Case Study

- Archery hunters of goats in Makaha are frustrated because DLNR is eradicating goats from the watershed adjacent to the game management area. There is no fence between the watershed and the game management area. They believe the eradication is wasteful and that it will decrease the size of the goat population available for hunting.
- Your job is to determine if (1) the eradication of goats from the adjacent watershed will impact the size of the goat population in the game management area, and (2) if it will impact harvest or hunter success in the game management area.

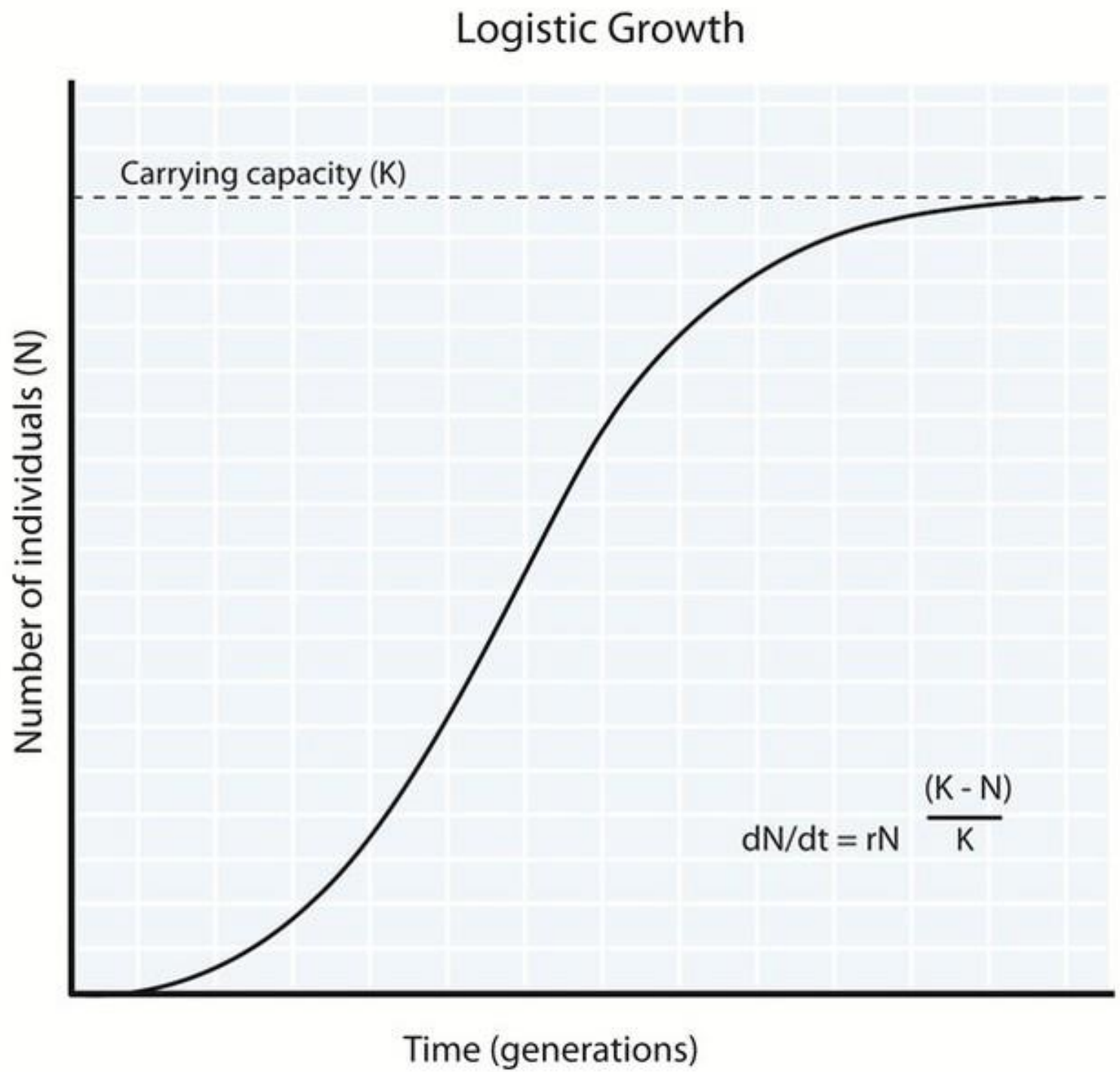
NREM450

Managing for Harvest

(1) Pair with a friend or two and identify all game species in Hawaii (birds, mammals)
(2) Google regarding hunting licenses and restrictions for each of these species

