Grassland Conservation

Native California grasslands have been **reduced by 99%** because of **land-use change** through urbanization and agricultural expansion (1). However, more than 250 vertebrate species rely on grassland habitats (2). Besides biodiversity, grasslands **increase climate resilience** and may be more resilient carbon sinks than forests (3,4), are important for **groundwater management**, and **support vulnerable pollinator species** (5).

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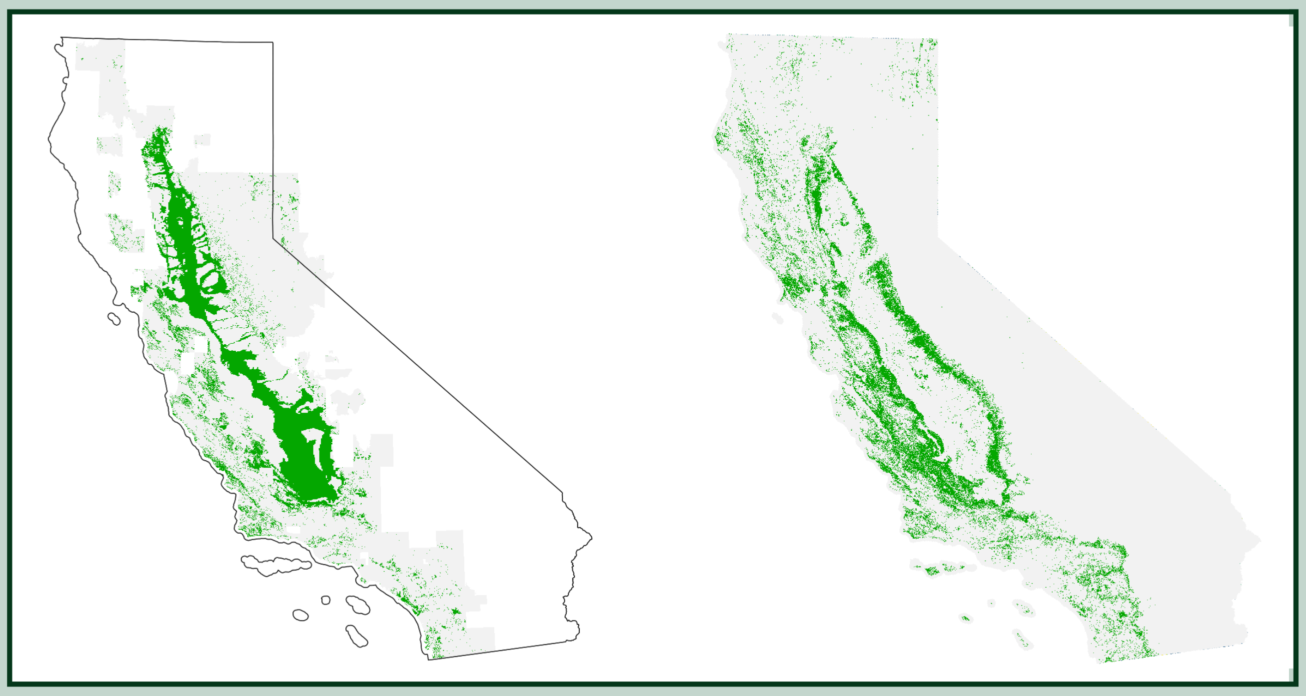
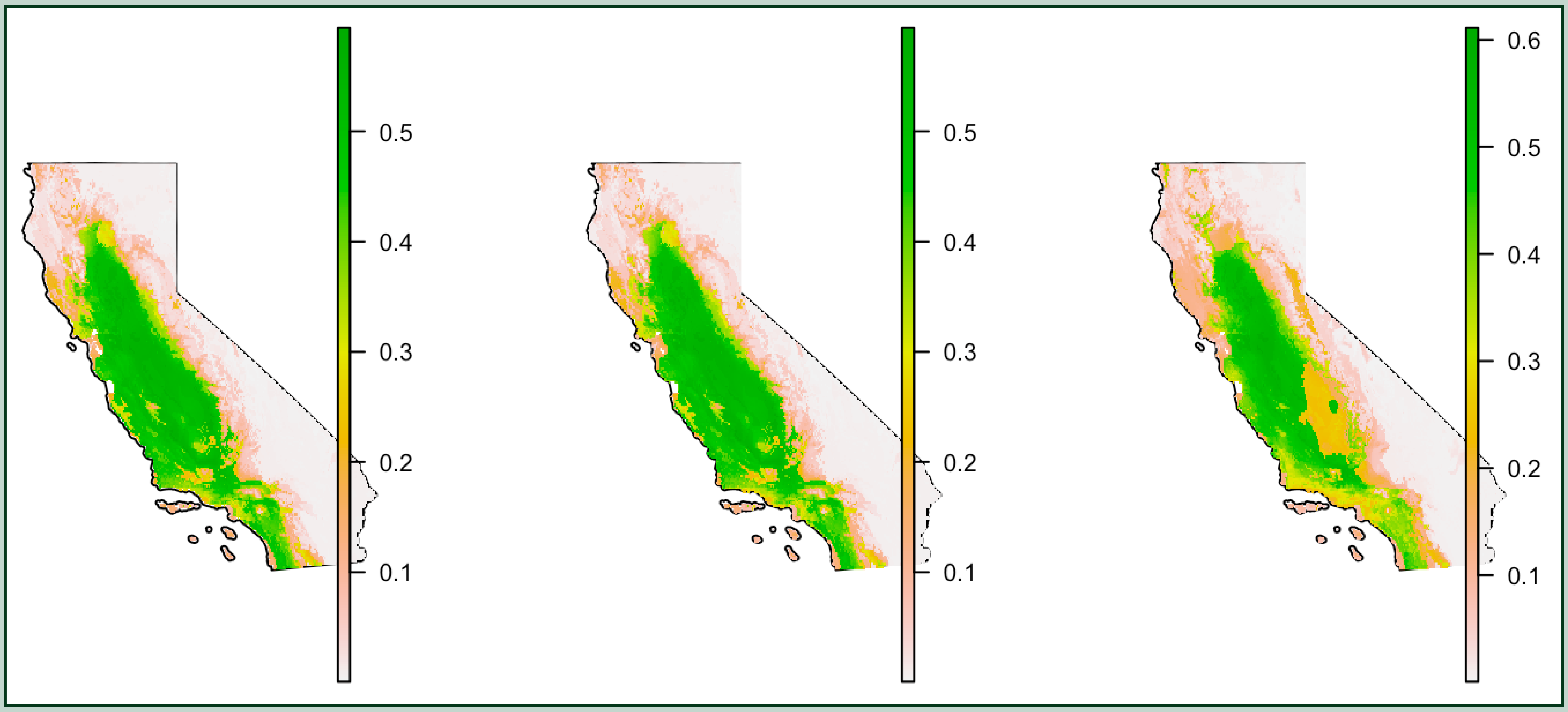
Grasslands in Northern and coastal California will be most resilient to climate change

