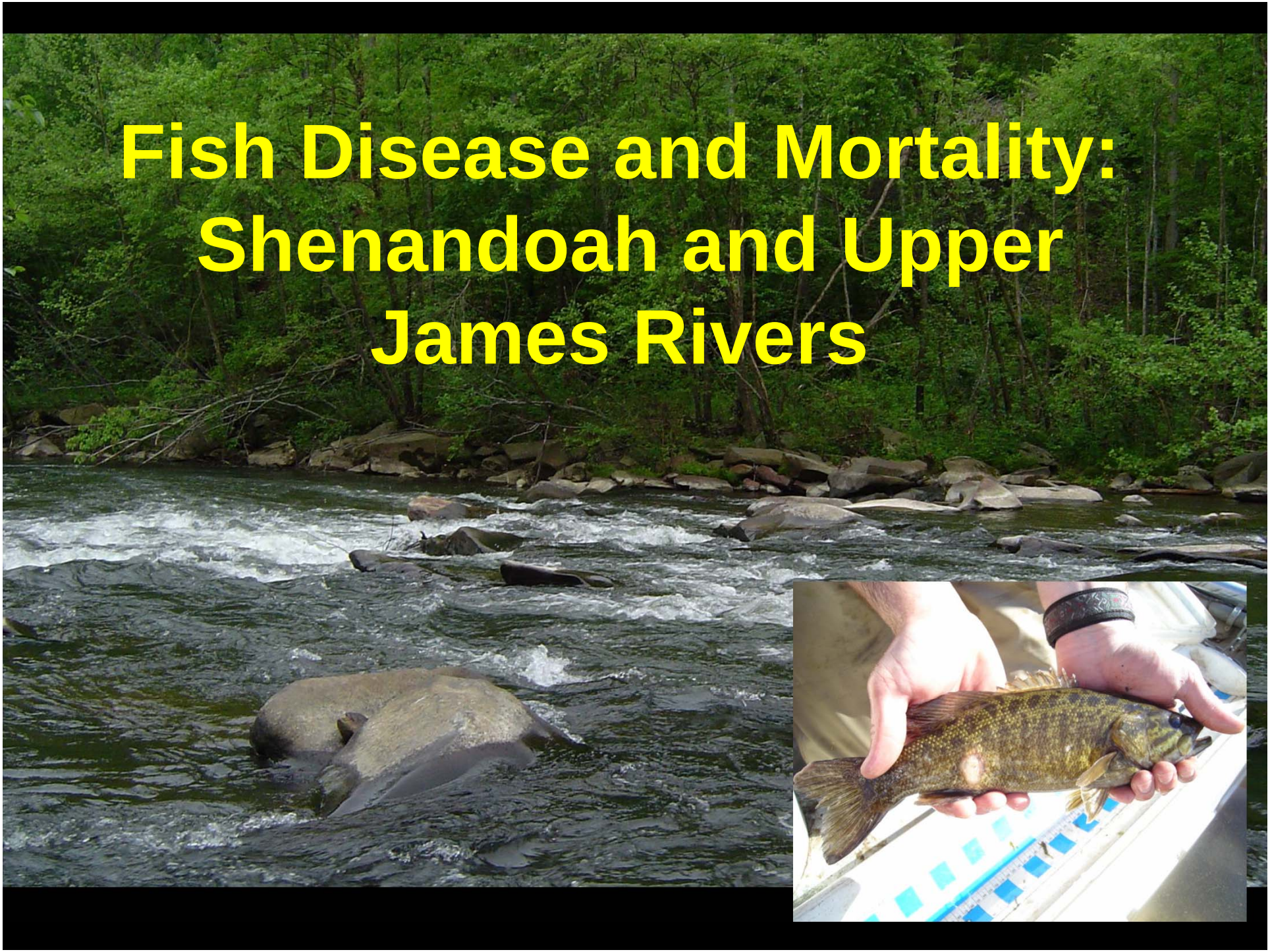
Fish Disease and Mortality: Shenandoah and Upper James Rivers

