The Pepperwood Conservation Grazing Pilot Project: Managing for Complexity in Our Coastal California Grasslands

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Pepperwood PRESERVE
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ABSTRACT

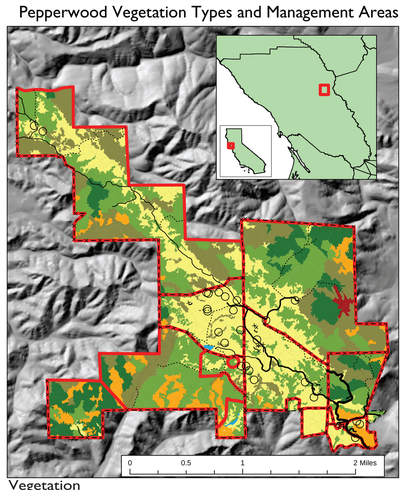
The fact that California's Coast Range grasslands are composed of a diverse mosaic of annual and perennial grass species presents a range of management challenges. At Pepperwood Preserve (Sonoma County, CA) we have historically used open range grazing practices to manage invasive non-native grass species such as Harding grass (*Phalaris aquatica*) and Medusahead (*Elymus caput-medusae*) across 900 acres of grasslands. Starting in 2013, we initiated a Conservation Grazing Pilot Project to test the value of high-density short-duration grazing to support our management objectives of improving soil health and favoring native plant species.

An advantage of the "conservation grazing" approach is that it can be modified to accommodate the diversity of our complex landscape. We utilize mobile electric fencing and watering systems to concentrate grazers at a high density, ranging from 10,000 to 300,000 lbs/acre, and the herd is typically moved every 12 to 96 hours. Conservation grazing allows for longer rangeland rest periods, reduces impacts from occurring during the same phenological phase or season every year, and introduces flexibility for targeting non-native vegetation during optimum treatment windows.

Through our adaptive management and grassland monitoring program we are documenting how our grasslands are responding to our best management practices on an annual basis. This practice allows us to review and modify our management methods so that we may attain our objectives.

Ultimately, we seek to contribute to the creation of healthy, vibrant working landscapes in California by demonstrating an economically feasible alternative to open range grazing that can target problematic areas of invasion and address issues of timing.

Pepperwood Vegetation Types and Management Areas



Map Prepared By:
Celeste Dodge
October 4th, 2014

Sources: TBC3 Vegetation Layer
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CONSERVATION GRAZING GOALS AND OBJECTIVES

Improve grassland health and increase native diversity
- Maximize cover and richness of native forbs and grasses
- Manipulate seasonal timing to promote native diversity
- Minimize cover of invasive plants
- Minimize the creation of additional bare ground
- Trample standing biomass (e.g. thatch) to encourage decomposition

Improve soil health
- Enhance nutrient cycles and microbial communities
- Increase organic matter and carbon storage

Improve watershed function
- Minimize soil compaction and increase water retention
- Control animal impact on wetlands, creeks and springs

Improve habitat for wildlife
- Create variable grassland structure and communities

Protect sensitive habitats and species
- Control animal impact on serpentine grasslands
- Enhance Grasshopper sparrow habitat

Achieve and maintain economic viability for producer
- Promote herd health
- Streamline herd tracking and management needs

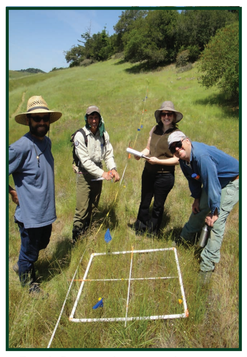


Fig. 1 Researchers conducting grassland monitoring gather around a transect plot to calibrate observations

GRAZING HISTORY: Pepperwood's grasslands have a long history of grazing by domestic animals, and more recently with the use of grazing as a weed management tool. Ungrazed exclosures allow for comparison with grazed areas.

1877 - First documentation of grazing with domestic animals on Pepperwood by survey crew.
1979 to 2012 - Seasonal open range grazing in 3 pastures, ~300 acres each.
Herd size: 80 to 300 stockers
2013 to Present - Year-round grazing in 1-2 acre paddocks, at high density for short durations.
Herd size: 55-78 head cow/calf operation

MONITORING: Pepperwood is operating as a Watershed Sentinel Site where we closely monitor climate, hydrology, and plant and animal communities at the preserve.

