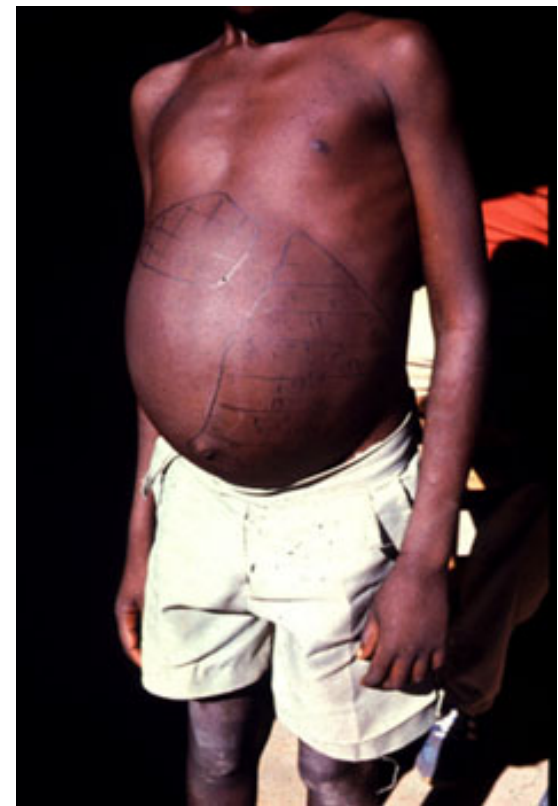


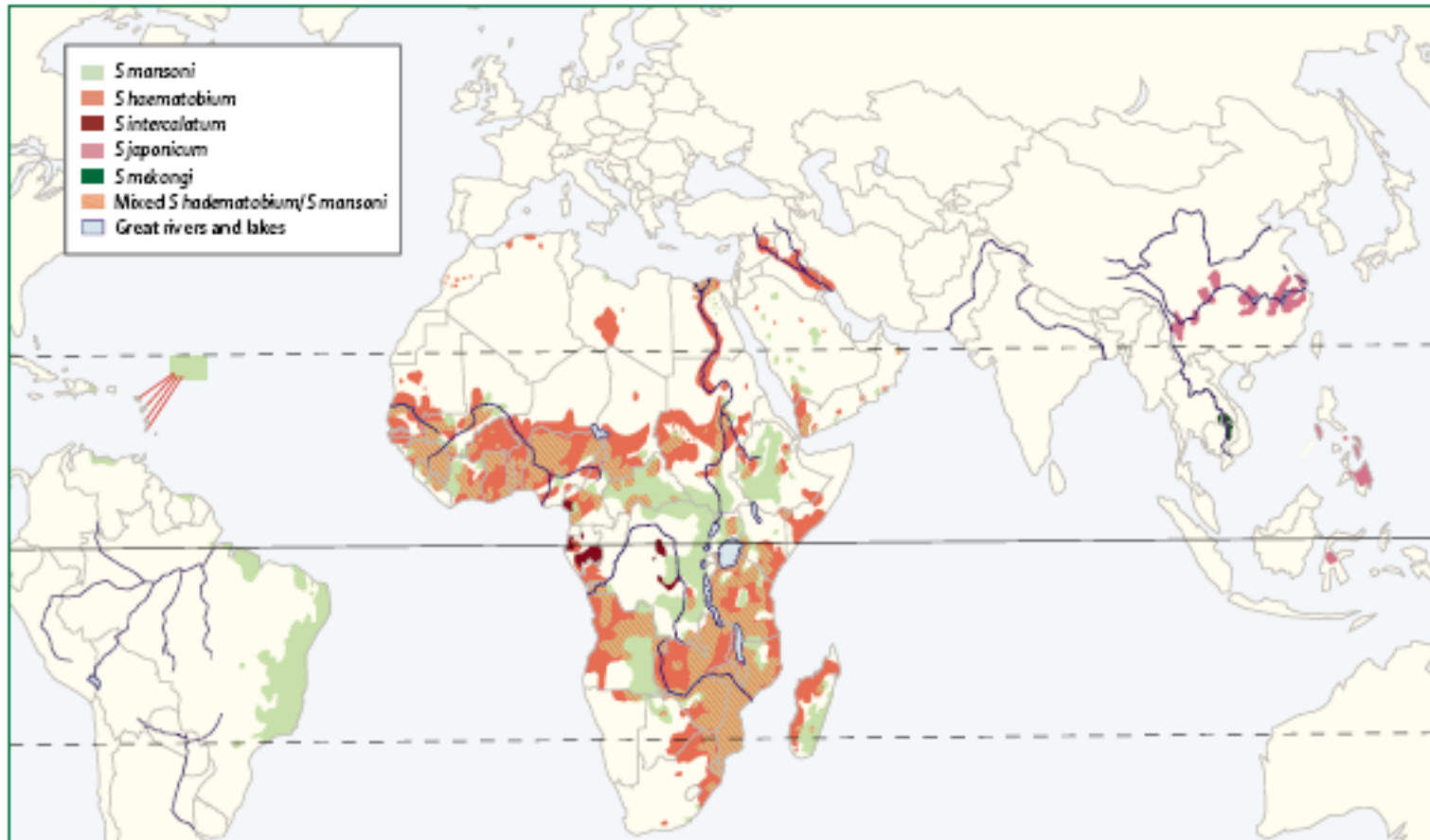
Spatial Patterns of Schistosomiasis:

A watershed approach to mapping environmental risk and human and animal disease outcomes.

Adam Akullian



Global Burden of Disease

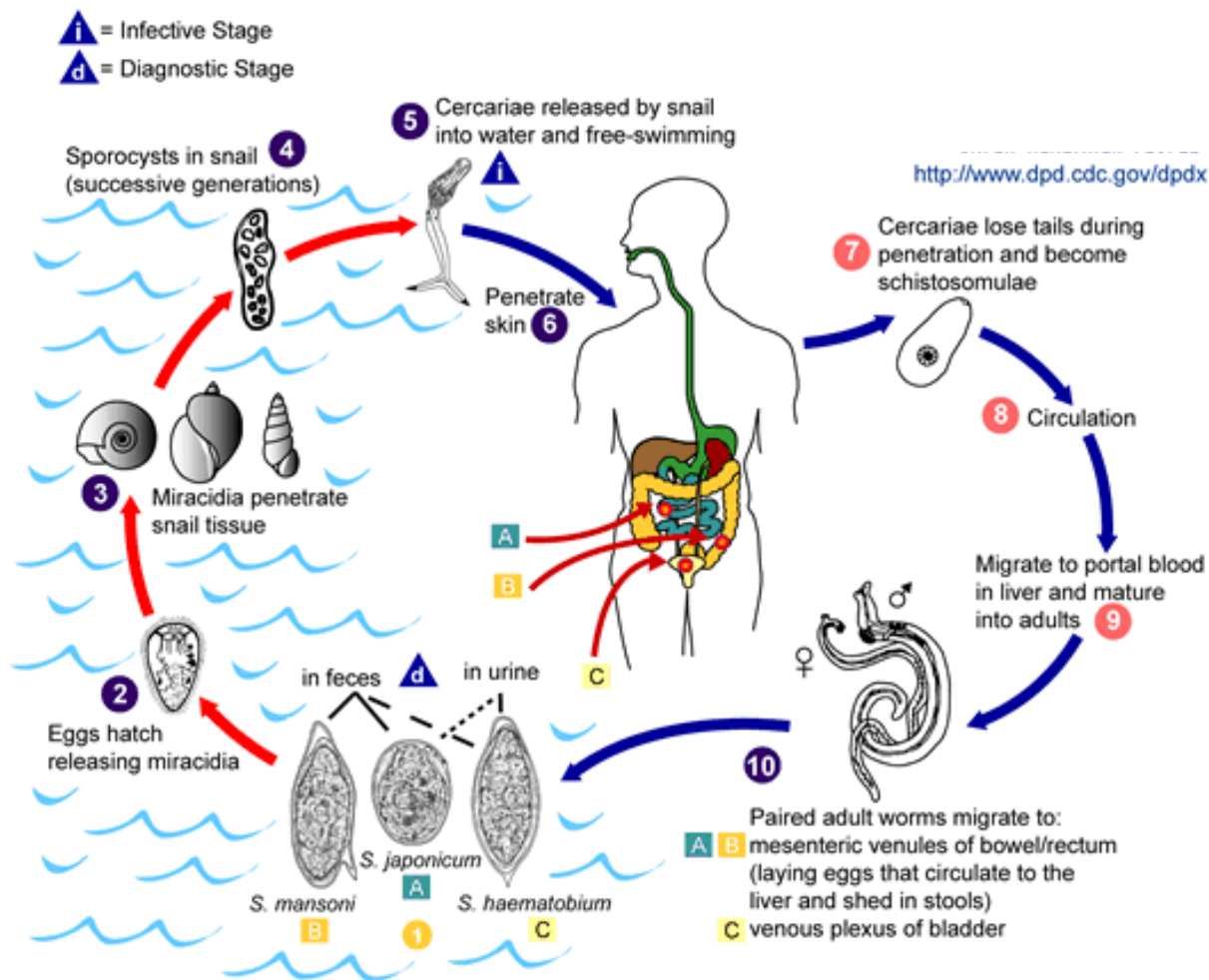


200 million cases occur world wide per year

Second to malaria in number of people infected and at risk of disease

Loss of between 1.7 to 4.5 million disability adjusted life years (DALYs)

Life Cycle of the Schistosome



Where can public health interventions break the cycle of transmission?

Why does disease persist?

- Snail habitat
- Human contamination of water ways
- Parasite migration
- Human migration
- Lack of secondary treatment
- Zoonosis (animal contamination)

Carabao Wallow



Environmental Disease:

Snail habitat, human alterations of environment, fecal water contamination, animal disease reservoirs.