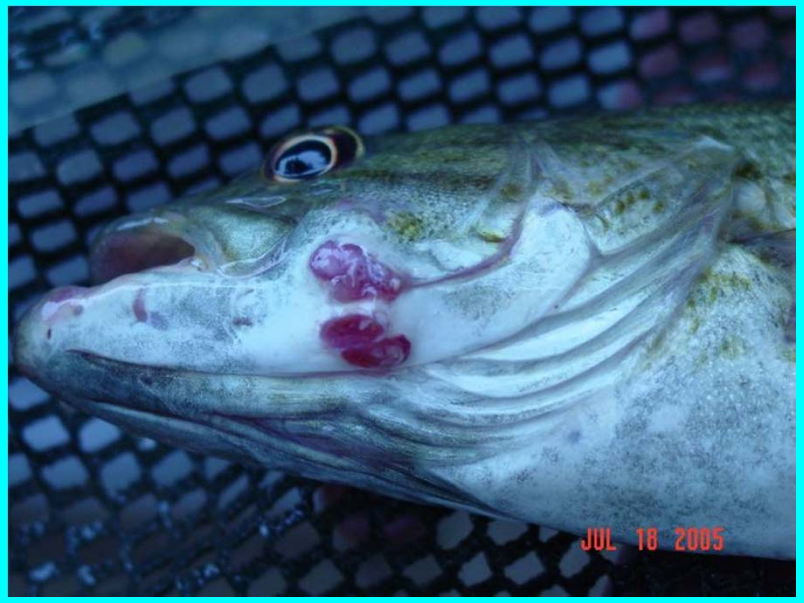


Early Spring 2004

North Fork Shenandoah

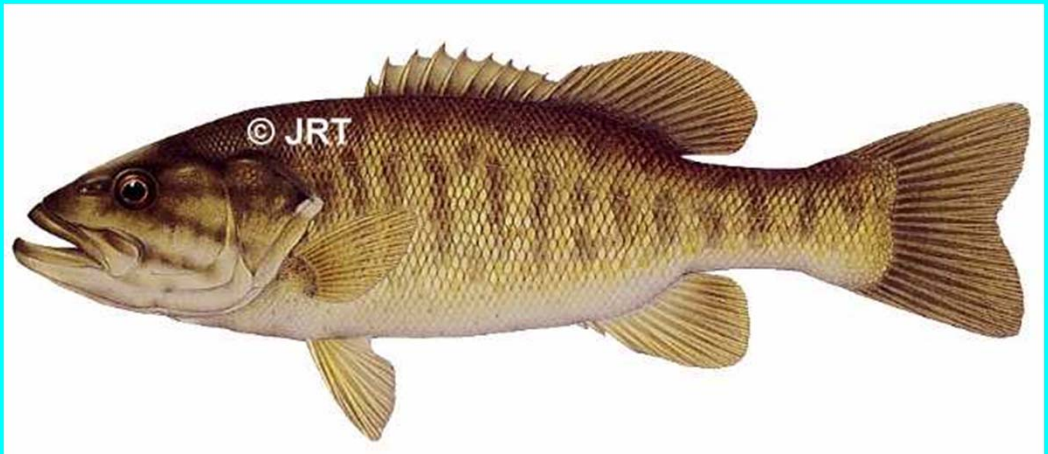
Continuing Reports

- Low numbers of fish: 2-3 months - spring
- Mostly smallmouth bass and redbreast sunfish
- Mostly adults
- Other species - mostly unaffected
- Many fish with skin lesions