Climate: Weather station network and soil moisture probes
Hydrology: Stream Flow & Fog Monitoring Projects
Grassland Vegetation: Grassland Monitoring Project - 25 transects monitored annually
Birds: Breeding Bird Survey Project - Point counts along 4 transects, surveyed 3 times every spring
Mammals: Wildlife Picture Index Project - 20 camera array on a 1-km grid

METHODS

Grazing prior to 2013: Stocking rates were adjusted to meet seasonal weather conditions and visually determined plant growth rates. Open range stockers were moved between pastures based on projected Residual Dry Matter levels.

Fencing: permanent, cattle excluded from sensitive plant and wetland areas
Water Delivery: permanent stations, developed to encourage cattle to avoid riparian habitats
Tracking: herd size and type (e.g. Animal Use Equivalents), date in and out of each pasture

Grazing since 2013: Conservation Grazing Program is adjusted based on daily visual observations and adaptation (see below).

Fencing: solar electric powered two wire fences to control the herd, cattle excluded from some paddocks to increase grassland structural diversity for wildlife and ground-nesting birds as well as to provide points of comparison with adjacent grazed paddocks.
Water Delivery: by gravity flow to each paddock via 1" poly pipe from two ground wells
Tracking: map paddocks by creating polygons and recording paddock size, herd size, herd type (AUEs), date in and out of each paddock, note special conditions, and take monitoring photos.

Daily Visual Observations & Adaptation: While considering weather patterns and herd manager needs, the preserve manager closely watches conditions on the ground including: soil conditions, disturbance level, forage height, grassland type, and animal performance. In general, we avoid grazing a paddock back to back during the same season and avoid breeding bird areas. We also consider access requirements during the wet season, water supply, and the needs of educational and research programs on the preserve.

Fig. 2 Pepperwood's Conservation Grazing herd gathered near a temporary trough within electric fenceline

Fig. 3 Solar panel and battery power source with ultra light fence posts

Stocking Rate & Recovery Period: The stocking rate was calculated as the Animal Use Months per acre with the assumption of a 30-day month (AUM = AUE * duration). Recovery period was calculated as the number of days between the monitoring date and the last time the monitoring transect was grazed.

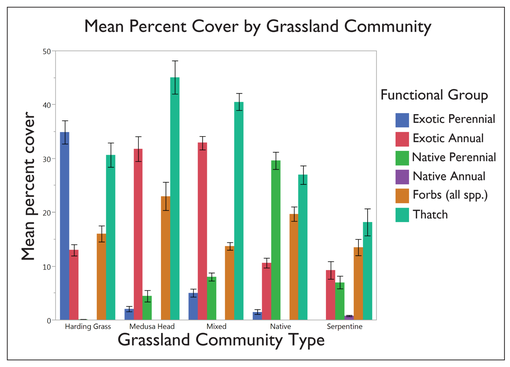


Fig. 4 Mean percent cover (2012-2014) of the grass functional groups, forbs and thatch in our target grassland communities; error bars are +/- 1SE from the mean

Grassland Monitoring: Beginning in 2011, we annually monitor 25 permanent grassland transects between the calendar dates of May 1-15. Transects were randomly established within target grassland communities: Harding grass (n=4), Medusahead (n=3), Mixed (n=10), Native (n=5), and Serpentine (n=3). At every 5 m mark along each 55 m transect we lay down a 1 m^2 quadrat monitoring plot and measure:

Percent Cover - (1) exotic perennial grasses, (2) exotic annual grasses, (3) native perennial grasses, (4) native annual grasses, (5) forbs, (6) lichens/mosses, (7) rock, (8) bare ground, (9) disturbance, and (10) thatch from the previous growing season (Fig. 4).
Thatch Depth - average of 4 measurements per quadrat
Species Composition - 0.25 m^2 within each quadrat
Above-ground Biomass - 0.1 m^2 collected 3 m away from transect

Modeling Methods: The relationship between grazing and percent cover of all variables listed above (excluding lichens/mosses and rock), species composition and biomass were assessed using Analyses of Covariance (ANCOVA). All ANCOVA models include: (1) Community Type, (2) Transect ID (nested within community type), (3) Sampling Year, (4) Stocking Rate, and (5) Recovery Period. All percent cover response variables were Log(x+1) transformed to meet normal distribution assumptions with the exception of thatch cover and mean thatch depth.

