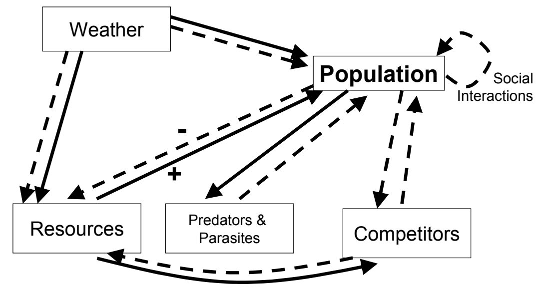
Population Growth IV. Population Dynamics

Population Dynamics



Population Dynamics

- **Trend**
  - consistent increase or decrease
- **Stable**
  - small fluctuations around a constant density
- **Erratic**
  - large fluctuations at varying intervals
- **Cyclic**
  - large repeated fluctuations at approximately constant intervals

Population Dynamics

What factors cause a population to change (or stay the same) as it does?

Determining Key Dynamical Factors

Approaches:

•Comparison Among Sites

•Comparison Across Years

•Experimental Manipulation

Case Studies

- Great tit (*Parus major*) & muskrat (*Ondatra zibethicus*): stable
- White-footed mouse (*Peromyscus leucopus*): erratic
- Snowshoe hare (*Lepus americanus*): cyclic

Great tit (*Parus major*): Stable

- Related to our chickadee
- Eats arthropods, seeds, berries
- Territorial during breeding season
  - birds that don't get territories don't breed
  - removing a territorial pair allows a "floater" pair to breed (Krebs & Perrins 1978)
- Show overheads

Great tit (*Parus major*): Stable

- Both reproduction and survival are strongly density dependent
  - Removing eggs & chicks caused higher adult survival (Kluijver 1966)
- Variations in density among years appear to be caused by changing food availability in winter

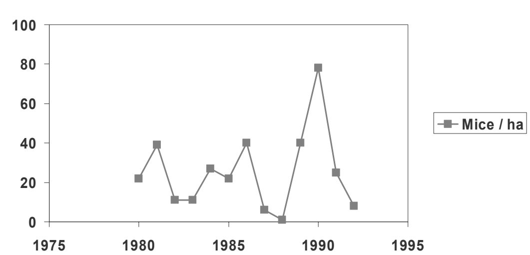
Muskrat (*Ondatra zibethicus*): Stable

- Studied by Paul Errington (1943, 1945)
- Strongly territorial like great tit
- Floaters (especially dispersing young) lack territories
- Predators (mink) kill many muskrats in high-density populations
- Predators mainly kill floaters
  - "doomed surplus"
- ***Threshold of Security hypothesis***: predation is only significant at population densities above territory saturation

White-footed mouse (*Peromyscus leucopus*): Erratic

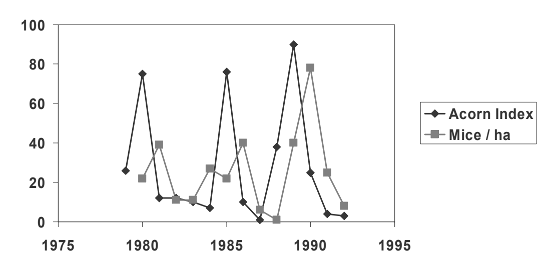
- Short lived (most live < 1 year)
- Can reproduce rapidly
- Omnivorous
- Do not hibernate
- Depend on tree seeds (especially acorns) as winter food

White-footed mouse (*Peromyscus leucopus*): Erratic



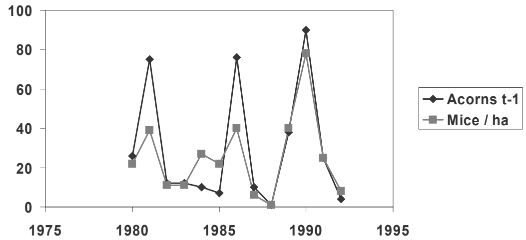
Mountain Lake Biological Station, Virginia (Jerry Wolff 1996)

White-footed mouse (*Peromyscus leucopus*): Erratic



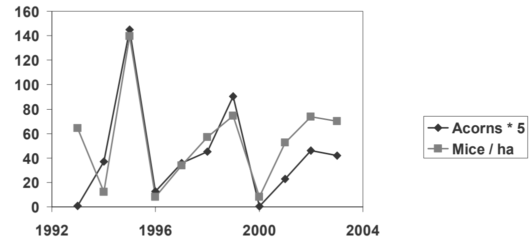
Mountain Lake Biological Station, Virginia (Jerry Wolff 1996)

White-footed mouse (*Peromyscus leucopus*): Erratic



Mountain Lake Biological Station, Virginia (Jerry Wolff 1996)

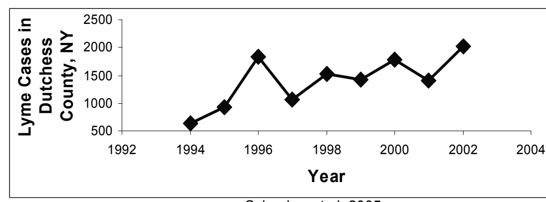
White-footed mouse (*Peromyscus leucopus*): Erratic



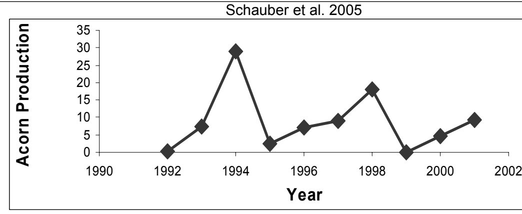
Millbrook, New York (Schauber et al., 2005)

