Effects of Climate Change on Range Forage Production in the San Francisco Bay Area

Chaplin-Kramer and George, 2013

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Introduction

Downscaled Global Climate Change Models Projections:

- Temperatures increase by 2100:
  - 1.5º - 3.0º C (lower emissions scenario)
  - 2.5º - 4.4º C (higher emissions)

- Uncertainty but total annual precipitation will decline (mostly spring) winter precipitation stable.

Introduction

- Precipitation model projections (Shaw et al. 2011)
  - Ø California: Decrease in forage production in CA 14 -58 % . Annual profit reduction ($22 million to $92 million)
  - Ø Bay Area: Increases in forage production Santa Clara, Alameda and Contra Costa.

Precipitation is not the only factor involved in forage production

Introduction

- Temperature and precipitation influence:
  - Ø Forage productivity
  - Ø Length of growing season
  - Ø Plant phenology (timing)
- Predictions of forage productivity need to incorporate changes in both.

Introduction

- Models in the Great Plains project increased plant production in the spring and longer growing season.
- Models in Southern Australia project lower pasture production with warmer and drier climate.

Objective: How forage production will change in response to simulated temperature and precipitation patterns.

Effects of Climate Change on Range Forage Production in the San Francisco Bay Area

- Study Area: 14.5 million acres
- North Bay: Sonoma, Marin , Napa and Solano
- South Bay: Santa Clara, Alameda, Contra Costa
- Growing season length and productivity are different.

Effects of Climate Change on Range Forage Production in the San Francisco Bay Area

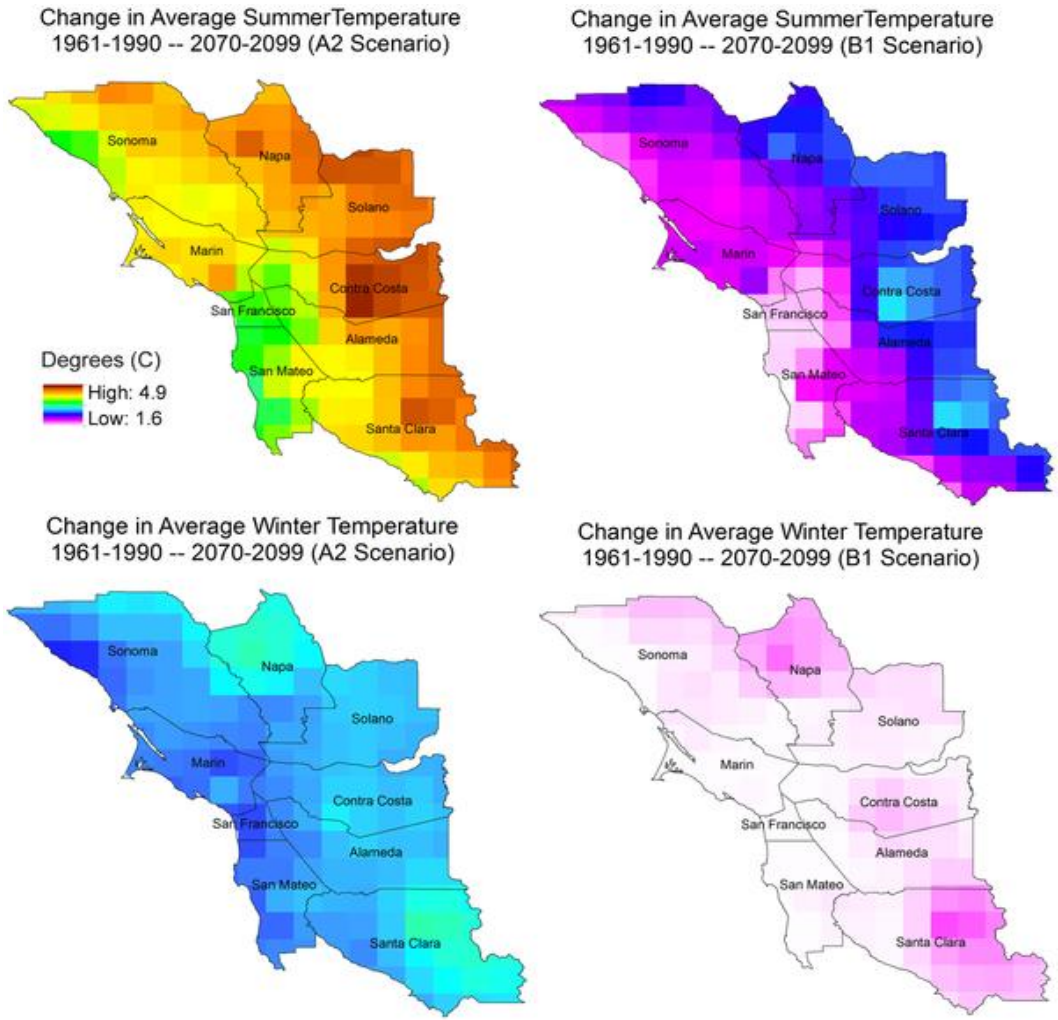
- Two Emission Scenarios:
  - Ø Lower B1
  - Ø Higher A2
- Four different models: (CNRM) cm3, GFDL CM2.1 (NCAR) CCSM 3.0 and PCM1
- Growing season length and forage production
- Mean from four models was taken for A2 and B1 and compared to simulated historical (1961-1990)

