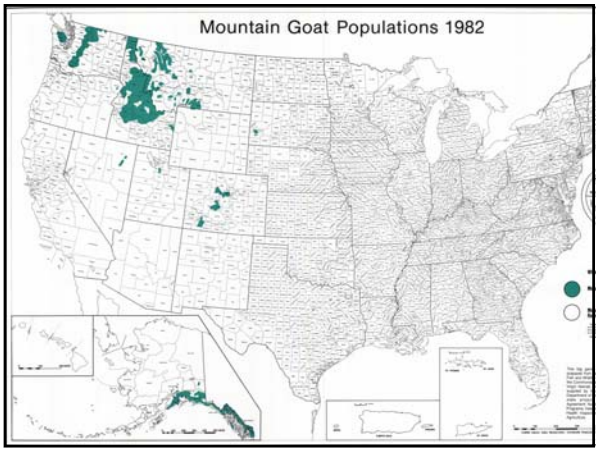
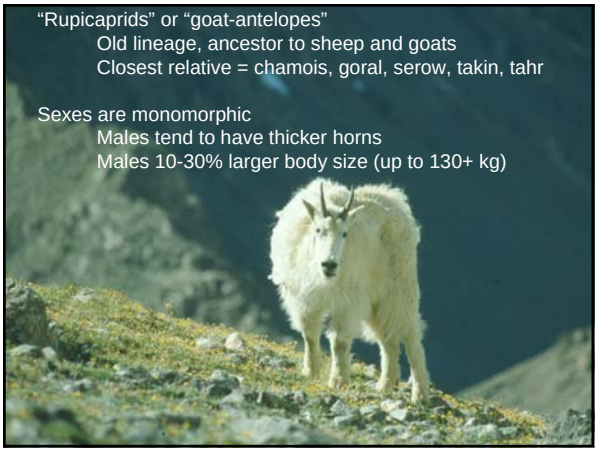
Mountain Goat and Mountain Sheep: History and Management Issues

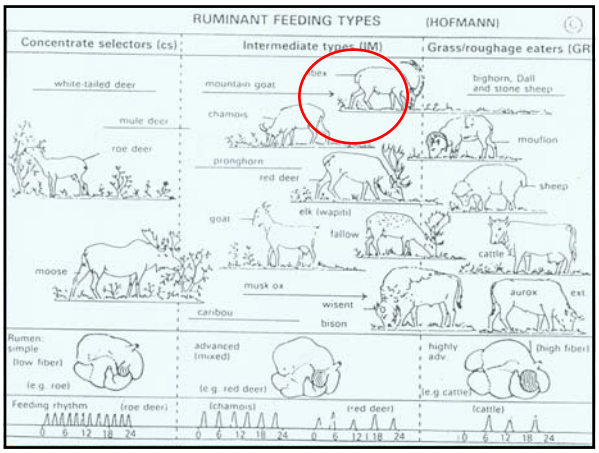
Mountain Goat

- Pop has not declined
- Range has expanded
  - CO, MT, OR, SD, UT, WA

Figure 23-1 Distribution of the mountain goat. (After Ref. 3.)







Introduced Populations

- Very successful… irruptive
- Management in National Parks
  - In Rocky Mountain NP
    - will be removed if it shows up
  - In Olympic NP
    - Introduced and did very well
    - Overgrazing and "digging" to make beds
    - Activity at mineral licks a problem
    - Trapping and transplanting

Harvest

- Would unlimited license sale be good idea?
  - Open habitat makes goats susceptible to firearm harvest
  - Island-like habitat limits movement from lightly harvested populations to areas of heavy harvest
  - Goats not sexually dimorphic
- Harvest conservative and closely monitored
  - Low growth rates in established herds
  - Census populations and set quotas (4-7% of fall pop)
  - Lottery used to issue licenses

