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EMAP
Great River Ecosystems



U.S. EPA Office of Research and Development

Environmental Monitoring and Assessment Program



Evaluation of reference conditions for contaminants and fish health indicators in Great Rivers of the U.S.

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Biomonitoring of Environmental Status and Trends (BEST) Program: Large River Monitoring Network (LRMN)

Identify, monitor, and assess environmental contaminants and their effects in fish

Endpoints

- Fish health indicators (*somatic indices, health assessment*)
- Histopathology (*general health, gonad*)
- Reproductive biomarkers (*vitellogenin, steroid hormones*)
- Contaminant concentrations (*organochlorine pesticides, metals*)
- Hepatic ethoxyresorufin O-deethylase (EROD) activity

BEST-LRMN Program

Many endpoint responses are species specific; therefore the program targets certain fish species

**Predator:
Largemouth Bass**



**Benthivore:
Common carp**



Endpoint data may be limited for certain species

LRMN Dataset

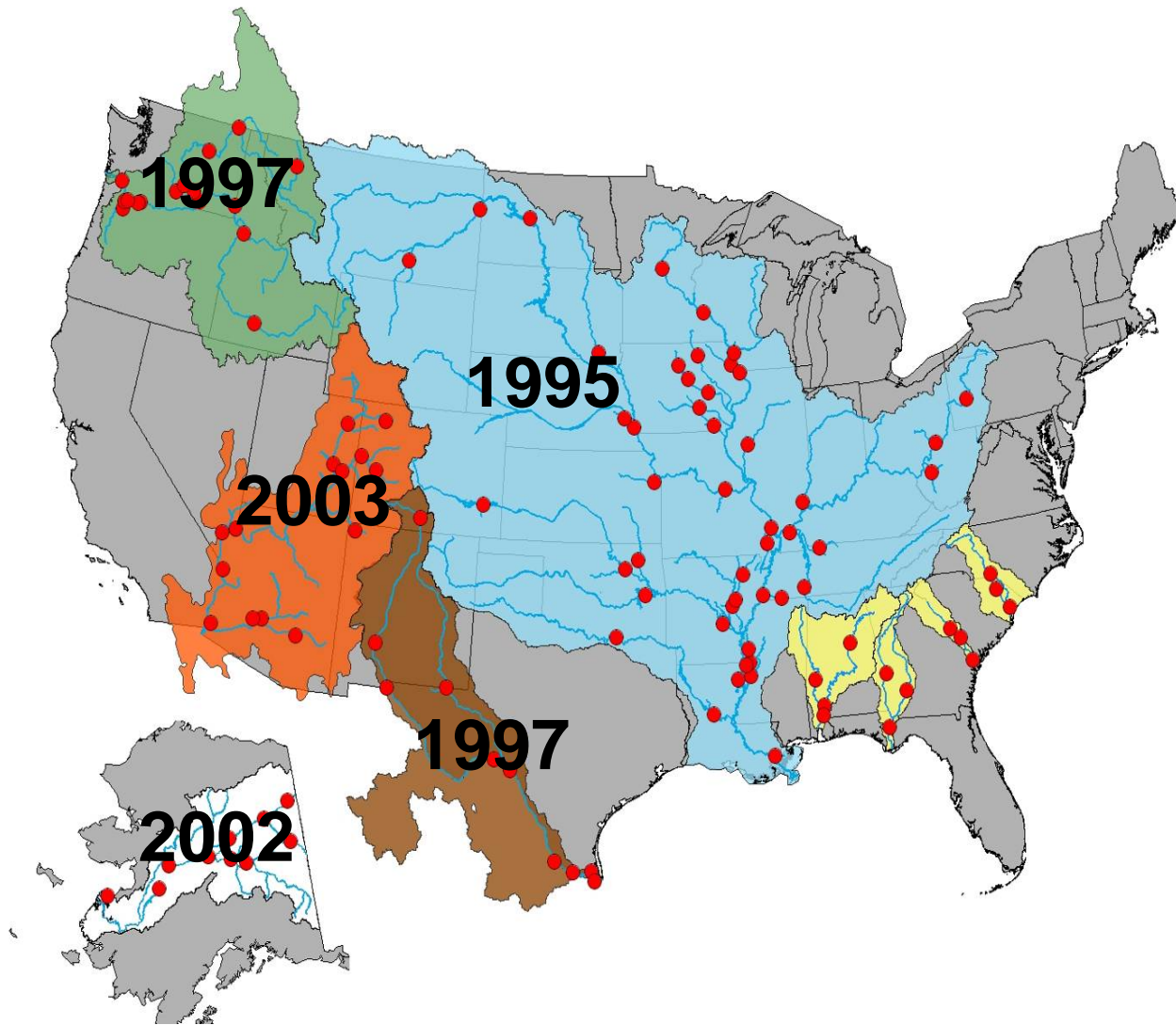
Sites: +100

Fish: +3200

Site Selection

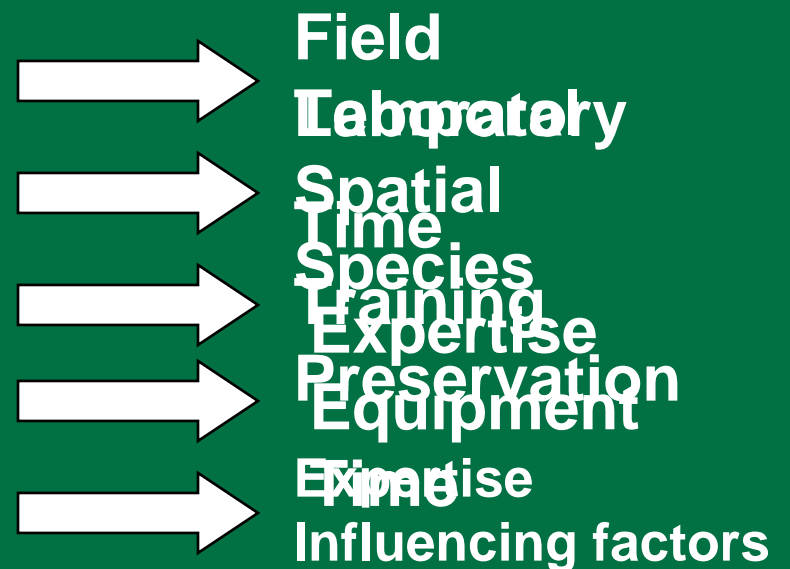
Random

Historical (NCBP)