Driving Force Assumptions for the United States based on IPCC Emission Scenarios

(table adapted from Ben Sleeter, USGS

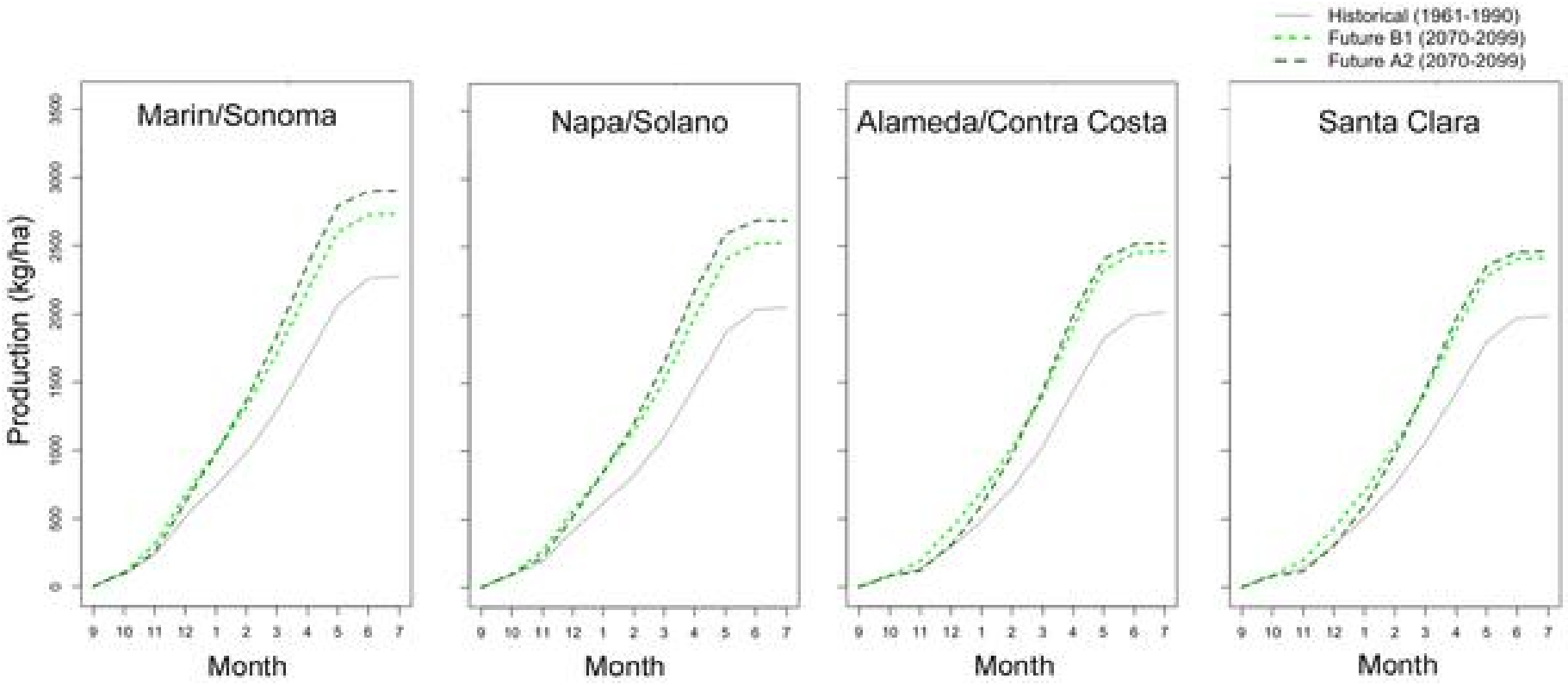
	A2	B1
DEMOGRAPHICS	High growth, sprawl	Medium growth, densification
ECONOMICS	Medium Income	High Income
TECHNOLOGY	Low rate of innovation	High rate of innovation
ENERGY	Fossil fuel intensive	Rapid diffusion of “green” energy resources
CLIMATE	VERY HOT temperature range: 3.4 °C; 2.0 – 5.4°C	WARM temperature range: 1.8 °C; 1.1 – 2.9°C
ENVIRONMENTAL PROTECTION	Conservation lower priority	Conservation high priority

