E²M²: Ecological and Epidemiological Modeling in Madagascar

Ecology Meets Epidemiology

Centre ValBio
Ranomafana National Park, Madagascar
6 – 14 January, 2020
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International Clinics on Infectious Disease, Dynamics, & Data
MMED: Clinic on the Meaningful Modeling of Epidemiological Data

May-June 2019, Cape Town, South Africa
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DAIDD: Clinic on Dynamical Approaches to Infectious Disease Data
December 2020, Stellenbosch, South Africa
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South African Center for Epidemiological Modeling and Analysis (SACEMA),
Director
Dr. Juliet Pulliam
*University of Stellenbosch*

ICI3D, Program Director
Dr. Steve Bellan
*University of Georgia*
Goals for this lecture

• To explain what we’re doing here
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• To explain what we’re doing here
• To introduce the “E” and the “M” in $E^2M^2$
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• To introduce the “E” and the “M” in $E^2M^2$
  • Ecology
  • Epidemiology
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  • Ecology
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  • Modeling
  • Madagascar
All course materials are available at:

E2M2.org
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What is an –ology?
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• “the study of”
• “the science of”
What is an –ology?

• “the study of”
• “the science of”
• goal: to explain
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What is Ecology?
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• The study of the interactions of organisms and their environment
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• The study of the **interactions of organisms and their environment**
  - Herodotus (c. 425 BC): Nile crocodiles open mouths for sandpipers
  - Term coined in 1866 by German scientist Ernst Haeckel

• Emphasis on explaining **dynamical processes** in nature
A Brief History of Ecology

1. Plant Biology
   - Clements (1905): ‘superorganism’
   - Gleason (1918): individualistic ecology
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2. Population Biology
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   - Lotka-Volterra (1920s): predator-prey models
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3. Mathematical Ecology
   - MacArthur (1950s): island biogeography
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3. Mathematical Ecology
   - MacArthur (1950s): island biogeography

4. Disease Ecology
   - Anderson and May (1980s)
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What is Epidemiology?
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- “the study of what is on the people”
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  – coined by Spanish physician Villalba in 1802
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• “the study of **what** is on the people”
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• Emphasis on the study and analysis of the distribution and determinants of health and disease (“risk factors”)
A Brief History of Epidemiology

1. **Four Humors**
   - Disease results from imbalance
   - Hippocrates (c. 400 BC)
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2. Miasmatic Theory of Disease
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   - Disease results from ‘germs’
   - Leeuwenhoek’s microscope (1675)
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4. Classical epidemiology
   - ‘Risk factors’
   - John Snow and London cholera (1854)
Applying Ecology and Epidemiology

• Applied Ecology = Conservation Biology
  - Goal: protect populations from extinction
Applying Ecology and Epidemiology

• Applied Ecology = Conservation Biology
  - Goal: protect populations from extinction
  - Approach: protected area reserves

Single Large or Several Small
4 acres 1 acre 1 acre
1 acre 1 acre
Applying Ecology and Epidemiology

• Applied Ecology = **Conservation Biology**
  - **Goal:** protect *populations* from *extinction*
  - **Approach:** protected area reserves
  - **Key Terms:**
    - **Minimal Viable Population** (MVP): minimum number of individuals sufficient to sustain 99% of population in 100 yrs
    - **Intrinsic growth rate** = $r$
    - **Finite population rate of increase** = $\lambda$
Applying Ecology and Epidemiology

• Applied Epidemiology = **Public Health**
  - **Goal**: protect **populations** from disease via pathogen **extinction**
Applying Ecology and Epidemiology

- **Applied Epidemiology = Public Health**
  - **Goal:** protect populations from disease via pathogen *extinction*
  - **Approach:** sanitation, quarantine, *vaccination*
Applying Ecology and Epidemiology

• Applied Epidemiology = **Public Health**
  - **Goal:** protect *populations* from disease via pathogen **extinction**
  - **Approach:** sanitation, quarantine, vaccination
  - **Key Terms:**
    - **Critical Community Size** (CCS): minimum number of hosts sufficient to sustain a pathogen indefinitely
    - **Basic Reproduction Number** = $R_0$
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Misaotra!