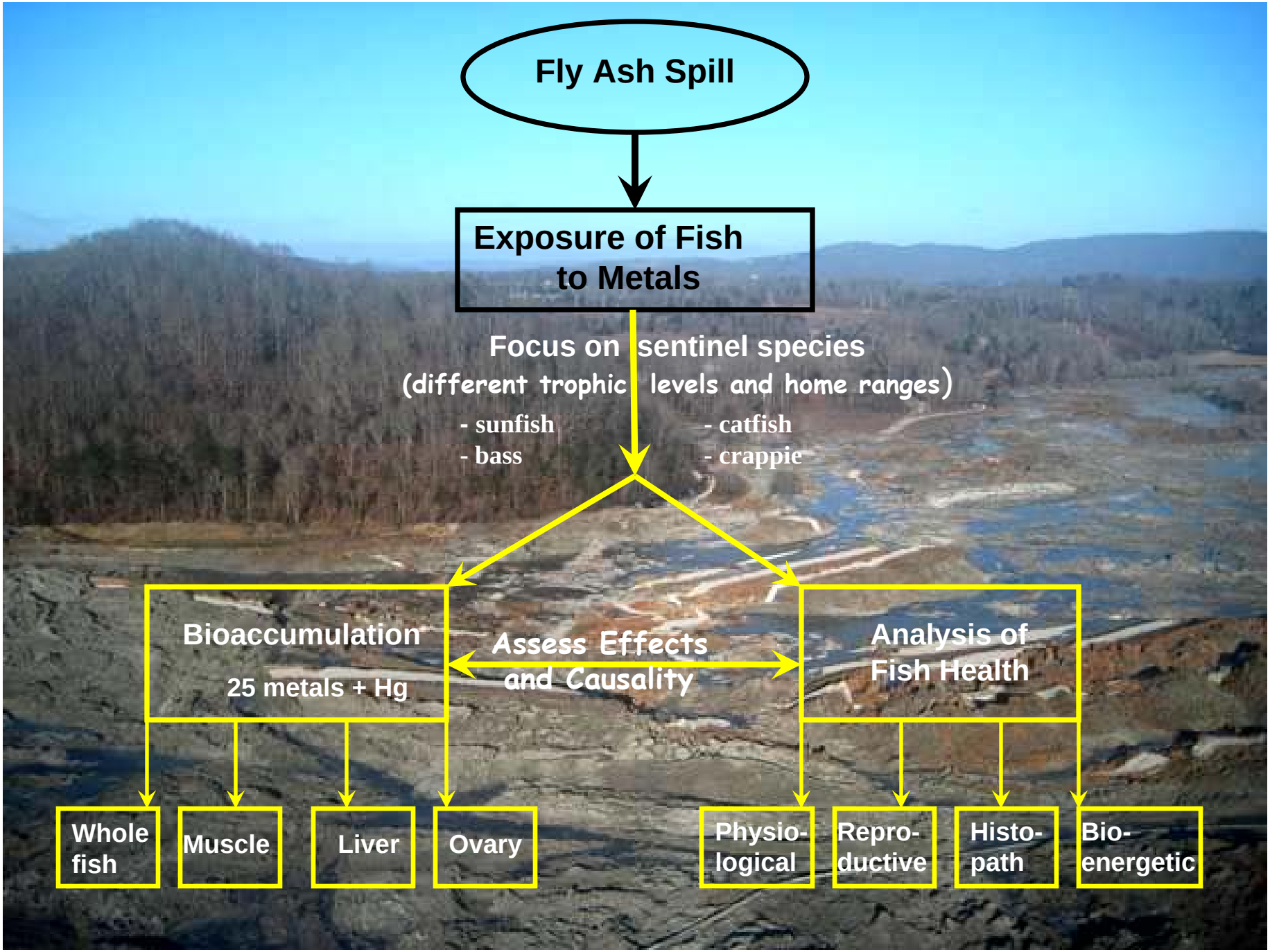
Objectives of Fish Health Studies

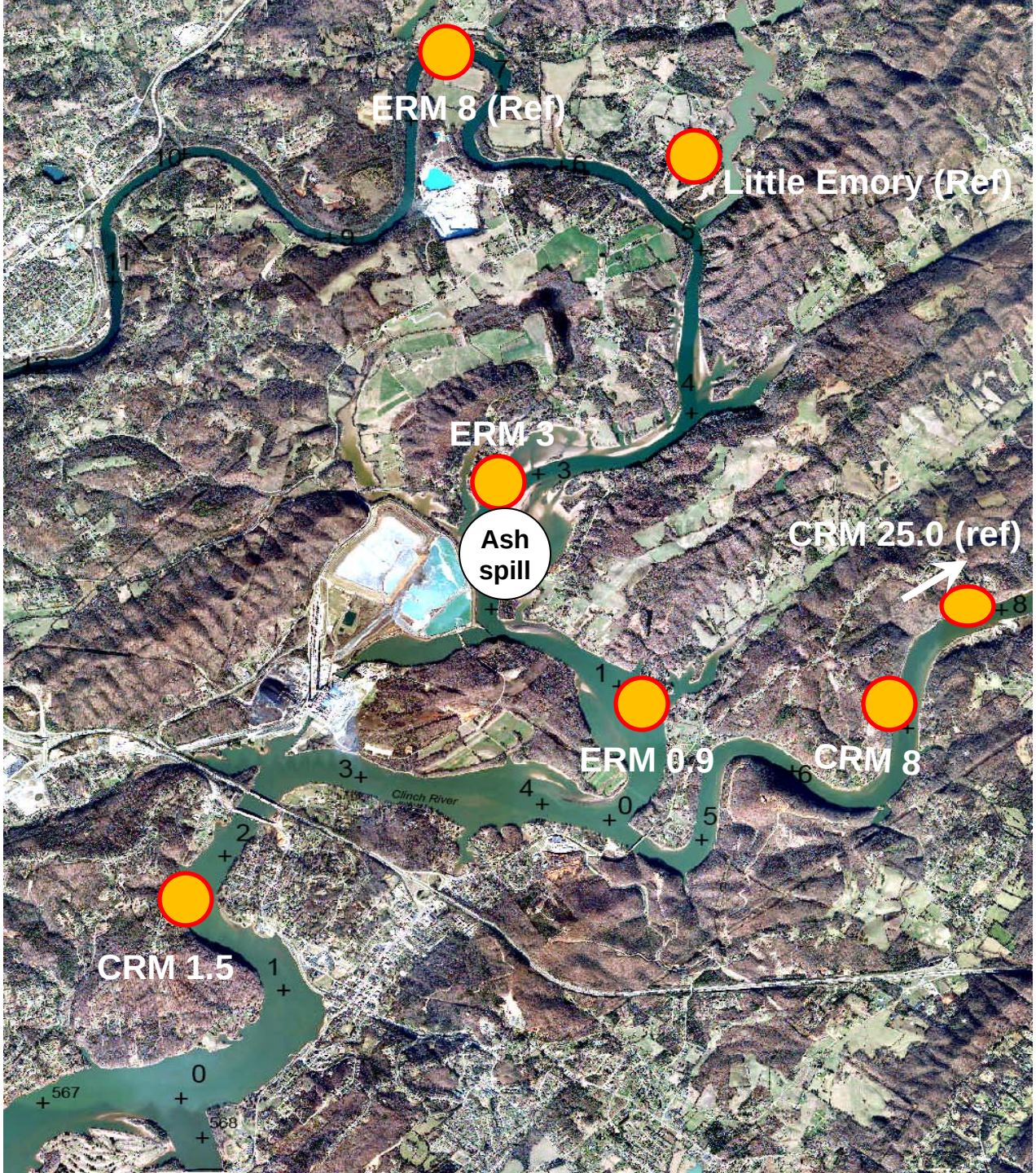
- Determine if fly ash exposure is causing short and/or long-term health effects on representative (sentinel) fish populations

- Assess potential causal relationships between levels of metals in fish tissue and various indicators of fish health

Tennessee River
Kingston
Fossil Fuel Plant
Clinch River
TVA intake canal
TVA Ash pond failure
Ash Spill
Flooded pastures
Emory River
Flooded community
Emory River

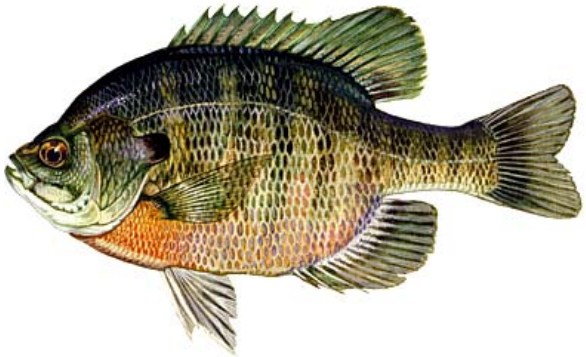
Ash
Ash
Ash
Fly ash
spilled
Into river
Ash in
river