White-footed mouse (*Peromyscus leucopus*): Erratic

- So what? Who cares about mice?
- Well...White footed mice
  - are major predators of gypsy moths
    - acorn failure may indirectly cause gypsy moth outbreaks (Elkinton et al. 1996; Jones et al. 1998)
  - can be important predators of songbird eggs
    - large acorn crops can indirectly cause songbird populations to drop (Schmidt et al. 2001)
  - are the primary reservoir of the bacterium that causes Lyme disease
    - large acorn crops can mean high risk of Lyme disease two years later (Ostfeld et al. 2001; Schauber et al. 2005)



Schauber et al. 2005



Snowshoe Hare (*Lepus americanus*): Cyclic

- Lives in boreal forest
- Feeds on plants, twigs, bark
- Preyed upon by lynx
- Exhibits cycles of about 10 years

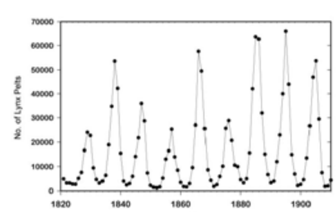


Figure 1. Canada lynx fur returns from the Northern Department of the Hudson's Bay Company from 1821 to 1910. The Northern Department occupied most of western Canada. The cycle for these data averages 9.6 years. Data are from Elton and Nicholson (1942). Photo: Mark O'Donoghue.

Krebs et al. 2001 What drives the 10-year cycle of snowshoe hares? Bioscience 51:25-35

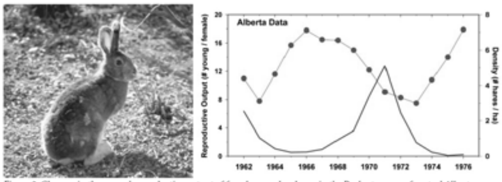


Figure 2. Changes in the annual reproductive output of female snowshoe hares in the Rochester area of central Alberta, 1962–1976. Reproductive output was measured in autopsy samples. Data from Cary and Keith (1979). Photo: Alice Kenney.

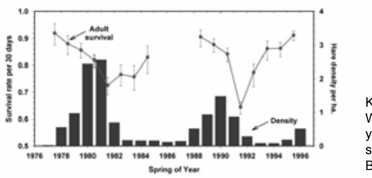


Figure 3. Changes in adult hare survival rates over the 10-year cycle at Kluane Lake, Yukon, from 1977 to 1996. Hare density (histogram) in spring of year t is plotted along with survival rates averaged from spring of year t to t+1 for radio-collared hares in control areas. Too few hares were captured in 1985–1987 to estimate survival accurately.

Krebs et al. 2001
What drives the 10-year cycle of snowshoe hares?
Bioscience 51:25-35

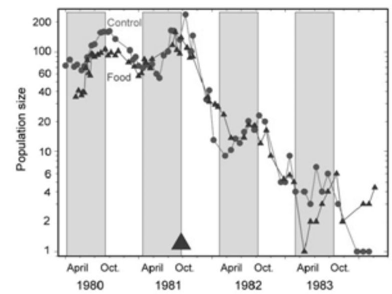


Figure 5. Changes in snowshoe hare numbers on control (1050, red) and food-supplemented (blue) areas during the population decline of 1981–1983 at Kluane, Yukon. The natural feeding experiment was begun in October 1981 (blue triangle). Summer months are shaded yellow. Data are from Krebs et al. (1985).

Krebs et al. 2001 What drives the 10-year cycle of snowshoe hares?
Bioscience 51:25-35

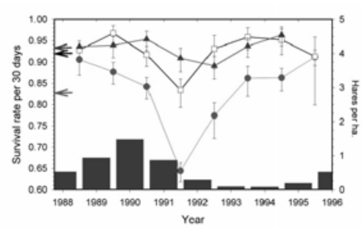


Figure 6. Changes in survival rates of snowshoe hare numbers on control and fenced areas during the population cycle of 1988–1996 at Kluane, Yukon. The arrows show the mean survival rate for each treatment. The survival rate per 30 days is averaged over each year, with 90% confidence limits, for radio-collared hares.

Krebs et al. 2001 What drives the 10-year cycle of snowshoe hares?
Bioscience 51:25-35

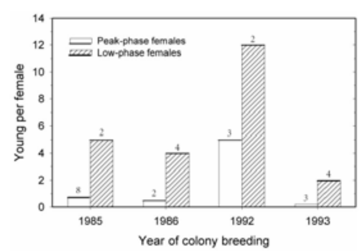


Figure 9. The annual reproductive output of snowshoe hare females maintained in a colony at Vancouver. Individual females were taken from field populations and classified by the state of the field population at the time of initial capture. For 4 years there were enough females to compare simultaneously the population of females taken from the peak phase of the cycle with those taken from the low phase. Low-phase females maintain a lifetime reproductive output much greater than peak-phase females; these lab results mimic the observed changes in field populations. Numbers above bars are numbers of females.

Krebs et al. 2001 What drives the 10-year cycle of snowshoe hares?
Bioscience 51:25-35

Snowshoe Hare (*Lepus americanus*): Cyclic

- Food addition alone did not stop crash (Krebs et al. 1985)
- Removal of lynx alone did not prevent crash (Stenseth et al. 1998)
- Exclusion of all mammal predators DID stop hare crash (Krebs et al. 1995)
- Extended effects on reproduction due to chronic stress
- Cycle results from interaction of food, predation, & stress

Things to Remember

- Populations can exhibit a variety of dynamics, depending on
  - strength of density dependent factors
  - strength of outside forces (fluctuating food, weather, predators, parasites, competitors)
- Determining what causes a population to change involves
  - comparison among sites
  - comparison across years
  - experimental manipulations
- Be able to discuss the case studies