

# What is wrong with my fish?

## Fish Health in Michigan

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*Department of Fisheries and Wildlife*

*Preserving our past... Creating our future*

MICHIGAN STATE  
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# Fish Health is different and similar to Wildlife Health



# Same General List of Potential Candidates with a few exceptions

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- Bacterial
- Viral
- Fungal
- Parasites
- Stress and physiological disorders
- Differences
  - No fisheries equivalent to prion based diseases
  - No wildlife equivalent to rapid environmental shock





# Generalized Fish and Wildlife Health Contrasts – Wildlife Better Known

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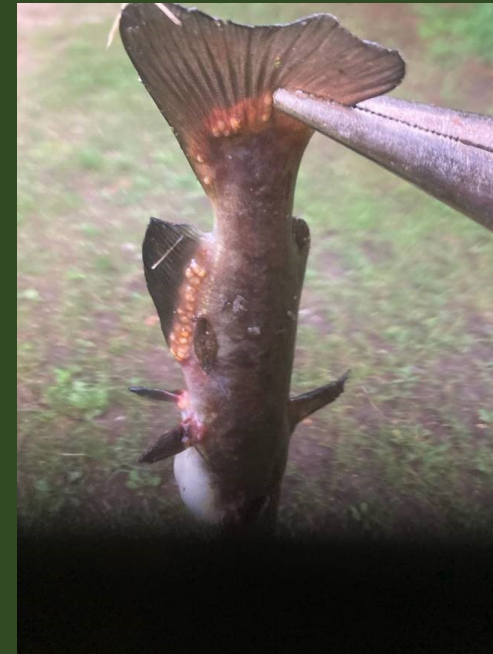
- Pathogen ID
- Detection and Sampling
- Distribution
- Native or Invasive
- Symptoms and Species affected
- Disease ecology and Virulence
- Origin
- Transmission Vectors
- Elimination or Containment



# Generalized Fish and Wildlife Health Contrasts

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- Treatments – Somewhat similar
  - Fish
    - Wild – Generally not possible
    - Hatcheries – Often possible as options are available
  - Wildlife
    - Wild – Possible occasionally
    - Captive – Possible as easier to handle animals and drugs available
- Resource Value Affected - Similar
- Human Implications of the Pathogen – Very Different



# Givens



# A Given - Michigan's Resource Scale

- Aquatic
  - Great Lakes (38,575 sq. miles)
  - Approx. 11,000 inland lakes (1,305 sq. miles)
  - 36,000-72,000 miles of streams/flowing water
- 154 species of fish
  - 27 non-native species
- Many species of invertebrates
  - 10 species of crayfish
  - 43 species of native mussels.....
- Thus, Most aquatic pathogens are poorly understood





# A Given - Fisheries Infrastructure

- Six state fish hatcheries
- Five egg take and harvest stations
- 20-40 extensive rearing ponds
- About 325 tons of fish from 21 species and strains are produced annually





# Last Givens

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- Funding and staffing
- Many pathways for pathogen movement and introduction – Most marginally controlled
  - Commercial transportation
  - Fish in Commerce
    - Bait
    - Private Aquaculture – Most controlled
    - Pet Trade
    - Live fish in transit
  - Anglers
- Most aquatic pathogens are very difficult to manage



# The Current Pathogen Actors Guild

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- Flavobacterium
- Bacterial Kidney Disease
- Furunculosis
- Epizootic Epitheliotrophic Disease
- Viral Hemorrhagic Septicemia
- Infectious Pancreatic Necrosis
- Whirling Disease



# Likely Who - The All-Star Pathogen List

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- Flavobacterium – Fish Enemy Number 1 – 100s of isolates
  - Bacterial coldwater disease (*Flavobacterium psychrophilum*)
  - Bacterial gill disease (*Flavobacterium columnare*)
  - Ubiquitous in distribution
- Bacterial Kidney Disease (*R. salmoncida*)
  - Caused population level mortalities of Great Lakes salmonids in the 1980s and early 1990s
  - Invasive?
  - Broadly distributed
- EEDv - Epitheliotropic Disease Virus – Salmonid Herpes Virus 3
  - Stress mediated Lake Trout skin disease in hatcheries
    - MSFH - high mortalities at times
  - Native herpes virus that never causes issues in the wild
  - Found in wild Lake Trout in lakes Superior, Huron and Michigan