Fly Ash Spill
Exposure of Fish to Metals
Focus on sentinel species
(different trophic levels and home ranges)
- sunfish
- bass
- catfish
- crappie
Bioaccumulation
25 metals + Hg
Assess Effects and Causality
Analysis of Fish Health
Whole fish
Muscle
Liver
Ovary
Physio-logical
Repro-ductive
Histo-path
Bio-energetic

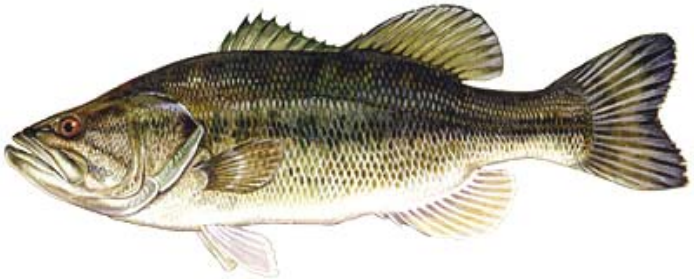

ERM 8 (Ref)
Little Emory (Ref)
ERM 3
Ash spill
CRM 25.0 (ref)
ERM 0.9
CRM 8
Clinch River
CRM 1.5

Sentinel species for assessing effects of contaminants of fish health

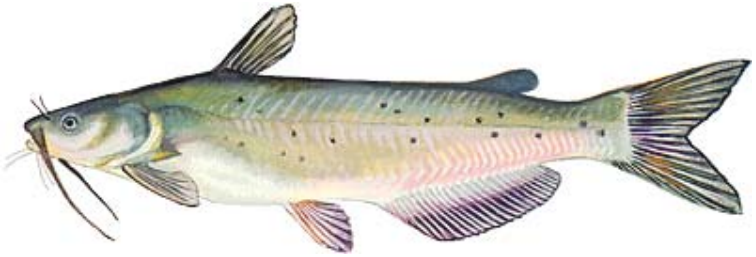
Bluegill
- mid trophic level/omnivore
- restricted home range



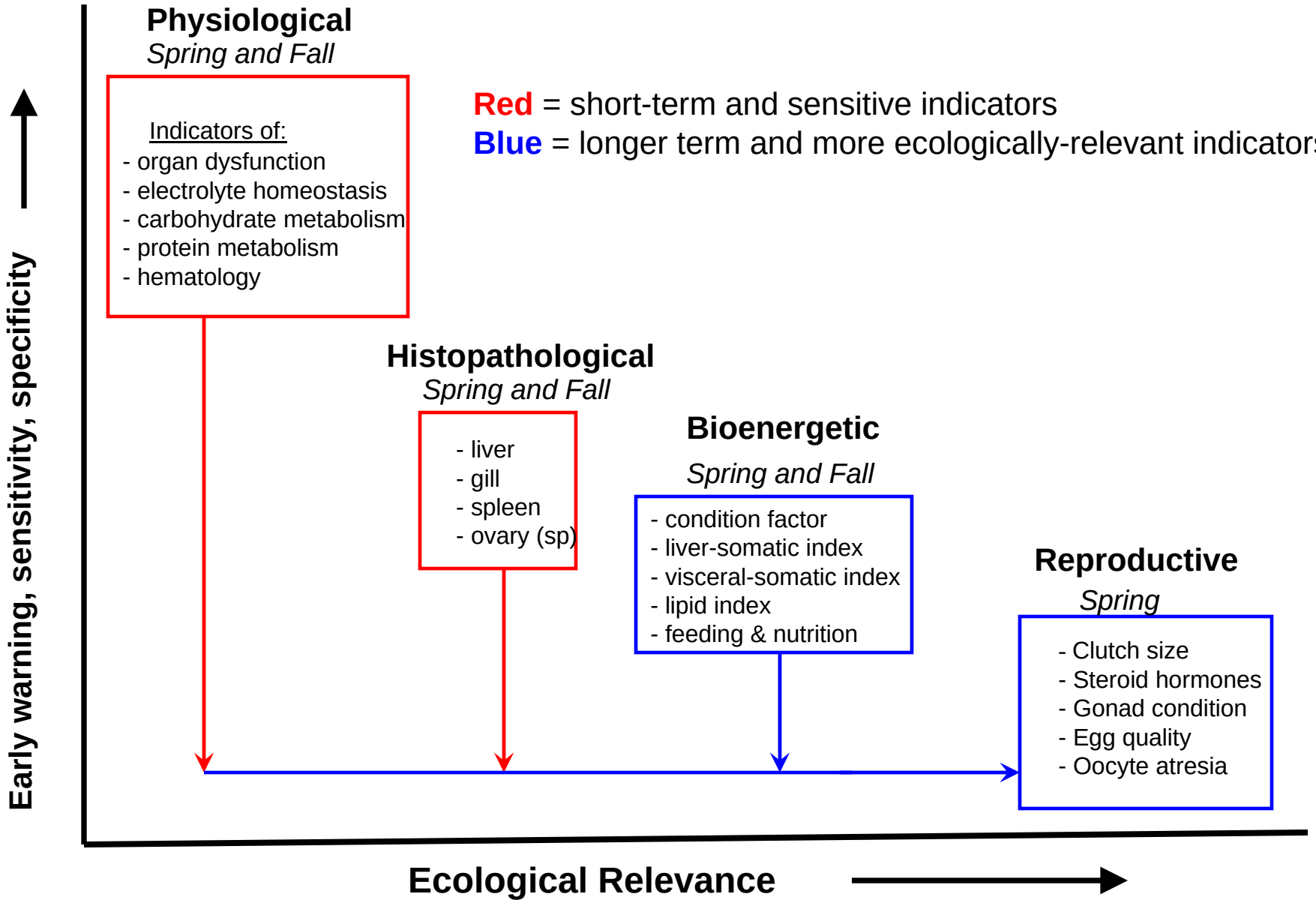
Largemouth bass
- upper trophic level/predator
- intermediate home range



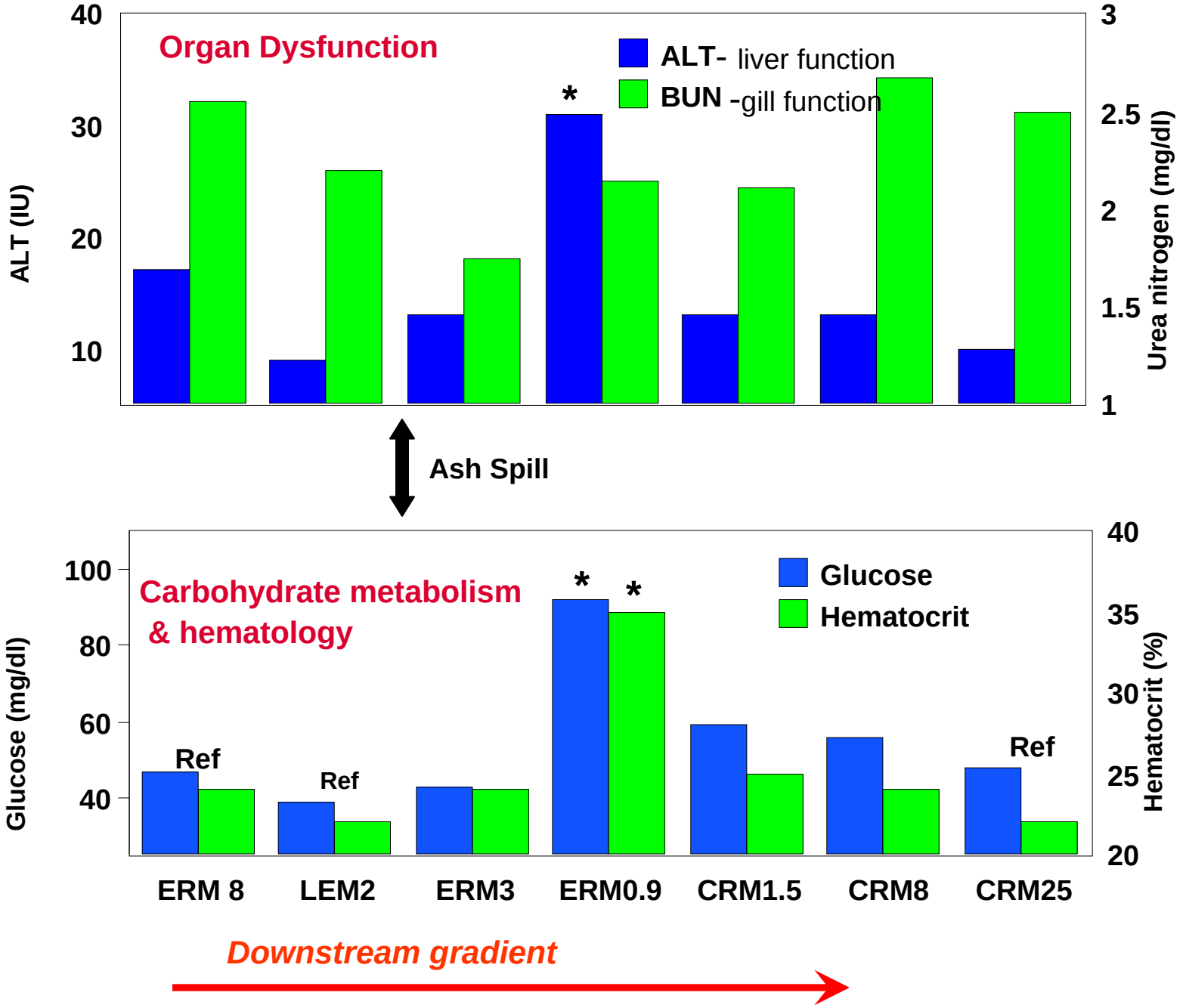
Channel catfish
- bottom feeder/omnivore
- large home range