Endpoints used by LRMN

Factors to consider	Rating
Cost	Green
Historical data	Green
Collection method	Yellow
Analytical method	Yellow
Interpretation	Red



Green = good/easy

Red = bad/difficult

Collection logistics of LRMN



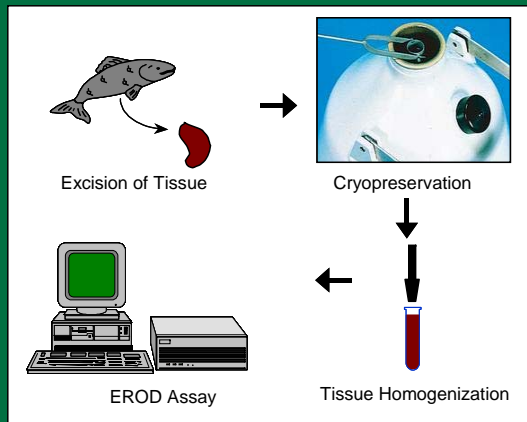
Live fish
Equipment
Min. 2 person crew



Hepatic microsomal ethoxyresorufin O-deethylase (EROD)



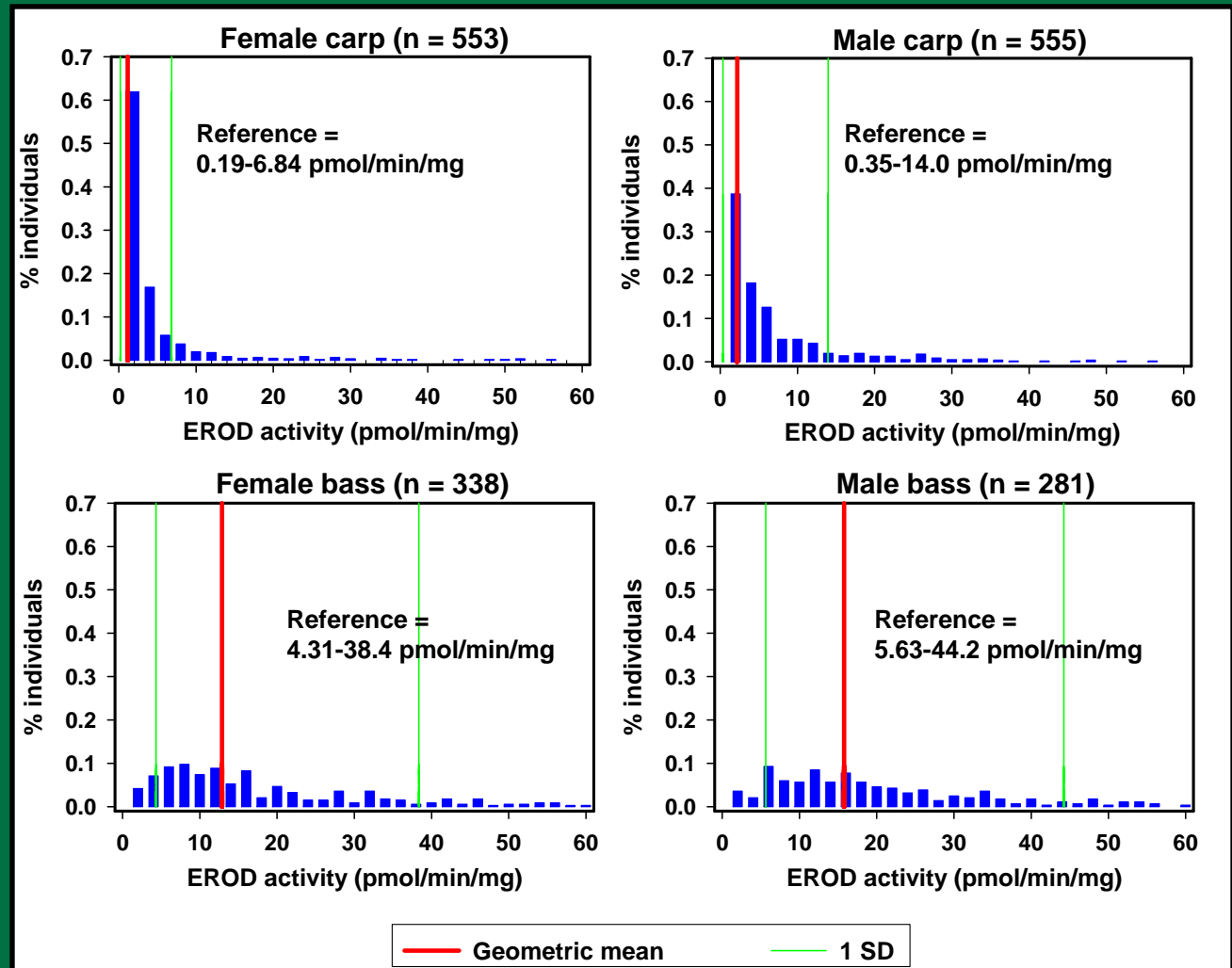
Factors to consider	Rating
Cost	Green
Historical data	Green
Collection method	Yellow
Analytical method	Yellow
Interpretation	Yellow



