The connection between grazing and soil health: what do we know and what are we learning?

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Central Coast Rangeland Coalition Meeting
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Objectives

- Discuss what we know about grazing and soil health, globally and in California
- Highlight what we’re learning from Point Blue’s Rangeland Monitoring Network
- What’s next?
What do we know about grazing and soil health?
Soil health: The capacity of the soil to function as a vital living ecosystem that maintains biodiversity and maximizes provision of (multiple) ecosystem services in a sustainable way.
How can grazers influence the soil?

Site Factors: e.g., Soil Texture, Climate

Direct Effects
- Soil compaction
- Consumption of foliage
- Movement of waste

Soil health & carbon storage

Shorter Time Scale

Longer Time Scale
How can grazers influence the soil?

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- Consumption of foliage
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**Indirect Effects – Individual Plant Level**
- Altered root exudation & foliage chemistry
- Re-allocation of C & N within plant

**Soil health & carbon storage**

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Indirect Effects – Plant Community Level
- Shifts in plant community composition
- Altered NPP

Soil health & carbon storage

Net Δ ?

Shorter Time Scale

Longer Time Scale
Grazing intensity influences soil organic carbon (SOC) and bulk density

Byrnes et al. (2018)

<table>
<thead>
<tr>
<th>Grazing Intensity</th>
<th>Effect Size</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Grazing (59)</td>
<td>-0.15</td>
<td>[-0.23, -0.07]</td>
</tr>
<tr>
<td>Moderate Grazing (44)</td>
<td>-0.13</td>
<td>[-0.18, -0.08]</td>
</tr>
<tr>
<td>Light Grazing (56)</td>
<td>-0.04</td>
<td>[-0.08, 0.01]</td>
</tr>
<tr>
<td>Heavy Grazing (49)</td>
<td>0.09</td>
<td>[0.06, 0.12]</td>
</tr>
<tr>
<td>Moderate Grazing (32)</td>
<td>0.09</td>
<td>[0.05, 0.12]</td>
</tr>
<tr>
<td>Light Grazing (48)</td>
<td>0.04</td>
<td>[0.02, 0.06]</td>
</tr>
<tr>
<td>Heavy Grazing (11)</td>
<td>-0.05</td>
<td>[-0.11, 0.01]</td>
</tr>
<tr>
<td>Moderate Grazing (9)</td>
<td>0.01</td>
<td>[-0.03, 0.04]</td>
</tr>
<tr>
<td>Light Grazing (9)</td>
<td>-0.01</td>
<td>[-0.09, 0.08]</td>
</tr>
<tr>
<td>Heavy Grazing (25)</td>
<td>-0.07</td>
<td>[-0.19, 0.05]</td>
</tr>
<tr>
<td>Moderate Grazing (16)</td>
<td>-0.13</td>
<td>[-0.24, -0.01]</td>
</tr>
<tr>
<td>Light Grazing (22)</td>
<td>-0.04</td>
<td>[-0.17, 0.09]</td>
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</table>
Rotational grazing strategies improve SOC and bulk density over continuous grazing

<table>
<thead>
<tr>
<th>Metric</th>
<th>Effect Size (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Organic Carbon (44)</td>
<td>0.25 [0.10, 0.41]</td>
</tr>
<tr>
<td>Bulk Density (43)</td>
<td>-0.04 [-0.07, -0.02]</td>
</tr>
<tr>
<td>C:N (5)</td>
<td>0.04 [-0.00, 0.09]</td>
</tr>
<tr>
<td>Total Nitrogen (16)</td>
<td>0.13 [-0.14, 0.40]</td>
</tr>
</tbody>
</table>

Effect Size of Rotational Grazing to Continuous Grazing

Byrnes et al. (2018)
What do we know from California?

Site Factors:
- Soil Texture,
- Climate

Carey et al. (in prep)
Point Blue’s Rangeland Monitoring Network
Rangeland Monitoring Network:

We measure **ecological function** of rangelands with **standardized protocols** across California.

- **25 counties**
- **80 properties**
- **300 + locations for soils**
- **800 + locations for birds**
What makes a good indicator?

According to The Soil Health Institute, good indicators are:

• Sensitive to changes in management systems
• Representative of soil processes relevant to agricultural production and environmental outcomes
• Indicative of agriculturally significant changes within 5 years
• Available for use in commercial production laboratories (reproducible, economical, directionally interpretable)

**and informed by your objectives!**
What makes a good indicator?

It helps if they are also:

• Defined regionally by soil groupings/type
• Characterized such that thresholds are known to indicate “poor”, “adequate”, “good” conditions based on outcomes
• Characterized such that relationships to management practices are known
Interpretability is key
Interpretability is key

(A)

Soil Health Indicator

Sample

Threshold

(B)

Percentage of Total Observations (%)

Soil Health Indicator

Score

Soil Health Indicator

Point Blue
Interpretability is key
What soil health indicators does RMN measure?

- Birds
  - Abundance
  - Diversity
- Vegetation
  - Species composition
  - Cover
- Soil Dynamic Properties
  - Organic Soil Carbon
  - Bulk Density
  - Water Infiltration
What soil health indicators does RMN measure?

We measure ecological function on rangelands across California to:

• Establish baselines for monitoring change
• Evaluate the ecological effects of grazing and other management practices
• Provide information to landowners to help guide decision-making
What are we learning?

N = 67 - 82
Grazing Information

Property-level summary, intended to characterize grazing management on the entire ranch.

![Graph showing distribution of animal units per acre across different regions of a property.](image-url)
Grazing Information

Property-level summary, intended to characterize grazing management on the entire ranch.
Scoring Functions for Central Coast Rangeland Soils
Scoring Functions for Central Coast Rangeland Soils

![Score vs. SOC 0-10cm and Bulk Density graphs]
Bulk Density Threshold Comparisons for Central Coast Rangeland Soils

- 13% compacted
- 72% compacted
Change over Time for Central Coast Rangeland Soils
Change over Time for Central Coast Rangeland Soils

- 13% Lost 0-10 cm
- 13% Gained 10-40 cm
- 9% Gained 0-10 cm
- 46% Lost Both
- 10-40 cm

Graph showing change in SOC and bulk density for different soil categories.
What’s next?
Assess management interventions

- Poor performing fields
  - Grazing?
  - Compost?
  - Innoculum?

- Well performing fields
Adequately characterize three soil health indicators across California’s rangelands

May be the indicators we already have, may be new ones.
Test Hypotheses & Validate Assumptions

e.g.,

- Relationship between aboveground & belowground diversity
- Relationship between plant/microbial diversity and soil carbon
- How much management can “move the needle”
Thank you!

And many . . .

ranchers, land trusts, RCDs, agencies, NGOs, and private donors

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