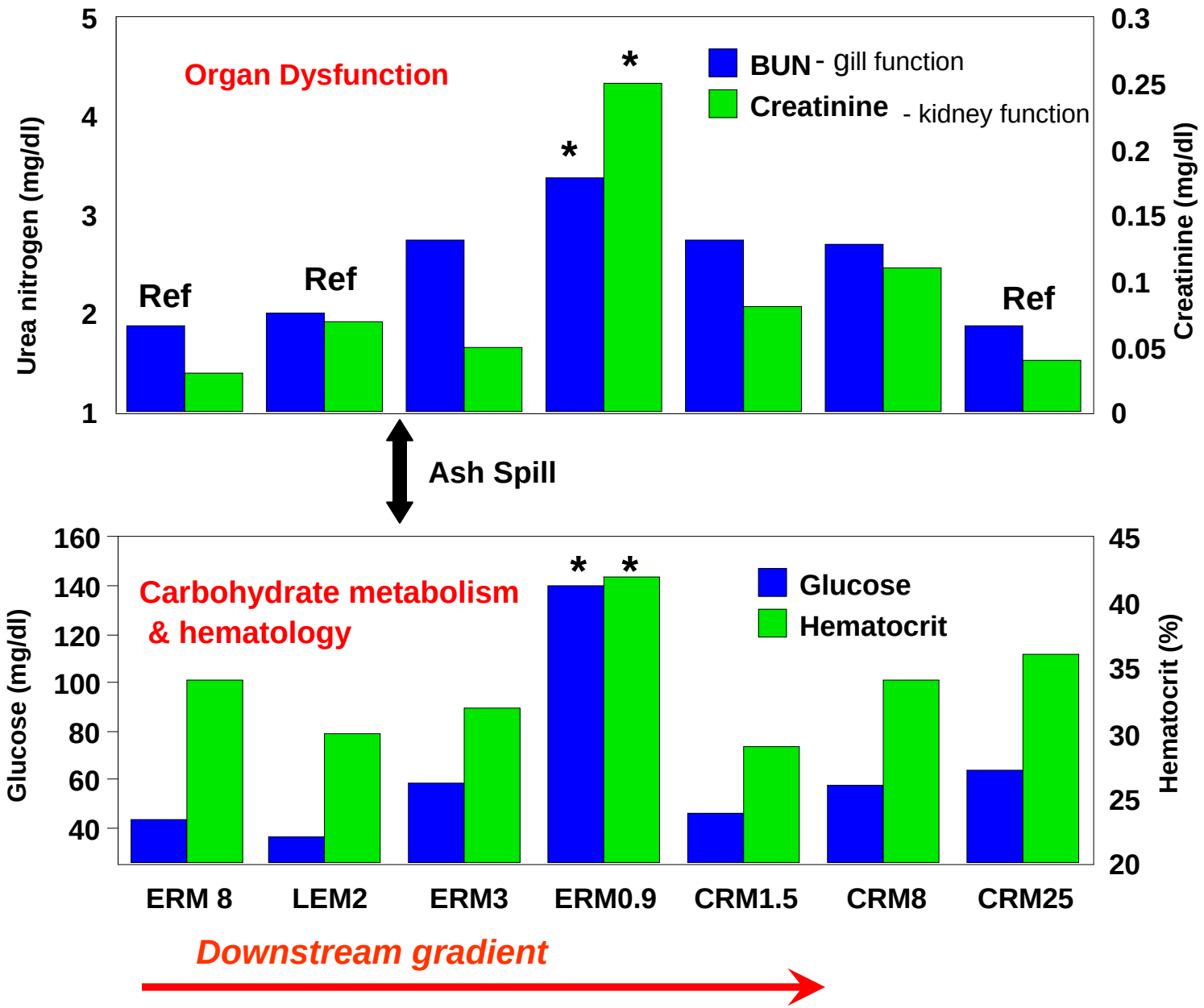
Measures of Fish Health



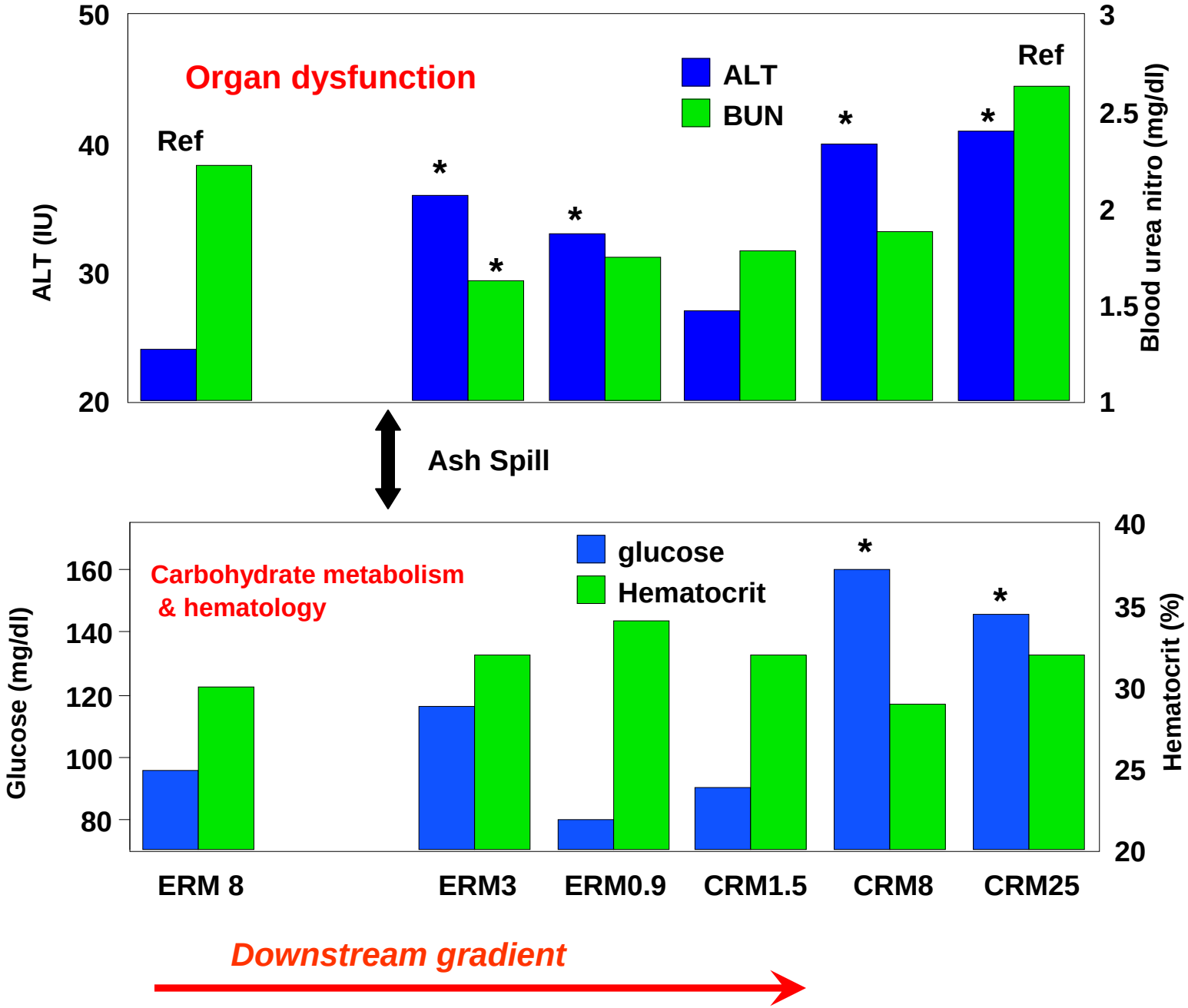
Individual health responses of Bluegill



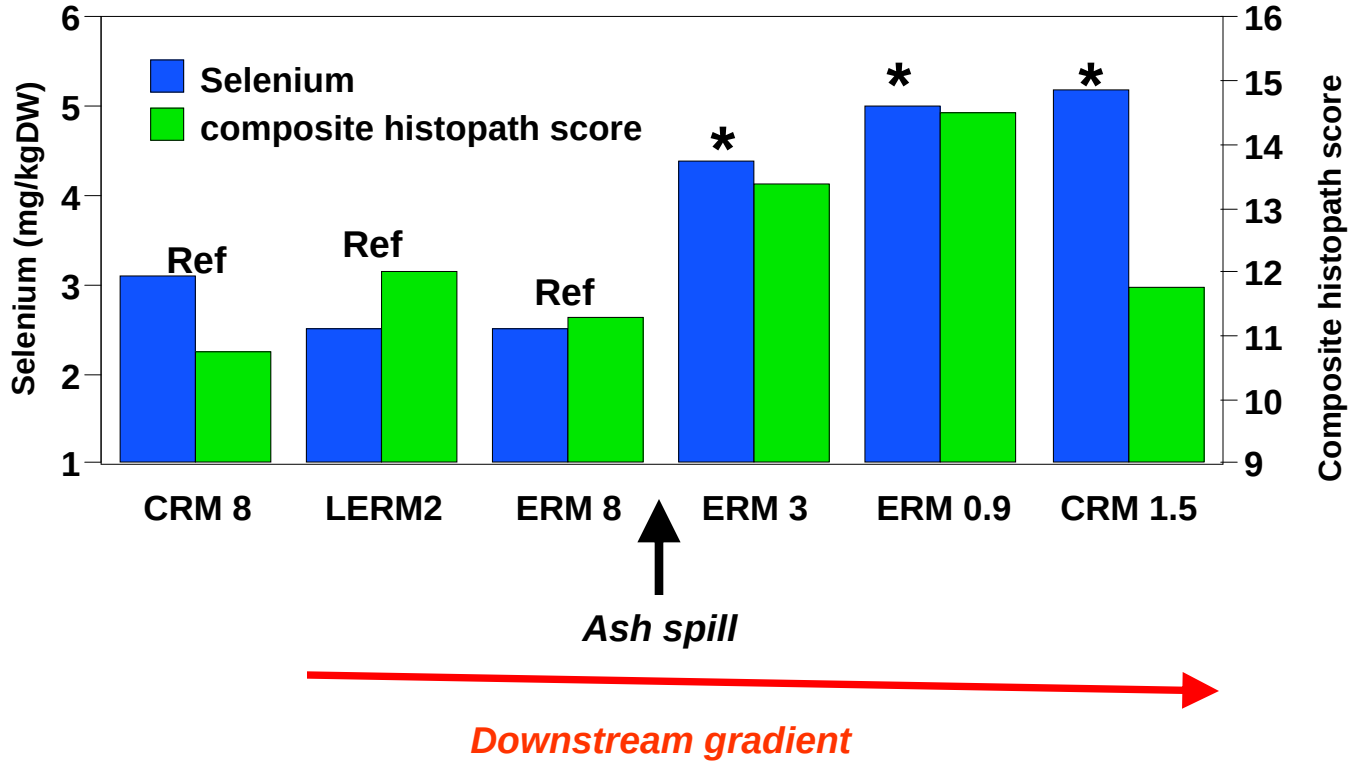
Individual health responses of Largemouth Bass