Frequency distribution of EROD

EROD activity in green area are reference or background

Influencing factors:
Species
Gender
Reproductive stage



Plasma vitellogenin and steroid hormones

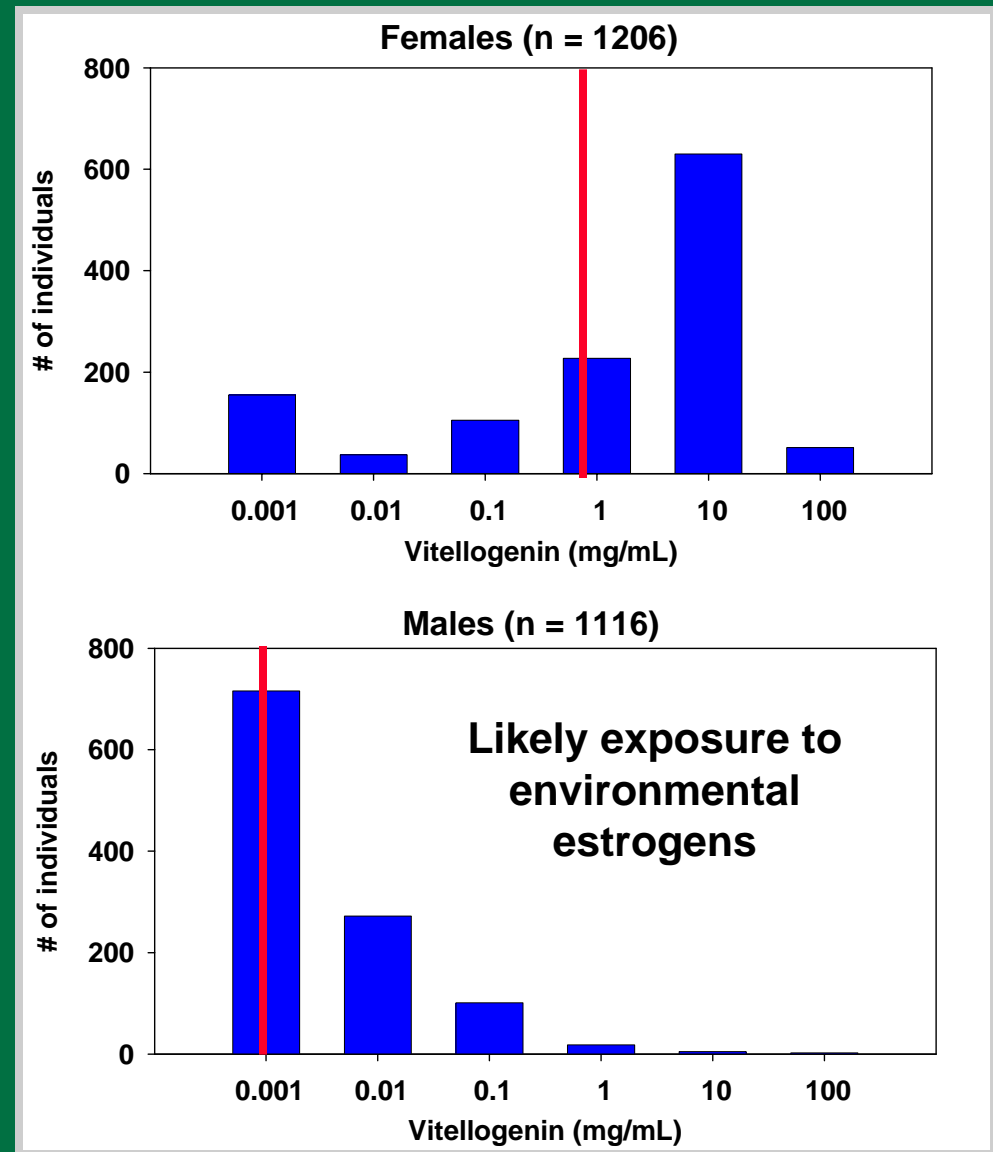


Factors to consider	Rating
Cost	Green
Historical data	Yellow
Collection method	Yellow
Analytical method	Yellow
Interpretation	Red

Frequency distribution of Vtg concentrations

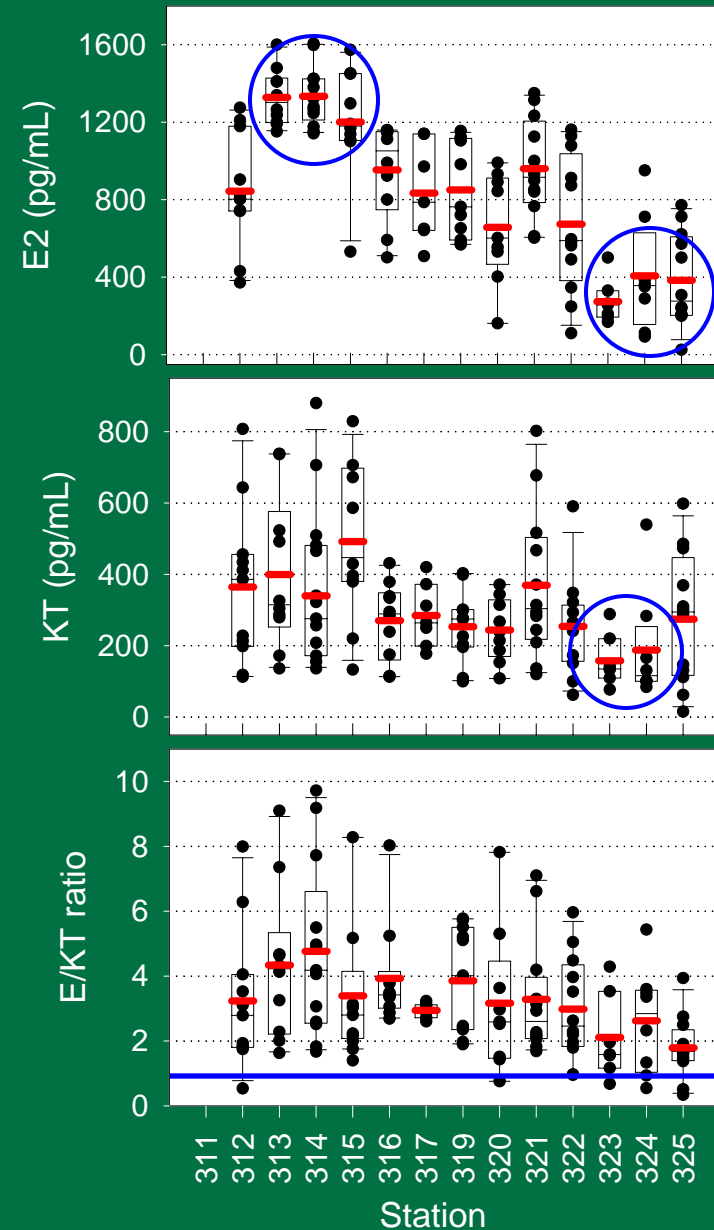
Conc. < detection limit:
13% of females
87% of males