# Likely Who - The All-Star Pathogen List

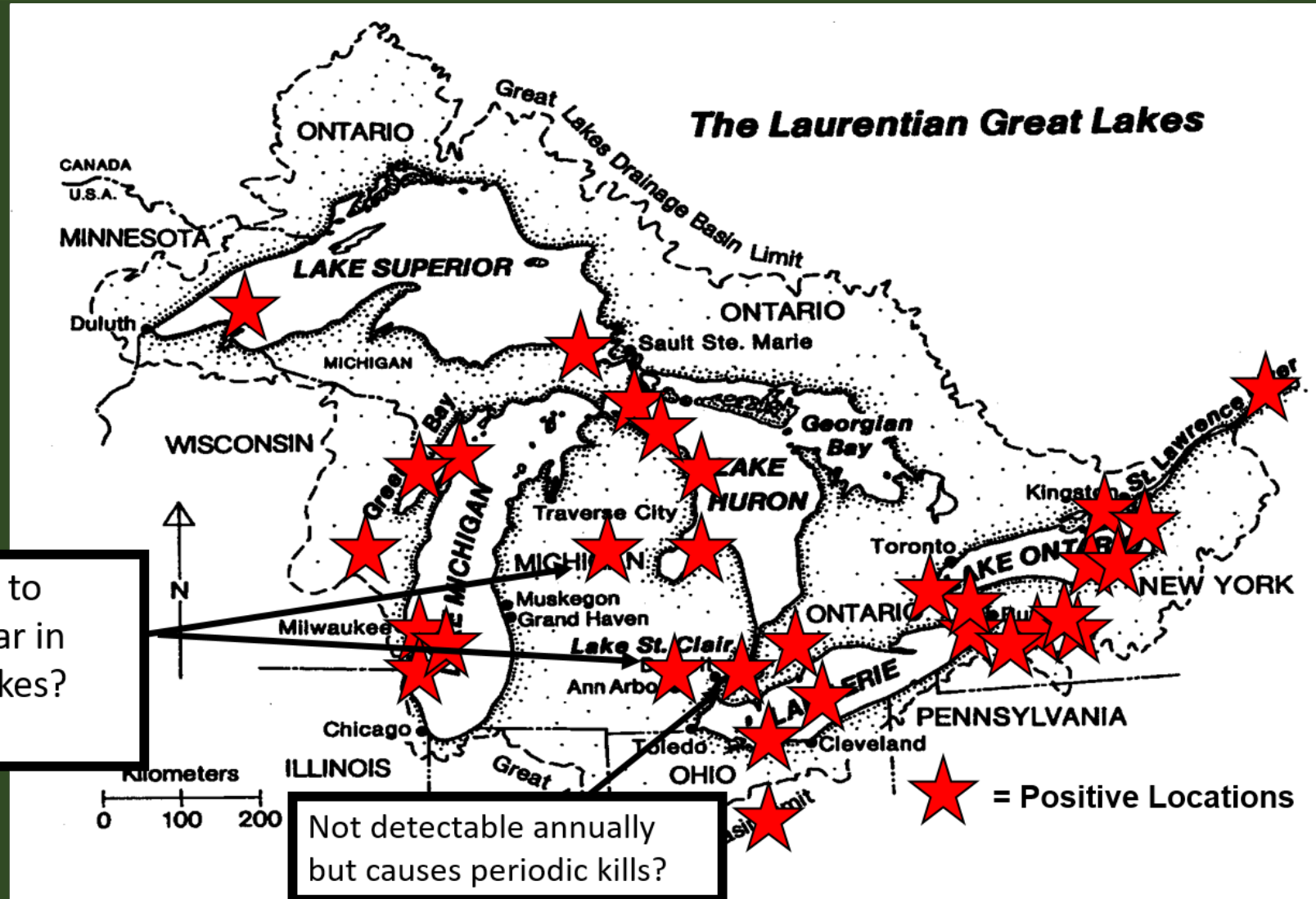
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- VHSv –Viral Hemorrhagic Septicemia virus (IVb) - Rhabdovirus
  - Invasive marine virus from Maritime Region of Canada that can infect over 25 fish species
  - Established about 2000 with the likely vector being commercial shipping.
  - Continues to cause large scale population level mortalities
    - 1000s (2018) to many millions of fish (2006 and 2017)





