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Causal Factors in Spring-Time Fish Kills

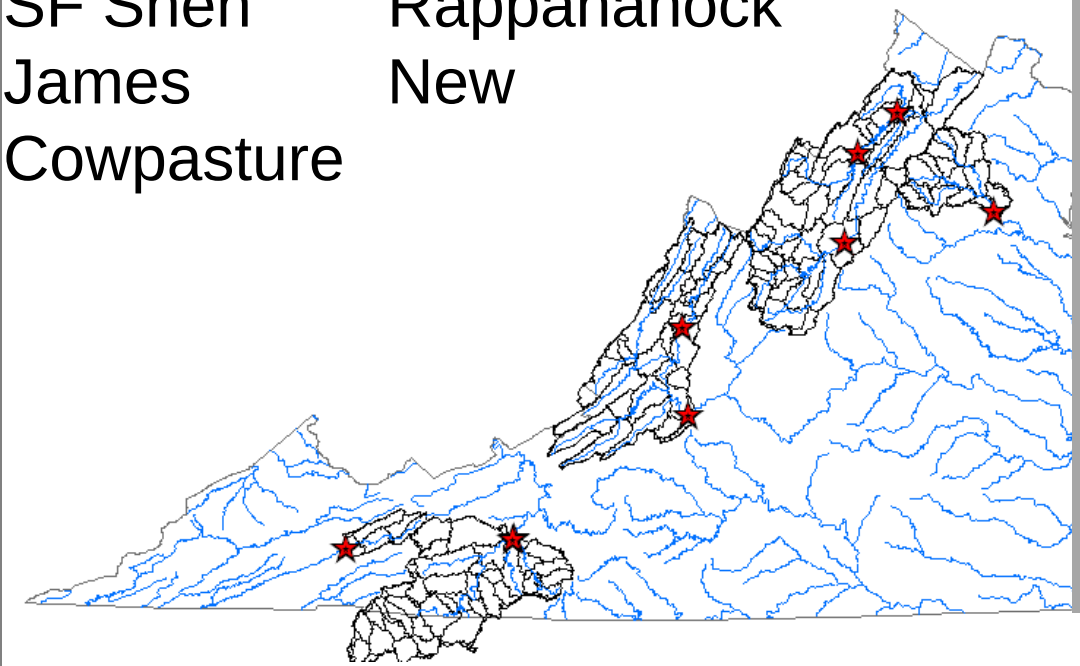
What We Did, What We Learned, What Next

November 17, 2008

SPORT FISH RESTORATION

Study Sites in 2008

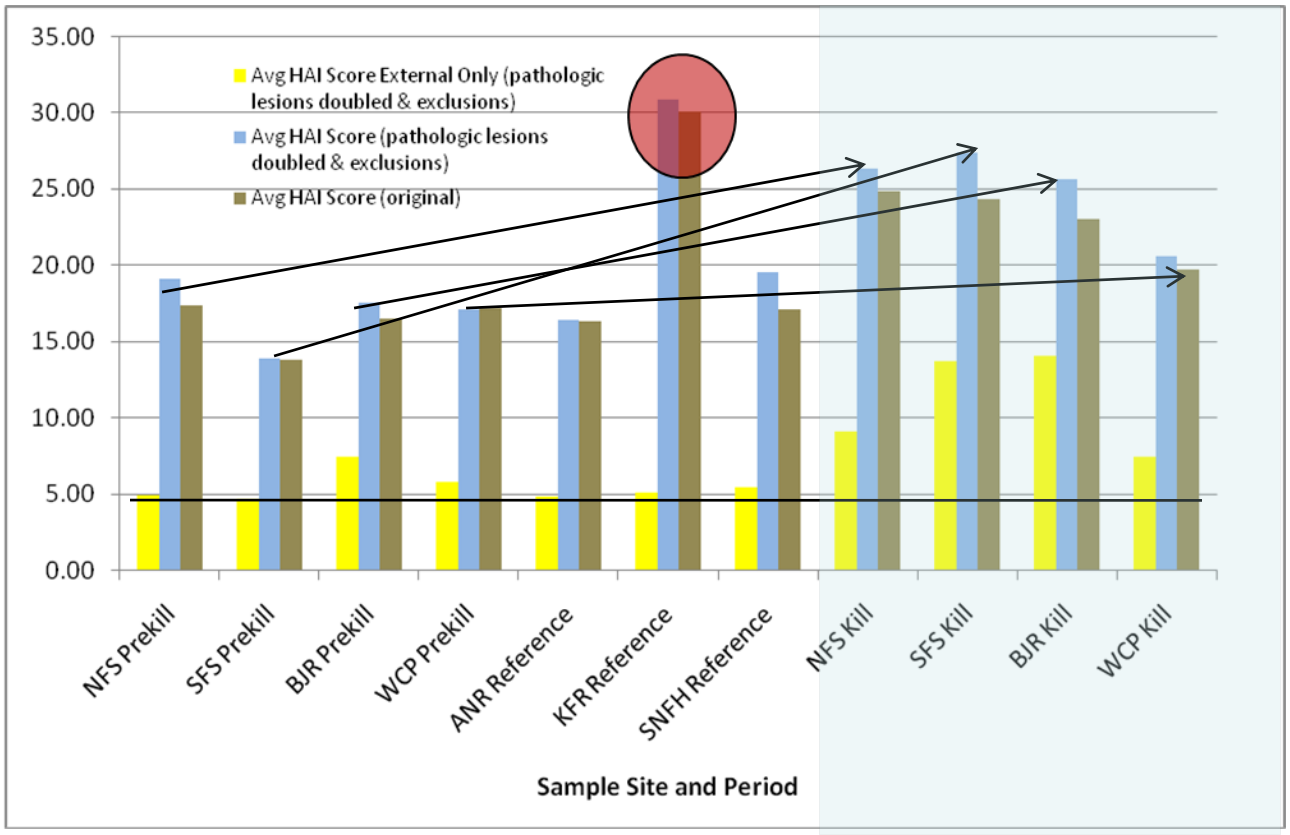
Kill Sites	*Reference*
NF Shen	NF Holston
SF Shen	Rappahanock
James	New
Cowpasture	



- Blood
- Tissues
- Parasites
- Snails and parasites
- Nutrients
- Metals
- Brook and Brown Trout
- Spring locations
- Fish Kill Intensity

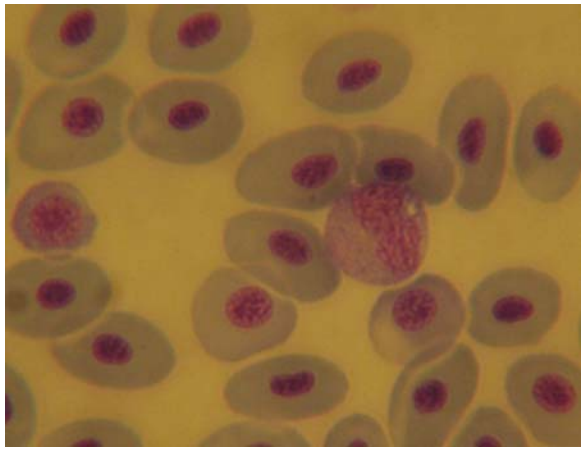
- Modified Health Assessment Index is able to differentiate between kill and pre-kill sites
- Some metrics more “meaningful”
- Blind studies to test correspondence with histological tissue sections (ongoing)