Conc. >0.01 mg/mL in
males is anomalous



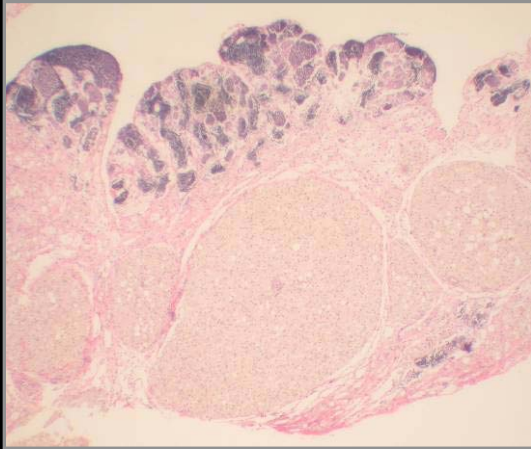
Steroid hormones in female carp

- Reference condition difficult to determine
- Samples collected Aug-Oct to minimize stage effects
- 17β -estradiol conc. differed among sites – delayed maturation (as determined by histopathology) at 323, 324, and 325
- 11-ketotestosterone conc. also relatively low at 323 and 324
- Compare hormone ratios

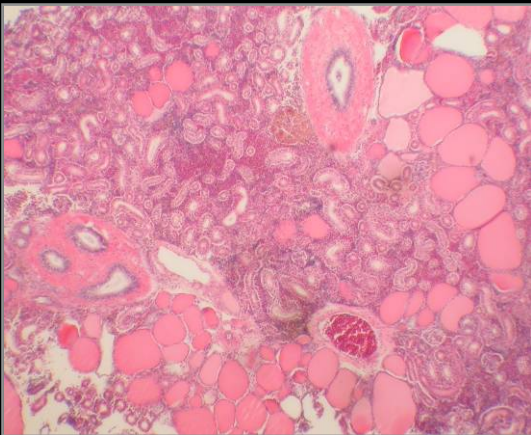


Histopathology

Testes with granulomas



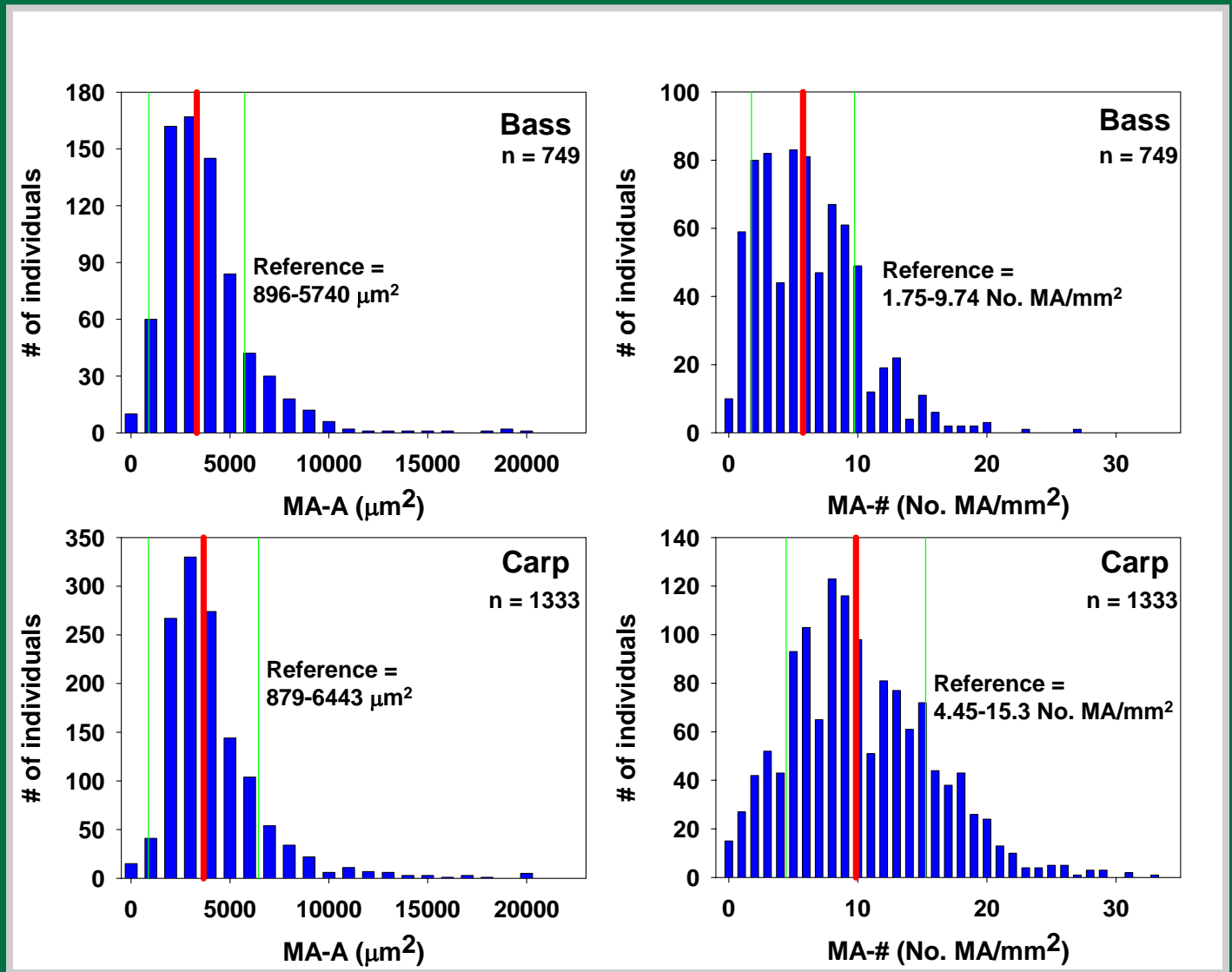
Anterior kidney with thyroid follicles



Factors to consider	Rating
Cost	Yellow
Historical data	Yellow
Collection method	Yellow
Analytical method	Yellow
Interpretation	Red

Much of histopathology is qualitative analysis. However, quantitative measurements can be made.

Frequency distribution of splenic macrophage aggregates



Fish Health Assessment Index (HAI)