Figure 1. Historical (1961–1990) and projected (2070–2099) average temperatures for summer (June, July, August) and winter (January, February) months in the Bay Area.



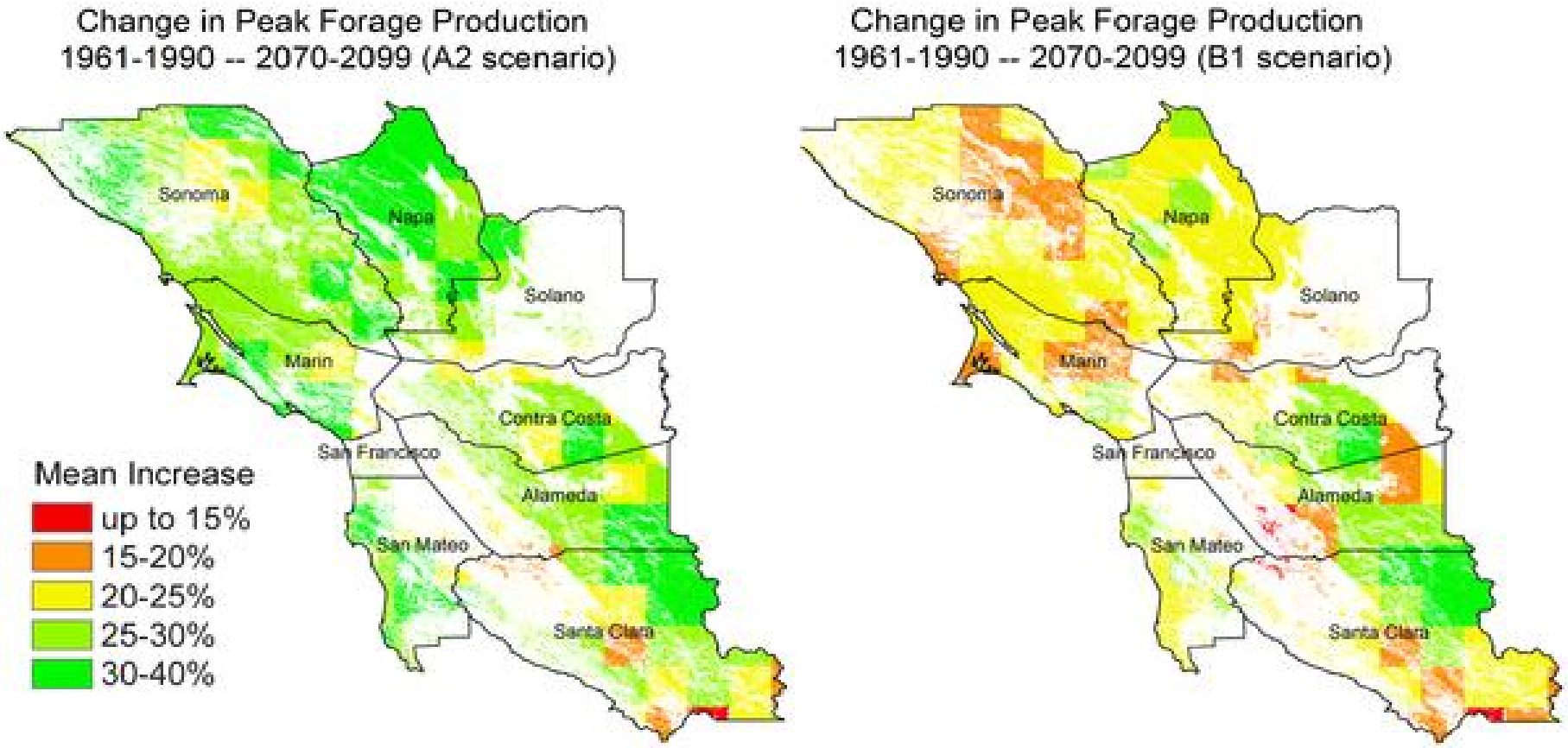
Lower change in winter temperatures than summer temperatures. More changes in eastern counties.