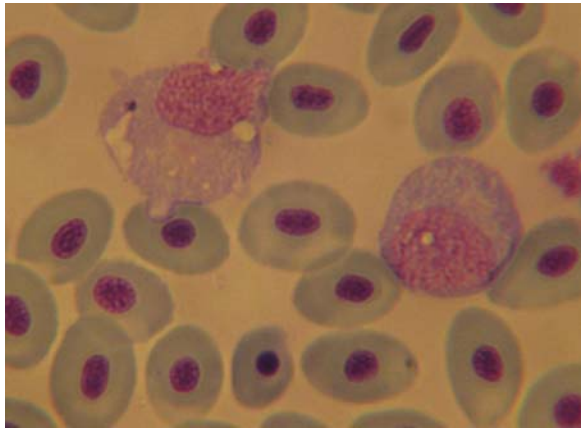
Potential for External HAI



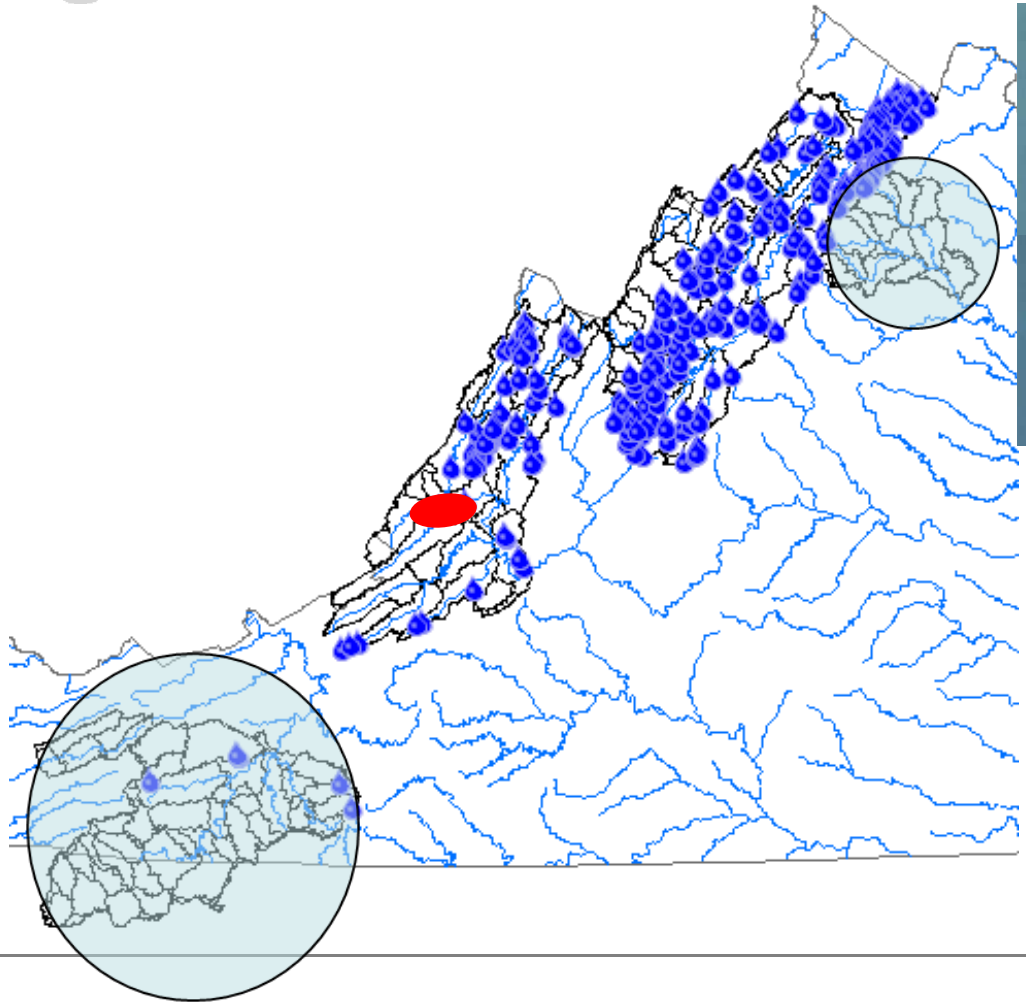
Blood

- Question whether normal haematological values can be established …
- Baseline values for 15 blood parameters
- Prelim: Only meaningful change - leukocytes