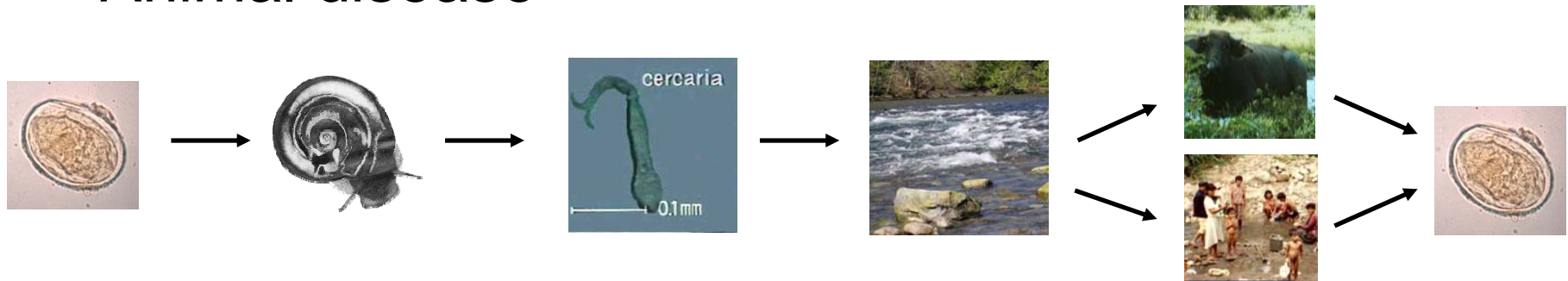


Disease of Poverty:

Lack of access to safe water and sanitation infrastructure; occupational risks; Lack of access to secondary treatment.

Public Health Goals

1. Link environmental risk to Human and Animal disease



2. Identify areas in the hydrological network where the potential for transmission is high
3. Develop sustainable environmental management to reduce human risk

Water contact is unavoidable







Parasite movement through environment

- Cercaria can travel long distances
- Humans and animals not confined to political boundaries

Transmission in one village is not independent of contamination in another

Linking *S. Japonicum* to mammalian infection

Political

Measures infection by region, village, or Household

Environmental

Measures infection by ecological zones or occupational boundaries

Hydrological

Watershed level groups villages by their hydrological connection

Objective

Identify a geographic unit that accurately captures the spatial variability of environmental risk and disease outcomes

Study Area

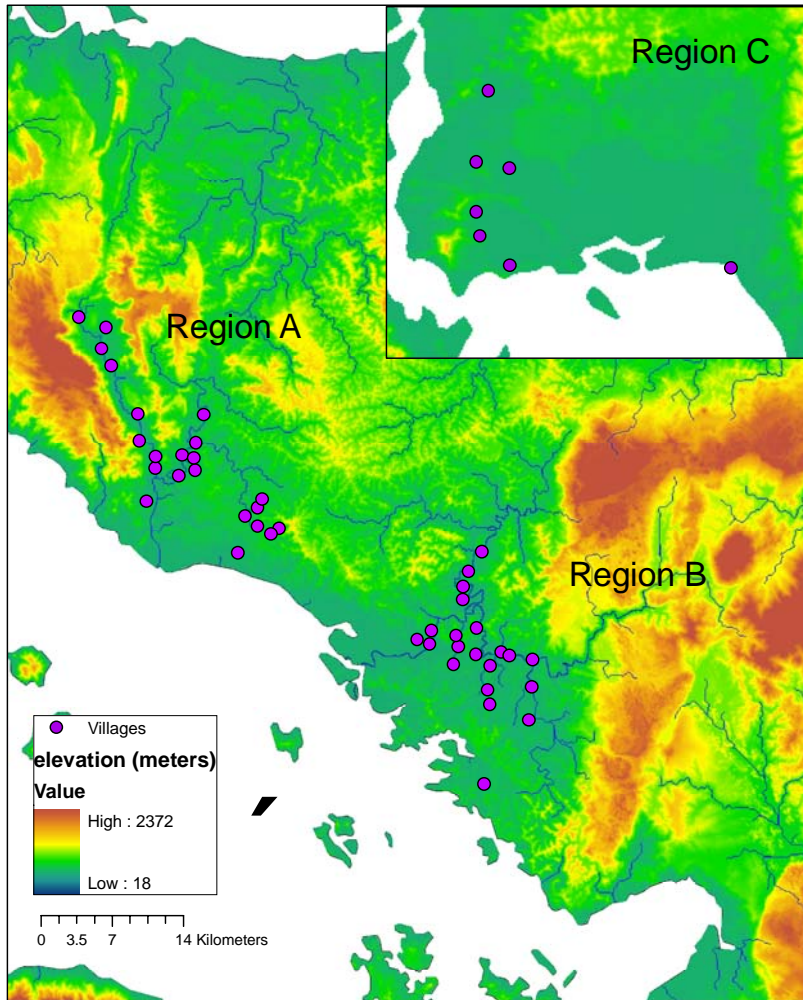
Southeast Asia

Western Samar Province,
the Philippines



Samar Island contains some of the few remaining pockets of disease In South East Asia

Study Area



3 Geographically separated regions (A,B,C)

50 Villages (Barangays)

5,624 Individuals provided at least one stool sample

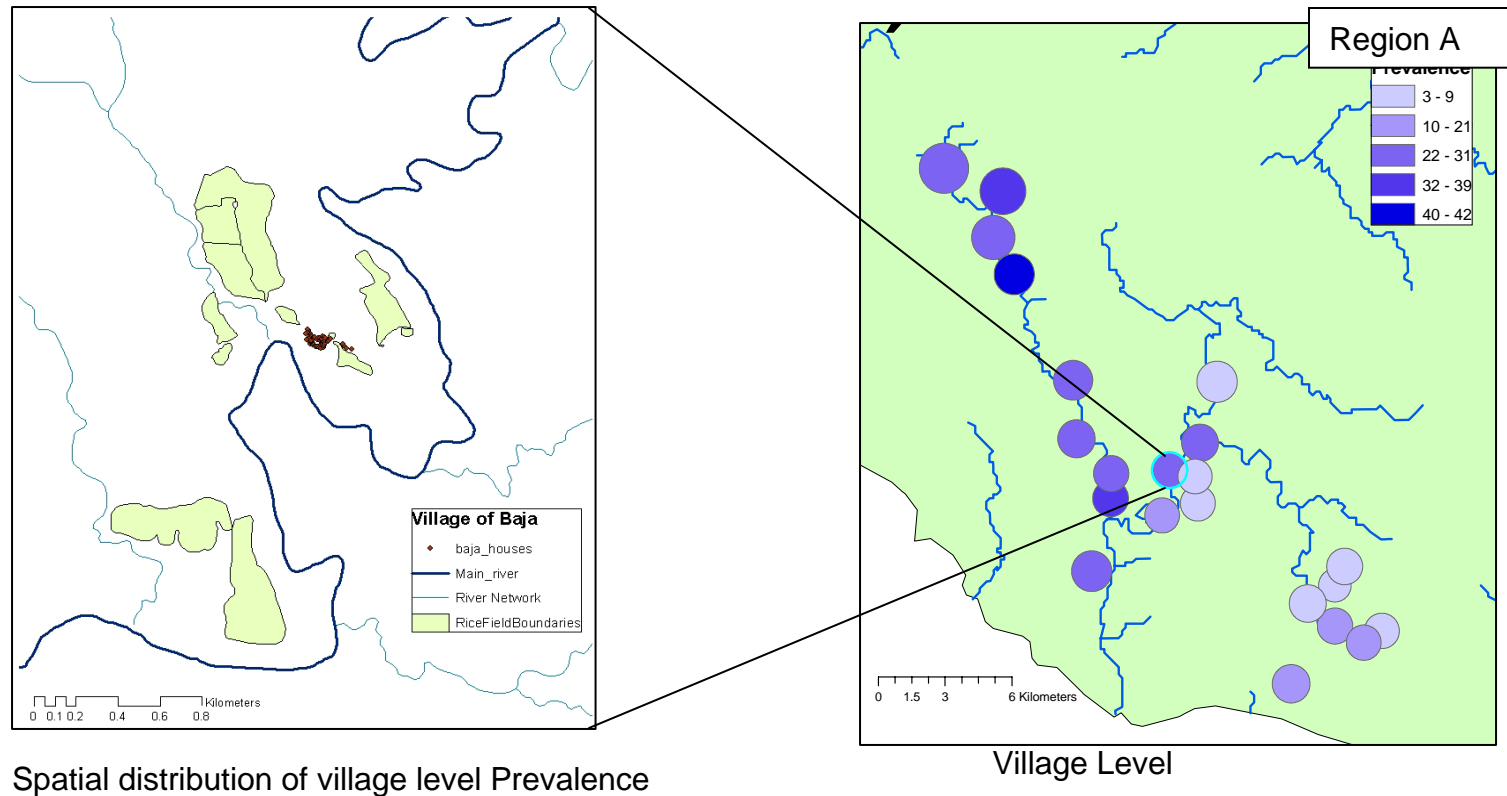
Perennially wet climate

Major River networks in Regions A and B

Ongoing Study:

A cross-sectional study of the prevalence of intensity of infection with *Schistosoma japonicum* in 50 irrigated and rain-fed villages in Samar Province, the Philippines (2006)
Mushfiqur R Tarafder¹, Ernesto Balolong Jr², H el ene Carabin^{*1}, Patrick B elisle³, Veronica Tallo², Lawrence Joseph⁴, Portia Alday², Ryan O'Neil Gonzales², Steven Riley⁶, Remigio Olveda² and Stephen T McGarvey⁵