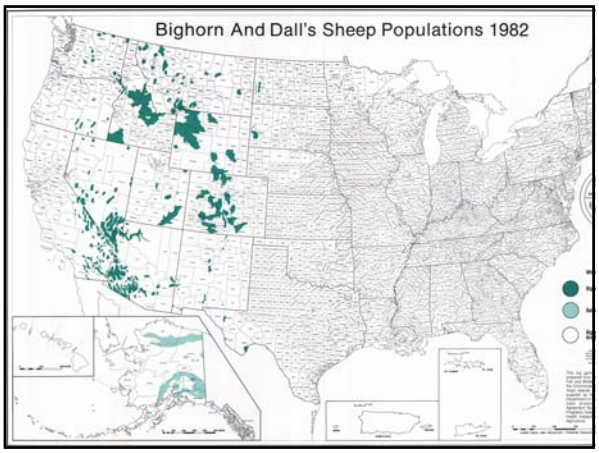
Mountain Sheep

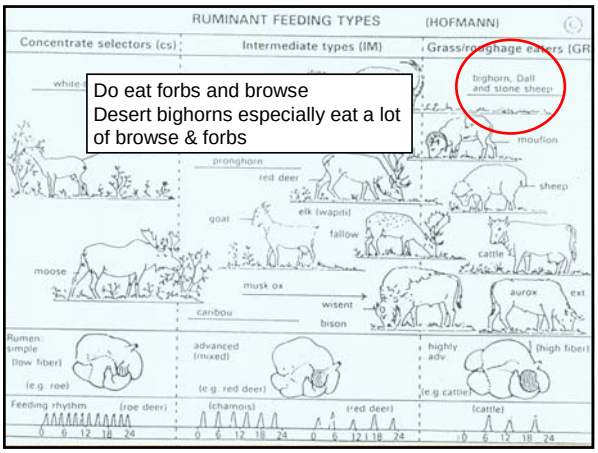
- Two main groups:
  - Thinhorn sheep
    - Dall's, Stone's
    - Alaska, NW Canada
  - Bighorn sheep
    - W US, Canada, Mexico
    - Mountains, desert mountains
- Prized game animal
  - Terrain, access
  - Symbol of the wild

Big Horn Sheep

- Pop decline from 1.5-2 million to 70,000
- Small, fragmented pops, <100 sheep
- CO pops stable or increase in 1990s
- Dall and Stone sheep a different species in NW Canada and AK.

Figure 25–2 Historic and current ranges of bighorn sheep in North America.





Do eat forbs and browse
Desert bighorns especially eat a lot of browse & forbs

Sheep Decline

- WSB 16:346-352
- Early decline due to unregulated hunting
- Now harvest closely monitored; poaching likely to be for large males, which would not reduce pop growth rates
- Populations still declining
- Why? Must understand species' ecology

Sheep Evolution

- Sheep evolved in glaciated mountains with abundant predators. Predator evasion strategy
  - Forage diurnally — Predators easy to see
  - In large, dispersed groups — Many eyes
  - In open habitat — Pred & sheep visible
  - Near escape cover — Run to escape cover
  - >>European and Asian relatives are adapted to more grassland type habitats, better runners than climbers

Sheep Evolution

- Sheep evolved in glaciated mountains with abundant predators. Predator evasion strategy
- Characteristics of sheep habitat:
  - High visibility
  - Abundant, continuous forage
  - Cliffs for escape terrain

Sheep Ecology

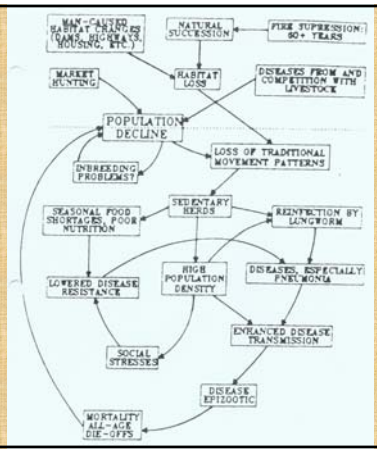
- Found only in portions of the landscape
  - Herd may have several of these spots within its home range
  - Herd moves among these spots
  - Moving among areas important part of sheep ecology
  - What are advantages of moving through the landscape?

Sheep Movements

- Advantages of moving around the landscape:
  - Respond to weather and patterns in forage avail.
  - Provides options when sheep are disturbed
  - Allows for gene flow among herds
  - Chance to find unoccupied, suitable habitat
  - Enables large herds to exist
  - Reduces chance of disease problems

Sheep Decline

- Disruption of movement patterns:
  - Roads, reservoirs, development, fire suppression
  - Succession: Grass→ Shrubs → Forest
  - Pop declines → Loss of knowledge of movement patterns and corridors
- Results in small, isolated, sedentary herds
- This sets up a cycle from which it is difficult for sheep populations to recover



Management Efforts

- Range protection and improvement
  - Try to improve winter range; may not be limiting
  - Open travel corridors; create more suitable habitat
- Transplants
  - Often sheep put back into areas they were once found without evaluating current habitat
- Drug treatment
  - Must address cause, not symptoms (JWM 64:505)
- Protect habitat and corridors, create new habitat
  - What techniques?