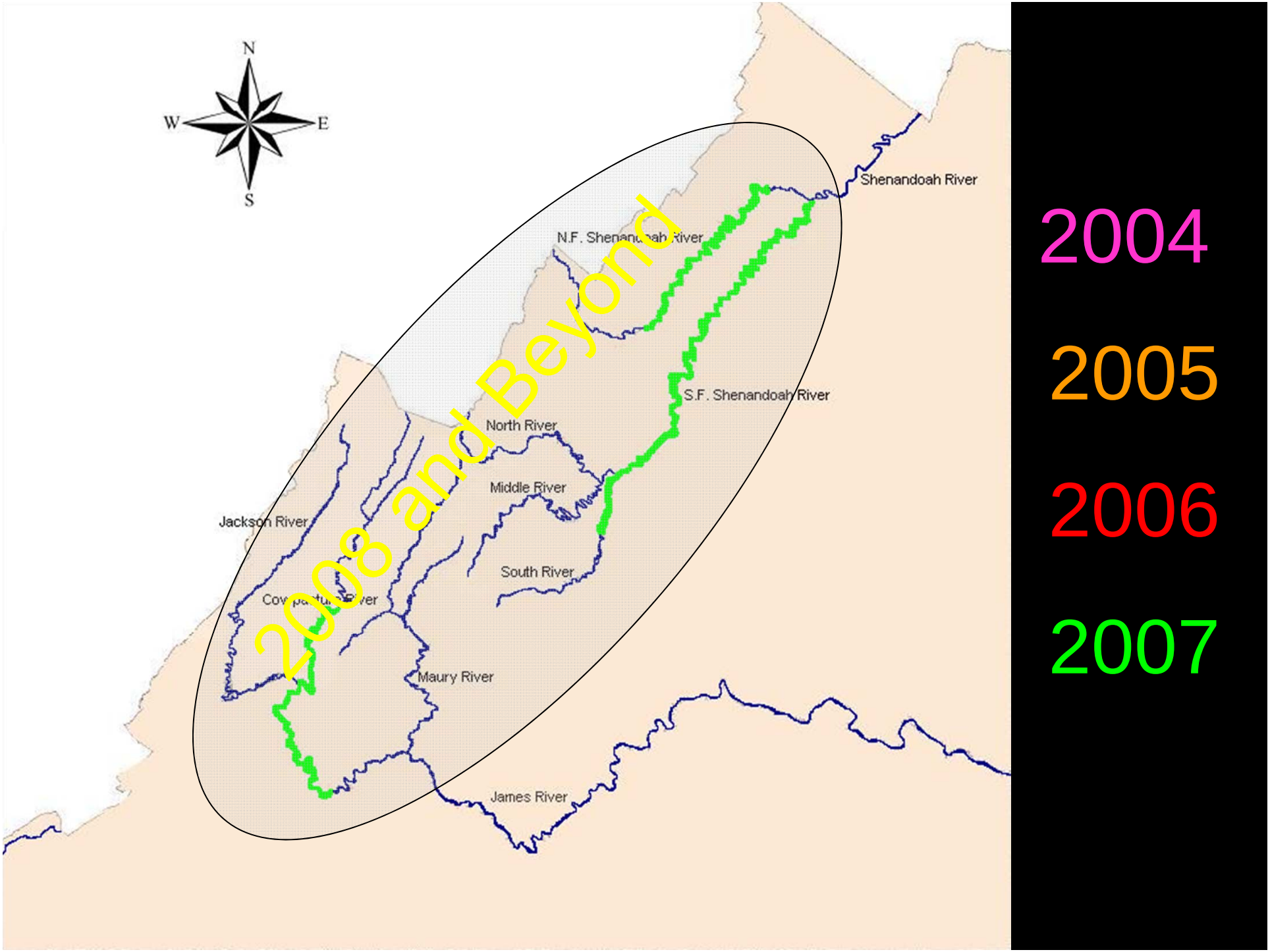
Up to 80% loss of the <u>adult</u> smallmouth bass and redbreast sunfish

- 75 miles of NF Shenandoah (2004)
- 100+ miles of SF Shenandoah (2005).

