Rangeland Measurements & Monitoring

Carrying Capacity

ECOLOGICAL Carrying Capacity

Definition?
Graphical relationship?

ECOLOGICAL Carrying Capacity

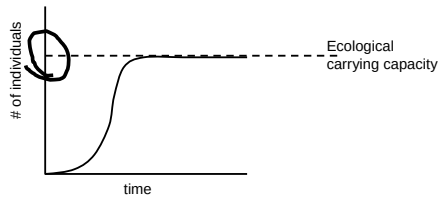
Longstanding idea:
Verhulst in 1838

The early 20's and 30's:
Leopold

The 60's and 70's:
Caughley
Noy-Meir in the 70's

ECOLOGICAL Carrying Capacity

- Number of individuals at point of "resource saturation" where births = deaths



KANGAROOS

What's carrying capacity?

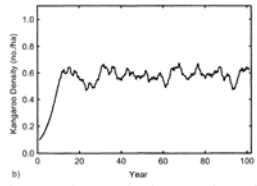
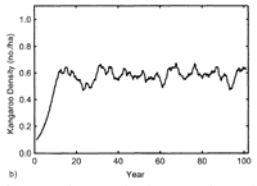


Fig. 2. Modelled trajectory of red kangaroo density through time in a) a stochastic system, and b) a 'deterministic' system. Starting conditions were $H = 0.1$ kangaroos/ha, and $V = 250$ kg/ha. Data used in the figures are from one representative replicate of the simulations of each system.

McLeod 1997

KANGAROOS

What's happening to veg?



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KANGAROOS VEGETATION

Is this realistic?

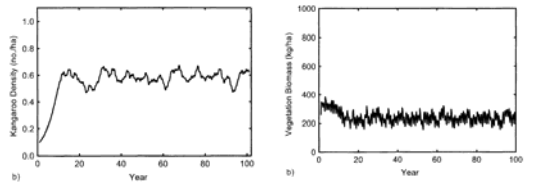

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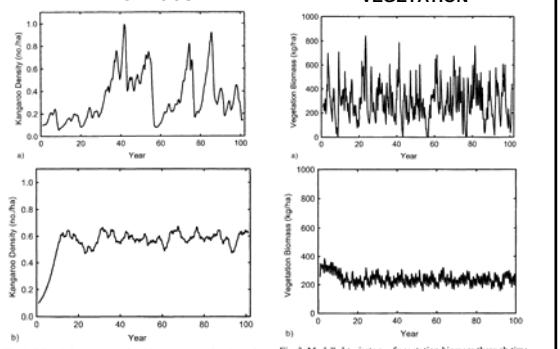
Fig. 3. Modelled trajectory of vegetation biomass through time for a) a stochastic system, and b) a 'deterministic' system. Starting conditions were $H = 0.1$ kangaroos/ha, and $V = 250$ kg/ha. Data used in the figures are from one representative replicate of the simulations of each system.

McLeod 1997

KANGAROOS VEGETATION



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Take-home message

- Carrying capacity for grazers dependent on:
  - Stability of vegetation
  - Stability of growing season
  - Population dynamics for grazers

Considerations in Determining Grazing Capacity

Things you can't control:

- Weather
- Water table
- Root zone depth
- Soil characteristics
- Topography
- Initial quantity of forage
- Initial quality of forage
- Drinking water distribution

Things you can manage:

- Management objectives
- Condition of forage
- Distribution of grazing in space and time
- Types of grazing animals
- Improvements – weed control, fertilization, seeding, irrigation
- Drinking water quality

SRM* definition of Carrying Capacity

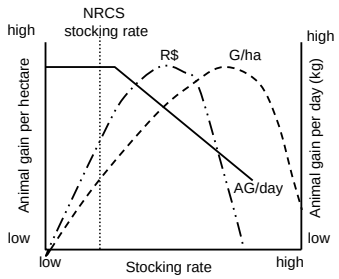
- The maximum stocking rate possible which is consistent with maintaining or improving vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production.

*SRM is the Society for Range Management

ECONOMIC Carrying Capacity

- Number of individuals that provides OPTIMUM profit per unit area

Economic Carrying Capacity

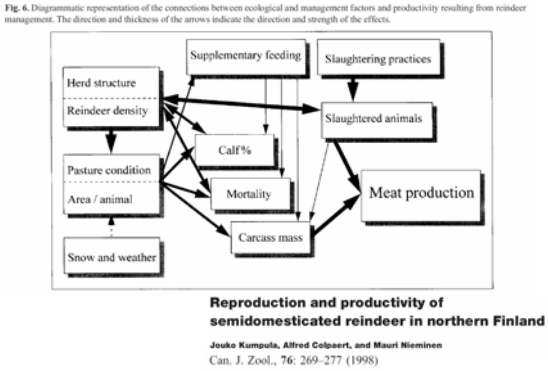


G/ha=kg/ha

AG/day= kg/animal/day

R$ = return per hectare in $

Impacts on Economic Carrying Capacity?