Using Historic plant community surveys, we determined the climates and soil types that best support grassland. The south-central valley cannot continue to support grassland under a moderate climate change scenario by the year 2070.



From left to right: Presence of grassland prior to 1930, Current presence of grassland



From left to right: SDM predicted suitability for pre-1930 grassland based on SDM; Predicted current suitability for grassland; Predicted suitability for grassland in 2070 under intertermediadte warming scenario

Based on our analysis, policymakers and scientists focusing on restoring grasslands should:

- Prioritize northern California and along the coast for expanding grassland protected areas since these areas will be most suitable for this ecosystem in the future.
- Utilize and implement historical data as a powerful guide for future conservation work in other ecosystem types
- Engage private landholders and farmers to reach 30 percent protection of this valuable and diverse ecosystem type via conservation easements and other methods where suitable.

Related Literature

(1) *California Native Grasslands Association - About.* (2020). California Native Grasslands Association. https://cnga.org/WhoWeAre#:%7E:text=Agriculture%2C%20invasion%20by%20exotic%20species,state's%20total%20native%20plant%20species.

(2) The Nature Conservancy (2021)

(3) Silver et al. (2011) Rangeland Ecology & Management

(4) Dass et al. (2018) Environmental Research Letters

(5) www.iucnredlist.org

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(7) Historic Vegetation Base Map (Pre-1900), Central Valley Historic Mapping Project | Data Basin. (2015). Data Basin. https://databasin.org/datasets/53783ba3685642509030100ae9a221d1/

(8) *State Soil Geographic (STATSGO2) data base for California | Data Basin.* (2011). Data Basin. https://databasin.org/datasets/1ff4328039f948529c33e7e71bb9b5fc/

(9) *PRISM Climate Group, Oregon State U.* (2007). Prism Climate Group. https://prism.oregonstate.edu/

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(11) Wilson, T.S., Sleeter, B.M. & Davis, A.W. Potential future land use threats to California's protected areas. *Reg Environ Change* 15, 1051-1064 (2015).

(12) GBIF. (2000). GBIF. https://www.gbif.org

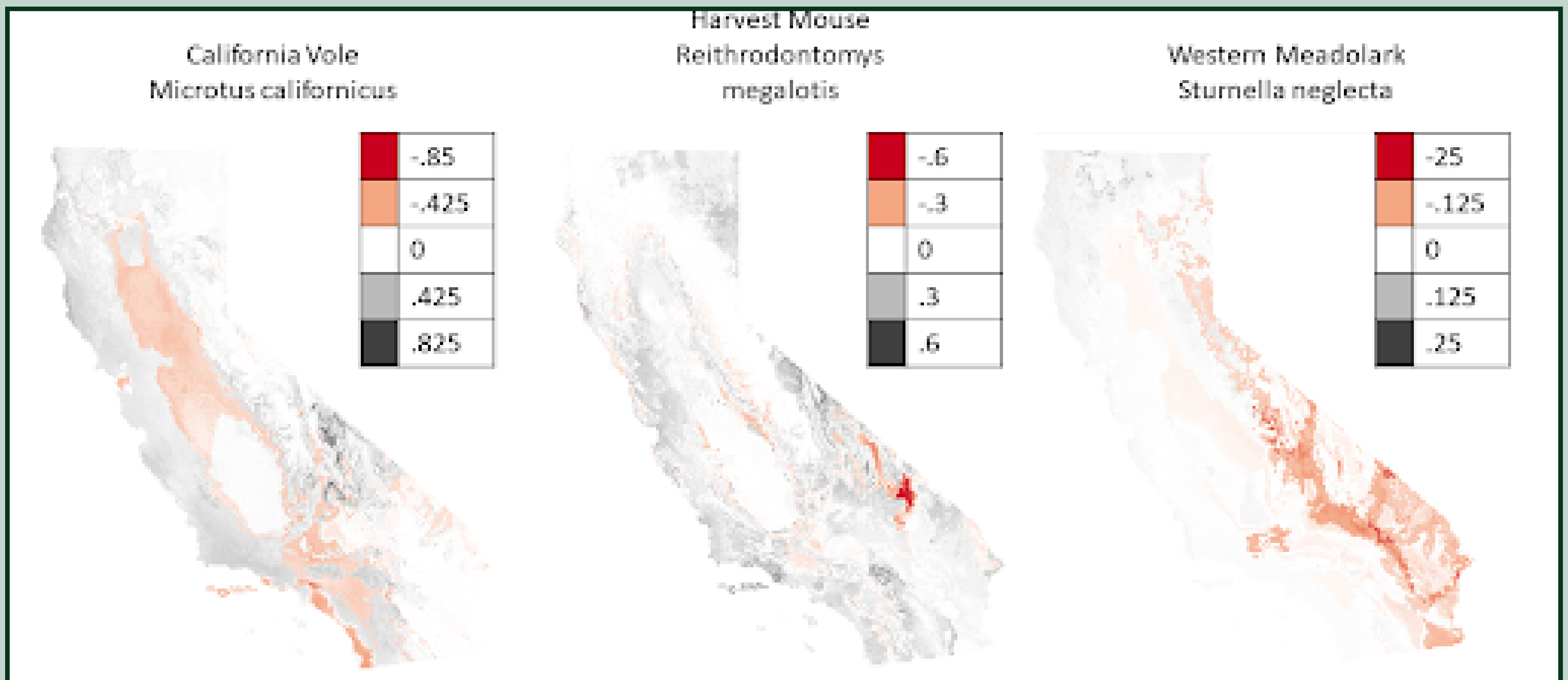
(13) Existing Vegetation Type. (2019). LandFire. https://landfire.gov/evt.php