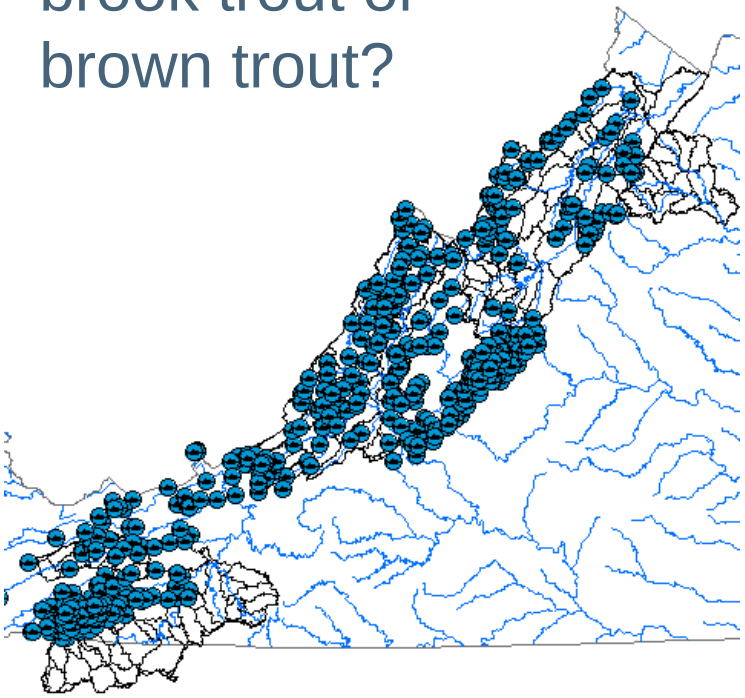


Springs and Jackson Tailwater



Trout Streams - a potential reservoir?

Do we have any Rome strain brook trout or brown trout?



Journal of Wildlife Diseases, 30(4), 1994, pp. 577–580

Relationship Between Resistance of Salmonids to Furunculosis and Recovery of *Aeromonas salmonicida* From External Mucus

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ABSTRACT: Fish were sampled at the Ed Weed State Fish Hatchery (South Hero, Vermont, USA) in September 1992. *Aeromonas salmonicida* was common, with concentrations as high as 10^5 to 10^7 colony-forming units per gram of mucus, and readily recovered from most mucus samples obtained from furunculosis-sensitive populations of brook trout (*Salvelinus fontinalis*), lake trout (*Salvelinus namaycush*), and Atlantic salmon (*Salmo salar*). The pathogen was the predominant microorganism and accounted for greater than 85% of the total number of bacteria isolated from the mucus of these fish. By comparison, *A. salmonicida* was recovered only from two rainbow trout (*Oncorhynchus mykiss*), and bacterial frequencies did not exceed 10^3 colony-forming units per gram of mucus. The pathogen was not recovered from the mucus of steelhead (*O. mykiss*) or Rome brown trout (*Salmo trutta*) selectively bred for resistance to furunculosis, even though there was widespread contagion throughout the hatchery and fish were cultured on a common, unprotected water supply.

One strain each of furunculosis-resistant brook trout and brown trout still are maintained at Rome (John Schachte, pers. comm.). Resistance of Rome trout to furunculosis is widely accepted by many practicing fish culturists, and these fish are used in many programs throughout the New England and Mid-Atlantic regions of the USA. Unfortunately, detailed information does not exist on actual hatchery performance during natural exposure to the pathogen. Our objective was to compare the recovery of *A. salmonicida* from mucus of furunculosis-resistant brown trout to recovery from more sensitive salmonids.

From the second week of July until the end of September 1992, a furunculosis epizootic among production lots of salmon and trout occurred at the Ed Weed State

Possible spreaders: creek chub, common shiner, golden shiner and white sucker?

