CALIFORNIA FIRE SCIENCE CONSORTIUM

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Research Brief for Resource Managers

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Grassland-Shrubland-Woodland Mosaic Shifts

Callaway, R.M., and F.W. Davis. 1993. Vegetation dynamics, fire, and the physical environment in coastal central California. Ecology74:1567-1578.

The "shifting mosaic" landscape pattern at Gaviota State Park, near Santa Barbara, CA, was verified by measuring the difference in vegetation cover between 1947 and 1989 aerial photos. Callaway and Davis were able "to quantify dynamic chaparral in vegetation patterns and the relative importance of fire, livestock grazing, topography, and substrate in **grassland**, **coastal sage scrub**, **chaparral**, and **oak woodland** distribution in central coastal California."

131 plots in Gaviota State Park were stratified by community type (i.e. grassland, coastal sage scrub, chaparral, and oak woodland) and then randomly located on a grid overlay of 1:6000 aerial photos from 1947. Using a glass reticle etched with 2.5mm^2 squares, and representing approximately 0.25ha plots, each plot's vegetation cover was measured and tallied. The park plots were all ungrazed, but 78 of the plots were unburned since 1929 while 53 plots had burned in either 1944, 1955, or 1986. Outside of the park, 89 more plots that were grazed and unburned were similarly analyzed. Vegetation cover tallies were repeated for the same 220 plots on a set of 1989 aerial photos. Total transition rates were summed and then divided by 42, the number of years between the two sets of photos. The resulting annual transition rates between vegetation types were correlated to an index of northness and compared to substrate and topographic classes. They were also used to model future community proportions 500 years into the future by multiplying the annual transition rates by each of the four current states in an iterative Markov chain process.

Management Implications

- Vegetation mosaics among major vegetation types in central California are dynamic and may shift dramatically even without disturbance (Fig.3)
- Grazing slows transition rates to woodier native vegetation types but increases the rate of transition of oak woodland to grasslands (Figure 5).
- Fire facilitates type conversion of coastal sage to grassland and eliminates succession of coastal sage to chaparral and chaparral to oak woodland (Fig.4).
- Vegetation shifts do not occur on all parts of the landscape and site characteristics may override disturbance or succession factors so that some vegetation types remain in place for long periods of time.

Even without any disturbance from fire or grazing, bi-directional vegetation shifts occurred among all four vegetation types, except oak woodland to chaparral (Fig.3). Grazing reduced the rate of vegetation transitions from less woody to more woody vegetation types, e.g. grassland to coastal sage or coastal sage to chaparral, and increased the transition of oak woodland to grassland (Fig. 5). Fire, in contrast, reversed those patterns and eliminated or reduced transitions from less woody

to more woody vegetation types and increased coastal sage transition to grassland (Fig. 4). In general, fire grassland and eliminated succession of coastal sage to chaparral and chaparral to oak woodland.

The authors postulate that "coastal sage scrub at Gaviota State Park... appeared to affect transitions between grassland and oak woodland. Chaparral and oak woodland rarely replaced grassland directly, but both rapidly replaced the coastal sage scrub that directly replaced grassland." However, the study only measured transitions between two points in time and could not directly observe multiple, cyclical shifts at a single location that would be required to verify this model.

It is important to remember that large portions of the study site did not change during the study period and that "Interactions among biology, disturbance, and the physical environment suggest that some patches in the vegetation mosaic change rapidly, while other patches, which appear identical in species composition, may remain in place for long periods of time." Neither chaparral on rocky soils nor coastal sage scrub on moderately drained silty clay to clay soil were replaced by other vegetation types.