External anomalies



Internal anomalies



Factors to consider

Rating

Cost



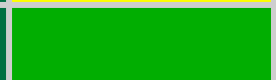
Historical data



Collection method



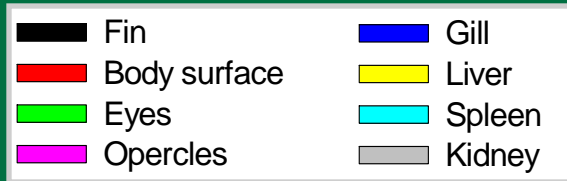
Analytical method



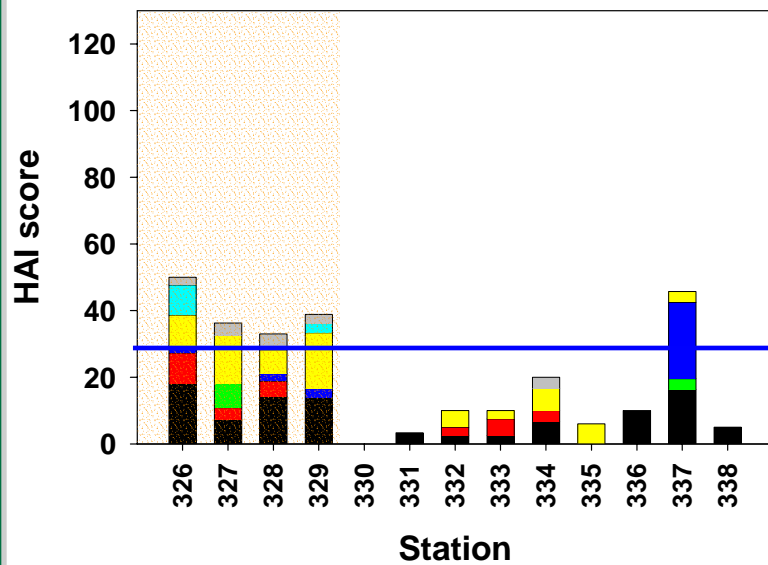
Interpretation



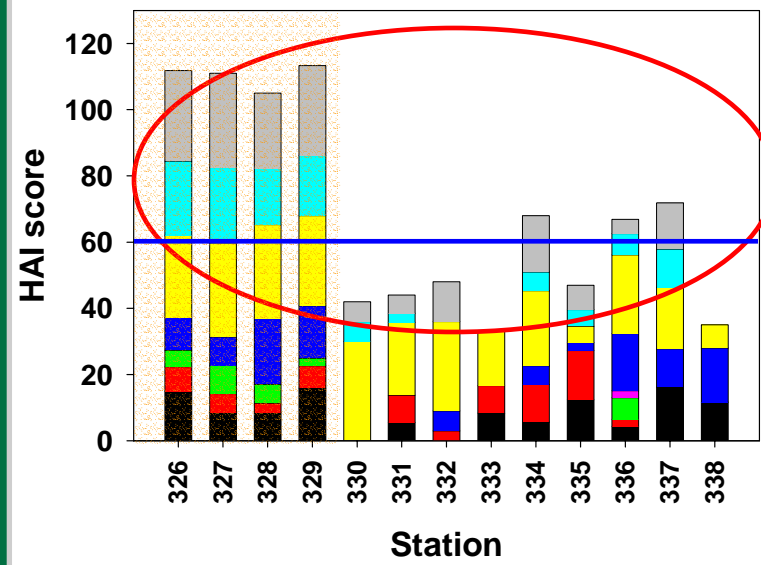
HAI scores and species differences