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Furunculosis in baitfish and its transmission to salmonids

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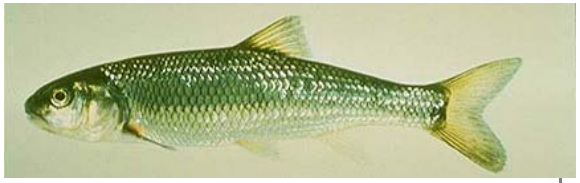
ABSTRACT: *Aeromonas salmonicida* subsp. *salmonicida* was isolated from 4 species of freshwater minnows commonly used as baitfish. Some of the infected baitfish developed deep-seated muscle lesions (furuncles) similar to those seen in salmonids with furunculosis. In non-salmonids, furunculosis has previously been associated with superficial ulcerative lesions from which atypical *A. salmonicida* was usually isolated. This report illustrates the ability of *A. salmonicida* subsp. *salmonicida* to cause furunculosis in 4 species of baitfish. It was transmitted from one species of minnow, the common shiner *Notropis cornutus*, to coho salmon *Oncorhynchus kisutch* and brook trout *Salvelinus fontinalis*, demonstrating the potential for baitfish to serve as a reservoir for the horizontal transmission of typical *A. salmonicida* from non-salmonids to salmonids held in the same body of water.



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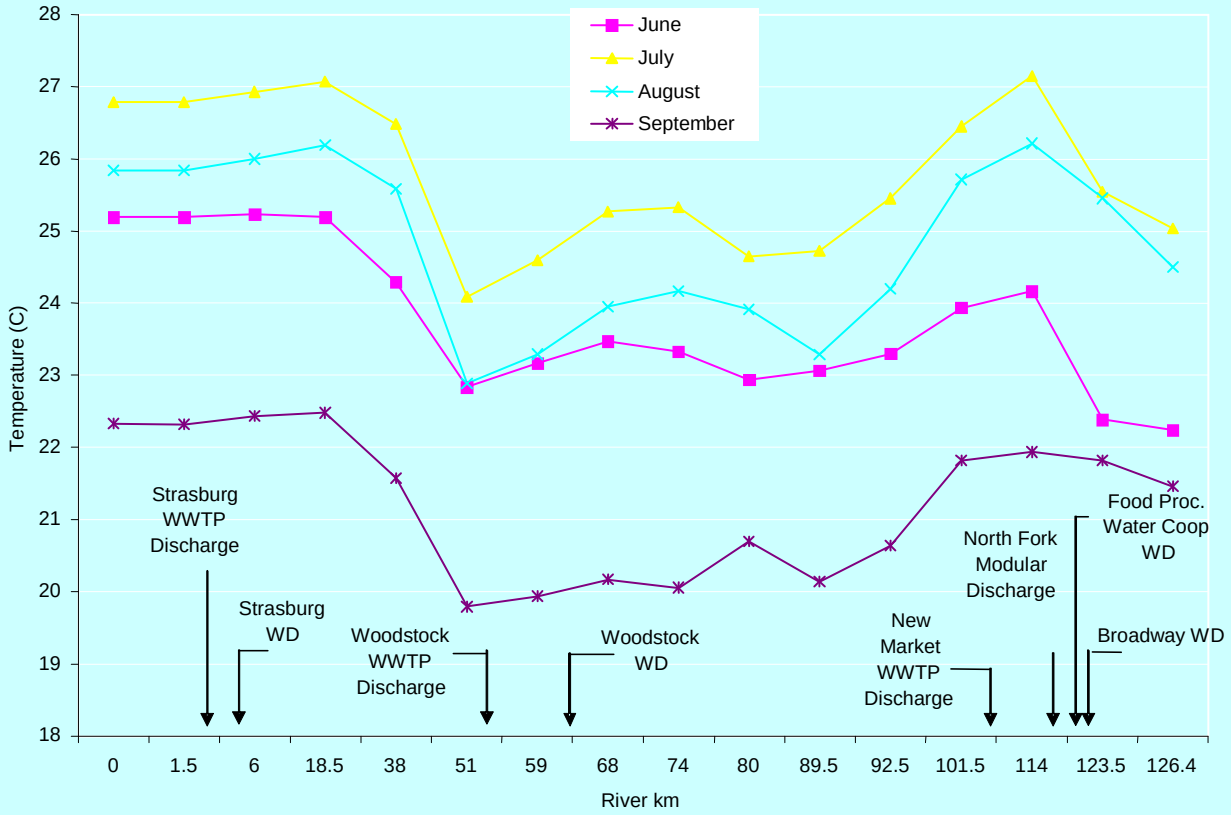
North Fork Shenandoah River Temperature Profile