Technical Summary

As a means to analyze grassland habitats and their species, we analyzed both current and future projections of species populations. We selected the meadowlark, California vole, and harvest mouse—three abundant grassland species—to create species distribution models in order to compare and contrast their outcomes as an indicator for grassland ecosystems. We collected species occurrence data for these 3 species on GBIF. The SDMs were created both for current and future climate scenarios for each species based on data pulled from WorldClim. Specifically for the future climate scenario, we used data projected into the year 2070 based on an intermediate warming scenario (rcp = 45). We also ran our SDMs with vegetation variables/data using 2011 land cover data from the United States Geological Survey. This was then used to create a MaxEnt model which was used to implement the species distribution model. The change in habitat suitability for each species was computed by subtracting the current SDM map from the future SDM map. The difference in suitability is shown below for each species.

The three indicator species produced different SDMs, but have some similarities in pattern. The Meadowlark and Mouse lose significant range in southeastern California and gain range in the north and west. The vole gained the most habitat along the coast. Since GBIF data relies on community science there are biases in how well the species were sampled. We think this is especially true for the harvest mouse and California vole, which had much of their occurrence data in population centers. We would be able to better define where grassland is with indicator species by analyzing additional species with SDMs and comparing the bigger set of results.

In our one page summary we focused on the historical data approach because three indicator species did not appear to be enough to get a good estimate of where grasslands are and will be. It is also challenging to find specialist species for grasslands. The historic vegetation analysis demonstrated that grassland range has not changed dramatically from 1900 to now, but will decrease in the future. Current grasslands do not span the whole range that is suitable. Therefore a variety of strategies will be needed to maintain the conserve grassland in a way that will be resilient to climate change.



The three maps represent the difference between the future habitat suitability and current habitat for each of the three indicator species. Red represents a loss of habitat while the greyscale represents added habitat areas. The occurrence data for each species are from GBIF (12) and the environmental variables are LandFire vegetation (13) and climate from BioClim (10).

For the grasslands predictor models, we pulled grassland occurrence data from the Historical Weislander Vegetation Maps from the 1930s. Because much of the central valley was missing from the Weislander data, we also pulled grassland occurrence data from the Historic Vegetation Base Map (pre-1900) from the Central Valley Historic Mapping Project. From each of the maps, we pulled 500 random presence points for grasslands which we put together to have a data frame of 1000 randomly selected grasslands presence points in California. From here, we created 2000 pseudo-absence points (which was later dropped to around 900 pseudo-absence points because of constraints on where we had environmental data).

To create a species distribution model (using grasslands as our species), we needed environmental variables which would include both soil type as well as climate factors. For the soil data, we used the State Soil Geographic Database for California from 1994, and for climate, we used historical Prism Climate Group data from 1930. For the current and future climate factors, data was pulled from WorldClim. For the future climate scenario, we used data projected into the year 2070 based on an intermediate warming scenario (rcp = 45).

Once this data was collected, we used the environmental variables (from both the soil and prism data) and the presence and pseudo-absence points to create a “sample with data” object. This was then used to create a MaxEnt model which was used to create the species distribution model for the current climate and the future climate using the data from WorldClim. This produced our three maps shown on the front page of the past, current, and future grasslands occurrence.

There appeared to be minimal differences between the current and past grassland species distribution models. The main threat to grasslands today is land-use change. The projected SDM for the intermediate warming scenario showed the most dramatic decrease in the southern central valley. Therefore, we conclude that conservation action with the primary focus of preserving and restoring grassland should focus on the coast and northern California.