Undesirable evolutionary consequences of trophy hunting

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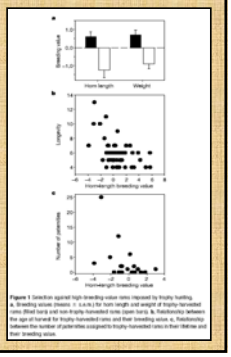
- Harvest Management
- Long-term study of Canadian bighorn sheep

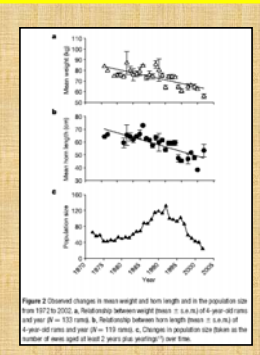
Bighorn Sheep

- Breeding success is correlated with horn size and age
- Large-horned rams are preferentially harvested
- Large-horned rams tend to grow large horns early in life



Long-term Selective Harvest

- Age-specific horn size of rams decreased despite changes in population density



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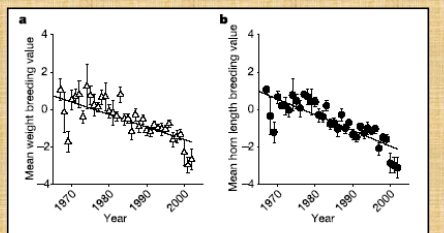

Figure 3 Changes in the mean breeding value of cohorts born between 1967 and 2002. **a**, Relationship between breeding value (mean ± s.e.m.) for weight and year of birth ($N = 783$ individuals). **b**, Relationship between breeding value (mean ± s.e.m.) for horn length and year of birth ($N = 783$ individuals).

Sheep Study: Different Than Seen in Deer….

Influence of population density on antler mass of red deer stags:

Declining trend despite heritability and "selection"

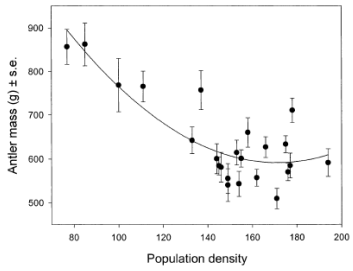

FIG. 3. Annual average antler mass, standardized to age 7, in relation to population density in year of antler growth. The bars represent one standard error of the mean, and the fitted line shows the quadratic effect of density. See Materials and Methods for definition of population density.

What is Different??

- Sheep: Harvest-induced "microevolution"
  - = "high-grading," selecting out the best "genetics"
- This *does not appear to occur* in deer
  - No change in population traits, even with heritability and "selection" (since only the biggest stags do all breeding)
  - At least not as quickly….
- Why not??

What is Different???

White-tailed deer

- Many different bucks are breeding
- Most successful bucks will have few fawns
- Can not predict successful breeders on the basis of antler characteristics

Harvest effects

- Mating system, habitat, etc., have a large influence on the distribution of breeding within populations
  - Harem or group-living species: 1 or a few males can monopolize matings
    - Red deer
    - Bighorn sheep
    - *Have to be good fighters to defend harems*
  - Solitary species: difficult for a few males to monopolize breeding (unless confined)
    - White-tailed deer
    - Fighting not necessary

Harvest effects

- Antlers and horns are secondary sex characteristics
  - Reflect "male handicaps" to advertise general health and body condition…. (who are these advertised to?)
- ***Antlers and horns are different***
  - Antlers re-grown each year
  - Not as correlated with other heritable traits
    - Growth rate, body size, etc.
  - More reflective of nutrition, condition in year of growth

Harvest effects

Variance component analysis of antler mass in red deer stags

Note that age, year, and environmental factors have a large influence on stag antler mass

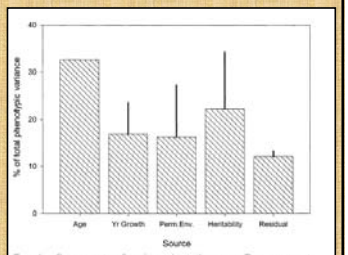

FIG. 4. Components of variance in antler mass. Bars represent percentage of total phenotypic variance in antler mass of males age 5 years or more. Sources of variance: age (in years, estimated from mixed model in Table 1); Yr Growth, year of growth; Perm. Env., permanent environmental effect; Heritability; Residual variance. Variance due to differences between ages is taken from mixed model in Table 1. Error bars are one standard error for random components.

Harvest effects

- Breeding success in rams:
  - Correlated with horn size, body size
    - At ~6 years old, rams big enough to defend estrous ewes
    - Peak breeding success 8-12 years old
  - Horn size and body size, growth rate appear to be genetically linked
    - Rams with good "genes" grow big horns at a young age
    - Can get shot before they reach peak breeding age
    - Since antlers are so heavily influenced by nutrition and body condition in year of growth, they are not as reliable a signal of "genetic quality"
    - How do deer breeders get around this limitation???

Harvest effects

- Putting it in perspective…
  - Small, isolated population
    - No dispersal, etc.
    - Low reproductive rate
  - Not "experimental" study- correlation only
    - Correlation does not = causation
    - Unreplicated (N = 1), no "control" unharvested population
  - Still, reason for caution
    - Problem = "selective" harvest
      - Same seen in fisheries stocks with only minimum limit
    - Solution = "slot limit"
      - Or, don't harvest young rams
      - Harvest mature rams with poor horn development