Modeled average temperature depicting a longitudinal profile along the NFSR during summer 2002 using SNTEMP. Three areas in the River show temperature peaks.

Where do we go from here?

- Environmental Stressors?
- What is reservoir for pathogen?
- What is route of exposure?
- What affects heterogeneity of host response?
- How is pathogen transmitted?

Weight of Evidence

Biological gradient.—

- There is a dose–response relationship either on a spatial or temporal gradient within the system.

- Agriculture pesticides?
- Metals?
- Mixtures?

Consistency of the association.—

- The response relationships between some of the stressors have been observed by other investigators at other times and places

- No field studies
- Laboratory investigations

Time Order—

- The cause precedes the effect in time, and also the effect decreases when the cause is removed or decreased (i.e., remediation).
- Data gap, cause unknown

Presence of exposure indicators.—

- There is the presence of exposure indicators and body burdens of contaminants in organisms.
- Haphazard toxicant sampling
- Follow up study to follow detox enzymes in blood or liver samples

Strength of association?

- A large proportion of the organisms in the contaminated system are affected compared to those from a reference area.

- Data gap
- Follow up - smaller ‘reference’ sites

Specificity of the association?

- Some of the observed effects are diagnostic of exposure.
- Not all fish get ulcerative lesions and some survive

Coherence of association?

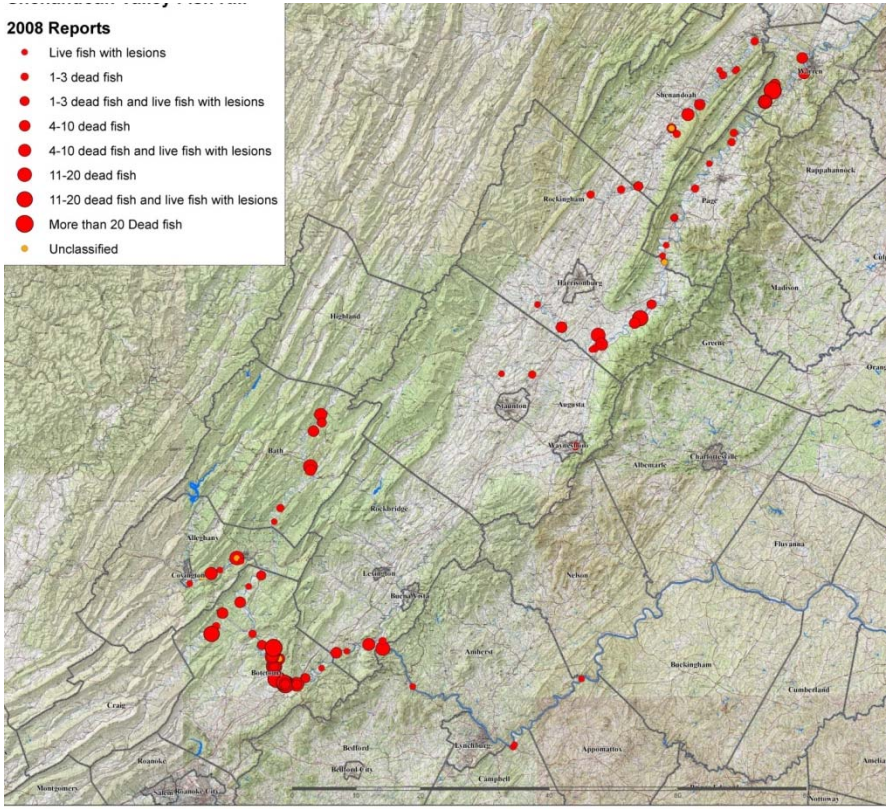
- The cause–effect relationship corresponds to the current understanding of mechanisms of effects.
- long-term exposure to mixtures of contaminants cause endocrine disruption and immune suppression.