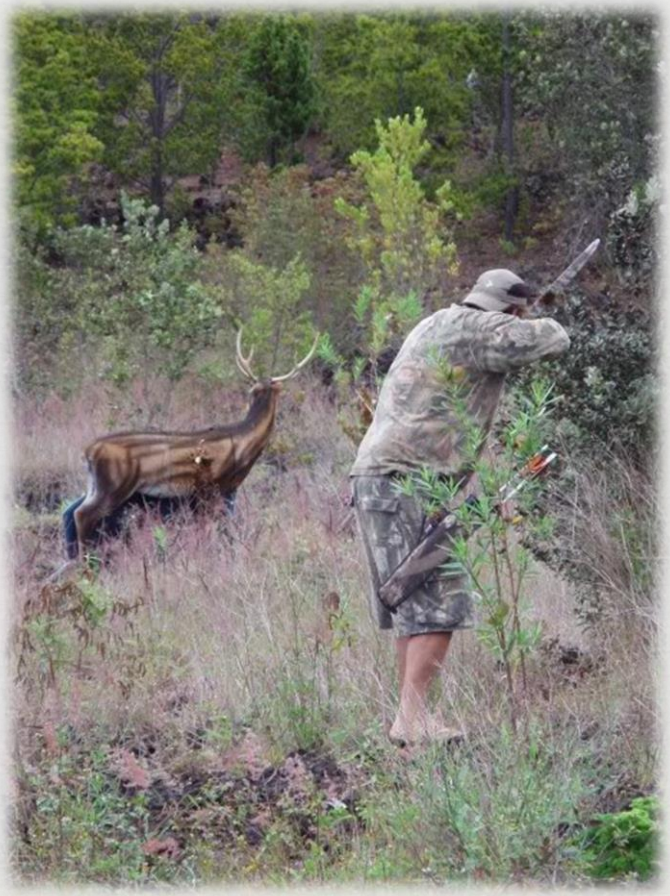
Learning Objectives

- Identify three major purposes for wildlife harvest
- Identify the 3 components of harvest management
- State the 6 areas of biological knowledge needed to set harvest levels
- List two major approaches that may be used to regulate wildlife harvest
- Describe the advantages and disadvantages of management by trial-and-error
- Discern why most populations may not be harvested without causing a decline and what may be done to allow for sustainable harvest
- List measured variables you must know to be able to sustainably manage for harvest
- Describe the mathematical relationships between density and yield at low population density, intermediate density, and carrying capacity
- Define maximum sustainable yield and explain why harvest limits should not be set at this point if the goal is sustainable, continuous harvest
- Compare and contrast the advantages and disadvantages of fixed-proportion and constant-effort harvest strategies
- Describe the advantages and disadvantages of age- or sex-biased harvesting
- Describe which systems and species may benefit from harvest reserves and explain why some species may not benefit from reserve systems


Logistic Growth
Carrying capacity (K)
Number of individuals (N)
dN/dt = rN (K - N)/K
Time (generations)

Wildlife Harvest

1. Sport hunting
   - Restrictions on sex, age
   - Experience, meat, trophies
2. Commercial harvest
   - Target is product (meat, skins, organs, etc.)
3. Wildlife control (removal of pest species)



North American Model

- Wildlife species within a state are the sole property of that state and not subject to private ownership on the land they inhabit (State vs. Heger, 1910)
- States responsible for "resident wildlife" harvest regulations
- Migratory birds are under federal custody (MBTA, 1918)
- Federal govt sets regulations for migratory game birds
- Rules apply regardless of ownership of the land the animals occupy

3 Components of Harvest Management

- Inventory of population
- Identification of population and harvest goals
- Development of regulations allowing goals to be met