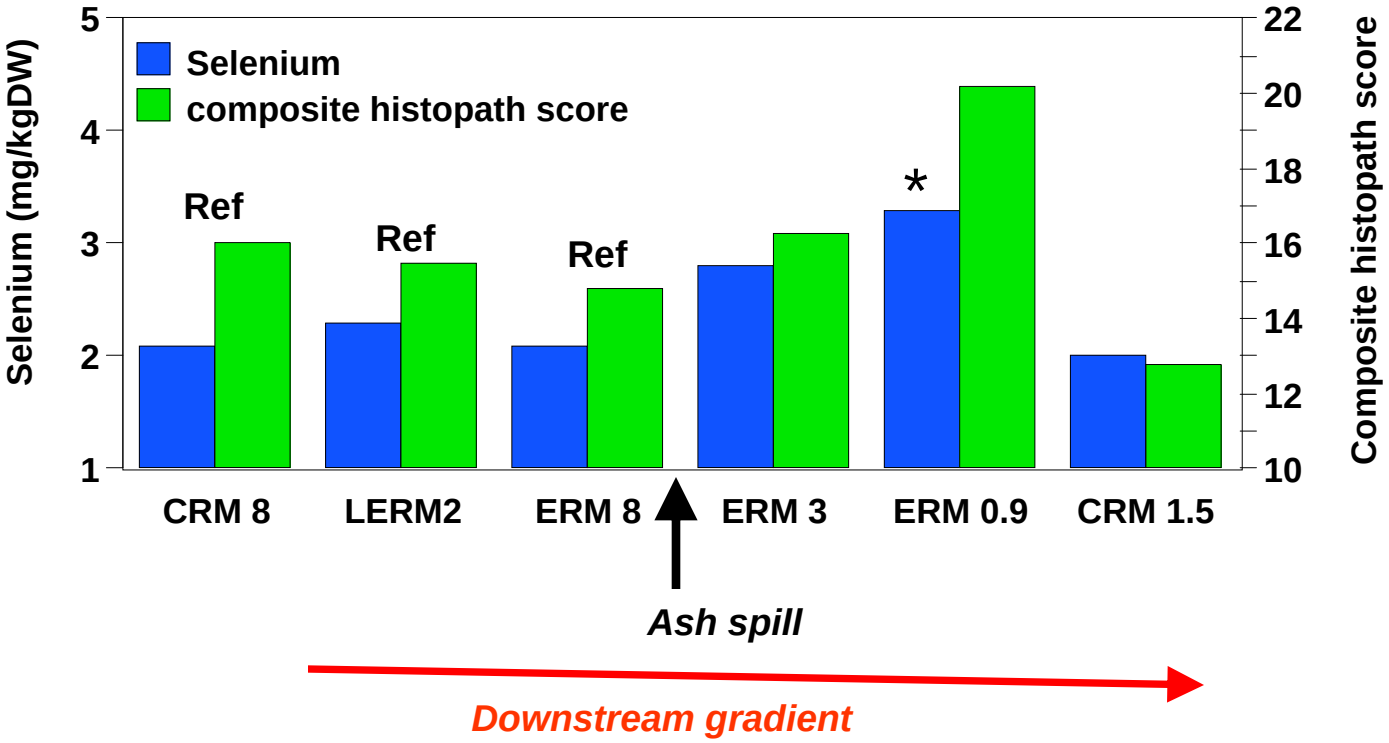
Individual health responses in catfish



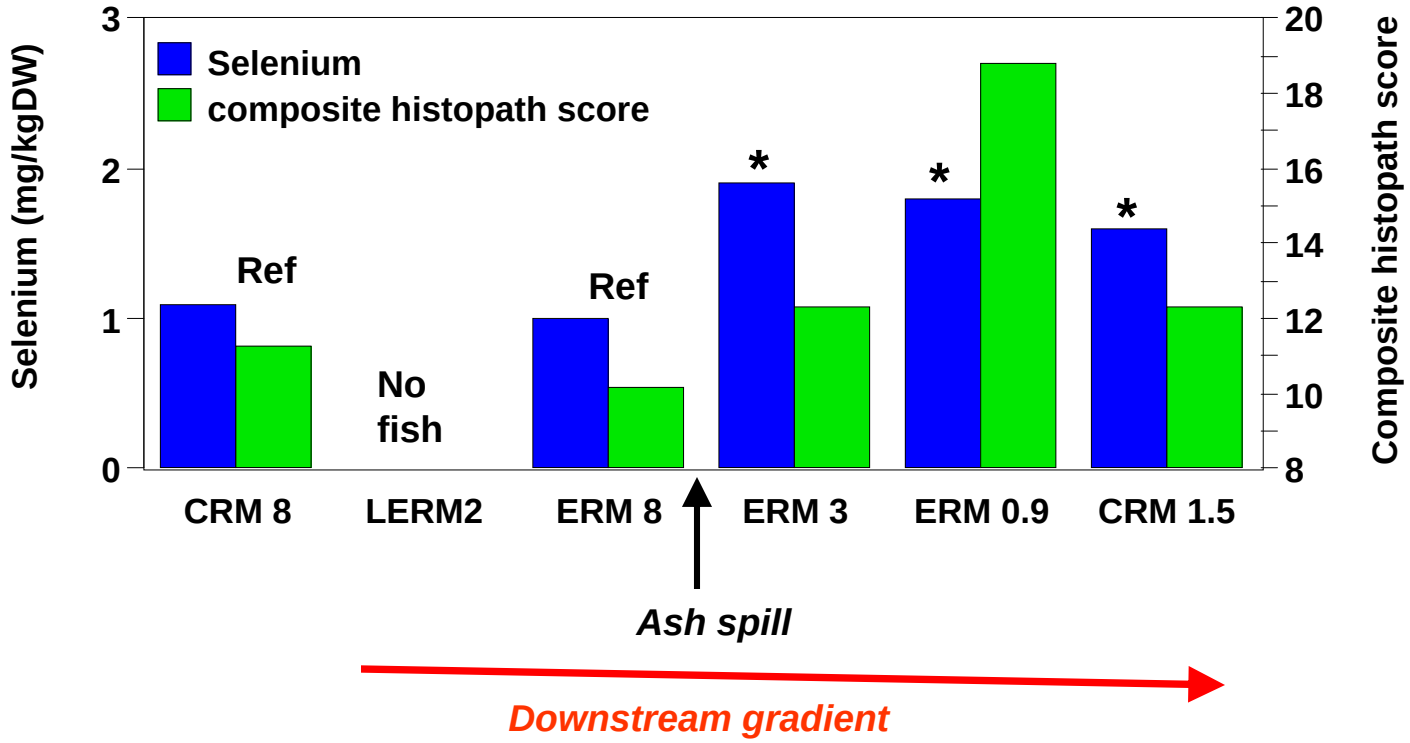
Spatial relationship between contaminant exposure and histopathological response of bluegill



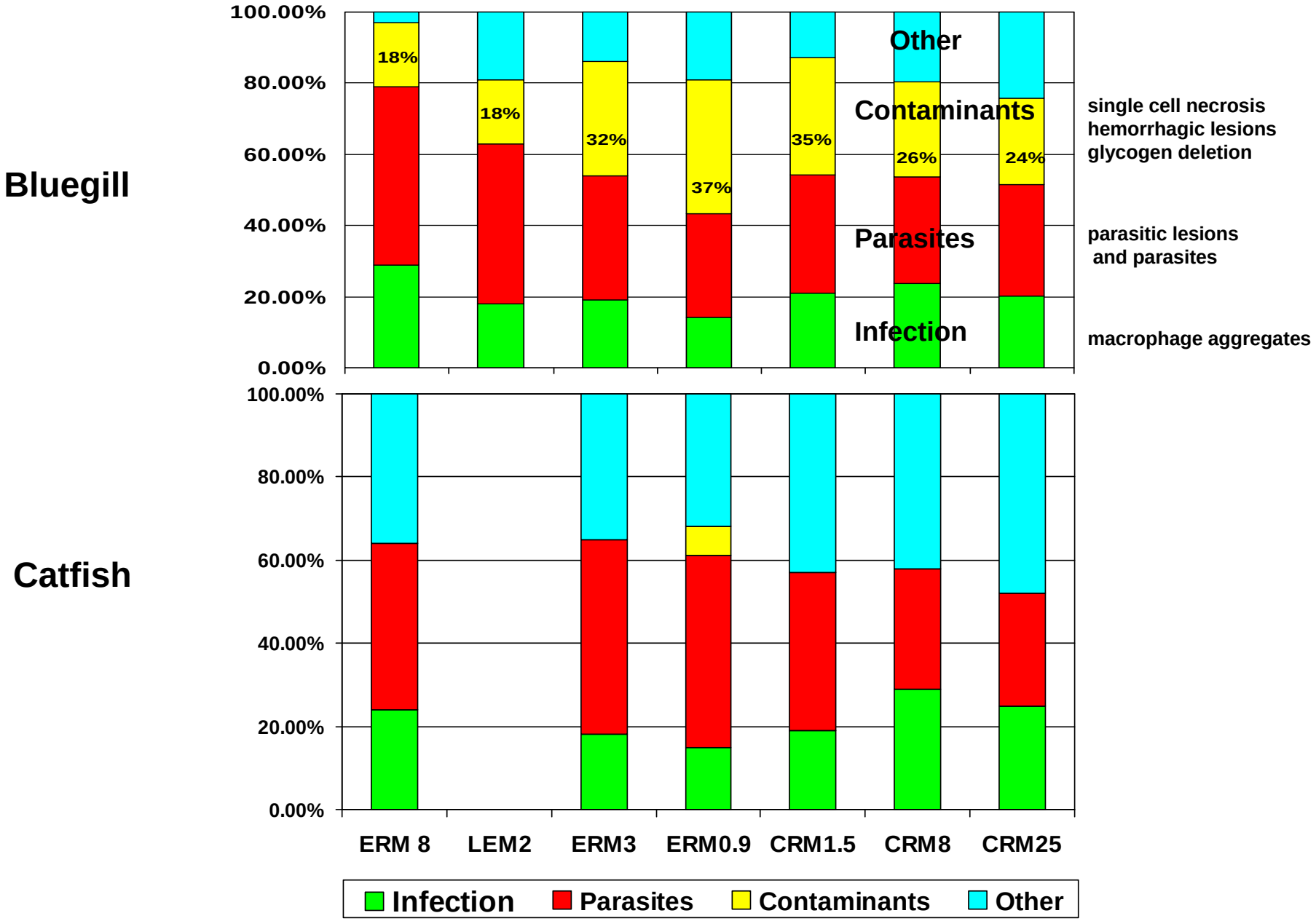
