Production

Rangeland Monitoring and Measurements

RS332 & RS532

Required reading: Sampling vegetation attributes (pp. 27, 50-54, 116-122)

Reference: Bonham (pp. 199-264)

ProducTION Definitions

Production: Amount of biomass accumulated in an area. (mass/area)

Biomass: Total weight of living organisms (here we focus on plants) in ecosystem.

Rangeland specific definitions

Standing crop: Amount of biomass present in an area at a POINT in time.

Peak standing crop: Highest value for standing crop within a year, usually at end of growing season. Varies by species.

ProducTIVITY Definitions

Productivity: Amount of biomass produced per unit area, per unit time—**a rate**. ((mass/area)/time)

Gross primary productivity (GPP): Total amount of energy fixed by photosynthesis per unit area, per unit time.

Net primary productivity (NPP): GPP minus losses by respiration.

Aboveground NPP: Productivity of seeds, shoots, etc.

Belowground NPP: Root productivity.

Production Definitions

Herbage: Production of herbaceous plants.

Browse: Production of woody plants that is available, accessible, and acceptable to animals.

Forage: Production of herbaceous and woody plants that is available, accessible, and acceptable to animals.

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COMMUNITY ECOLOGY

Large herbivores in sagebrush steppe ecosystems: livestock and wild ungulates influence structure and function

Daniel J. Manier · N. Thompson Hobbs

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Abstract Improving understanding of the connections between vegetation, herbivory, and ecosystem function offers a fundamental challenge in contemporary terrestrial ecology. Using exclosures constructed during the late 1950s, we examined effects of grazing by wild and domestic herbivores on plant community structure, aboveground herbaceous primary production, and nutrient cycling at six sites in semi-arid, sagebrush rangelands during 2001–2002 in Colorado, USA. Enclosures provided three treatments: no grazing, grazing by wild ungulates only, and grazing by wild and domestic ungulates. Excluding all grazing caused an increase in shrub cover ($F = 4.97$, $P = 0.033$) and decrease in bare ground ($F = 4.74$, $P = 0.037$), but also a decrease in plant species richness ($F = 6.19$, $P = 0.018$) and plant diversity ($F = 7.93$, $P = 0.008$). Effects of wild ungulate grazing on plant cover and diversity were intermediate to the effects of combined domestic and wild grazing. Aboveground net primary production was higher in both grazed treatments than in the ungrazed one ($F_{wild + domestic} = 2.98$, $P = 0.0936$ and $F_{wild\ only} = 3.55$, $P = 0.0684$). We were unable to detect significant effects of grazing on other ecosystem states and processes including C:N ratios of standing crops, N mineralization potential, or nitrification potential. Best approximating models revealed positive correlation between N availability and herbaceous cover and a negative correlation between herbaceous primary production and the ratio of shrub-herb cover and plant diversity. We conclude that ungulate herbivory, including both wild and domestic ungulates, had significant effects on plant community structure and ecosystem function during this 42-year span. Responses to the wild ungulate treatment were consistently intermediate to responses to the no grazing and wild + domestic grazing treatments. However, we were unable to detect statistical difference between effects of wild ungulates alone and wild ungulates in combination with livestock.

Production: Uses

Useful for:

- Estimating **grazing capacity**
- Estimating range condition (based on percent composition by weight)
- Good indicator of ecological dominance
- Energy budgets
- Carbon storage

Not useful for:

- Rare plant monitoring if harvest destructive
- Year to year fluctuations may limit use in trend studies

Production

Advantages:

- Good indicator of ecological dominance
- Intuitive and easy to visualize

Disadvantages:

- Difficult/time-consuming to estimate
- Definitions are dubious – Many sources of error in estimation and **interpretation**

Production: Sampling Considerations

- Clearly define attribute measured
  - Average production vs. Single year
  - Herbage vs. Forage
  - Standing crop vs. Peak standing crop
  - Grazed vs. Ungrazed
- Moisture content varies with species and time of year so production expressed on oven dry basis
- Ground rules:
  - Clipping height
  - Rooted plants vs. all biomass in vertical projection
  - Current year's growth vs. current + litter + standing dead

Production Methods

Direct methods

- Harvest
- Weight estimate
- Double sampling
- Comparative yield
- Dry weight rank
- Reference unit (woody biomass)
- Dimensional analysis (woody biomass)

Indirect methods

- Cover
- Visual obstruction-Robel pole
- Capacitance meter
- Rising plate meter
- Spectral reflectance

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Harvest Method

- Harvest plant biomass within 3 dimensional volume of quadrat.

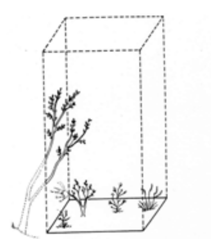

Figure 2.16 Theoretical volume over a plot area. Plants clipped include all material within the volume, not just that rooted within the plot.

Harvest Method

Separation by species:

1. Clip and weigh each separately
2. Clip and weigh all together, but estimate % composition in field
3. Clip and weigh all together and separate in lab prior to weighing

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Harvest Method

Advantages:

- Direct measurement, no estimation

Disadvantages:

- Time consuming
- Potential confounding factors
- Often need large sample due to variation between quadrats

Harvest Method

Quadrat size:

- Minimize variance
- Good data distribution
- Convenient

Harvest Method: Considerations in Grazed Ecosystems

If production is estimated using cages and clipping ungrazed biomass,

1. cages can influence production,

and

2. contribution of compensatory growth, if it occurs, is not accounted for.

Harvest Method: Other Considerations

- Varied moisture content of species

- Species reach peak production at different times, thus total production always underestimated

- Separation of current and past years' growth

Weight-estimate Method

1. Estimate weight of different species by repeated estimation, clipping, weighing, and adjustment of estimates

2. Once proficient, only estimate – don't clip

3. Convert field weights to dry weights:
   1. Clip representative sample
   2. Dry in lab and weigh
   3. Multiply estimated field weights by dry weigh %

Weight-estimate Method

Uses:
- Inventory & monitoring
- Not sufficiently rigorous for research

Advantages:
- Fast

Disadvantages:
- Accuracy depends on observer skill
- No way to quantify observer bias

Double Sampling
(Calibrated Weight Estimate Method)

1. Estimate biomass in large number of quadrats
2. Subsample of estimated quadrats clipped and weighed
3. Relationship between estimates & dry weights used to correct estimates

Double Sampling
(Calibrated Weight Estimate Method)

Advantages:
- Useful in wide range of vegetation types
- Observer bias quantified
- Faster than harvest method
- Increased precision because of large sample size

Comparative Yield Method

Further refinement of weight-estimate method and double-sampling estimate –

Estimates are RANK estimates NOT direct weight estimates

Advantage:
- Large sample quickly obtained

Disadvantage:
- Not well suited for large shrubs

Dry Weight Rank Method

Estimates percent composition of species on a dry weight basis – how does this relate to production?

Procedure:
1. In each quadrat, 3 species that account for greatest proportion of dry weight are ranked 1, 2, and 3. Ranks correspond with 70%, 20%, and 10% of composition, respectively.
2. Weighted average composition is calculated for each species ranked:
   [(# of rank 1 x .7) + (# of rank 2 x .2) + (# of rank 3 x .1)]/total number of quadrats

Dry Weight Rank Method

Assumptions:
- Multipliers (0.7, 0.2, 0.1) are appropriate
- Observers rank species correctly
- At least 3 species occur in each quadrat
- **There is no correlation between the ranking of any given species and total plot yield.**

If used in combination with comparative yield, violations of the last assumption can be corrected using weight estimation data.