RESULTS

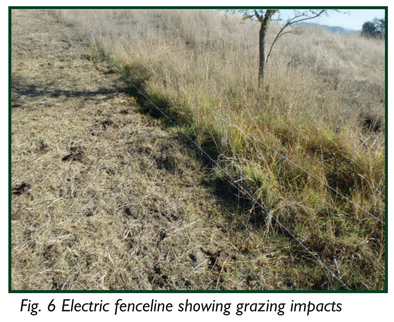


Fig. 6 Electric fenceline showing grazing impacts

Fig. 7 Early season grazing before medusahead becomes unpalatable gives way to native perennials such as Purple needlegrass (Stipa pulchra)

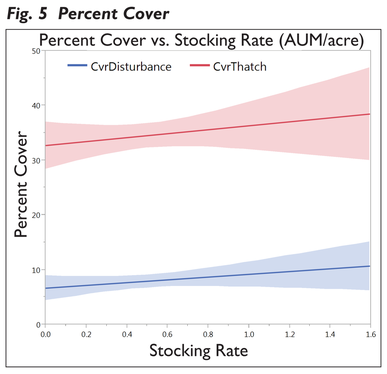
Visual Observations: We find the herd adapts to changing grassland conditions of each season and can be sustained without supplemental feeding. Cattle readily eat native grasses and cropped native bunch grasses were able to produce new growth, even in severe drought conditions. Grazing appears to promote both native and exotic perennial grass vigor. Coyote brush is often severely impacted by cattle, while coast live oak seedlings are rarely damaged by cattle. High density grazing during the spring flowering period dramatically reduces forb seed production. Well timed grazing can significantly reduce seed production in Harding grass and can promote native grasses when growing in competition with medusahead.

Recovery Period:
Average- 77 days
Max- 359 days
Min- 0 days
STDEV- 111 days

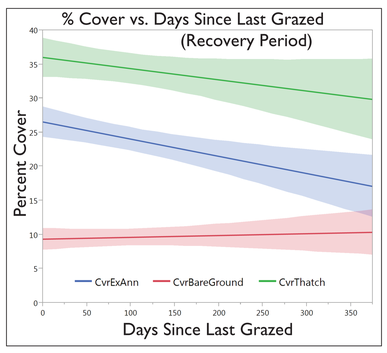
Stocking Rate:
Average- 0.58 AUM
Max- 1.52 AUM
Min- 0.02 AUM
STDEV- 0.36 AUM

Grassland Monitoring: We assessed potential impacts of grazing on the number of total plant species, forbs and grasses. We also separated these three categories into native versus exotic species for this analysis.

Fig. 5 Percent Cover



(a) *Percent cover of disturbance and thatch by stocking rate*. Between 2011 and 2014, stocking rate was significantly associated with increased percent cover of disturbance (R^2=0.40, DF=1, F=5.9, p=0.015) and thatch (R^2=0.63, DF=1, F=6.8, p=0.009). Whereas, the percent cover of exotic annual grasses had only a marginal positive association with stocking rate (p=0.059).



(b) *Percent cover of exotic annual grasses, bare ground and thatch by recovery period*. The recovery period (days since last grazed) had a negative relationship with the percent cover of exotic annual grasses (DF=1, F=27.6, p<0.0001), marginal positive relationship with bare ground (p=0.053) and marginal negative relationship with thatch cover (p=0.072).