Relationship between contaminant exposure and histopathological response of Largemouth bass



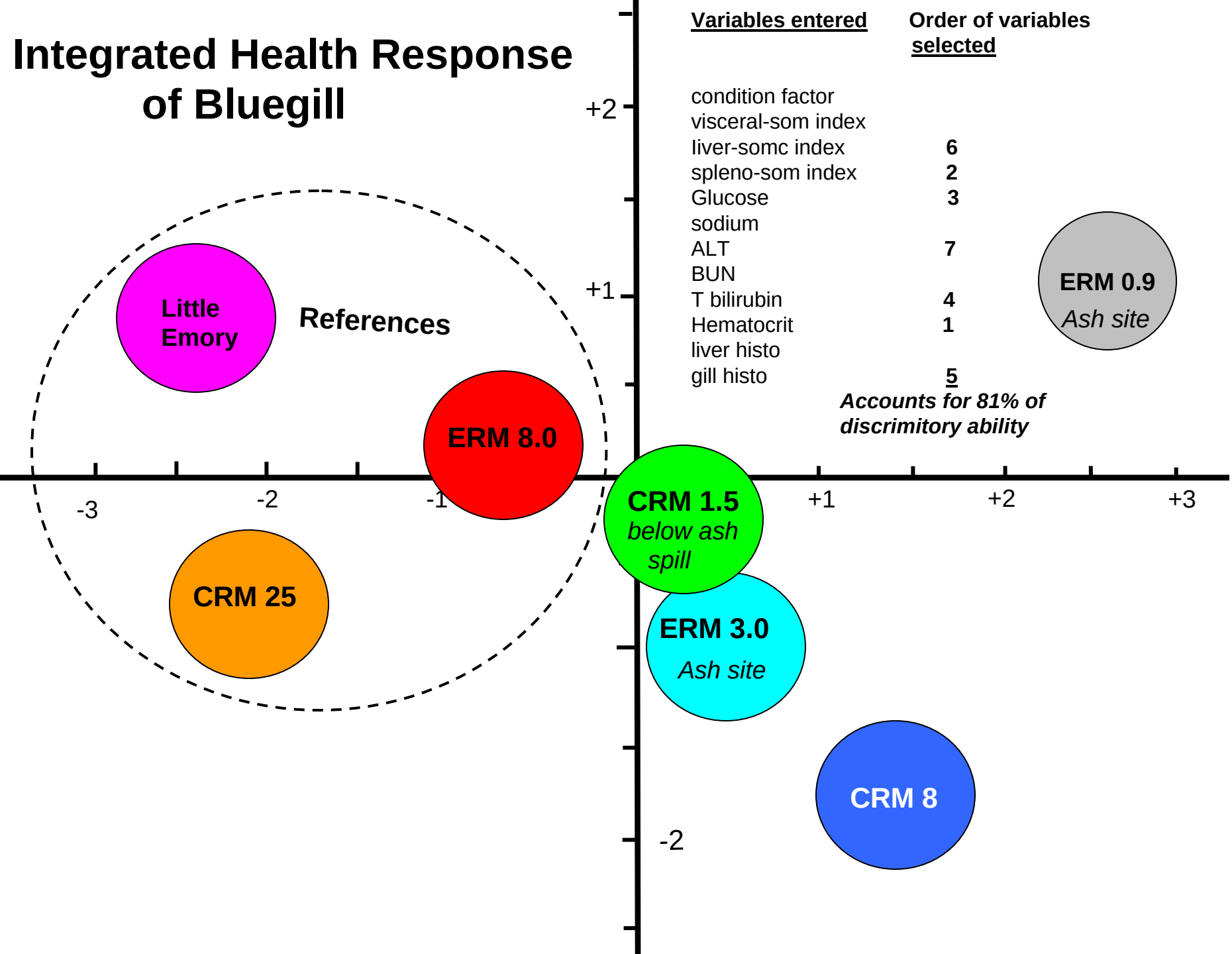
Relationship between contaminant exposure and histopathological response of channel catfish