Results: Forage Production



Increases in forage production throughout the Bay Area by the end of the century due to increased temperatures. Winter temperatures may be more limiting than precipitation.

Figure 3. Change (%) in peak forage production by late-century (2070–2099), relative to historical conditions (1961–1990), shown for current rangelands (grassland, savannah, and shrubland) in the Bay Area.



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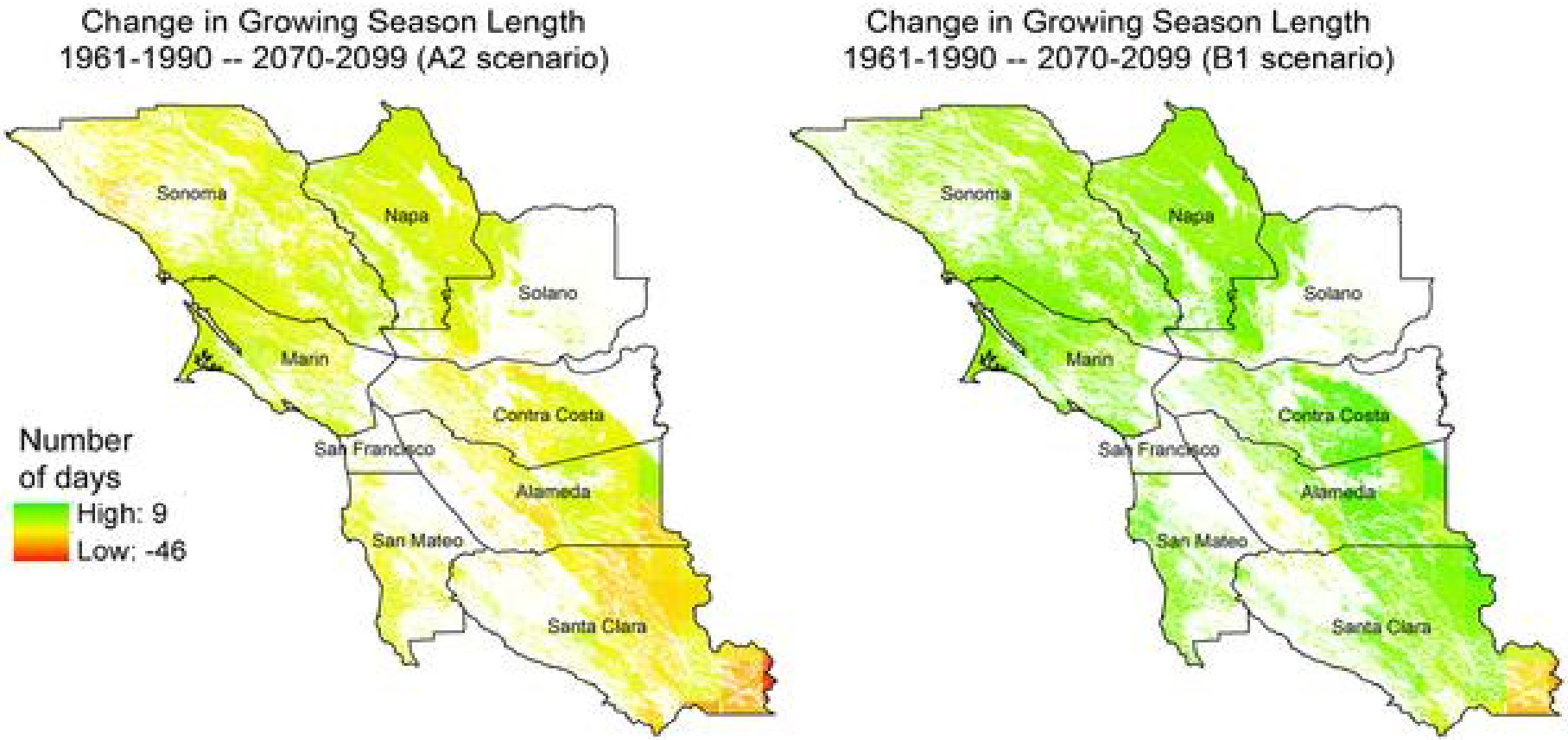
Results: Growing Season