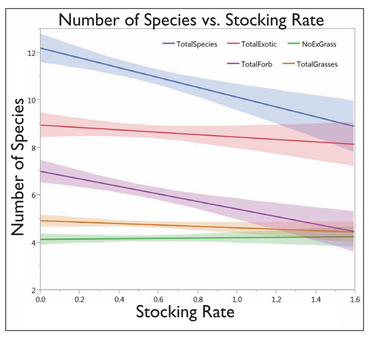


Fig. 6 Species Diversity

Number of species by stocking rate for (i) total species, (ii) exotic species, (iii) exotic grasses, (iv) forbs, and (v) all grasses. Stocking rate was negatively associated with the number of species (R^2=0.50, F=11.9, p=0.001), exotic species (R^2=0.58, F=8.2, p=0.004), forbs (R^2=0.43, F=6.0, p=0.015), and grasses (R^2=0.41, F=4.9, p=0.027), but positively associated with the number of exotic grasses (R^2=0.44, F=6.7, p=0.01). The longer the recovery period, the fewer number of grass species (F=7.1, p=0.008), specifically exotic grasses (F=8.1, p=0.005) that were growing within transects (not shown here).

DISCUSSION

Visual Observations: Maintaining close observations of rangeland and grassland habitats by management staff have been an important source of information on grazing impacts. Although livestock reportedly avoid native grass such as *Stipa* sp. (George et al., 2013) we find that cattle readily eat native grasses and may benefit native species. Well timed grazing can significantly reduce seed set in Harding grass and can promote native grasses in competition with medusahead (Fig. 7).

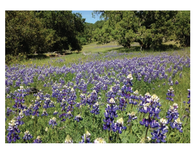
Grassland Monitoring: Through our monitoring program we will be able to track the response of our grassland communities to our Conservation Grazing practices over time.

Percent Cover by Stocking Rate (Fig. 5a)
- Increased stocking rate may create and reveal disturbance (e.g. underlying or new hoof punch).
- Increased stocking rate may reveal thatch, resulting in an increased percent cover observation due to reduced above-ground biomass.

Percent Cover by Recovery Period (Fig. 5b)
- Increased recovery period may reduce the cover of exotic annual grasses due to the buildup of thatch cover (even though thatch cover marginally decreased with longer rest period we have documented an inverse relationship between thatch and exotic annual grass cover among years).
- The marginal increase of bare ground with longer rest period may be due to our serpentine grasslands, which have been historically grazed in summertime only and have a long recovery time.

Species Diversity by Stocking Rate & Recovery Period (Fig. 6)
- Increased stocking rate may reduce the number of total species, primarily driven by the reduction of forb species, but also observed in exotic species (forbs and grasses) and grass species (native and exotic).
- While an increased stocking rate may encourage exotic grass diversity, extending the recovery period may have an opposite effect.

Above-ground Biomass by Stocking Rate & Recovery Period
- Stocking rate and recovery period had no significant relationship with total, fresh, or thatch biomass. Instead, biomass appears to be a function of grassland community type (e.g. Harding grass communities produced significantly greater biomass than all other community types in our study, with the exception of fresh medusahead biomass - data not shown here).



CONSERVATION GRAZING BENEFITS & CHALLENGES

Benefits: Grazing can be targeted to accomplish specific management objectives. Electric fencing allows for high levels of control over density and stocking rate, as well as duration, timing and location of grazing impact. Fences can be placed and adapted precisely as needed. Animal health requirements can be met without supplemental feeding. Our methods encourage managers to pay close attention to pasture conditions (may also be considered a challenge).

Potential challenges or disadvantages: This management style is time intensive, requiring approximately 8 hrs/wk by a herd manager of 100 head. Additional time requirements may include close monitoring of pasture conditions by a land manager (also a benefit). High density grazing during forb blooming periods dramatically reduces forb seed set (may also be a benefit if targeting exotic forbs). Calves are able to penetrate fencing leading to fence failure. Economic viability requires adequate herd reproduction to meet financial goals. Meeting the needs of other property uses such as our education and research programs can be complex.

FUTURE STEPS

Conservation Grazing & Monitoring Program
- Establishment of a Conservation Grazing Working Group
- Development of an Adaptive Conservation Grazing Management Plan that identifies best management practices and monitoring protocols
- Refine our monitoring program to assess our goals and objectives including soil health, soil compaction and hydrology
- Continue fine-tuning our grazing practices based on our observations and monitoring results
- Explore the potential for grazing experiments
- Develop additional grazing exclosures and improve control comparisons
- Facilitate coordination between land managers, cattle operators and researchers
- Develop educational workshops and tours to inform the public about conservation grazing

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