Biomass Production

Range 357
Bruce H. Brockett & Lovina Roselle

Gross primary production

- Total amount of organic matter in an ecosystem including **above ground** (leaves and stems) and **below ground** (roots) biomass

Biomass

- **Total weight** of living organisms (per unit area), including **plants and animals**
- In Range Science biomass usually refers to **plant mass only**
- Expressed as lbs/acre, or kg/ha on a dry matter basis (kg DM/ha)
- But sometimes as wet mass e.g. trees biomass in a savanna

Phytomass

- Total weight of plant biomass in an ecosystem per unit area

Standing crop

- Amount of **biomass** at a given site
- Usually refers to **above ground** plant biomass.

Peak standing crop

- **Maximum** amount of **above-ground** plant biomass observed during a given year

http://hydrolab.arsusda.gov/RSinARS/posters/poster02.html
Why do we measure biomass?

Reasons for measuring biomass

• Indicates the structure and function of an ecosystem
• Also enables comparisons to be made between ecosystems

Higher the biomass, THEN higher the stored carbon

Reasons for measuring biomass

• Indicates the structure and function of an ecosystem
• Enables comparisons to be made between ecosystems
• Hence important in determining carbon emissions
• Used to select a suitable stocking rate based on an estimate of carrying capacity
• Also important in fire ecology

Reflects amount of sunlight water, and minerals which plants can capture and convert into biomass

International Biological Program (IBP)

• Major program to measure production
• Began in the 1960’s

http://www.mass.gov/envir/forest/images/multiLayerForest.jpg
Biomass is therefore …

- A commonly measured attribute for range inventory and monitoring programs
- Used as an indicator for ecological and management processes

For fire management, biomass is used in fuel modelling and to determine emissions from fires

… but not all biomass provides fuel for a fire.
Only a proportion of biomass is fuel

Biomass Summary

- Ecological indicator
  - provides a measure of species dominance
  - reflects amount of energy stored in vegetation
  - indicates the potential productivity of an ecosystem or of a site
  - estimate carrying capacity

- Management indicator
  - evaluate stocking rate
  - assess range condition
  - assessing fire risk and predicting fire behavior
  - assessing hydrologic properties of a site
  - assess value of site for wildlife habitat

Biomass Sampling

- In rangeland studies biomass typically refers to measure of **phytomass**

- Other terms:
  - Standing crop
  - Herbage
  - Forage
  - Browse
Measuring Biomass

Advantages
1. Straightforward and easy to interpret
2. Can be objectively measured
3. Can be measured with little training
4. Accuracy of estimation easily tested
5. Provides a measure of plant dominance

Measuring biomass

• Direct methods
  • Destructive sampling
  • Accurate

• Indirect methods
  • Non-destructive sampling
  • Less accurate

  • Sometimes combination of direct and indirect methods are used

Direct methods

• Clipping or Clip-and-Weigh Method
  – clip vegetation at ground level
  – separate out dead material (necromass and litter)
  – sort by species groups if necessary
  – placing in drying oven for 48 hrs
  – Weight
  – Get grams/ ** m2

Direct methods: disadvantages
1. Time and labor consuming
2. High variability between quadrats necessitates many quadrats be sampled to detect differences between sites or years
3. Might not be able to sample the same area over time
4. Not practical for inventory and monitoring purposes over extensive areas

Indirect methods

• Weight estimate
• Dry weight ranking (biomass per species)
• Comparative yield
• Visual obstruction methods (VOM)
• Capacitance methods
• Compaction methods (rising plate, and pasture disc meter)
• Image spectroscopy
Weight estimate method
Developed in the late 1930’s
• Double-Weight Sampling
  – Also referred to as the Calibrated Weight Estimation Method
  – Establish weight unit for each species occurring
    • Decide on a weight unit appropriate for each species
    • Visually select a representative weight unit
  – Harvest and weigh plant material
  – Count weight units of each species in quadrat
  – Periodically harvest to check estimates of production
  – Less destructive and less time consuming than direct measurements

Comparative Yield
Total production in a sample quadrat is compared to 1 of 5 reference quadrats
Relative ranks are recorded rather than estimating weight directly
• 1 represents a low-yielding area
• 5 represents a high-yielding area
• 3 represents a yield half way between 1 and 5
• Reference plots are then clipped and weighed
• Sample quadrats compared and rated back to reference quadrats

Dry weight ranking
• Developed by t’Mannetjie & Haydock (1963)
• Used for the grass layer
• Produces biomass by species

Rising Plate Meter
Consists of a weighted disk on a measuring pole
• Plate dropped freely onto vegetation
• Plate meter readings depend on height and density of vegetation in plot
• Some plots must be clipped to calibrate meter
• Simple to use and easy to transport
• Works well to estimate herbaceous biomass on relatively productive sites e.g. planted pastures

Falling plate

Rising Plate
http://www.farmmap.co.nz/platemeters/how-to-use-rising-plate-meter.php
An Acrylic Plastic Weight Plate for Estimating Forage Yield

Pasture Disc Meter

Folding Plate Pasture

Yard stick

Visual obstruction method: Robel pole
Indirect Methods: Capacitance Meters mid 1970’s

- Electronic capacitance is directly affected by forage height and density
- Strongly influenced by phenology
- Estimates are more precise in the absence of excess litter
- Double sampling required to calibrate meter
- Measure can be affected by plant moisture and ambient conditions
- Can be difficult to transport in field
- Minimize sampling time and expense


Indirect Methods: double-weight sampling

- Requires less time than direct methods
- Accuracy depends on:
  - Experience of observer
  - Alertness of observer
  - Vegetation Type
- Rule of thumb is to sample at least 1 out of every 7
- More important to be precise and consistent than accurate
Indirect Methods: double-weight sampling of woody biomass

- Crown Volume or Dimension Analysis
  - Crown volume often highly correlated to current season’s growth biomass
  - 3-dimensional volume used in double-sampling
  - Dimensional shape selected that best describes the plant
  - Sub-sample of measured plants are clipped and weighed
  - Regression analysis done with crown volume as the x-variable and clipped weight as the y-value

Some challenges in measuring biomass......

1. Gross Primary Productivity rarely sampled because of difficulty measuring below ground biomass
2. Plants reach peak phytomass at different times of year (i.e. warm season (C4) vs. cool season grasses (C3))
3. Difficult to separate current year’s growth from previous year’s growth
4. Affected by seasonal and annual climatic fluctuations (may not suitable for long-term trend studies)
5. Biomass can be altered by herbivore utilization (which could necessitate exclosures)
6. Up to 25% of phytomass can be removed by insects and rodents