Stocking rate

- Number of animals per unit area per unit time.
- Amount of land allocated to each animal unit for grazable period of year.

Animal Unit (AU)

AU = a 1,000 lb (405kg) non-lactating cow or its equivalent in forage demand (animal intake).

Forage demand = 2% of body weight/day
e.g. 405 kg x 0.02 = 8.1 kg/day

Animal Unit Month (AUM)

AUM = potential forage demand of one AU in 1 month (30 days).

e.g. 8.1kg/day x 30 days = 243 kg

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Is your rangeland capable of sustaining this forage intake? For how many animals?

= Grazing capacity

Animal Unit Equivalent (AUE)

AUE = forage demand of a particular kind and class of animal relative to that of AU

e.g. mature, nonlactating cow = 1
mature bull = 1.5
cow-calf pair = 1.35
ewe-lamb pair = 0.3
saddle horse = 1.25
mature elk = 0.65

Methods of Estimating Grazing Capacity

- Forage Inventory Method
- Utilization-based Methods
- Comparison Method
- Stock and Monitor Method

Forage Inventory Method

- Based on determining air dry weight of forage on a per area basis.
- Adjusted for:
  - accessibility (slope and distance to water)
  - allowable use ("proper use factor") = amount of forage that can be removed without limiting plant's future production.

Forage Inventory Method

1. Stratify grazing unit by vegetation type (ecological site).
2. Determine total forage production for each type.
3. Adjust total forage production for inaccessibility.
   - Distance from water
   - Slope

Forage Inventory Method

4. Determine proper use factor for veg type. (Lower PUF needed if range in POOR condition)
5. Calculate forage demand for species of animal. (2% of body weight = daily intake)
6. Divide usable forage/forage demand = **Grazing Capacity**
7. Consider stocking at 90% of GC to buffer against drought.

Utilization-based Methods

- Compare actual use with:
  - proper use
  - current stocking

Ave. Annual AUMs =

$$\frac{\text{Ave AUMs removed annually x PUF}}{\text{Average annual \% utilization}}$$

Comparison Method

- Compare grazing unit with like areas nearby with a history of sustainable management.
- Adjust for differences in ecological site, range condition, topography, water, etc.
- Unreliable, especially if manager is inexperienced.

Stock and Monitor Method

- Use known history of stocking rates and monitoring history to adjust stocking rates.
- Requires experience and judgment.

Problems with Calculating Grazing Capacity

- Forage inventory method is the most problematic because:
  - Vegetation varies over space and time, both seasonally and interannually
  - Difficult to assess total production accurately
  - Not all vegetation is equally preferred by animals
  - Animals do not use range uniformly
  - Proper use factors often unreliable and not empirically derived
  - Estimates of forage demand vary (2% - 2.6%) and are subject to error.

Problems with Calculating Grazing Capacity

- "Average" stocking rate not useful
  - Variable production year-to-year
  - Most systems are stochastic, not deterministic

Problems with Calculating Grazing Capacity

- Problem of forage allocation to more than one species, especially wildlife.
  - How much do diets overlap?
  - How does habitat use differ among species?
  - How does accessibility differ among species?
  - How do social factors impact range use?
    - Social interactions
    - Disease transmission
    - Economic gain

Problems with Calculating Grazing Capacity

- Must be considered given OBJECTIVES.

CC Summary

- Use extreme caution when estimating CC.
- Use:
  - utilization mapping
  - comparisons of current and desired utilization
  - interpretation of current range condition
  - use knowledge of past and current stocking history
- **Monitor, monitor, monitor**
- Manage adaptively!
  - Adjust with conditions
  - Adjust in response to monitoring data

DROUGHT in the early 2000's

- Effects:
  - Estimated losses of blue grama: 30-85%
  - Degradation of riparian areas
  - Loss of perennial grasses
  - Increase in bare ground
- NRCS recommendation:
  - Decrease stocking rate by 30-50%
  - 1 cow month/4-5 acres = 50-60 kg of forage/month/ha
- NRCS prediction: With proper stocking, may have production back in 5 years