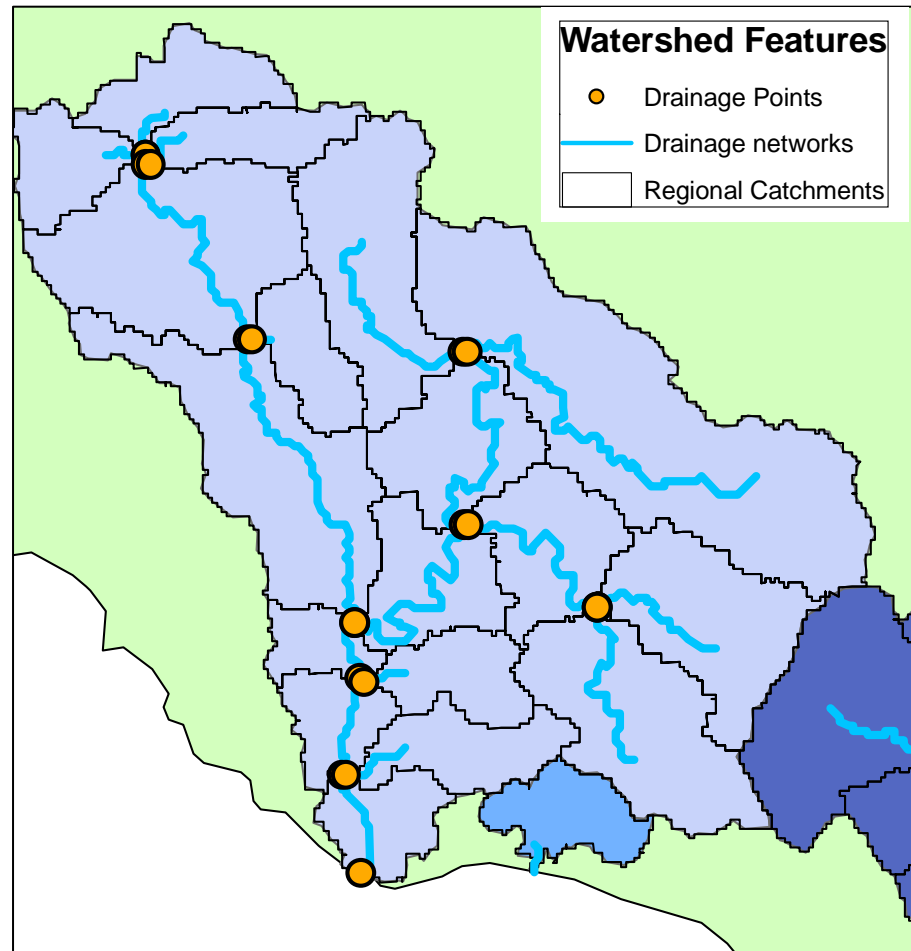
Village level disease analysis



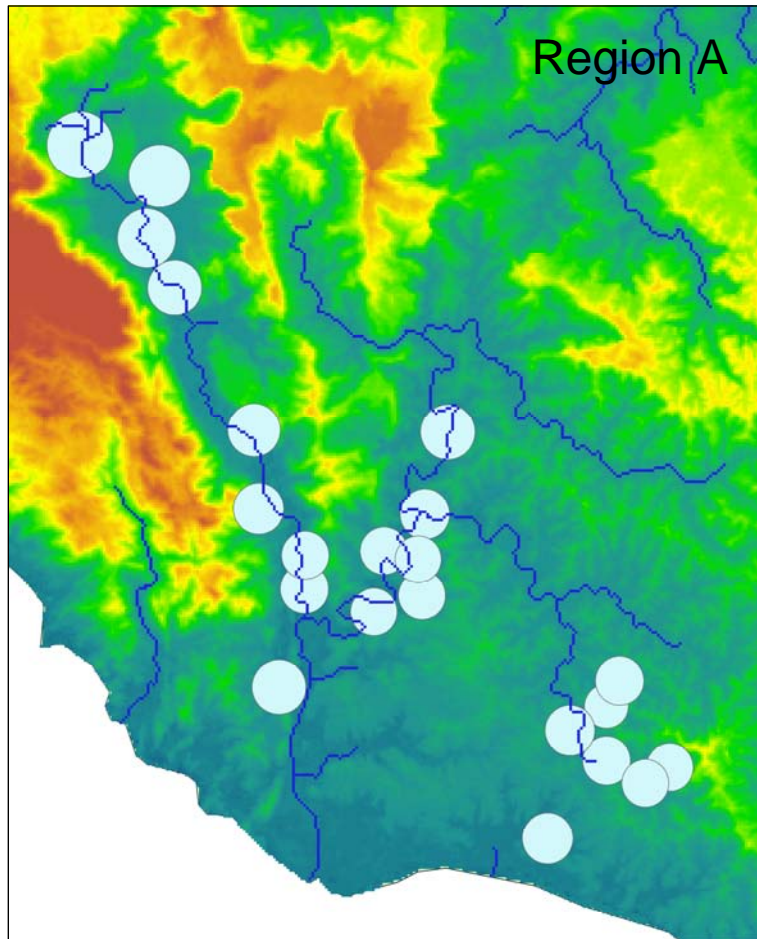
Rice fields, irrigation canals, and local water bodies, are interspersed among village boundaries. As a result, sites of *S. japonicum* transmission may overlap considerably between villages

Catchment

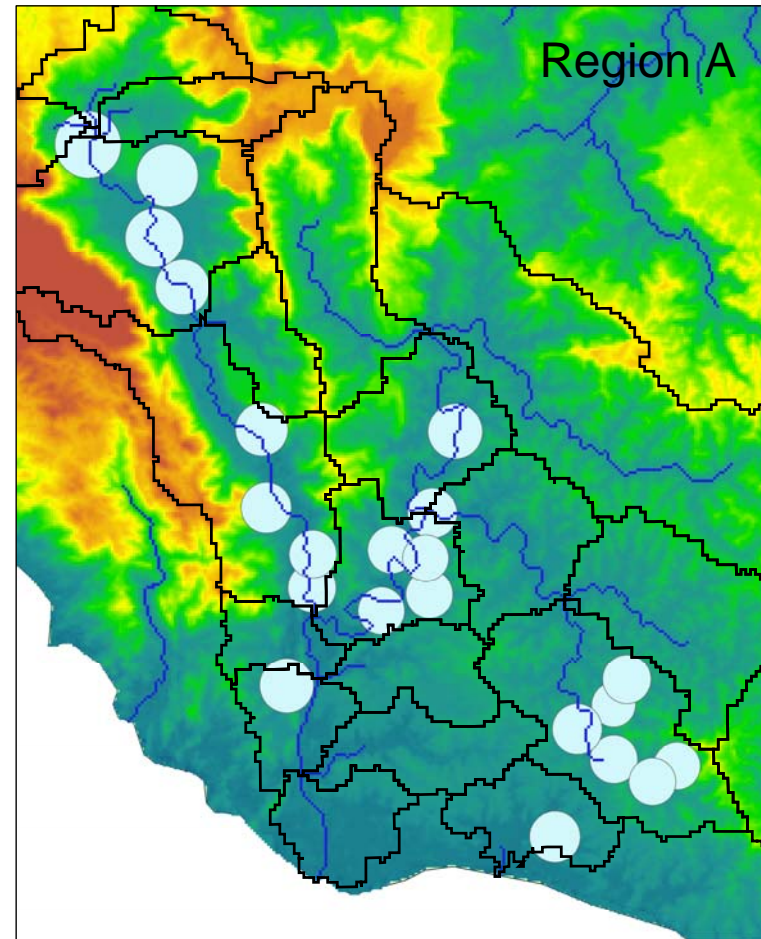
Area of land that drains water to a stream segment.



