Dynamics of Circum-Arctic Tundra Plant Communities in Response to Climate Warming and Grazing Pressure

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OUTLINE OF TALK

Research background
Data and methods
Results:
  - Climate change effects vs. grazing effects
  - difference between climate change and grazing
  - comparison of simple difference and combined effects on tundra vegetation
Discussion
CURRENT AND FUTURE CLIMATE WARMING

Background

Chapin 2005
IPCC 2007

Warming Projections

Temperature Anomaly (°C)

IPCC 2007

(Hansen et al. Rev. Geophys. 2010)
GRAZING BY REINDEER AND CARIBOU (RANGIFER TARANDUS)

Background

Reindeer near camping ground

(Vors and Boyce, 2009 GCB)

Reindeer diet (Flenniken, 2007)
Differences in herding practices can make big differences in tundra plant community composition.

Forbes et al. 2009 PNAS
Background

GREENING OF THE ARCTIC

Change in maximum “greenness”

Data provided by Uma Bhatt. Maps by climate.gov team.
CIRCUMPOLAR SCALE EFFECTS OF WARMING AND GRAZING ON ARCTIC TUNDRA VEGETATION

Research questions

• How does projected climate warming affect tundra plant community biomass and productivity?

• How do reindeer and caribou grazing across the Arctic affect tundra plant biomass and productivity?

• How do grazing and warming interact to affect tundra plant communities across the pan-Arctic?
ARCVEG – ARCTIC TUNDRA VEGETATION DYNAMICS MODEL

Total Soil Organic Nitrogen

Plant Nitrogen by Functional Type

Plant-Available Nitrogen

Climate / Grazing
Current plant biomass
Plant attributes
(Herbivory/Senescence/Mortality)

Climate (mineralization)

Climate
Current plant biomass
Plant attributes
(Plant uptake/Growth)

Yu et al. (2009, 2011)
MODEL SETTING- PAN ARCTIC

- Bioclimatic subzones

![Bioclimatic subzones map](image-url)
MODEL SETTING - PAN ARCTIC

- Soil organic nitrogen: output from Terrestrial Ecosystem Model
MODEL SETTING- PAN ARCTIC

- Grazing: frequency
MODEL SETTING- PAN ARCTIC

- Grazing: percent - based on population density
MODEL SETTING- PAN ARCTIC

- Projected climate change – CCSM 3.0 A1B scenario
Simulated for 600 years, at year 500, impose projected climate change for each grid.
Simple difference between climate change and grazing caused biomass change

Results

DIFFERENCE IN INDIVIDUAL EFFECTS

- Most of the biomass changes in the three southernmost subzones
- very little change in subzones A (2.1%) and B (6.4%)

Epstein et al. 2012
Simple difference between climate change and grazing caused biomass change

Combined effects of climate change and reindeer/caribou grazing caused change

Results

INDIVIDUAL EFFECTS VS. COMBINED EFFECTS
DISCUSSION AND FUTURE RESEARCH

• Grazing can abate tundra plant response to climate warming in terms of aboveground biomass

• Both climate change and grazing caused greater absolute aboveground biomass change in southern subzones and the Russian arctic tundra

• Interpretation of “greening of the Arctic” can be complicated given the integrated nature in the system
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