6 Areas of Biological Knowledge to Set Harvest Levels

- Population size and range
- Habitat requirements and movements
- Resilience to human disturbance & habitat change
- Estimates of demographic rates
- Key factors regulating populations
- Effects of environmental regulation

Wildlife Harvest

Regulate by:

- Quota on off-take
- Control harvesting effort
  - Restrict length of hunting season
  - Limit number of people involved

Management by Trial-and-Error

- Leads to cyclic changes in harvest intensity over time
  - Behavioral response by harvesters and managers
  - When hunting or fishing is good, more people want to do it.
    - Should decrease due to less satisfaction as more people "join", or competition, or because pool of potential new hunters is exhausted
  - When it is bad, less people want to do it.
- Similar to predator-prey cycles

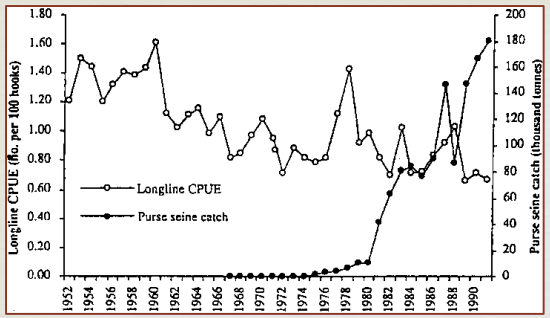
Cautions

Harvest must be sustainable

- Can take year after year without jeopardizing future yields
- Overharvesting major contributor to endangerment of vertebrate species (Wilcove et al. 1998)

Most unharvested populations are not increasing…

- So sustained yield is zero!
- If you want to harvest, you must
  - stimulate growth (↑nest sites, cover, food)
  - Reduce other forms of "take" (predation, etc.)*
  - Reduce competition for resources



Basic Principles

individuals removed < number of new recruits to population

- Must know:
  - Population size
  - Variation in recruitment from year to year
  - Methods to accurately monitor size and recruitment
  - Other forms of "take" such as predation

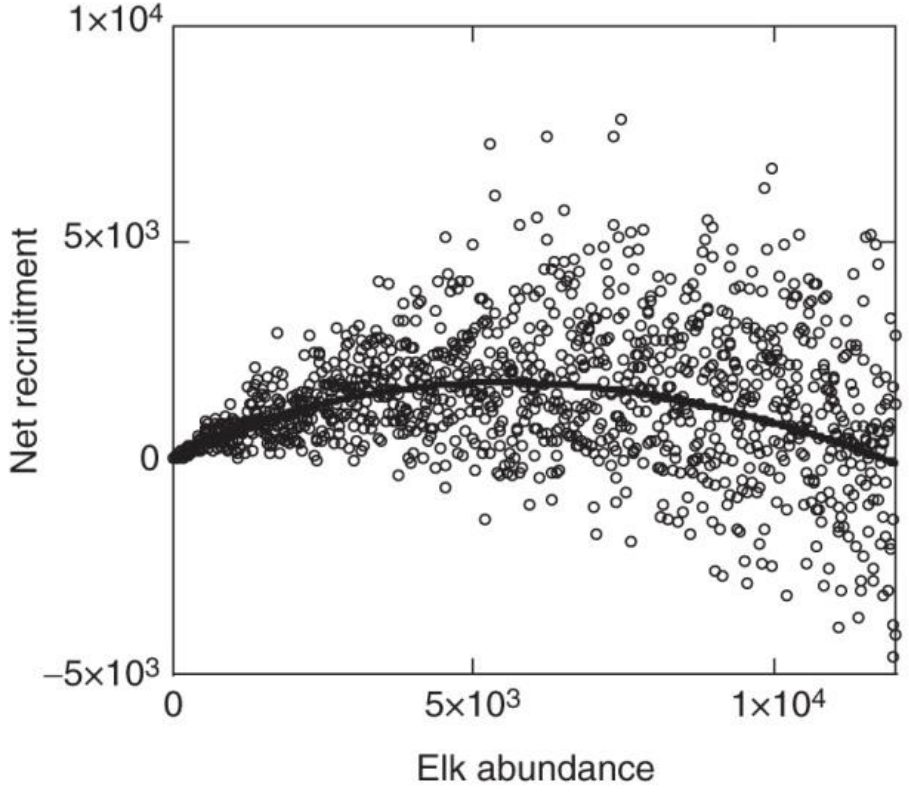


Figure 18.1 Estimated variability in the net recruitment of Yellowstone elk in relation to population density, based on Monte Carlo simulation at observed levels of environmental stochasticity (see Chapter 16). The expected net recruitment is shown by the solid hump-shaped curve.

