Deterministic versus Stochastic Models

- **Deterministic**
  - Model parameters are exact
  - Output is exact

- **Stochastic**
  - Model parameters are estimates with some variation
  - Output has variation

Stochastic nature of populations

- More likely to go extinct
- Demographic stochasticity
- Sex ratios
- Inbreeding
- Allee effects
- Fragmentation effects

Life Tables

- **Types**
  - Static
  - Cohort

- **Uses**
  - Estimate the probability of dying at time $x$
  - Examine the effect of age on fecundity
  - Estimate mortality rates through time

Life tables

- **Observed data**
  - Age/stage
  - Number alive at time $x$
  - Number of offspring at time $x$

- **Derived data**
Life history traits

- Robert MacArthur and Edward O. (EO) Wilson
- Theory of Island Biogeography 1967
- r and K selected species
  - Iteroparity vs. semelparity
  - Offspring size vs. offspring number
  - Parental care
  - Habitat
  - Offspring survival
  - Parental survival
  - Time to sexual maturity
Species Interactions

- Autecology
- Synecology
- Competition
  - Negative interaction
  - Intraspecific (intraspecific growth curves, natural selection)
  - Interspecific
    - Diffuse

Effects on populations

Competitive Exclusion

- Competitive exclusion principle
  - Two species that compete cannot coexist
  - One will drive the other to extinction
  - Joseph Grinnell 1908, Георгий Гаус (Gause) 1934
- May work in some circumstances
- Predator-mediated competition
- Disturbance-mediated competition
- Parasite-mediated competition

Character Displacement

- Avoid competition or
- Drift
- Trait in allopatric vs sympatry
- Note means and sd

Exploiting ecological principles for human health and welfare

- Reduce antibiotic-resistant and other pathogens by introducing better competitors (example and example)
- Invasive species are thought to be better competitors
  - Resources
  - Too sexy! (example)

The niche

- Fundamental
- Realized
- Habitat selection
**Predation**

- Negative/Positive relationship
- Population oscillations
- Arms race
- Hypercarnivores

**Parasitism/Infectious Disease**

- Positive/Negative relationship
- If there are several parasites per host, how many species of parasites?
- Endoparasites
- Ectoparasites
- Direct life cycle
- Indirect life cycle
  - Definitive host
  - Intermediate host
  - Paratenic host

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**Malaria**

**Important terms**

- Vector
- Morbidity vs. Mortality
- Arbovirus
- Zoonoses, Epizootic
- Incidence vs. Prevalence
- Endemic vs. Epizootic

**Effects of diseases on populations**

- Emerging Infectious Diseases
- Endemic vs. Epizootics
- Examples
  - WNV
  - WNS
  - Rabies
  - Chytrid fungus
  - CWD
- Zoonoses
  - Ebola, AIDS, SARS, MERS, Rabies, Lyme, Babesia, RMSF

**Mutualism**

- Positive/positive
- Pollination
- Frugivory
- Grooming
  - Oxpecker
- Gardening
  - Leaf cutter ants and fungus
Ecological Communities

- Communities
- Assemblages
- Species Richness
  - Species accumulation curves
- Evenness
- Diversity
  - Shannon Index \( H = - \sum p_i \cdot \ln(p_i) \)
- Biodiversity
- Diversity and Disease
  - Dilution effect

Food Webs

- Trophic level
  - Producers
  - Primary Consumers
  - Secondary Consumers
  - Tertiary Consumers
  - Detritivores
  - Parasites
- More primary production = more trophic levels

Energy Flow

- Gross vs. net productivity
- Consumption Efficiency \( CE \) (biomass consumed)
  - Aquatic ecosystems
  - Terrestrial ecosystems
  - 5% in forest, 25% grassland, 50% in phytoplankton communities
- Assimilation efficiency \( AE \) (gut -> body)
  - Herbivores low (C:N dependent) 20%
  - Carnivores 80%
- Production efficiency \( PE \) (food -> growth)
  - Inverts 30-40%
  - Endothermic vertebrates 10%
  - Endothermic vertebrates 1%
- Trophic Level Transfer Efficiency
  - \( CE \times AE \times PE \)

Aquatic Biomass Pyramid

- Trophic level
  - Dry mass (g/m²)
  - Tertiary consumers: 1.5
  - Secondary consumers: 11
  - Primary consumers: 37
  - Primary producers: 809

Most ecosystems (data from a Florida bog)

- Trophic level
  - Dry mass (g/m²)
  - Primary consumers (zooplankton): 21
  - Primary producers (phytoplankton): 4

Some aquatic ecosystems (data from the English Channel)

Inverted Pyramid in an Aquatic Ecosystem