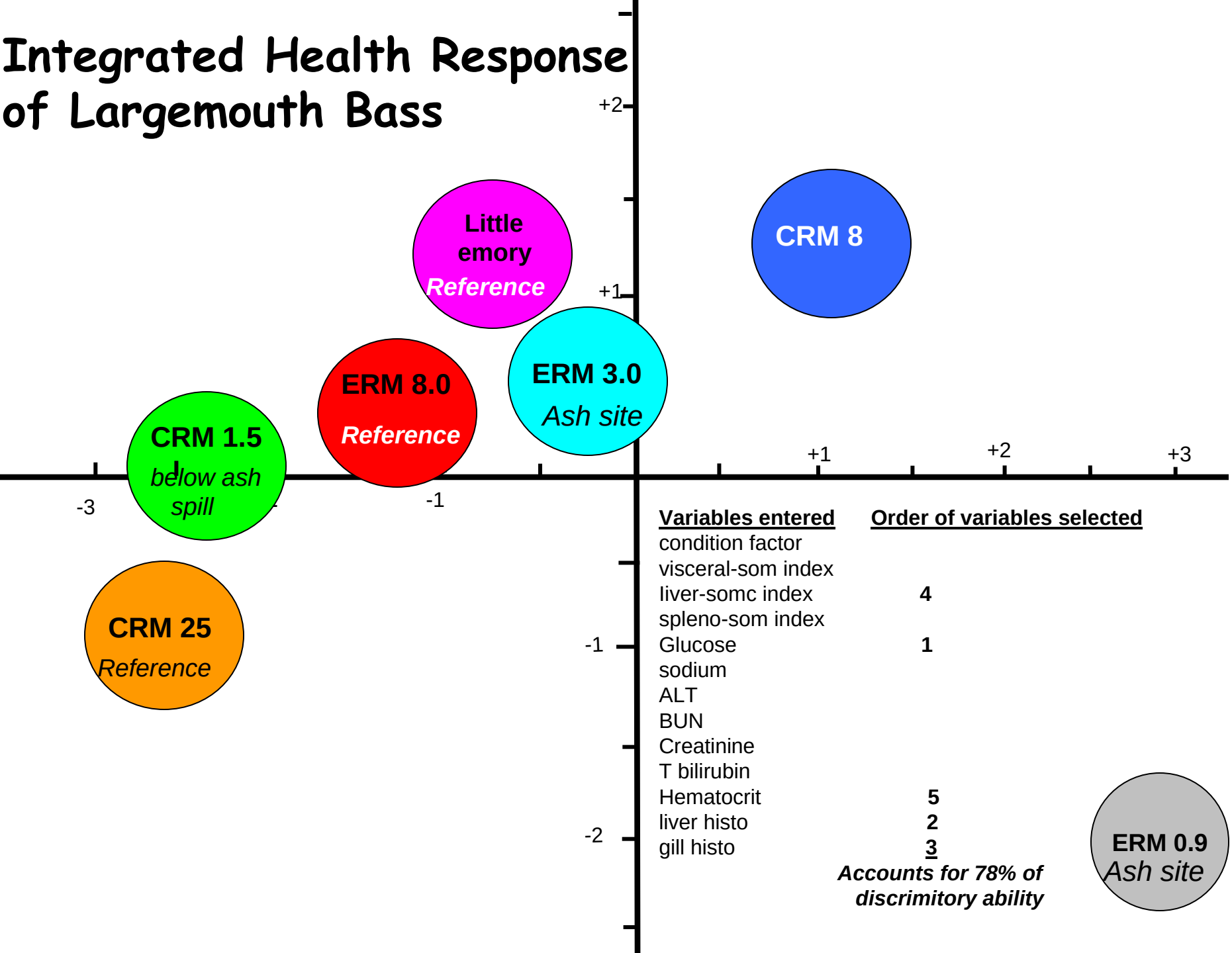
Histopathological lesions in liver are diagnostic indicators of different types of stress responses



Integrated Health Response of Bluegill



Integrated Health Response of Largemouth Bass



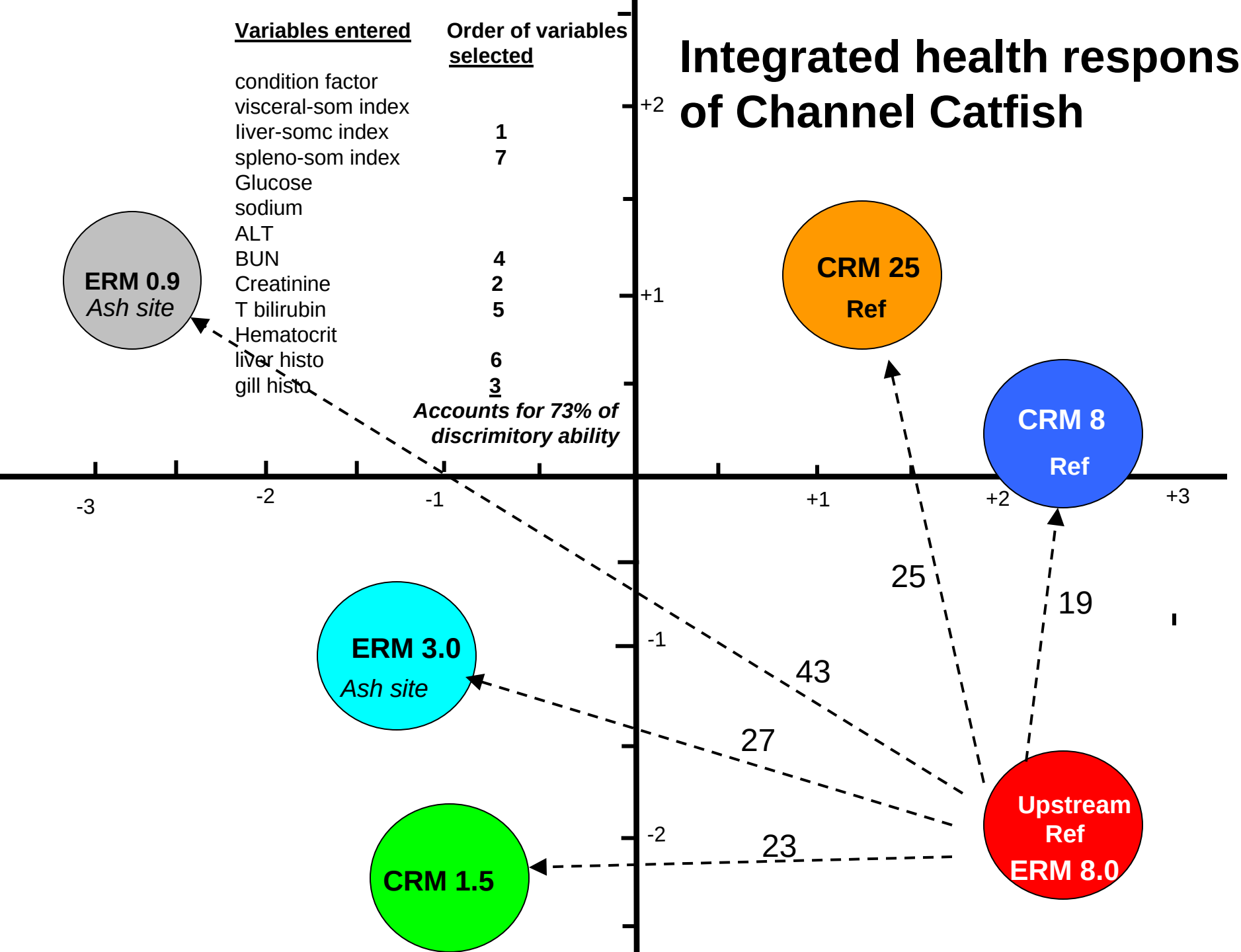
Variables entered	Order of variables selected
condition factor	
visceral-som index	
liver-somc index	**4**
spleno-som index	
Glucose	**1**
sodium	
ALT	
BUN	
Creatinine	
T bilirubin	
Hematocrit	**5**
liver histo	**2**
gill histo	**3**