Female carp



Female bass



Age, length, weight, somatic indices

Otoliths

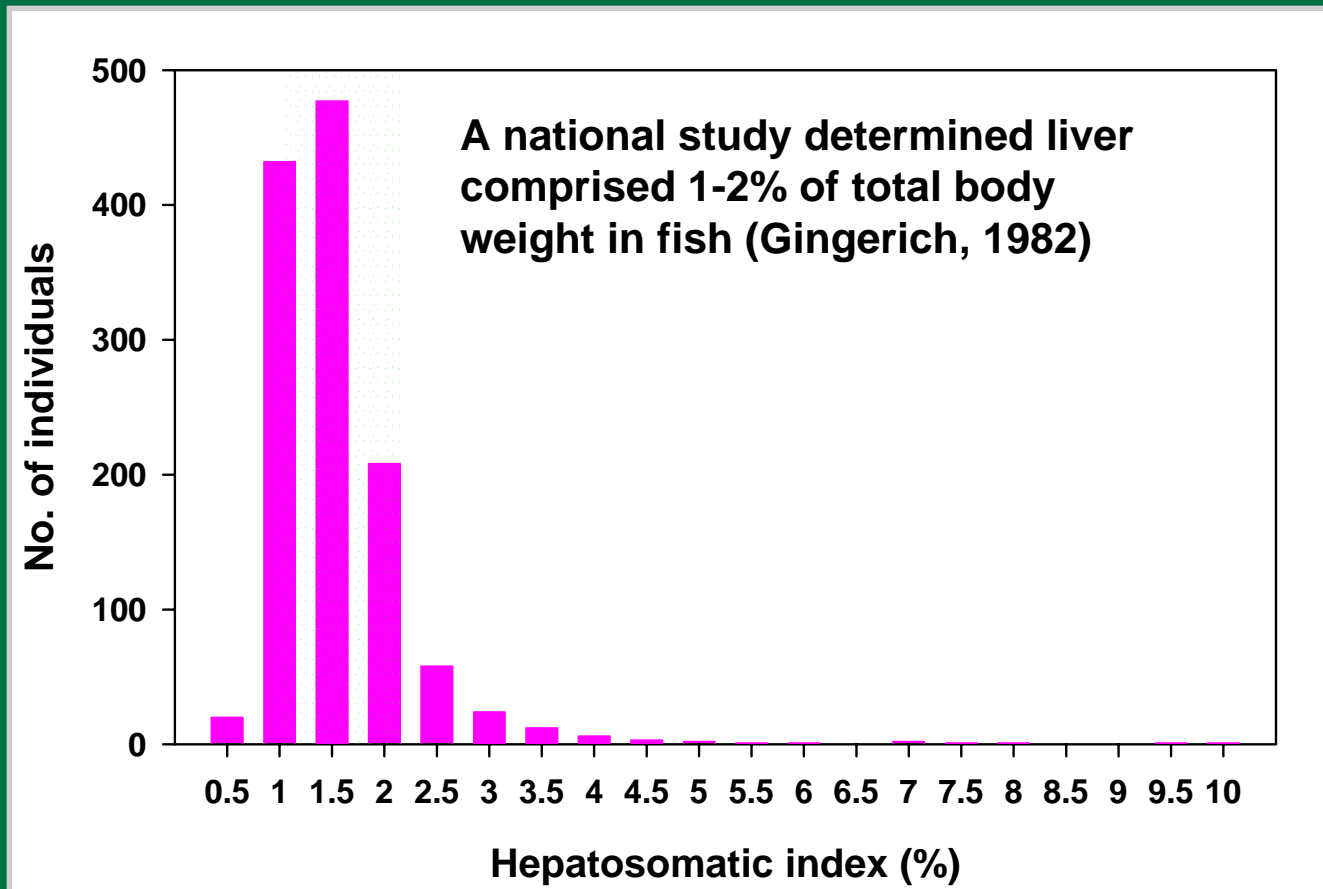


Enlarged spleen



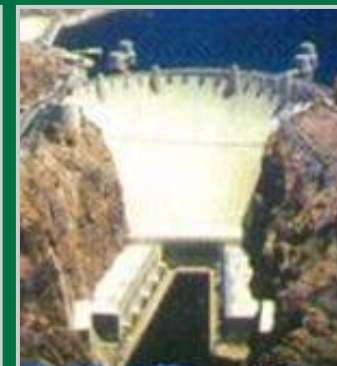
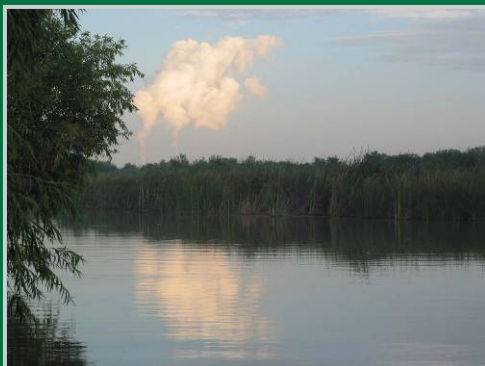
Factors to consider	Rating
Cost	Green
Historical data	Green
Collection method	Green
Analytical method	Green
Interpretation	Yellow