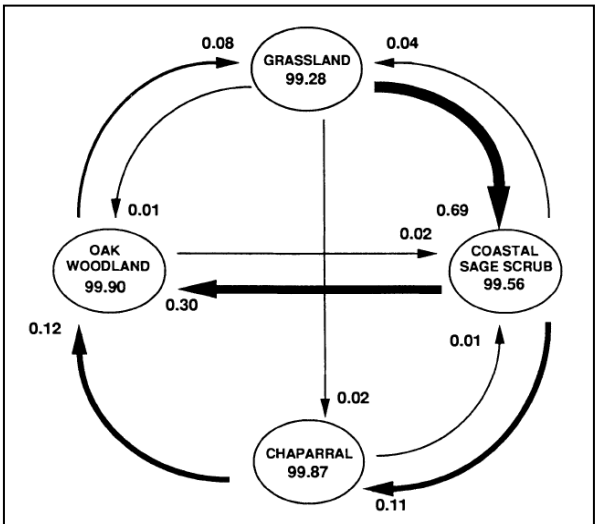

FIG. 3. Annual transition rates among plant communities in unburned plots (n = 78) with livestock excluded within Gaviota State Park, as determined from changes in vegetation between 1947 and 1989 shown on aerial photographs. The numbers in the ovals estimate the probability, as a percentage, that a given community will remain the same; the numbers on the arrows estimate the probability that a community will change in the indicated direction (thickness of lines is proportional to the probability of that change).

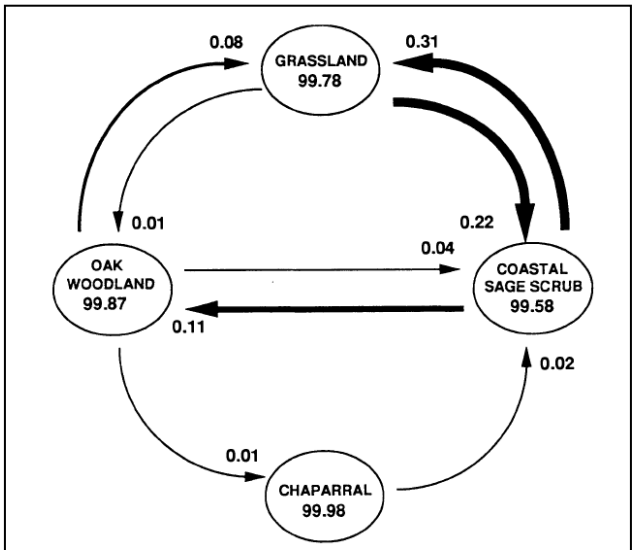

FIG. 4. Annual transition rates among plant communities in burned plots (n = 53) with livestock excluded within Gaviota State Park, as determined from changes in vegetation between 1947 and 1989 shown on aerial photographs. Numbers as explained in Fig. 3.

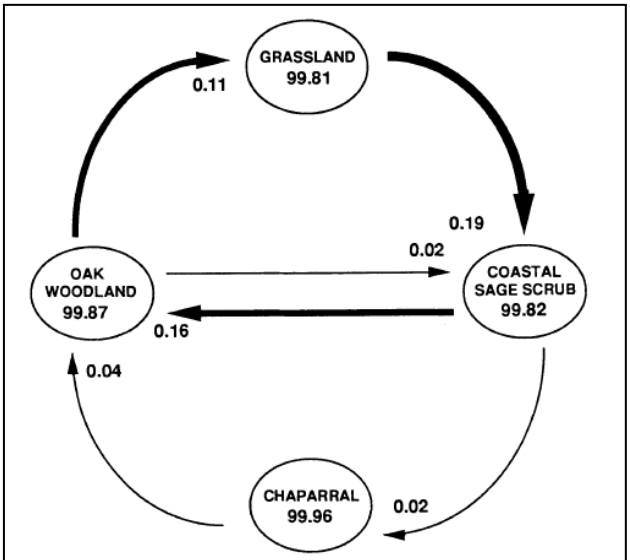

FIG. 5. Annual transition rates among plant communities in unburned plots (n = 89) outside of Gaviota State Park exposed to livestock grazing, as determined from changes in vegetation between 1947 and 1989 shown on aerial photographs. Numbers as explained in Fig. 3.