Accounts for 78% of discrimitory ability

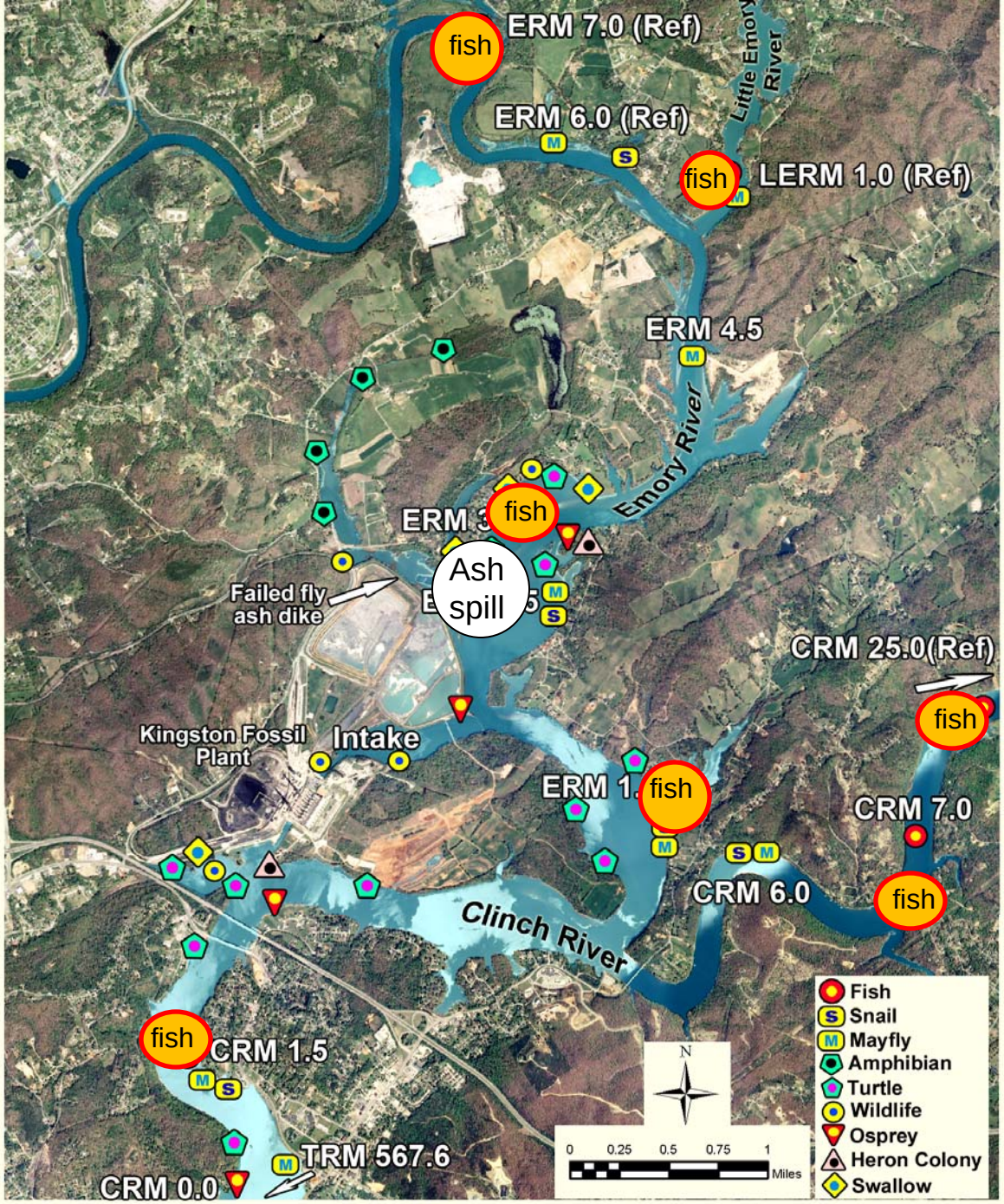
Integrated health response of Channel Catfish

Variables entered	Order of variables selected
condition factor	
visceral-som index	
liver-somc index	1
spleno-som index	7
Glucose	
sodium	
ALT	
BUN	4
Creatinine	2
T bilirubin	5
Hematocrit	
liver histo	6
gill histo	3

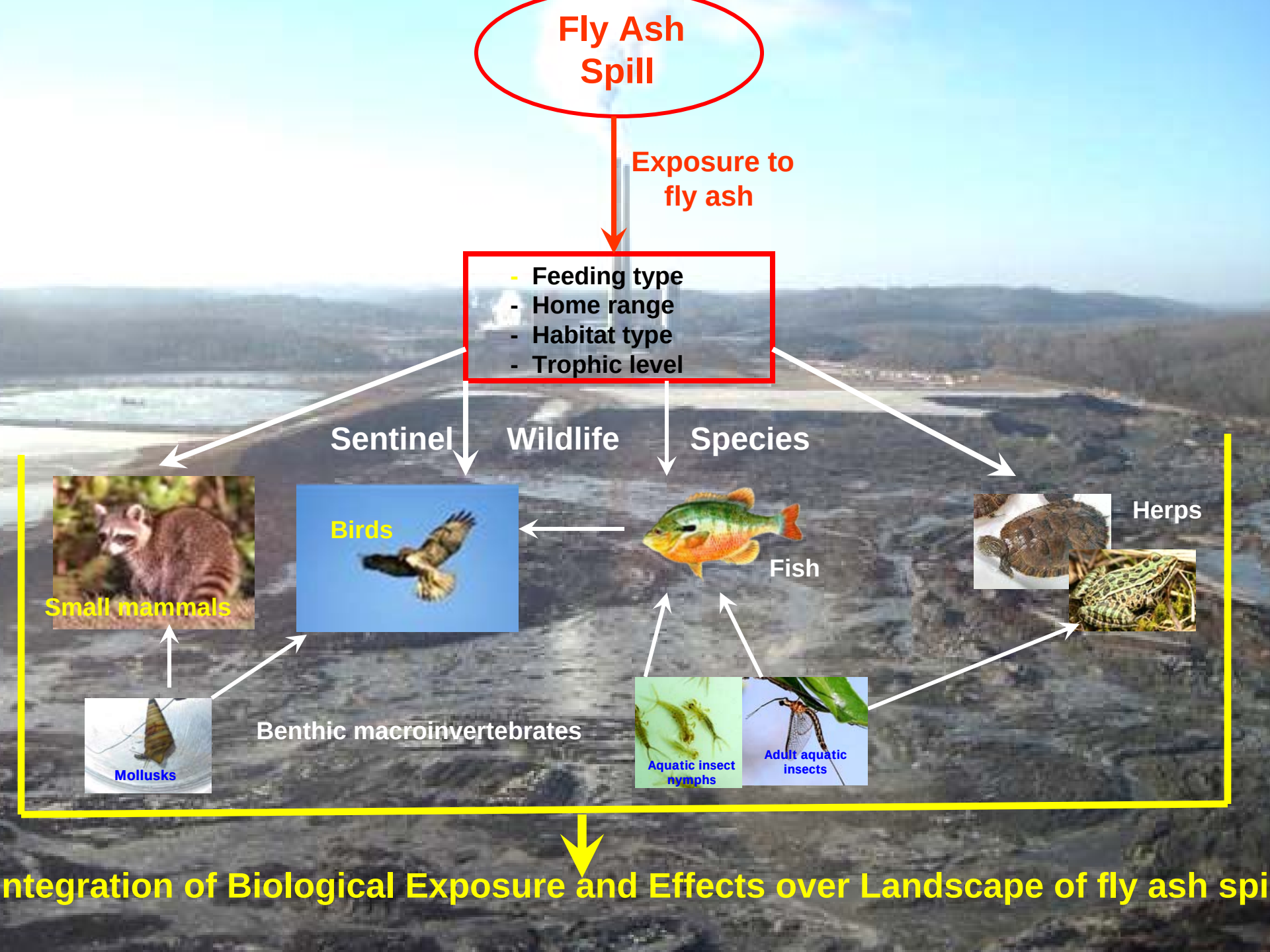
Accounts for 73% of discrimitory ability