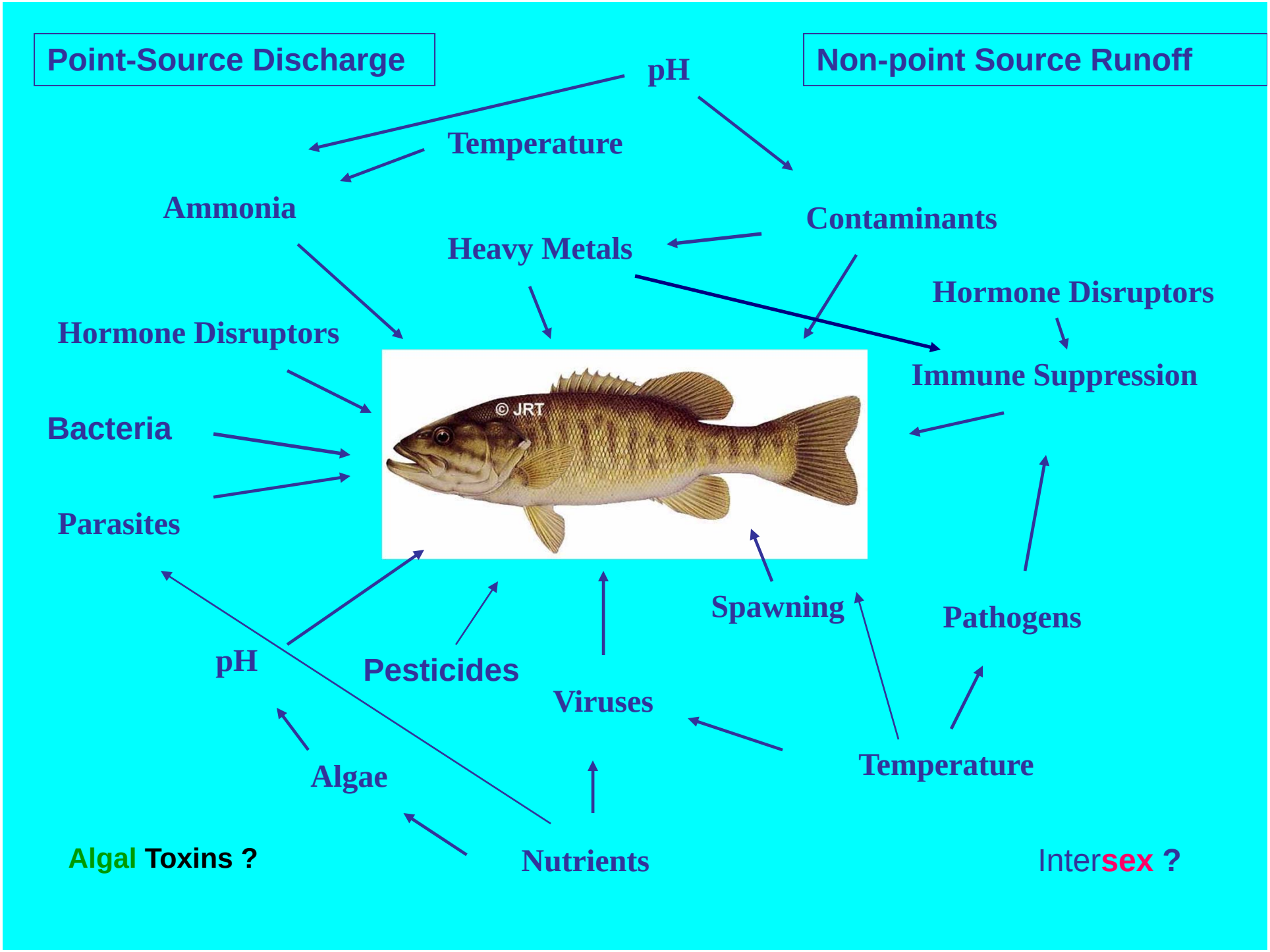


When and Where…

- 2004 - NF Shenandoah
- 2005 - SF Shenandoah
- 2006 – NF and SF Shenandoah
- 2007 – NF and SF Shenandoah, plus the Cowpasture River
- 2008 to present – all of above, plus Upper James and tributaries


N
W
E
S
Shenandoah River
N.F. Shenandoah River
S.F. Shenandoah River
North River
Middle River
Jackson River
South River
Maury River
James River
2008 and Beyond
2004
2005
2006
2007

So, what's wrong
with this picture?