Wildlife Ecology, Conservation, and Management, Third Edition.
John M. Fryxell, Anthony R. E. Sinclair and Graeme Caughley.

Companion Website: www.wiley.com/go/Fryxell/Wildlife

Density & Yield

Absolute yield: actual amount harvested

- Proportionate Offtake
  - Absolute yield divided by population size
  - Increases as density is reduced
  - Remember: Resource limitation to growth
  - Trade-off between yield and density
    - Low density means higher yield as a percentage of population size, but absolute yield is relatively small
    - Highest yield at intermediate density levels, below carrying capacity, because induced rate of increase multiplied by density is at maximum

Fixed-Quota Harvest Policy

- Sustained-yield pair
- Quota must be set low enough to be safe at the lowest anticipated density
- Probably best to avoid a fixed-quota harvest policy, even though it is convenient

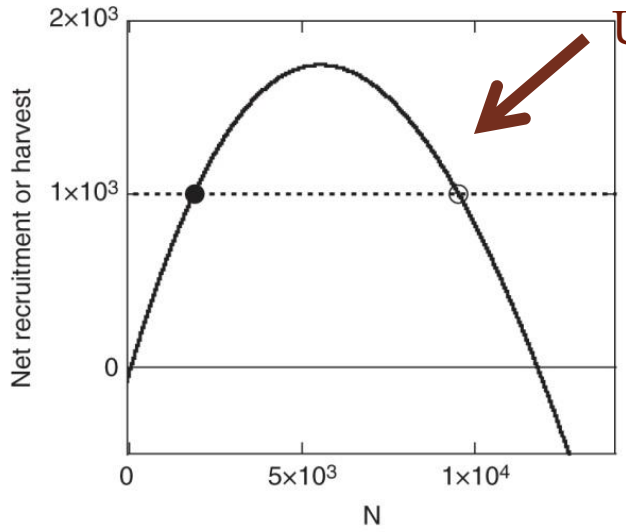


Figure 18.2 Expected net recruitment of Yellowstone elk in relation to population size (hump-shaped curve) plotted relative to a constant harvest quota of 1000 individuals. At a given harvest quota, there are stable (open circle) and unstable (filled circle) population equilibria. At population densities above the open symbol, the elk population would decline and eventually converge on the stable equilibrium. Perturbation of the population below the filled symbol on the other hand, would lead to further elk decline and eventual extinction. Values in between the equilibria would lead to convergence on the upper equilibrium.

Maximum Sustainable Yield

- MSY is unsustainable in the long-term
  - Environmental variation
  - Demographic variation
  - Small perturbations lead to slide to extinction

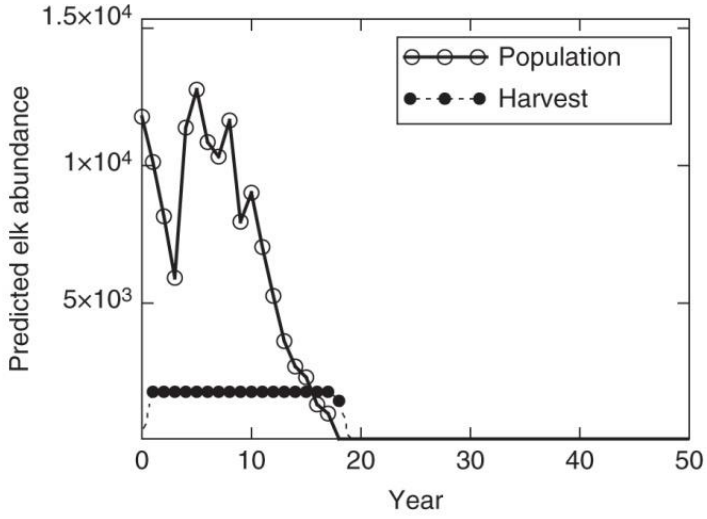


Figure 18.3 Predicted variation in elk abundance under aconstant quota harvest policy, with annual elk harvest set at the maximum sustainable yield (1760 individuals per year). The simulation starts with elk at their ecological carrying capacity (12,000).