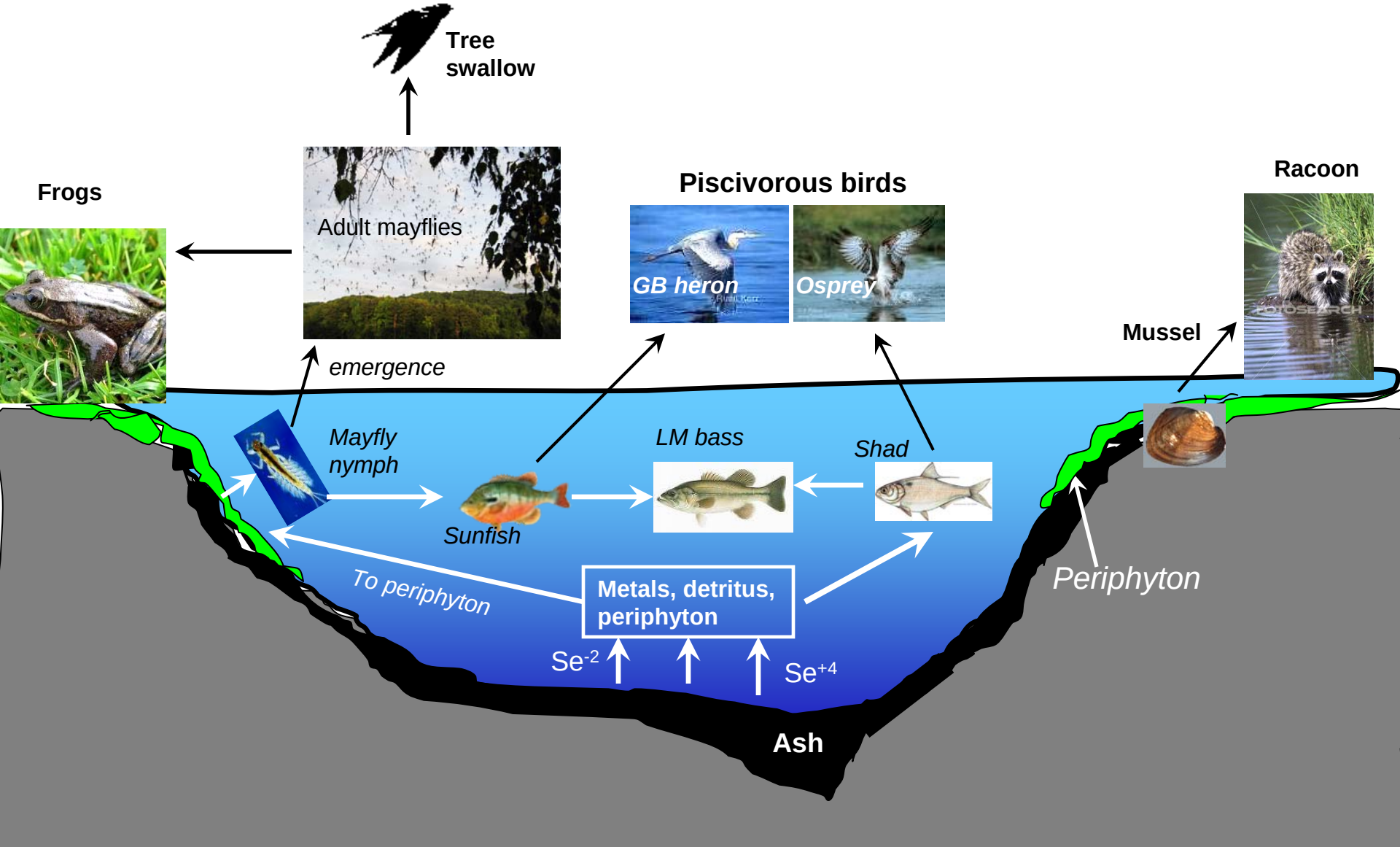
Relevance and Application of Fish Health Studies to Overall Scope of TVA Fly Ash Project



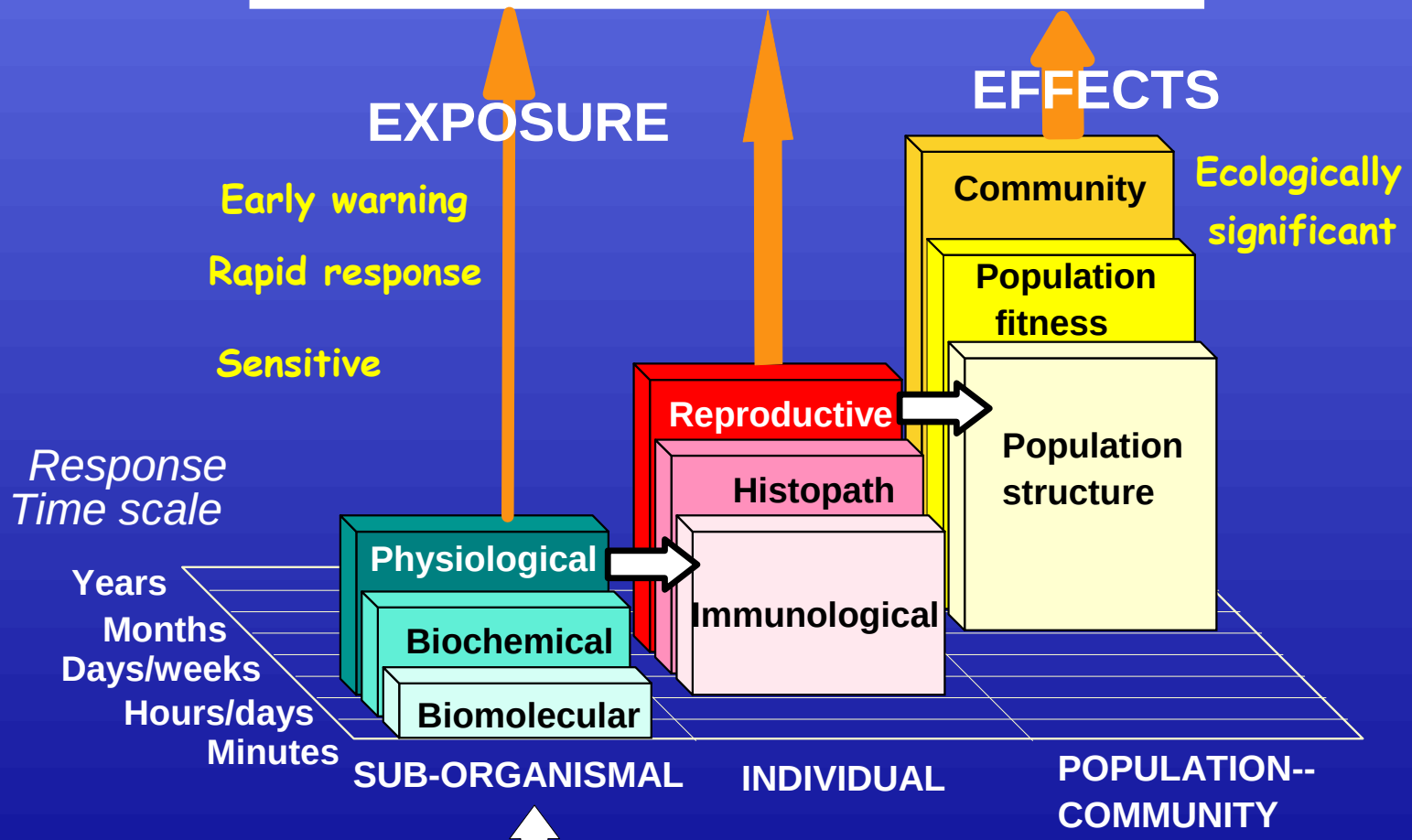
Map imagery provided by: Tennessee Valley Authority, E&T - Environmental Resources, Geographic Information & Engineering


Fly Ash Spill
Exposure to fly ash
- Feeding type
- Home range
- Habitat type
- Trophic level
Sentinel Wildlife Species
Small mammals
Birds
Fish
Herps
Mollusks
Benthic macroinvertebrates
Aquatic insect nymphs
Adult aquatic insects
ntegration of Biological Exposure and Effects over Landscape of fly ash spi

Application to aquatic food chains



Ecological Risk Assessment
Assessment of Fish Health
Natural Resource Damage Assess.



Exposure to Fly Ash

Conclusions

- As demonstrated by various individual bioindicators, the health of all 3 species is lower downstream of the fly ash spill than at reference areas

- The integrated discriminant analysis procedure indicated that the overall health of all 3 species was poorest at a site 2 miles downstream of the ash spill but recovered rather quickly downstream

- Spatial gradients in the composite histopathology score, an overall indicator of fish health, generally followed downstream patterns in levels of selenium in fish tissue

- Even though the health of fish immediately below the ash spill appears to be compromised to some degree, effects appears to be localized to a small area and to resident species

- Food chain studies in combination with the use of multiple bioindicators provide a weight-of-evidence approach for evaluating possible causal relationships between exposure to fly ash metals and biological responses