Methods: Catchment delineation

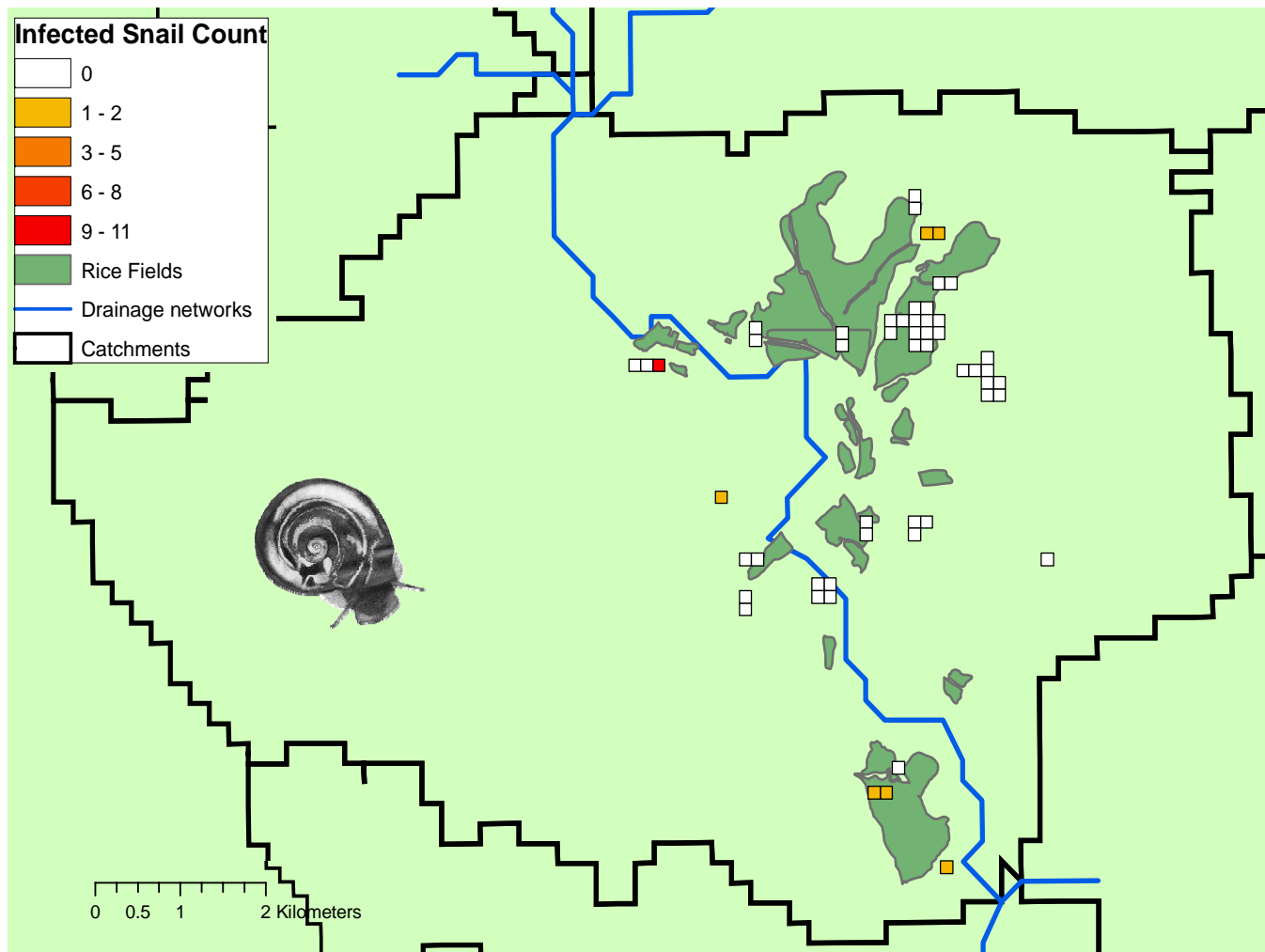


Village distribution



Catchment distribution

Measuring Environmental Risk



Thesis Questions

- 1) Do catchments accurately capture the geographic distribution of *S. japonicum* environmental risk?
- 2) Does catchment level snail infection predict human and animal (rat) disease outcomes?

Disease Estimators

1) Prevalence

- Estimates the percentage of people or animals infected in a population

2) Index of Potential Contamination (IPC):

- Estimates quantity of eggs passed in a population of Humans or Animals
- Village level IPC = Infection prevalence (% infected) x infection intensity (eggs per gram stool)
- Ecologically grounded metric



Limitations of disease estimators

Prevalence:

- Does not account for disease intensity

IPC:

- Measures *potential* for contamination, not actual number of eggs reaching water
- Errors in detecting eggs
- Errors in the counting of eggs in fecal specimens

Measuring Disease

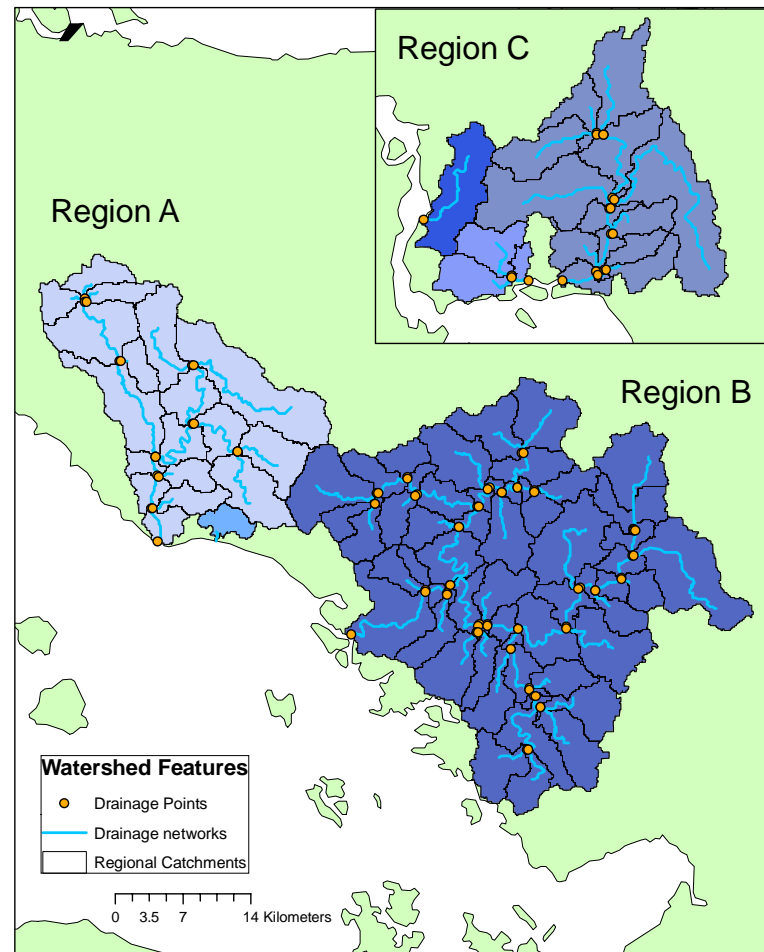
Snails: Number of Infected Snails within catchment per km stream link.

Rats: IPC

Humans: IPC and Prevalence

Results: Regional Hydrology

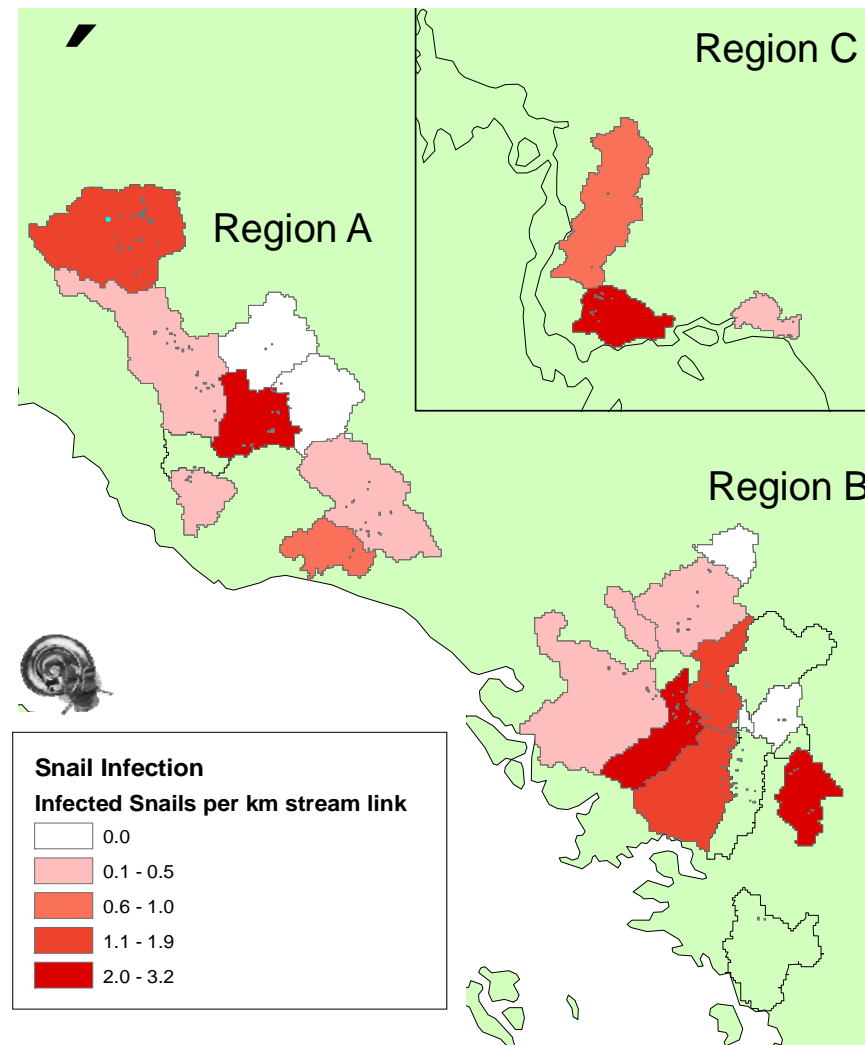
Regional watersheds, catchments, drainage networks, and drainage points



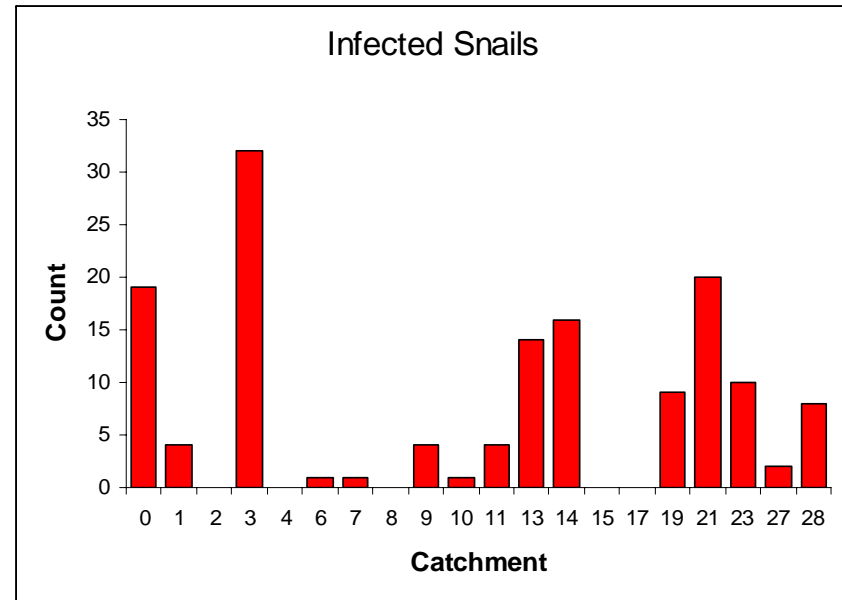
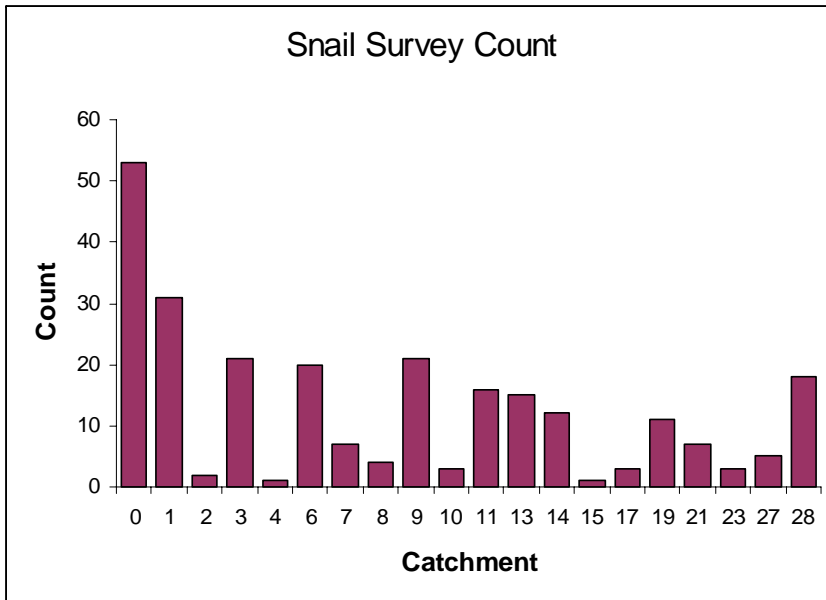
Snail Sampling