- Shorter growing season due to delayed germinating rains and/or early depletion of soil moisture.
    - A2: Two weeks shorter overall.
    - B1: One day to 1 week. Eastern Santa Clara and Alameda Counties could drop 100 days in length.

Figure 4. Change in rangeland season length by end-century (2070–2099), relative to historical conditions (1961–1990) for current rangelands in the Bay Area.



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Variability in length of growing season

Inter-annual variability for length of the growing season decreases with climate change*. Extreme events likely to increase.

- A2 Scenario:
  - Ø Two weeks shorter overall.
  - Ø 3 weeks shorter Santa Clara.
- B1 Scenario:
  - Ø Decreases (1 day to 1 week)

*Years of no forage production are not included

Drought

- Some years with no germination = no growing season (historically occurs once every 30 years).
- Lower frequency of non-germination days in southern counties for B1 and higher for A2.
- North Bay unaffected and more dry years in Southeastern Santa Clara.

Model Limitations and Other Climate Impacts

- Precipitation only used to model length of growing season. No within season effects are modeled (midwinter droughts?).

- Inter-annual variability masked by outliers. Minimums below mean forage production do not include years with no forage.

All models are wrong some are useful

Model Limitations and Other Climate Impacts

- Other effects need to be considered:
  - Ø CO2 fertilization could increase forage production and lower protein content.
  - Ø Landscape level vegetation changes: shrubland expansion oak woodland into grasslands
  - Ø Changes in animal performance and behavior
  - Ø Water availability

Discussion

- Shorter periods of adequate forage quality despite increases in forage production.

- Differences due to timing of germination:
  - Ø A2 delayed, more in South than North Bay
  - Ø B1 Earlier germination 2-3 days on average.
- Implications to the livestock industry:
  - Ø Delayed start if the growing season with improved forage quality could impact the fall calving season, earlier weaning of calves (cow-calf)
  - Ø Breeding and marketing shifts.
  - Ø Summer pasture availability(access to public lands sooner and longer).

Conclusion: Challenges and Opportunities

- Increased forage production counterbalanced by shorter growing seasons
- Increased drought = increased risks
- Increased opportunities
    - Grazing for vegetation management: fuel loads and invasive species
    - Pollination
    - Other ecosystem services: connectivity

More information: California Rangeland Conservation Coalition

www.carangeland.org

Thank you!