Point-Source Discharge
Non-point Source Runoff
pH
Temperature
Ammonia
Contaminants
Heavy Metals
Hormone Disruptors
Hormone Disruptors
Immune Suppression
Bacteria
© JRT
Parasites
Spawning
Pathogens
pH
Pesticides
Viruses
Temperature
Algae
Algal Toxins ?
Nutrients
Intersex ?

Our Approach: Partnerships

Public / Private

- Government Agencies
- University Researchers
- Non-Profit Organizations
- “Friends” Groups
- Individuals

Processes

- Hypothesis Testing
- Fish Kill Task Force & Subgroups
- Fisheries Networking
  - University Researchers
  - Government Scientists
  - AFS Network
- EPA C.A.D.D.I.S. Process
  - 2 multi-day workshops w/ WV
- CBF 2007 Fish Health Conference

The Science

- Extensive Water Quality & Sediment Studies
  - Baseline
  - Storm Events
  - Nutrients, ammonia, arsenic
  - Emerging contaminants
- Several Fish Health Studies
  - Pathology – external and internal
  - Blood
  - Viruses and Bacteria
- Large-Scale Benthic Invertebrate Study
  - Shenandoah and tribs

What Have We Learned?

Water Quality

Water Quality

Baseline and Storm Flows

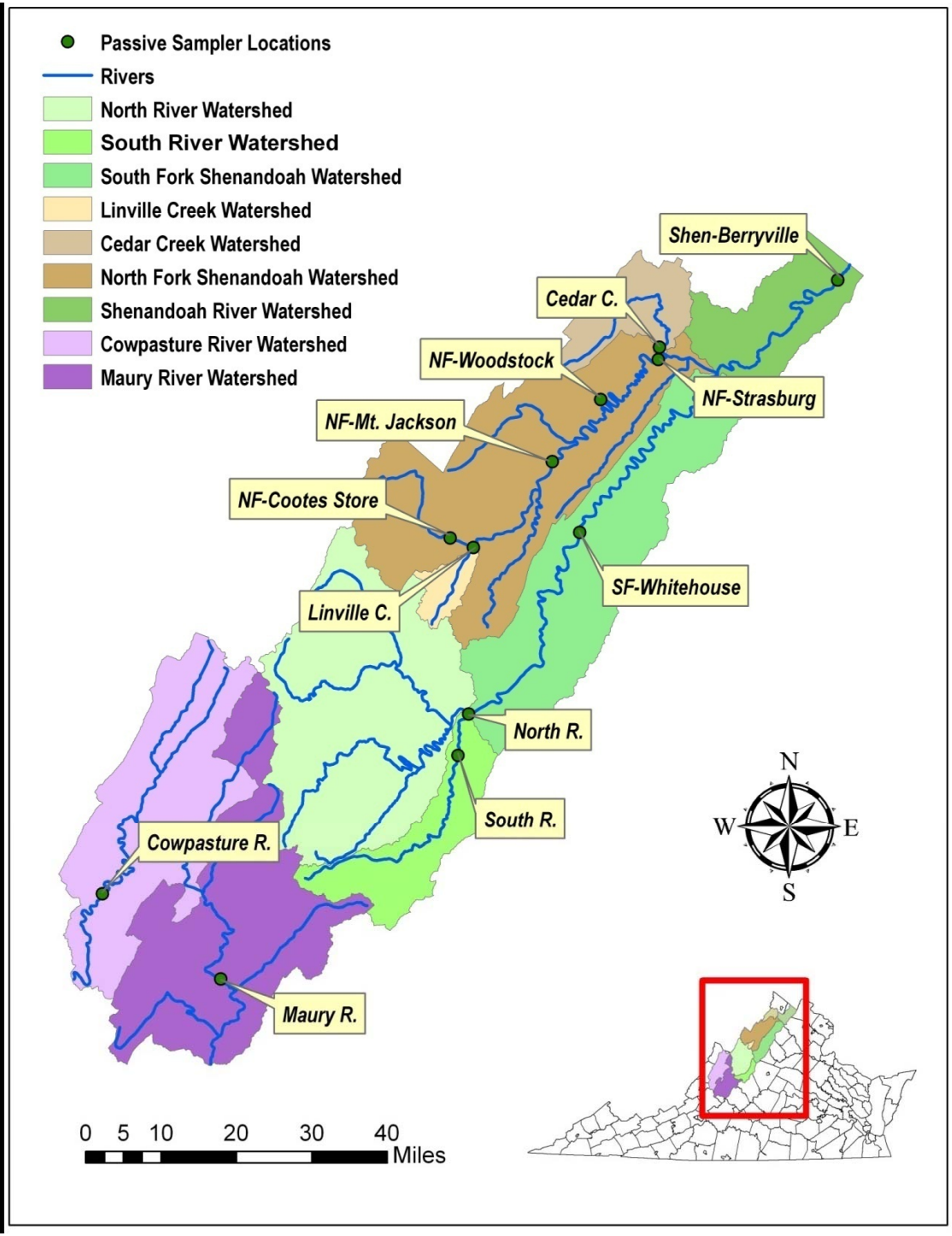
- Nutrients, metals, organics, pesticides
  - No chemicals at levels that exceed water quality criteria or known toxic thresholds
  - No clear proximate cause
- Events are correlated with temperature - YES