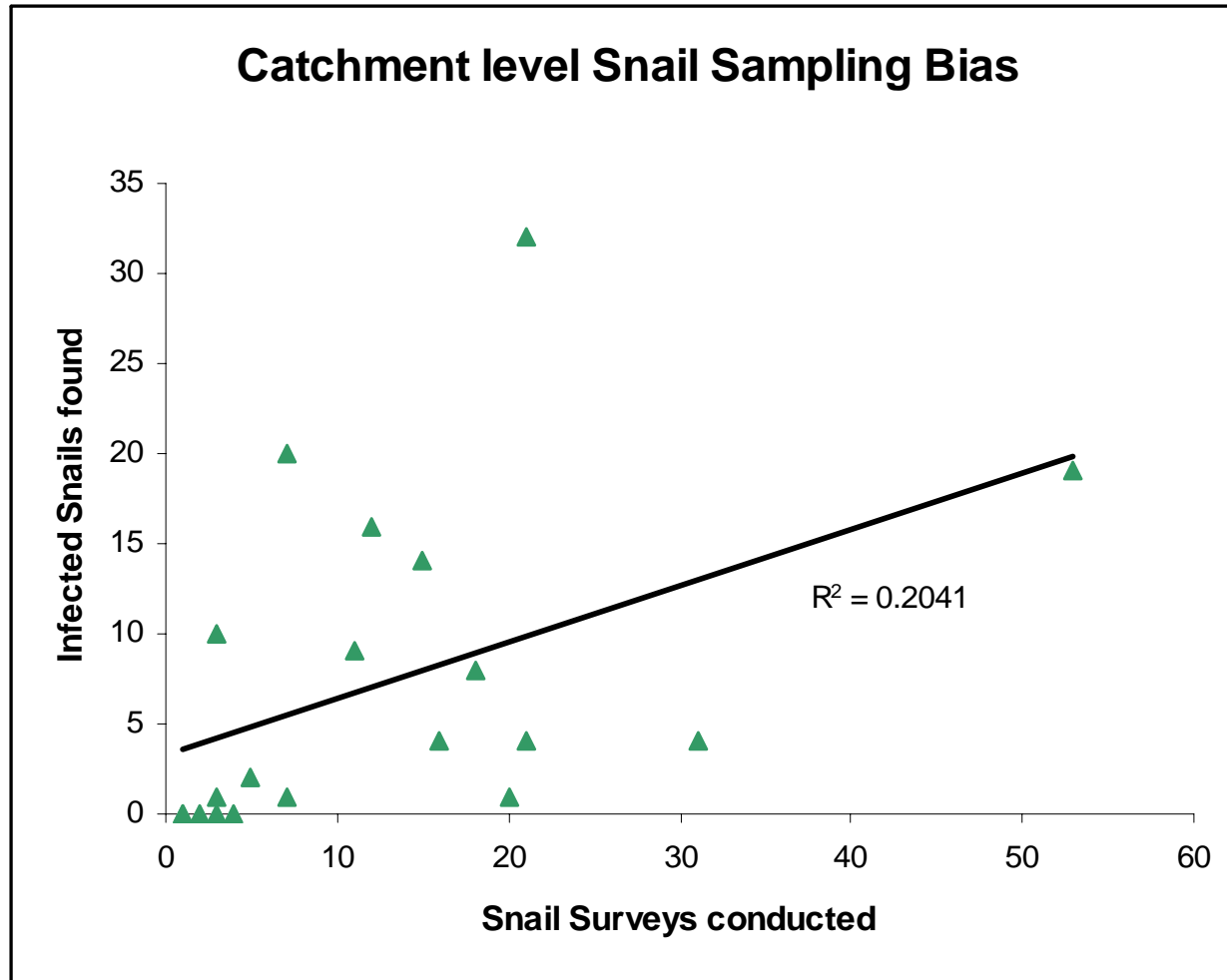
Catchment level snail Infection



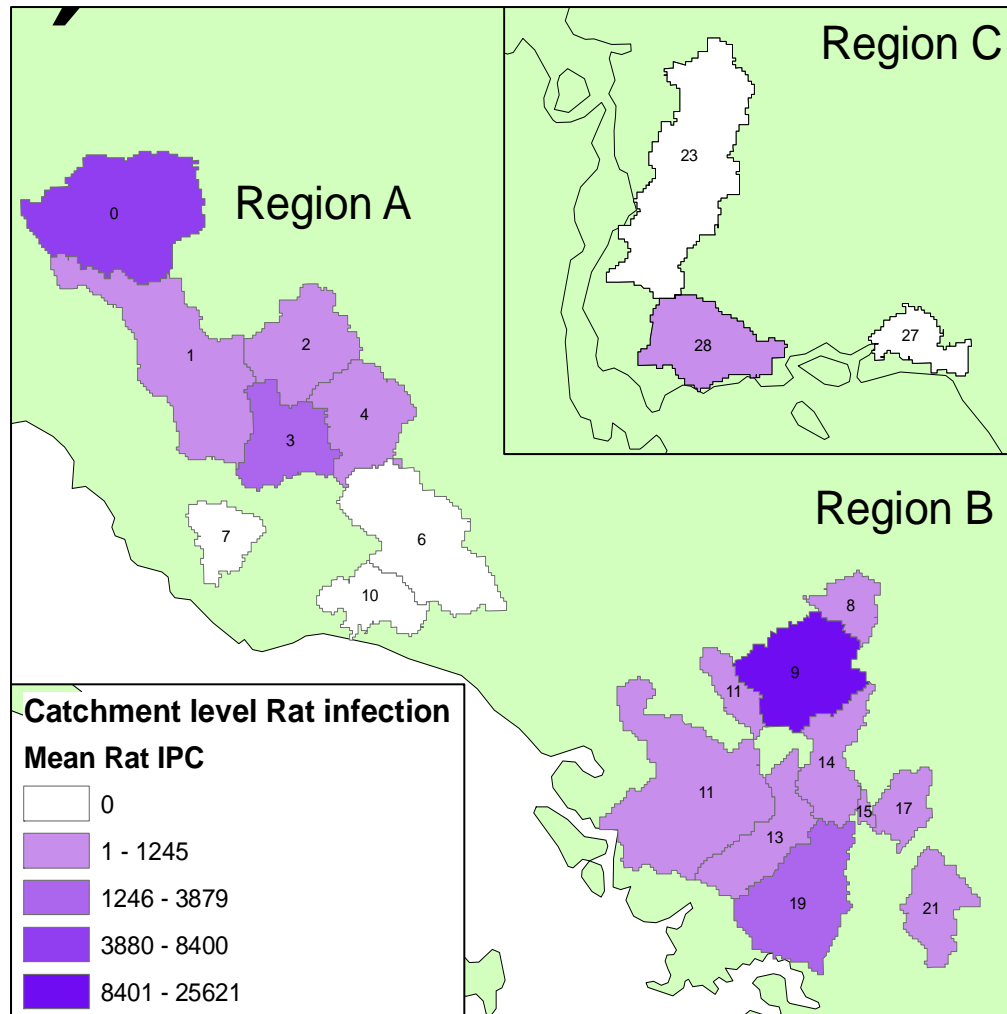
Snail Sampling



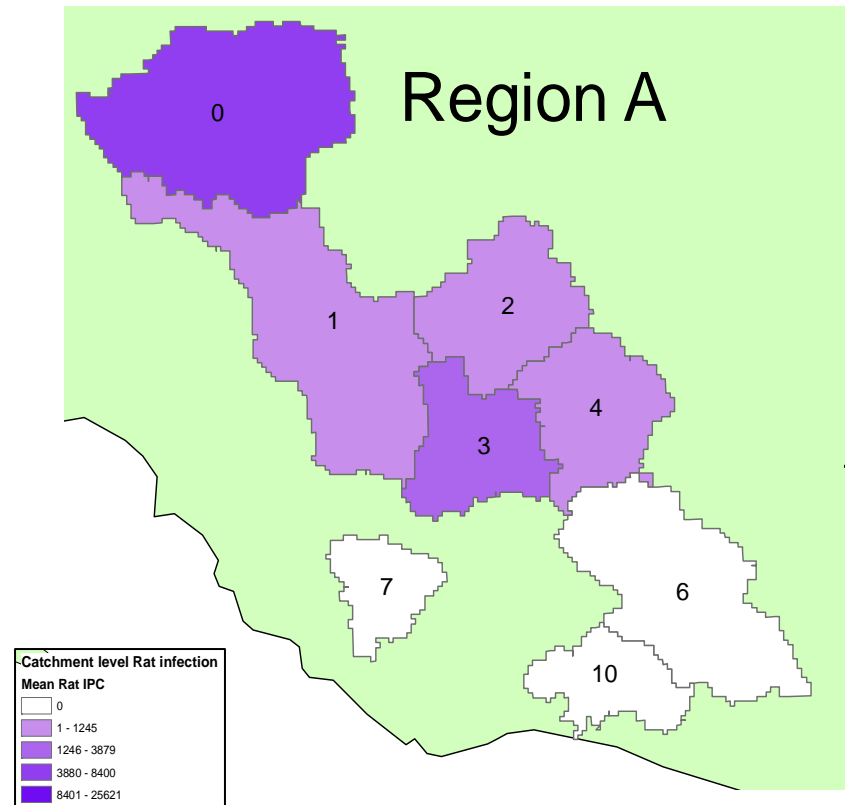
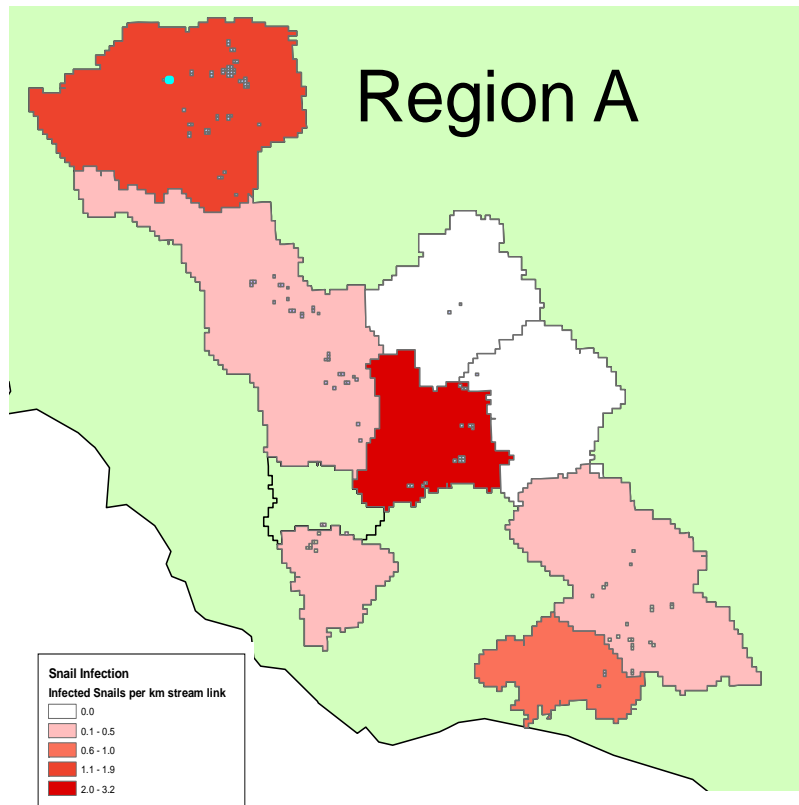
Snail Sampling bias