Frequency distribution of hepatosomatic index in all LRMN fish



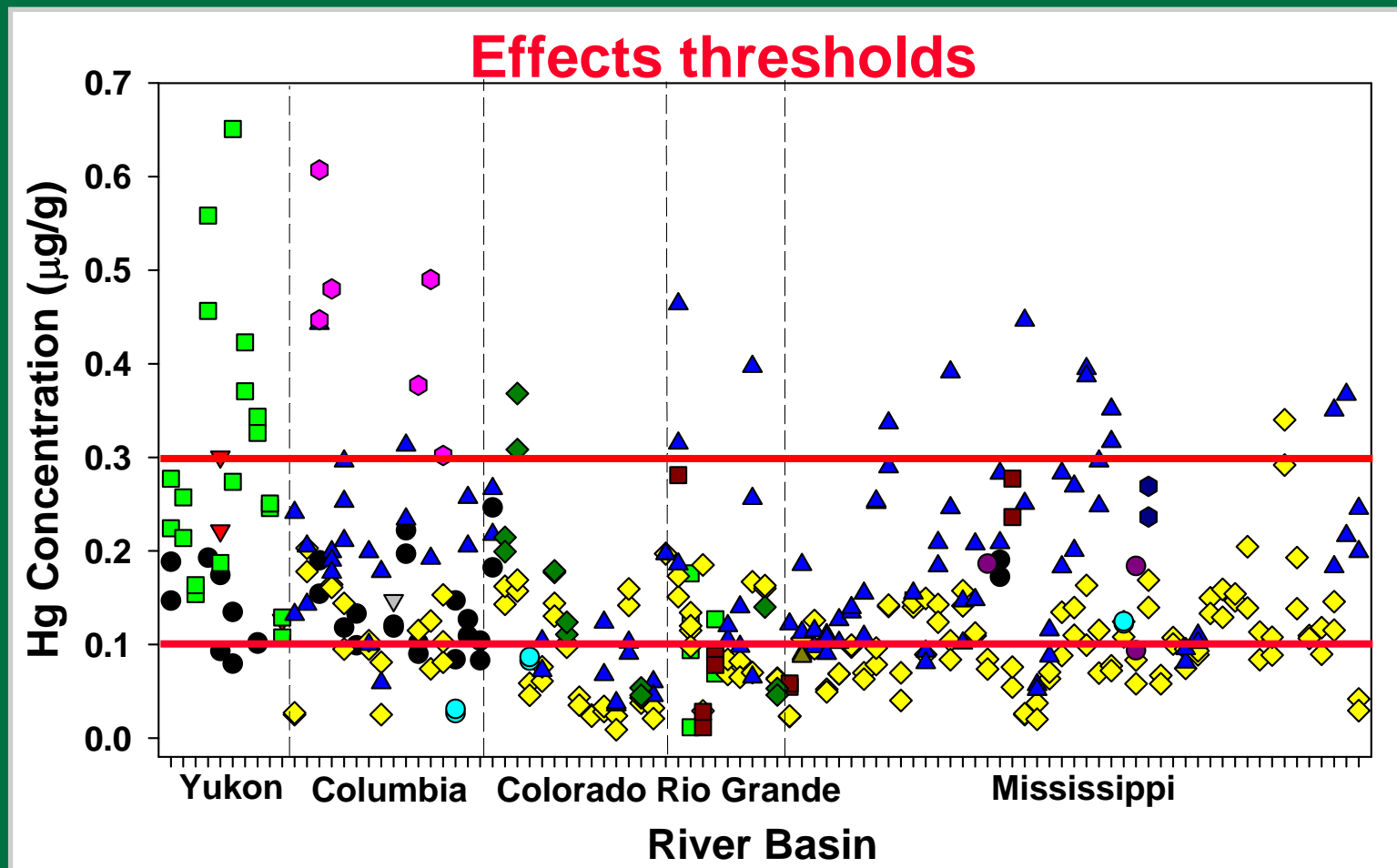
$$\text{HSI} = \text{liver weight} / (\text{total body weight} - \text{gonad weight}) * 100$$

Pesticides and inorganic contaminant concentrations

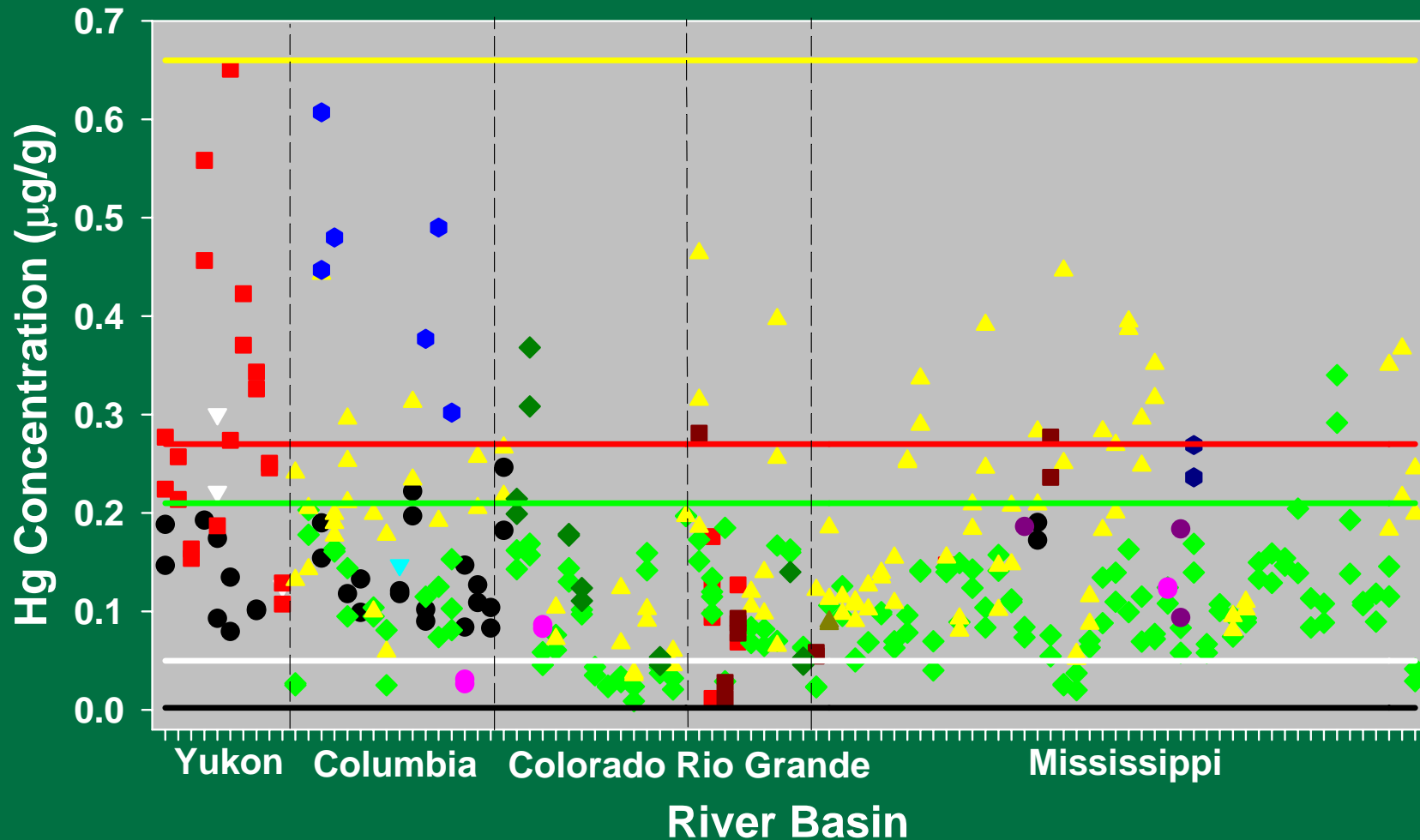


Factors to consider	Rating
Cost	Red
Historical data	Green
Collection method	Green
Analytical method	Green
Interpretation	Yellow