- What we don't know:
  - Other chemicals? We cannot measure every known chemical
  - Effects of mixtures of chemicals?
  - Role of other stressors (biological, physical)

Passive Samplers

Parameters Sampled

Class of Compounds	# of Parameters
PAHs	34
Organochlorine Pesticides and PCBs	34
Agricultural Herbicides and Pesticides	35
Waste-indicator Chemicals	61
Pharmaceuticals	30
Hormones	4
Estrogenic Potential	1
Total =	199 Parameters


Passive Sampler Locations
Rivers
North River Watershed
South River Watershed
South Fork Shenandoah Watershed
Linville Creek Watershed
Cedar Creek Watershed
North Fork Shenandoah Watershed
Shenandoah River Watershed
Cowpasture River Watershed
Maury River Watershed
Shen-Berryville
Cedar C.
NF-Woodstock
NF-Strasburg
NF-Mt. Jackson
NF-Cootes Store
SF-Whitehouse
Linville C.
North R.
South R.
Cowpasture R.
Maury R.
N
W
E
S
0 5 10 20 30 40
Miles

Findings

- Many of these compounds are wide-ranging.
- They are present in areas where fish are dying and in waters not experiencing problems
- If you look hard enough you will find it.
- But what do our results really mean?

Our Results

- Generally indicative of agricultural area
- No compounds at levels that exceed water quality criteria, published lethal limits or benchmark screening criteria

Passive Samplers - Conclusions

- No evidence that chemical contaminants in water are proximate cause of fish kills
- But… Water quality causes cannot be completely ruled out because:
  - Not all chemicals tested
  - Effect level data and criteria are not available or relevant for all chemicals
  - Mixture effects and sublethal effects not completely considered

Benthic Invertebrates 2006-2007

Benthic Invertebrates – VA Tech

North & South Forks Shenandoah

- We found…
- Higher quality than other large rivers, even those with no fish kills
- Improved benthic communities since baseline studies in the 1960s
- no spatial patterns that corresponded with areas of heavy fish kills

A river-wide toxic event that kills fish would also be expected to kill the invertebrates. That did not happen

Fish Health

Fish Health – Multiple Studies

- Pathology showed…
  - Damage to skin, gills, and internal organs
  - High numbers of parasites
  - Hormonal stress responses
  - Intersex (immune suppression, hormones?)