Rat Infection

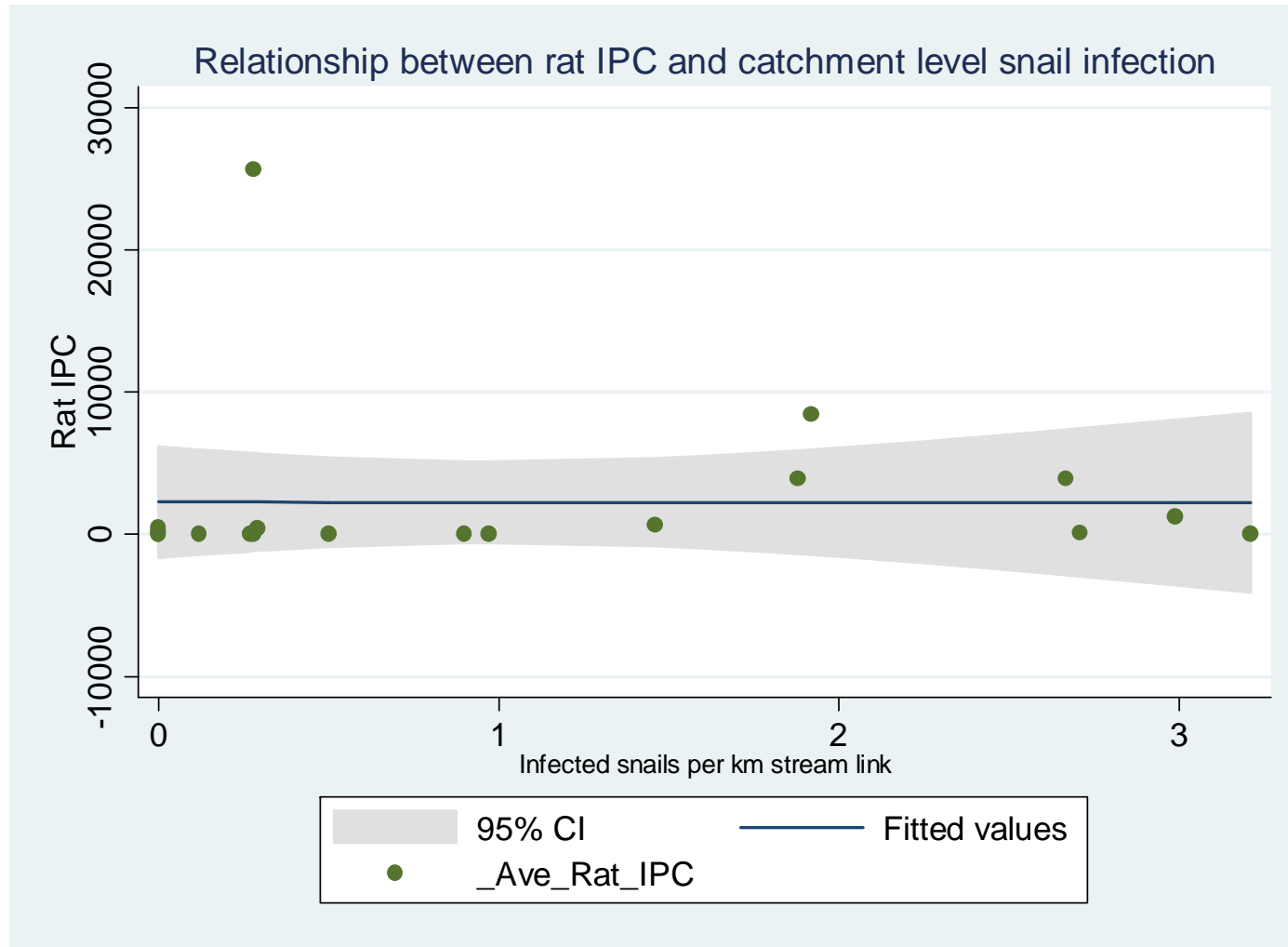


Snail and Rat Infection

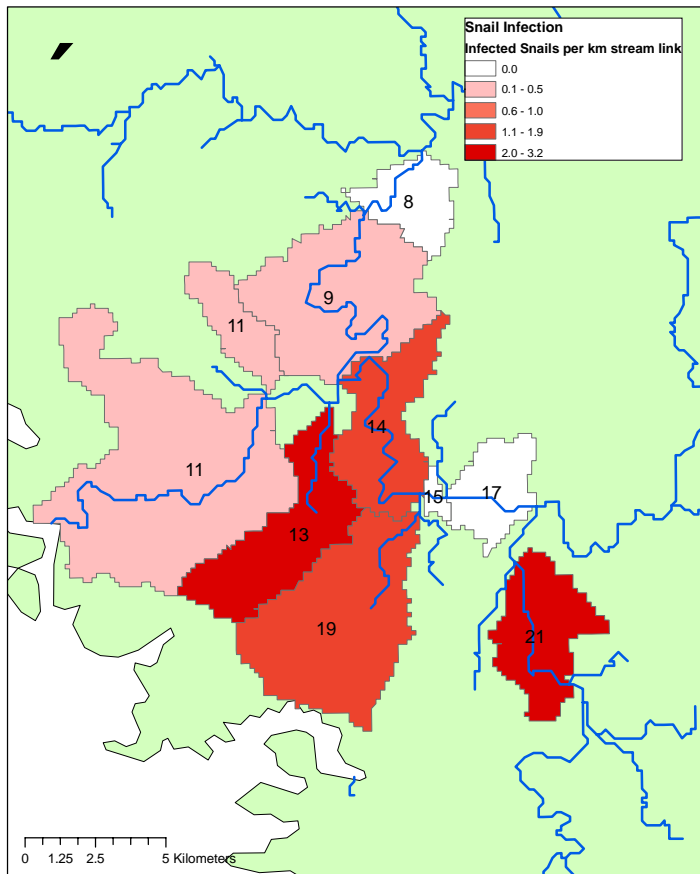


No Visual Correlation

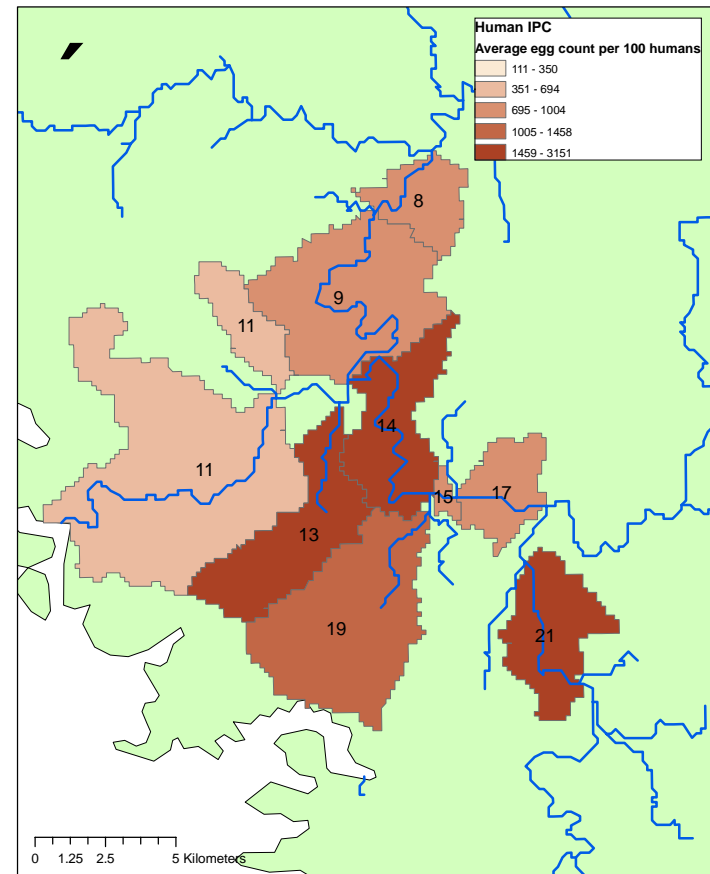
Snail and Rat Infection



Region B: Human and Snail Infection

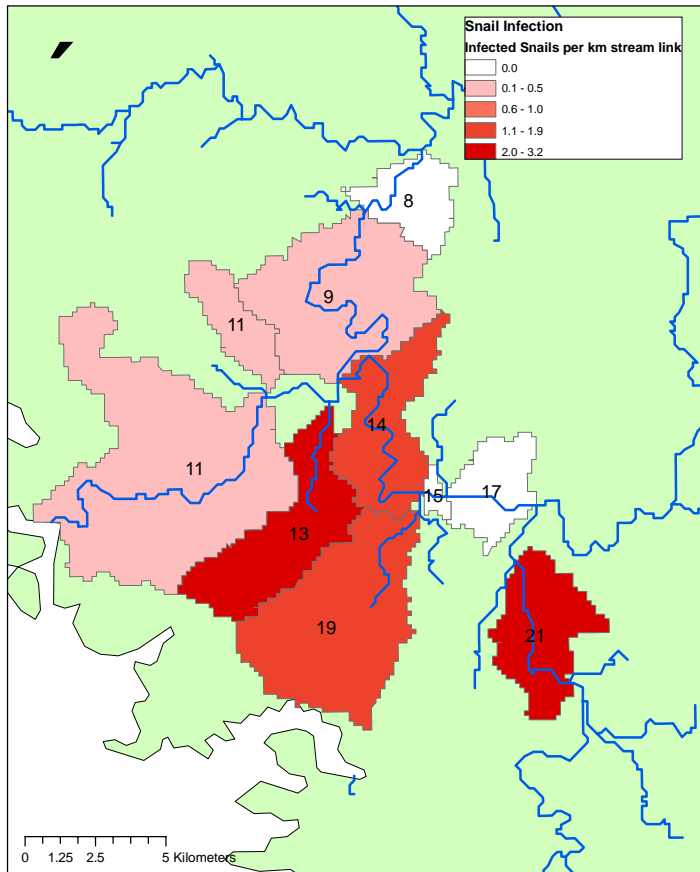


Snail Infection

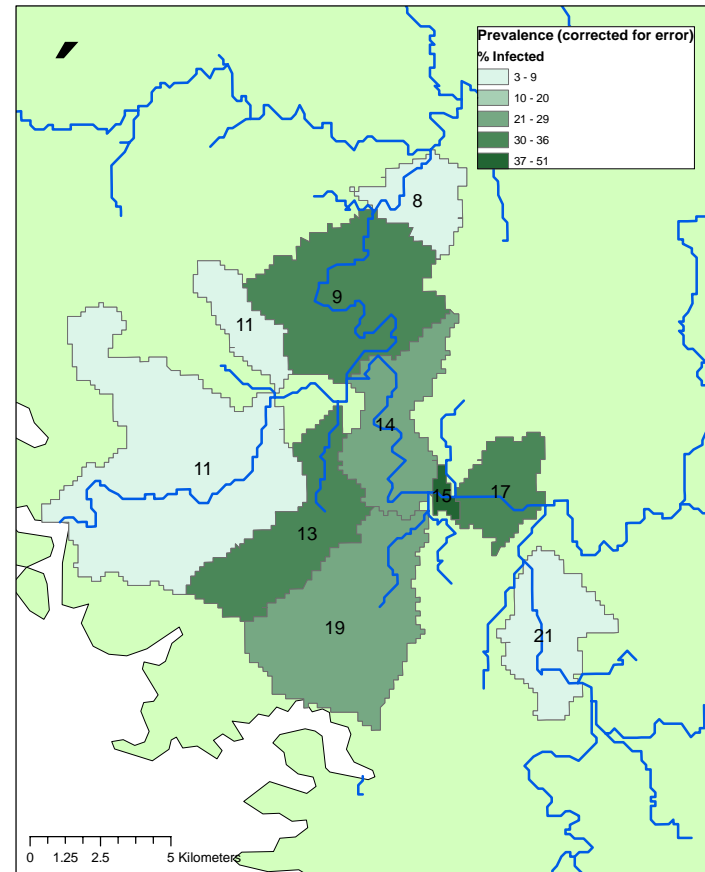


Human IPC

Region B: Human and Snail Infection

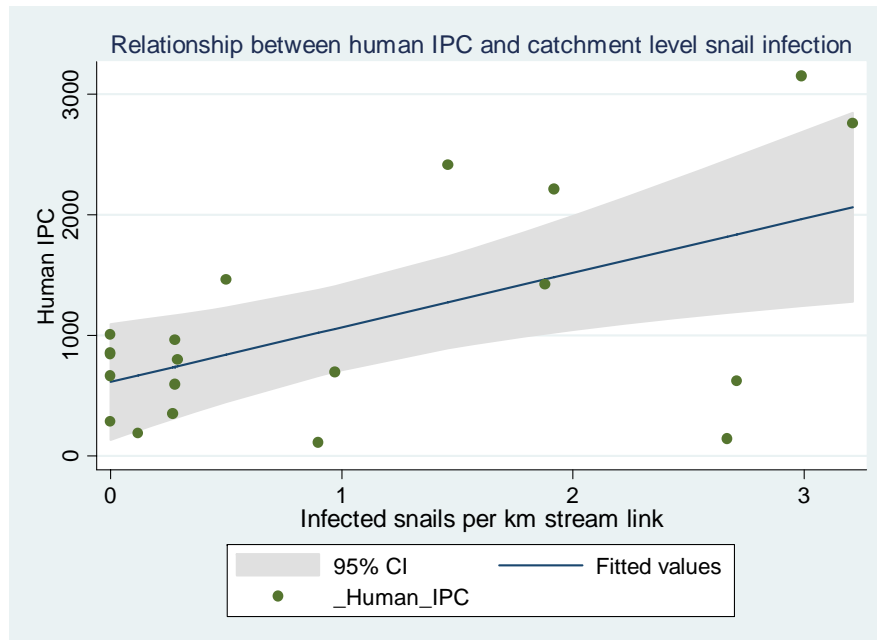


Snail Infection

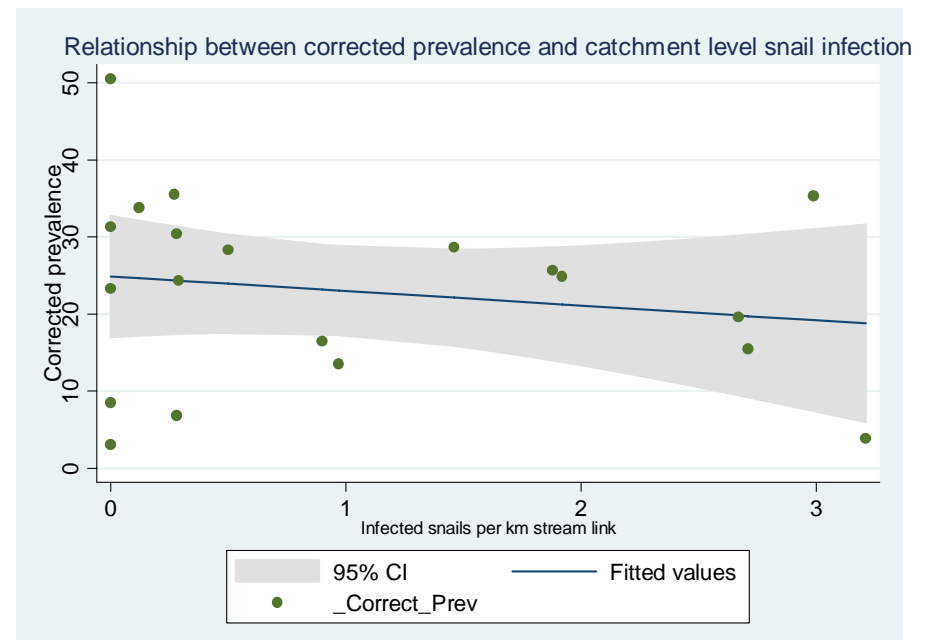


Human Prevalence

Comparison of Disease Estimators



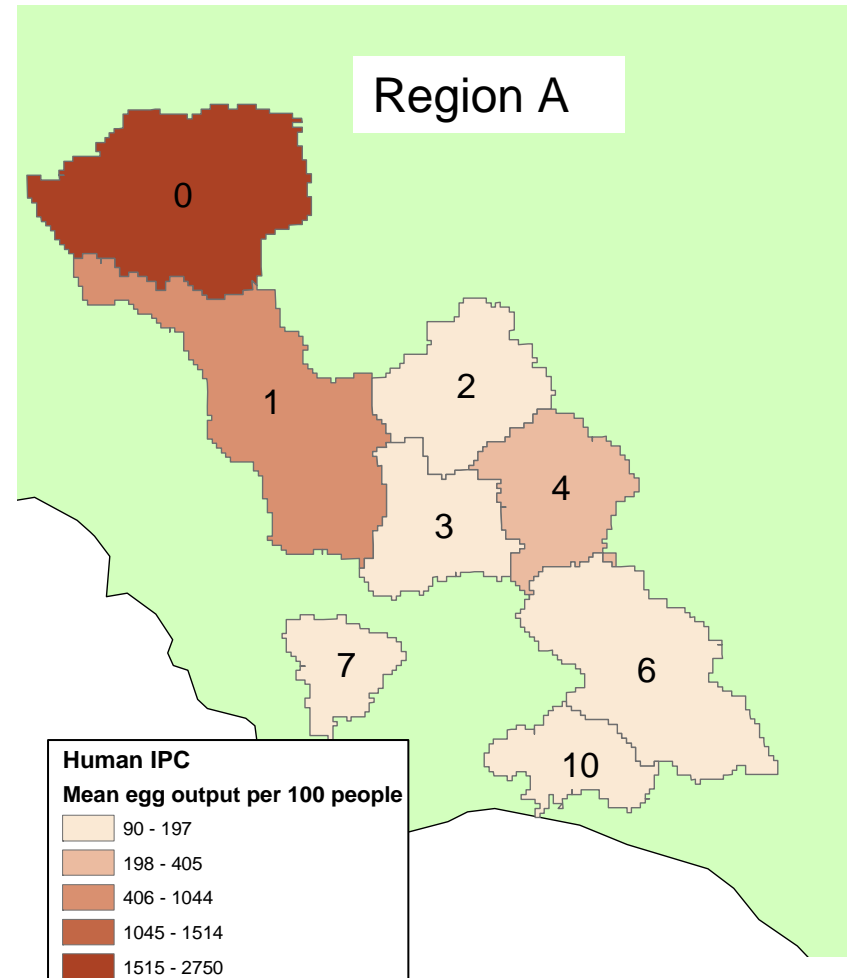
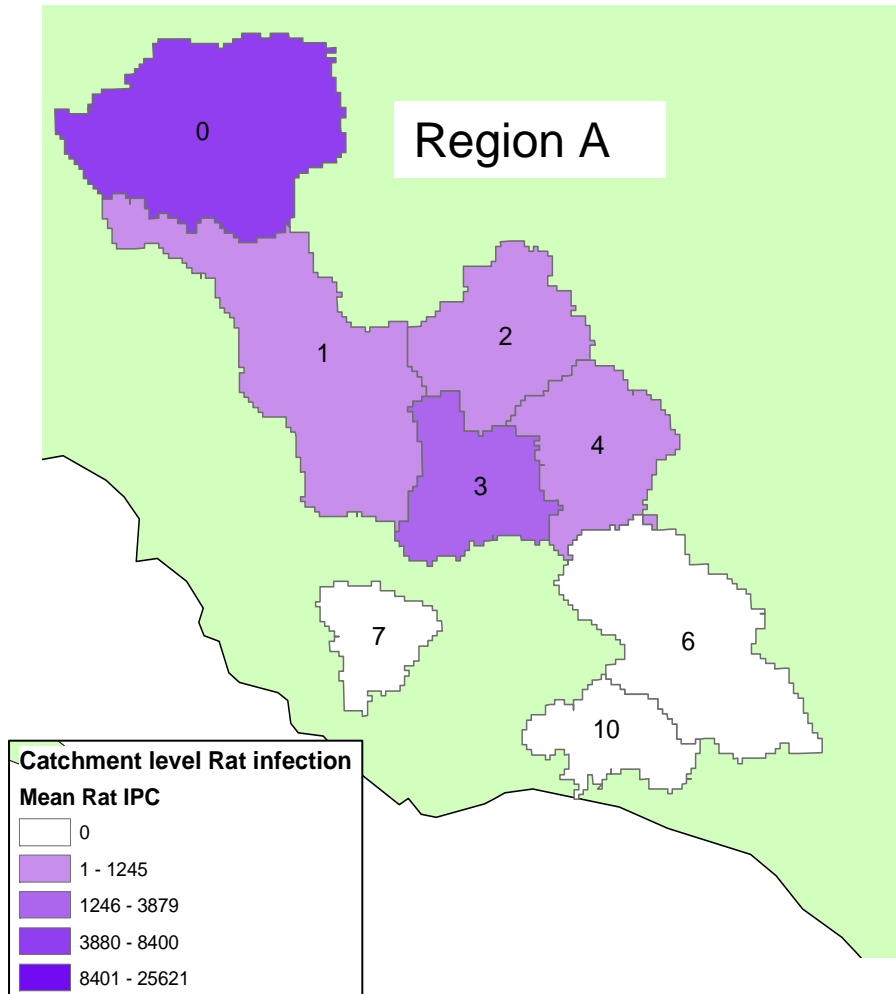
Snail and IPC



Snail and Prevalence

Inconsistent Relationships

Rat and Human Infection



Limitations to catchment method

- Uneven distribution of snails
- Loss of small scale variability