# Current VHSv Distribution in the Great Lakes Basin



# Likely Who – The All-Star Pathogen List

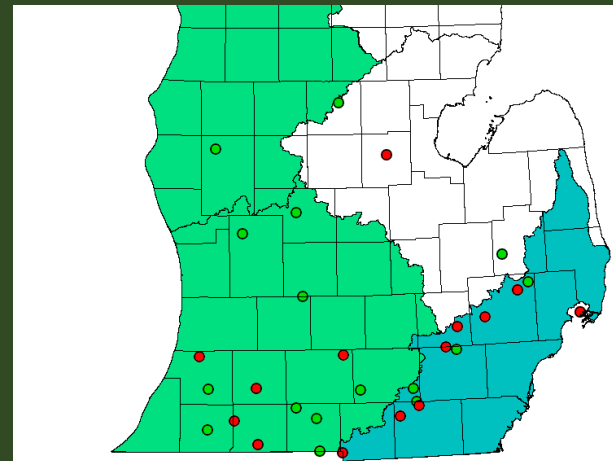
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- Furunculosis (*A. salmonicida*) - Bacteria
  - Historically caused large hatchery mortalities but controlled by vaccines today
  - Found widely in wild trout populations and only occasionally see clinical signs
- IPNV - Infectious Pancreatic Necrosis virus – Birnaviridae
  - Stress mediated issue in hatcheries and does periodically cause mortalities in trout
  - While seen in a few waters in wild trout, it is very uncommon



# Likely Who – The All-Star Pathogen List

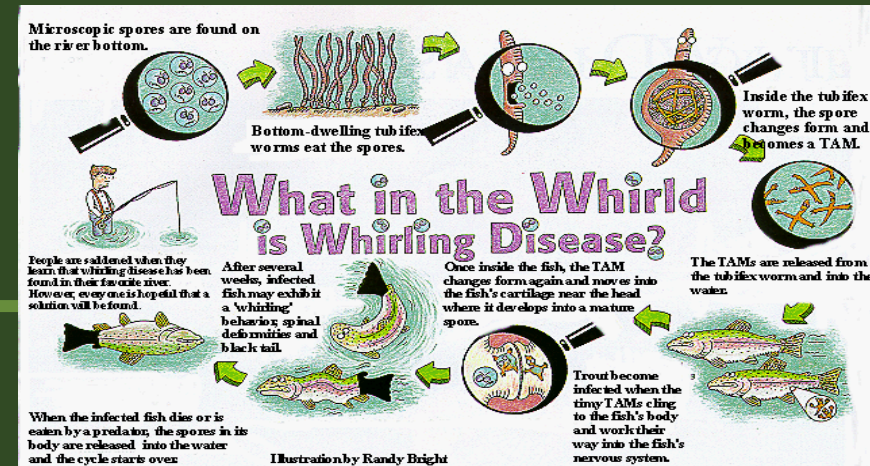
- Largemouth Bass Virus (LMBv) – Iridoviridae (Ranavirus like)
  - Invasive pathogen from the Southern US
  - Arrived in MI about 2000, likely from by an angler translocation
  - Southern MI lakes through the early 2000s and caused mortalities of 10-20% of adult Largemouth Bass
  - Now making a resurgence in SMB and causing skin lesions along with potential recruitment issues



2000-2005 Locations



# Likely Who – The All-Star Pathogen List



- Whirling Disease - *Myxobolus cerebralis* - Myxosporean
  - Invasive parasite from Europe
    - First found in MI in 1968
  - Population level effects in Western trout rivers but not in Midwest or East
  - We do not have the right intermediate tubificid (aquatic worms) hosts
    - Lineage III and IV are the key ones
    - Conditions favorable for these linkages could change with climate change as they need high organic material and temperatures than the other lineages





