MI Swimmer’s Itch Survey (2016)

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Schistosomiasis:

- 2-host life cycle (SNAILS)
- Exposure in water
- **Human schistosomes** (3 spp)
  - 2\textsuperscript{nd} most important tropical disease worldwide
  - 200-300 million people infected/yr; 800,000 deaths

- **Avian schistosomes** (12-15 spp)
  - Trying to infect birds
  - Itchy bumps 1-2 days post-exposure
  - Gradually fade over ~1 week

*Trichobilharzia cercaria* penetrating skin

Adult worms (in blood vessel)
Michigan: home of swimmer’s itch!

- *Trichobilharzia* spp.
- First described by Cort in Douglas Lake (1928)
What determines swimmer’s itch exposure?

- Snail population density
- Percent snails infected
- Cercariae produced per snail
- Bird infection
- Temperature variation
- Algal growth

Cercariae in water

WIND?

SWIMMER’S ITCH!
Management Strategies

• Snail control
  – Copper sulfate
  – Niclosamides
  – “Raking”

• Bird control
  – Hunt/relocate

• Pollution control

• Skin creams
  – LIPODEET!!

• Predictive modeling
  ➢ Management decisions
  ➢ Real-time alerts
2015 Research Aim – focus on temporal surveys

- What factors influence daily variation in cercaria abundance at individual sites?

  - Predictive model – cercaria production with variable temperatures
    - Postulates warm temperatures are energetically costly to snails
    - Combines **metabolic theory** & **dynamic energy budget** theory
    - Parameterized by measuring temperature-dependence of host **food assimilation** & **respiration**
2015 Research Aim – focus on temporal surveys

- What factors influence daily variation in cercaria abundance at individual sites?

1. Volunteer sampling – daily filtered-water samples (50 L, 35 um)

2. Quantitative/Real-time PCR – optimized & completed Fall 2015
2015 Research Aim – focus on temporal surveys

- What factors influence **daily** variation in cercaria abundance at individual sites?

**Selected data:**

- **Site 1**
- **Site 2**

- **Time-series analyses ongoing....**
2015 Spatial patterns (14 sites on 8 lakes)
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- **Snails + %Forest → More cercariae in water**

- **More urbanization** (within 1 mi of lake) → **More *Stagnicola* snails**

Urbanization vs. *Stagnicola*

Urbanization → Water clarity

Water clarity → Attached algae
2016 Spatial survey (38 sites on 16 lakes)
What determines patterns of schistosome cercariae abundance across a broad landscape?

Potential predictors:
- lake size/depth/hydrology
- Land use & soil/rock types
- Climate (temp, precipitation, wind)
- Snail & invertebrate densities
- Pollutants (pesticides & nutrients)
- Algae/vegetation growth
- Bird visitation

Nutrients     Snail densities     Land Use
H1: Urbanization $\rightarrow$ Nutrient runoff $\rightarrow$ Eutrophication

Strengths of nutrient hypothesis:
1. Urbanization is a source of nutrient runoff
2. Nutrient runoff frequently linked to algal blooms (when nutrients are limiting)

Weaknesses:
1. N & P poor predictors of attached algae, snails, & avian schistosomes in 2015
2. N correlated with agriculture not urbanization in 2015 survey
H2: Urbanization $\rightarrow$ Herbicide runoff $\rightarrow$ Water clarity

**Strengths of herbicide hypothesis:**
1. Atrazine best predictor of snails & trematodes in a prior large-scale survey (Rohr et al. 2008, Nature)
2. Urbanization associated with different herbicides from agriculture (e.g., 2,4-D)
3. Herbicides can drive changes in attached-algae communities reported by many lake associations (more diatoms = “golden algae”)
Herbicides & trematodes:

2008 Nature paper, Univ. S. Florida

Cattle tank experiment:

Herbicide

Fertilizer

+PERIPHYTON

+Snails

+Cercariae
**Strengths of insecticide hypothesis:**

1. Large-scale experiments confirm that insecticides increase snail populations by killing their arthropod predators, including crayfish.
2. Crayfish declines have been observed by local riparian owners.
3. Crayfish are also important predators of zebra mussels, which have major effects on water clarity (and therefore attached algae).
**H4: Forest & Birds**

Urbanization
- Riparian development
- Lawn maintenance
- Septic systems
- Road construction
- Population growth
- Recreational use

**Strengths of bird visitation hypothesis:**
1. Bird definitive hosts known to drive snail prevalence
2. Forest cover linked to bird visitation & trematode parasites in prior studies

**Weaknesses:**
1. Poor-quality bird data from 2015... changing volunteer instructions for 2016
2. Forest might have different effects on different bird species at different scales...
Continuous/Daily monitoring:
• Cercaria density - daily filtered-water samples (volunteers + qPCR)
• Wind speed & direction (volunteers)
• Water temperature & light penetration (HOBO loggers)
• Bird visitation