- What do these symptoms mean?
  - No clear cause and effect between fish kills and
    - Intersex
    - Parasites
    - Specific chemical compounds

Fish Bacterial Studies

USGS

- **2008 - A Breakthrough?**
- **Early spring – Fish appeared healthy. Bacterial cultures showed diverse communities**
- **During kills – sudden change – dominance by *Aeromonas salmonicida*, a known fish disease-causing pathogen**
- **After kills – a return to diverse bacterial population**
- **Reference streams (with no fish kills) did not contain *Aeromonas salmonicida***

Fish Bacterial Studies

continued….

- **Questions being explored:**
  - **Is *A. salmonicida* the cause???**
  - **How did it get in these rivers?**
  - **Where is it surviving during summer?**
  - **Do other stressors to push fish "over the edge?"**

Overall Summary (so far)…

- No single chemical found at or even close to toxic levels
- Combinations of water quality constituents
  - Additive?
  - Synergistic?
  - Secondary Stressors?
- Fish health measurements – stress evident, but no clear proximate cause of mortality
  - Histology
  - Blood chemistry
  - Hormones
  - Organ function
  - Parasites
  - Intersex
- Benthic Community – not indicative of toxic event
- Biological pathogens
  - *Aeromonas salmonicida*

The Plan for 2011

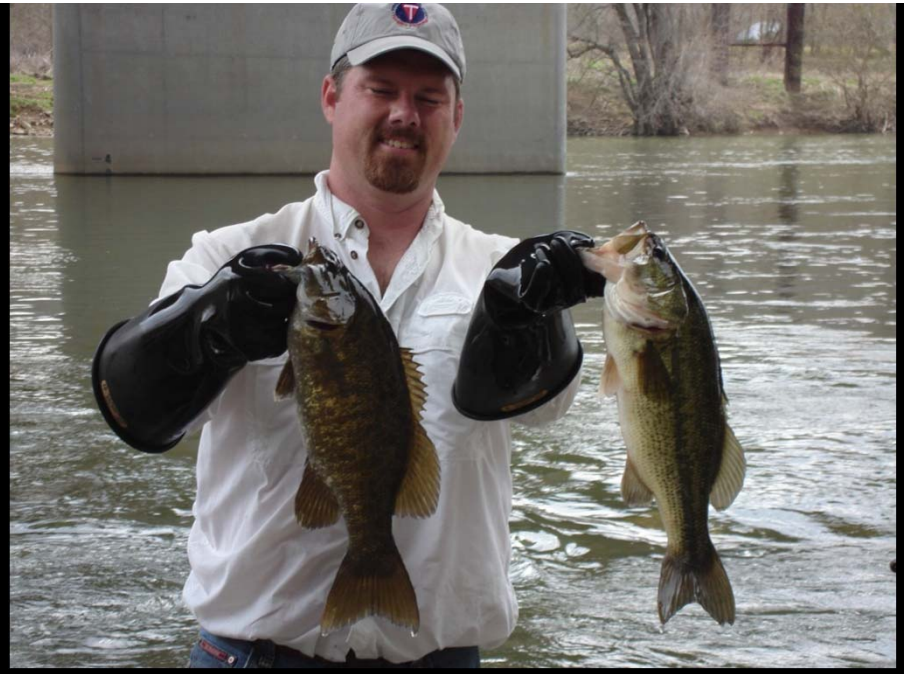
Continue to track outbreaks and provide field assistance for researchers

So… How is the Fishery Doing?

- **Severe Impacts in 2004 and 2005 to fish populations, fishing, and tourism**

- **Minor Impacts from 2006 to present. Fish populations have rebounded nearly to historic levels**

Reproduction and Recruitment
- Exceptional -



Return of Quality Fish

Questions?