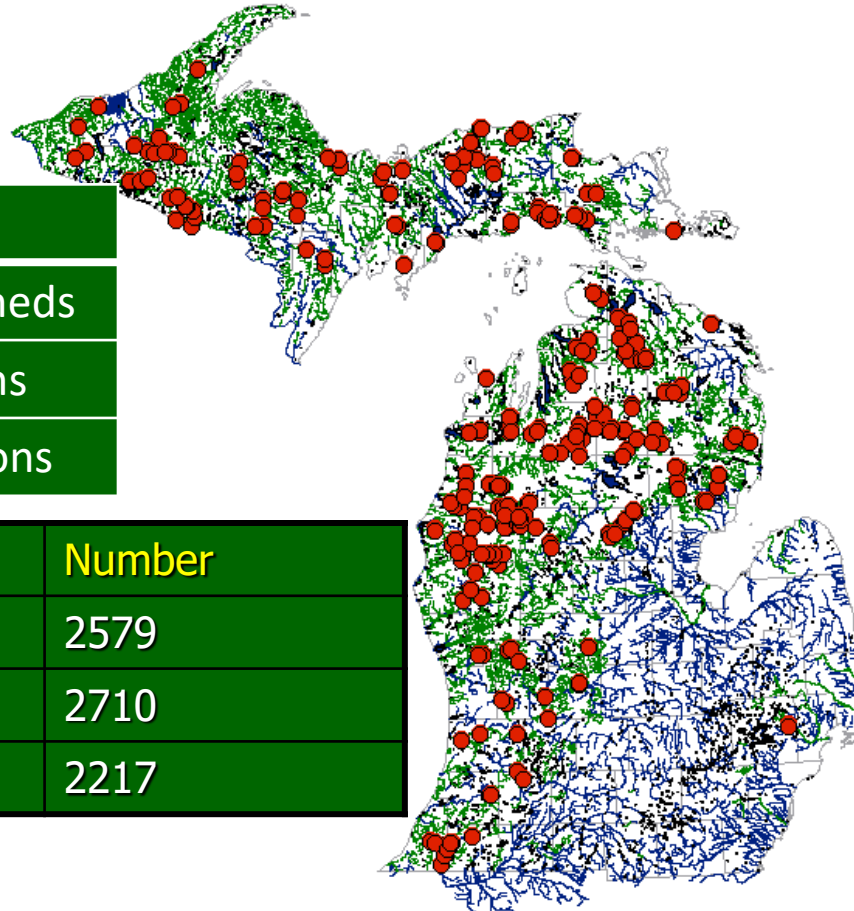
# Wild Fish Disease Survey Sites 1998-2003

## Sampled

58 Watersheds

142 Streams

272 Locations



Species	Sites	Number
Brook Trout	158	2579
Brown Trout	139	2710
Rainbow Trout	158	2217



# 1998-2003 Results

Species	Sample Sites	Positive Watersheds	Positive Streams	Prevalence
BKT	158	6	9	55%
BNT	139	3	6	38%
RBT	158	7	11	72%

About 10% of Michigan Trout Streams are Positive for *Mcer*



# Likely Who – The All-Star Pathogen List

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- Thiamine Deficiency Syndrome
  - Key forage species, particularly Alewives, have a high concentrations of long fatty acids and thiaminase
  - Cause thiamine loss in salmonids, particularly Lake Trout
  - Complete recruitment failure as the fry do not develop without adequate thiamine
  - Requires thiamine treatment of eggs in hatcheries
- Coolwater fish diseases are marginally understood
  - Carp viruses (Koi Herpesvirus) and STN Herpesvirus
  - Expect surprises from climate change



# Likely Who's Next

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- IHNV – Infectious hematopoietic necrosis virus – Rhabdovirus
  - West Coast salmonid disease
  - Not in Great Lakes Basin
  - Can cause large epizootic events
- ISAv - Infectious salmon anemia virus – RNA virus - Isavirus
  - East Coast and European virus with large losses seen in Atlantic Salmon farms
  - Not in Great Lakes Basin
  - Nonvirulent forms that can become virulent





# Likely Who's Next

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- PKD – Proliferative Kidney Disease – Myxozoan parasite
  - West and Intermountain
  - Causes large epizootic events in stressful conditions for salmonids and Mountain Whitefish
  - Not in Great Lakes Basin?
  - Currently, testing is difficult but new assays in development
- Spring Viremia of Carp - Rhabdovirus
  - Found in the US in a few locations but not MI
  - Can jump hosts to native minnow species



# Key Fish Health Program Components

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- Policy, Staffing and Funding
- Surveillance
- Biosecurity
- Inspection and Testing
- Treatment
- Research and Assessment
- Public Communication



# Key Fish Health Decision Questions

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- Pathogen ID?
- Ecology?
- Hosts?
- Virulence?
- Distribution and origin?
- Vectors?
- Elimination or containment?
- Treatment?
- Resource value affected?



# Fish Health Policy

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- Fish health is a food and economic security issue
  - Nearly all fish pathogens are not human pathogens
- Must have a firm science-based policy basis
  - GLFHC Model Fish Health Program and GLFC community of practice
  - Test using AFS-Bluebook or OIE procedures
  - Coordinated processes, procedures and communication
  - Require inspections for importations and transfers
  - Require all private stockings of public waters and bait industry to use inspected and certified fish with species specific testing
    - Salmonids - VHSV, IHNV, ISAV, IPNV, and *Myxobolus cerebralis*
    - Other species – LMBV, *Heterosporis* sp., STN Herpesviruses, SVCV, KHV, FMNV, GOSV
    - Based on host sensitivity, virulence, and transmission to other species