Weekly surveys:
• Snail quadrat sampling & collection (identification, size distribution)
• Turbidity & zebra mussel densities (quadrats)
• Crayfish trapping
• Zooplankton sampling (density, composition)

Site-level measurements:
• Attached algae (periphyton) growth & composition
• Zebra mussel settling rates
• Water chemistry (nitrates+nitrites, organophosphate, ammonia)
• Pesticides (atrazine + products; 2,4-D; organophosphates + carbamates)
• Sediment cores (Phosphorus, Organic carbon)
• Substrate & shoreline characteristics; fetch; slope

Lake-level characteristics:
• Land use in watershed & near shore
• Lake size & depth
Future directions: **ECONOMIC IMPACT STUDY (proposal)**

**Urbanization**
- Riparian development
- **Lawn maintenance**
- Septic systems
- Road construction
- Lake management
- Recreational use

**Local Income**

**Tourism**

**Insecticide runoff**
- Arthropod predators (crayfish)

**Zebra mussels**

**Herbicide runoff**

**Nutrient pollution (N, P)**

**Forest cover**

**Bird visitation**

**Snail abundance**

**Avian schistosomes**

**Housing market**

**Cottage rentals**

**Private beach use**

**Public beach use**

**Public risk perception**

**Swimmer’s itch**

**Doug Carr**

Oakland University
Future directions:
• Skin cream testing (in vitro project)
Collaborator – swimmer’s itch reporting & mapping

Patrick Hanington
University of Alberta

http://swimmersitch.ca/

Stay up to date on current outbreaks in Canada

Report Your Itch!

How the report is used:
To align with the reporting strategies in place by local health authorities, each swimmer’s itch report is recorded and archived for surveillance purposes. If five or more reports are received from the same lake, within one week, the reports are given directly to local health authorities for outbreak response actions. This may result in signs being placed on beaches, or further investigation into the issue. For up-to-date information on lakes currently experiencing such swimmer's itch outbreaks, please visit the Report Map page on this site.

Information Letter and Consent Form

Study title: Enhancing accessibility and use of Alberta’s natural water recreation areas through prevention of swimmer’s itch transmission
Acknowledgements

Collaborators:
Pieter Johnson, Sara Paull, Bryan LaFonte, Curt Blankespoor, Ronald Reimink, David Szlag

Oakland University Support:
Doug Wendell (chair), Arik Dvir, Cathy Starnes, Sheryl Hugger, Rita Perris, Kathy Lesich

Oakland Undergraduate researchers:

Local Volunteers (2015):
Al Flory and Monica Schultz- Crystal Lake
Ted and Barb Fischer- Crystal Lake
Pat and Sherry Grant- Crystal Lake
Mike and Sara Litch- Glen Lake
Rob Karner- Glen Lake
John DePuy- Glen Lake
John Kassarjian- Glen Lake
John Lutchko- Lake Leelanau
Dave Hunter- Lake Leelanau
John Popa- Lake Leelanau
Wayne Swallow- Lake Leelanau
Bob and Mason Blank- Platte Lake
Wilfred Swieki- Platte Lake
Len Allgaier- Little Traverse Lake
Dean Manikas - Lime Lake
Russ Kittleson - Walloon Lake
Ron Reimink & Curt Blankespoor - Higgins Lake

Funding:
Oakland University Startup
Al Flory & Monika Schultz
Chimney Corners Resort
Platte Lake Improvement Assn
Glen Lake Association
Lake Leelanau Lake Assn
Leelanau Clean Water
Walloon Lake Association
Lime Lake Association
Higgins Lake Property Owners Assn
SICON LLC
Twin Lakes Property Owners Assn
Elk-Skegemog Lake Assn
Crystal Lake & Watershed Org.
Lake Margrethe Foundation Fund
Hamlin Lake Preservation Society
Portage Lake Association
Intermediate Lake Association

Karie Altman
Jeff Stephens
Madelyn Messner*
Jason Sckrabulis*
Aaron Stoler
Temperature & trematodes:
(Ongoing collaboration with Piet Johnson’s lab Univ. Colorado)

- **Thermal Stress Hypothesis**
  - Depletion of host energy reserves at stressful temperatures
    - Lower cercaria production following excessively warm periods

- **Temperature-shift experiment:**
Temperature & trematodes:
(Ongoing collaboration with Piet Johnson’s lab Univ. Colorado)

- **Predictive model:**
  - Based on *metabolic theory* & *dynamic energy budget* theory
  - Parameterized by measuring temperature-dependence of host *food assimilation* & *respiration*