Study Elements

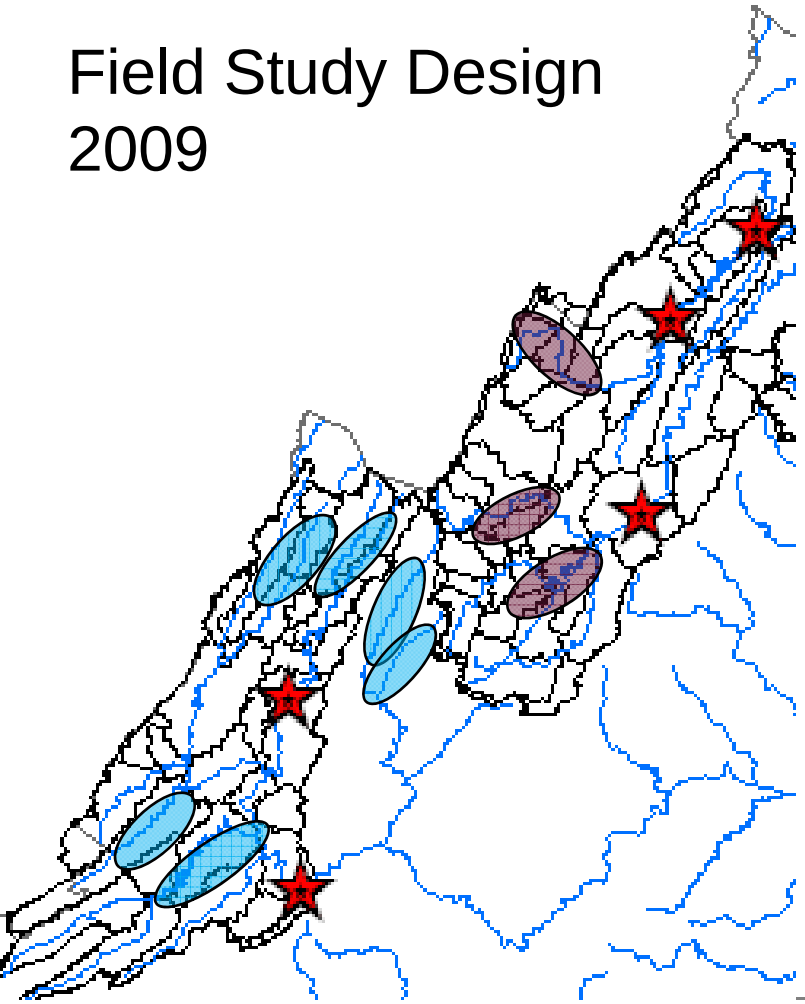
- Pathogen distribution and transmission
- Carriers: trout, sculpin, snail, clam, trematode
- Stressors that reduce resistance (arsenic, atrazine, etc.)

What We Should Do Next

- Fish Health Over Time at Fixed Stations
- Kill Intensity Model
- Pathogen surveillance
- Heterogeneity of Infection



Field Study Design 2009



- Factorial Sampling Design
- Responses
  - Fish Immune Competence
  - Lesions
  - Carriers and Spreaders
- Measure Stressors
- Compare Survivor Body Burdens

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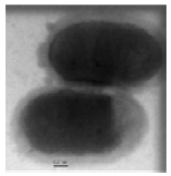

Lab Exposure Studies