Fixed-proportion Harvesting Strategy

- Harvest rate (h) must not exceed the maximum intrinsic rate of population growth (r_{max})
- Population growth is unpredictable
- Recruitment information is often not known
- Harvest levels are set long before annual recruitment is known
- Fixed-proportion strategy is more sustainable than fixed-quota

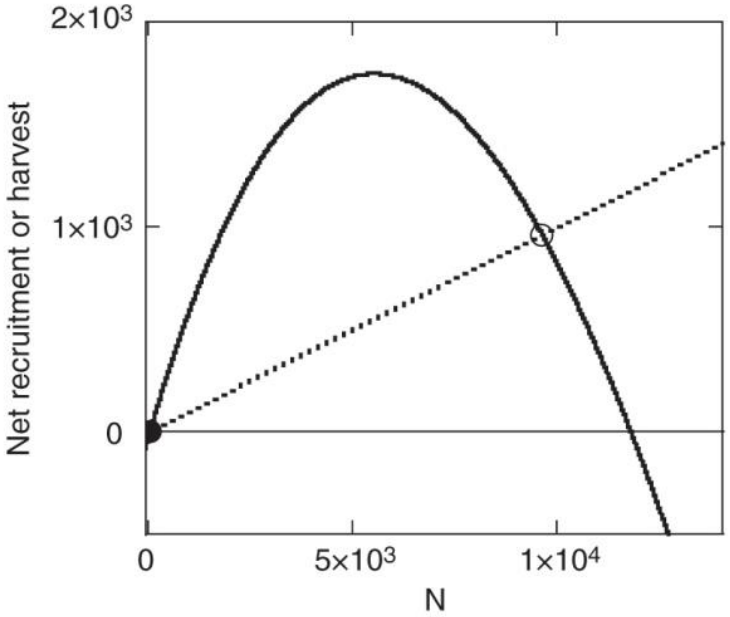


Figure 18.4 Expected net recruitment of Yellowstone elk (hump-shaped solid curve) in relation to population abundance, plotted relative to a constant proportionate harvest (straight dotted line). The intersection of the net recruitment curve and the harvest function identifies the stable equilibrium, at which off-take equals the growth increment to the population. At any given harvest proportion, there is one stable (open circle) and one unstable (filled circle) equilibrium. At population densities above the stable equilibrium, the population would decline and accordingly converge on the stable equilibrium. Values in between the equilibria would cause increase in elk numbers leading eventually to convergence on the upper stable equilibrium.

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Fixed-proportion Harvesting Strategy

Harvests drops following years of poor recruitment but improves in years following above-average recruitment

- Less risky, but not risk-free
- May still produce overharvesting if
  - several years with unusually low recruitment
  - large error in manager's assessment of current population size

Constant-effort Harvesting Strategy

- Controlling effort results in a constant proportion of the population harvested
  - effort (i.e. limit # hunting permits, length of season)
- Remember: yield tracks density!
  - density effects
  - Time, area, success
- Regulatory "mechanism" is built into system
- "safe" as long as harvesting effort was calculated correctly

Age- or Sex-biased Harvesting

- Early 1900's
- Large mammals
- Harvesting directed at
  - Males rather than females
  - Older rather than younger age groups
- Tag or license restrictions on hunters
- Protects breeding segment of population
- Consider long-term implications
- Know the life history and behavioral patterns of species (sex-biased mortality in certain age classes, etc.)

Harvest Reserves

- Set aside some sites as no-harvest zones in close proximity to harvested subpopulations
  - Popular in marine ecosystems
  - Hasn't been used much yet in terrestrial systems (but *de facto* in some areas, such as for pigs in Hawaii)
  - Works best in species with small, well-defined home ranges that disperse well into neighboring areas
  - Doesn't work well for nomadic or migratory species