Mercury concentrations in LRMN fish



Wildlife at risk to mercury in LRMN fish



- Kingfisher (0.002 µg/g)
- Osprey (0.05 µg/g)
- Eagle (0.27 µg/g)
- Mink (0.21 µg/g)
- Otter (0.66 µg/g)

Contaminant concentrations

Pesticides and inorganics

Factors to consider	Rating
Cost	Red
Historical data	Green
Collection method	Green
Analytical method	Green
Interpretation	Yellow

DDT, toxaphene, Hg, Se, As

New generation chemicals

Factors to consider	Rating
Cost	Red
Historical data	Red
Collection method	Green
Analytical method	Red
Interpretation	Red

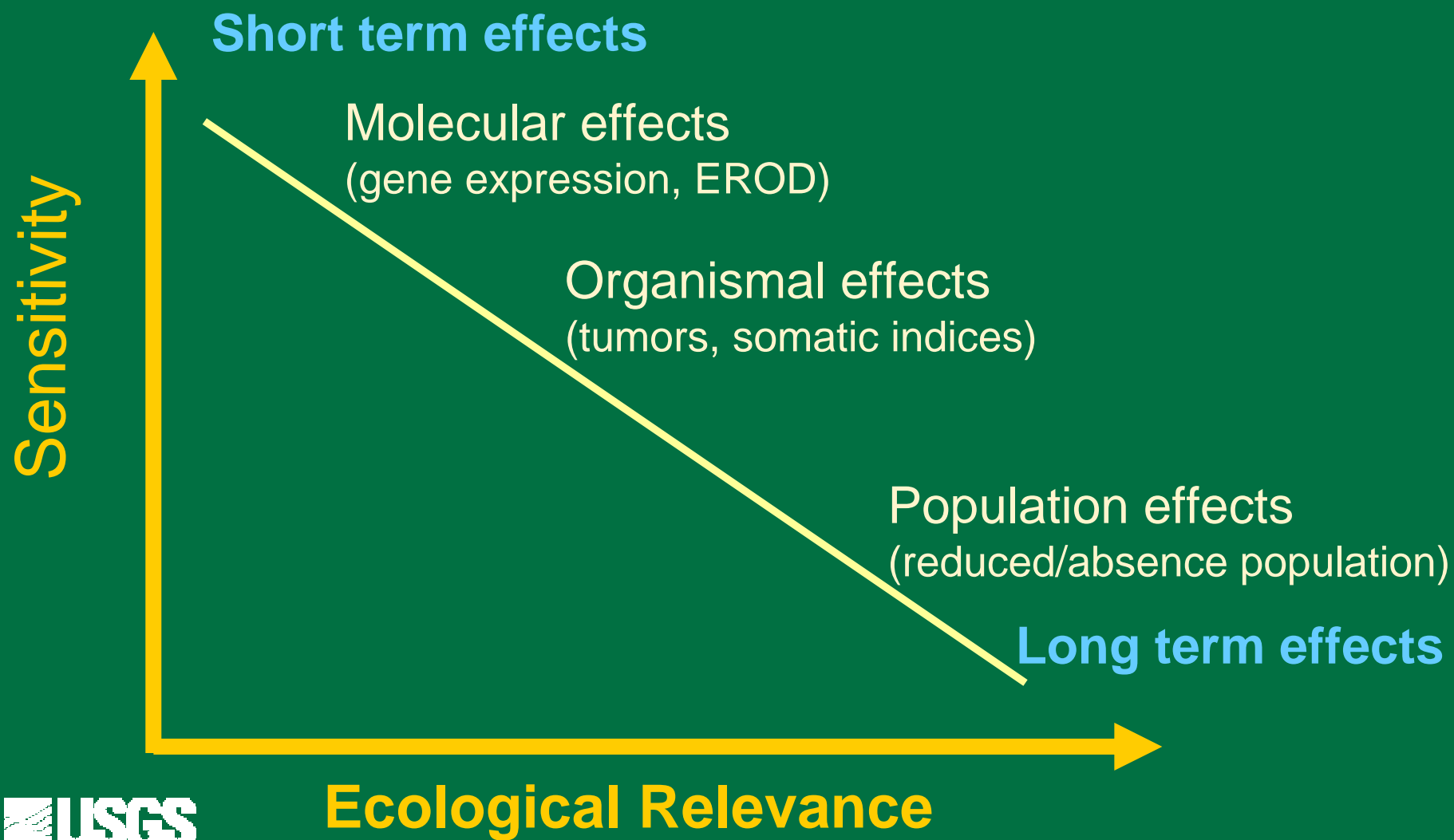
Pharmaceuticals, perchlorate

Emphasizes the importance of examining biological endpoints

Summary of endpoint use in fish health assessment

Endpoint	Method	Interpretation	Overall Use
Age, length, weight, somatic indices	Green	Yellow	Green
Health Assessment Index	Green	Yellow	Green
EROD	Green	Yellow	Green
Vitellogenin	Yellow	Red	Yellow
Steroid hormones	Yellow	Red	Yellow
Pesticides, Inorganic contaminants	Green	Yellow	Green
New generation contaminants	Red	Red	Red
Histopathology	Yellow	Red	Yellow

Overall use of LRMN endpoints in fish health and ecosystem assessment



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USGS Columbia Environmental Research Center: K. Echols, S. Finger, T. May, D. Nicks, C. Orazio, C. Schmitt

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University of Florida – Gainesville: N. Denslow



For more information on BEST-LRMN:

Contact me:
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Related publications (in pdf):
www.cerc.usgs.gov/pubs/pubs.htm

Fish health database:
www.cerc.usgs.gov/data/best/search.htm