# Fish Health Staffing and Budget

- Staffing
  - Policy and Analysis (0.3 FTE)
    - Gary Whelan
    - Edward Eisch
  - Field sampling from units
  - Coordination (0.5 FTE)
    - Jeremiah Blaauw
  - Laboratory (PERM – MSU AAHL)
    - Dr. Thomas Loch
    - Michelle Gunn Van Deuren
    - Many grad and undergraduate students
- Annual Budget
  - Approx. \$450,000-\$500,000 (1.5%)



# Surveillance – Broodstocks

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- All feral broodstocks tested annually
  - Steelhead
  - Chinook and Coho Salmon
  - Walleye
  - Muskellunge
  - Lake Sturgeon
- Captive broodstocks – Tested multiple times annually
  - Brook and Lake Trout
  - Brown and Rainbow Trout





# Best Case Wild Fish Surveillance

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- Use temporal and spatial sampling design
  - Fixed and random sites like our Status and Trends sampling
- Use citizen scientists as an initial screening tool
- Sentinel sites - key initial pathogen locations
  - Duluth, **Sault Ste. Marie**, Chicago, **Detroit**, Toledo, Cleveland, Welland Canal, Toronto, Hamilton, and Montreal
  - High use waters – Houghton Lake, Lake St. Clair



# Wild Fish Surveillance – Current MI Approach

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- Hatchery surface water supplies
  - MSFH and PRSFH
- Fish transfers from wild sources to other waters
  - Surrogate species
- *Myxobolus cerebralis* in selected waters
- Fish kill investigations
- Eyes in the Field – 380+ citizen observations since February 2018
- Lack of resources does not allow appropriate statistical design
  - Opportunistic and reactionary approach



# Biosecurity

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- Field
  - All gear and equipment is disinfected
- Fish Production
  - UV filters at MSFH and PRSFH
  - Individual equipment for each raceway and tank
  - Foot baths at building entrances
  - Facilities are intensively cleaned, and all dead fish removed as soon as observed
  - Mortalities closely monitored to examine for disease patterns



# Biosecurity

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- Fish Production
  - All fish stocking trucks are disinfected after use and limited truck transfer between facilities
  - Other than eggs and fry from broodstock facilities, fish are not transferred between facilities
  - Actively manage hatchery fish against pathogens
    - Keep different types of fish as separate as possible
    - Vaccines
    - Select against pathogen carriers
    - Cover raceways to reduce stress
    - Keep densities and stress as low as possible
    - Herd immunity used for select diseases
  - Extensive testing of production fish
- Baitfish



# Testing and Inspections

- All GLFHC agencies report on their fish health findings
- Test all GLFHC Model Program pathogens for appropriate species
  - *R. salmoncida*, *Y. ruckeri*, *A. salmonicida*
  - VHSV, IHNV, ISAV, IPNV, EEDV (Salmonid herpesvirus 3), White sturgeon iridovirus, Sturgeon herpesviruses
  - *M. cerebralis*, *Heterosporis* sp.
- Test broodstocks, production, and transfer fish
- MSU- AADL Testing Totals – FY2021
  - Total cases – 169 (6573 fish)
  - Inspections – 124 (5703 fish)
  - Diagnostic – 31 (591 fish)
  - Wild Fish Diagnostics and kills – 15 (279 fish)



# Disease Treatment

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- Complete diagnostic testing done on affected hatchery fish
- Use available chemicals and drugs that are registered or under INAD
  - Vet scripts also used but infrequently
- For all bacterial pathogens, we test antibiotic susceptibility before treatment
  - Prevent antibiotic resistance





# Research

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- Developing pathogen histories
  - Analyses of published Great Lakes parasites completed
  - Analysis of published inland Michigan fish parasites in draft manuscript
  - Whirling disease history in Michigan in progress
  - Histories on BKD, EEDv and TDS planned
- Database refinement and population, and trend evaluation of current data in progress
- Statistical sample sizes in progress with PERM faculty
  - Standard sample sizes are based on wrong statistical model
    - Standardized random instead of clumped



# Research

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- MSU-AADL (PERM)
  - Flavobacteria control work
  - Pathogen challenge experiments
    - VHSv susceptibility for White Suckers
  - STN pathogen analysis
  - PKD test development



# Public Communications

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- The public notices dead fish
  - Respond to all public inquires and Eyes in the Field Reports
- If it bleeds, it leads with the press
  - Get confirmed information out into the press on fish kill events
  - Proactive with fish health press releases
    - Winter and summerkill
- Emphasize epizootic risk from fish pathogens
  - Viruses – None
  - Bacteria and fungi – Mostly none
  - Parasites – None if cooked
    - Freshwater fish – Do not eat raw fish products



# Questions or Comments

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