- Human and animal movement and exposure across catchments
- Cercarial not bounded by catchments

Conclusions

- Catchment method needs more verification
- High uncertainty in snail infection
- Inconsistent relationship between snail and human/rat disease outcomes
- Catchment level rat infection may predict environmental risk

Further Study

- Better understand movement of people and animals within and across catchments
- Compare village level disease outcomes within each catchment
- Conduct cercaria water sampling at different points along water courses within catchments
- Measure the transfer of cercaria from one catchment to another

Acknowledgements

Professor Stephen McGarvey (Brown University)

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Dr. Helen Carabin (University of Oklahoma)

Lynn Carlson (Brown University)

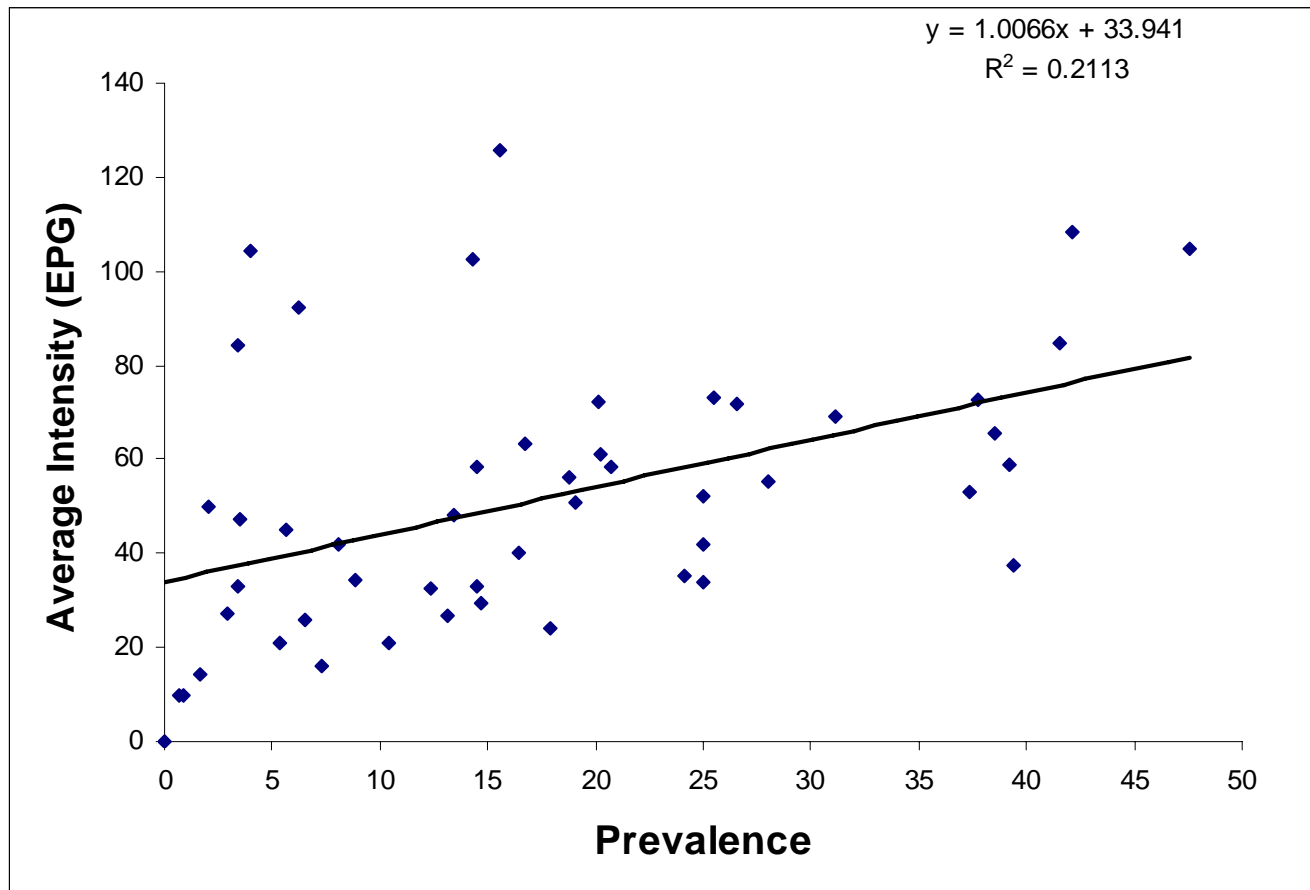
Professor Rachel Morello-Frosch

Collaborators on the STEP Schistosomiasis
project

Friends and Family



Prevalence vs. Intensity



Greater % of people infected contributes to more contamination and more intense infection

Regional Comparison

Region	Snail Infection	Corrected Human Prevalence
A	0.77 (-0.1 - 1.6)	23.3 (15.9 - 30.6)
B	1.12 (0.12 - 2.1)	23.9 (11.5 - 36.4)
C	1.39 (-1.5 - 4.3)	19.1 (-0.9 - 39.0)

Methods

2) Catchment level Infection Estimators

- Approximate relative transmission risk by summing number of infected snails in each catchment and normalizing count to stream length
- Average village level human and animal infection estimators
- Compare spatial distribution of snail infection with human and animal disease outcomes