# Grazing Spring-Fed Wetlands; Tradeoffs for Managers

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Dr. Barbara Allen-Diaz presented the results of a sixteen-year study aimed at answering several questions pertaining to the effects of cattle grazing on perennial spring-fed wetlands within oak-woodlands in California. The study examined what variables are most important to determine ecosystem effects; does the qualitative perception of grazing match the quantitatively measured effects of grazing; and finally how research information regarding grazing can help inform management strategies.

The study examined the effect of cattle grazing on several variables over the course of the sixteen years it was conducted. Data were collected on species composition and vegetation cover every year. Water quality was measured every year during the first five years of the study and intermittently thereafter. Channel morphology was looked at during the first five years and the final year of the study. Emergent aquatic insect abundance was examined one year, and nutrient cycling was examined over a four-year period in the middle of the study.

The study was conducted at the Sierra Foothill Research and Extension Center near Brown's Valley. The study site consisted of three watersheds each containing three blocks of spring systems. Three treatments were prescribed based on upland residual dry matter levels, the traditional indicator utilized by ranchers as opposed to RDM levels around the springs. Each spring in the study was included in a two to five hectare pasture and one pasture in each watershed was left ungrazed, one was lightly grazed leaving 1200-1500 kg/ha of RDM, and the third was moderately grazed allowing 600-900 kg/ha of RDM to remain. The grazing was done by cattle and simulated season-long grazing with the animals being brought on in November and December, and again in February and March, with a final cleanup in May to achieve the desired RDM levels.

At each spring wetland included in the study, a transect was run across it and two randomly selected permanently marked ten meter long vegetation line point transects were established perpendicular to the original transect and parallel to the flow from the spring head. The same vegetation and channel morphology sampling scheme was established along the channel of the creek flowing from the wetland at a random distance from the spring head. The emergent aquatic insect abundance in each spring was studied one year utilizing an insect trap erected within the springhead.

This research has yielded numerous interesting results. Bi-monthly water quality measurements showed no significant difference between treatments in regards to levels of nitrate, electrical conductivity, pH, and phosphorous concentrations. The data pertaining to total herbaceous cover around the springs demonstrated some valuable lessons. During the first five years of the study, from 1992 to 1996, no significant difference in total herbaceous cover was demonstrated between the ungrazed, lightly grazed and moderately grazed treatments. However, once the subsequent five years of data is examined, from 1996 to 2000, some significant differences between treatments develop. The ungrazed treatment continues to fluctuate, the moderately grazed treatment is trending down, and the lightly grazed treatment is trending upwards in terms of total herbaceous cover around the springs. Once the data from 2000 to 2004 is included another story begins to develop, there is no significant difference between the ungrazed and lightly grazed treatments, and although the moderately grazed treatment rebounds there is still significantly less total herbaceous cover around the springs in that treatment compared to the ungrazed and lightly grazed blocks. The valuable lesson to remember from this sequence of data collected over sixteen years is that different conclusions can be drawn from the results of a study depending on the temporal scale and what data and variables are being examined. So there are tradeoffs that must be considered over the long term depending on what effects a manager is most interested in for prescribing any grazing standards.

Over the course of the study no significant difference in total herbaceous cover adjacent to the creeks was observed between treatments. During the year that emergent aquatic insects were studied the moderately grazed spring demonstrated a decreased diversity of these.

Four additional springs were also studied over a four-year period to observe changes in nutrient cycling as a result of being grazed or ungrazed; the grazed treatments were grazed by cattle from May through October. Nitrogen retention is very important for maintaining productivity because it is the most limiting nutrient in temperate terrestrial ecosystems like those included in this study. Nitrogen is a highly mobile nutrient and if not utilized by plants can be lost through two essentially undesirable pathways: denitrification which occurs when nitrate is reduced to nitrous oxide and lost to the atmosphere, or through leaching of excess nitrate which pollutes ground and surface waters. The study aimed to examine the flow of nitrate from the upland above the spring head and in the spring system to determine if nitrate was being lost. When grazing was removed the research demonstrated an increase in nitrate coming out of the system; presumably because when grazed, plants are continuously growing and thus taking up nitrogen that might otherwise be leached and lost from the system if left ungrazed. "The nitrate story in this ecosystem is essentially that annual grass dominated uplands are a nitrate source for downslope ecosystems. Surface water nitrate concentrations appeared to respond to upland nitrate pulse, although the concentrations were consistently low. Spring-fed wetland sediments and waters maintained high nitrate concentrations that increased with grazing removal. Furthermore grazing removal significantly increased gaseous nitrogen loss.

The methane story was essentially the opposite of what was observed in the case of nitrogen. To investigate the effect of grazing on methane production trace gas emissions were measured monthly from March through September 2002. Over this time period the temperature varied from a high of 32ºC in July to a low of 5ºC in March. Mean methane flux was observed to be from –9.29 + -4.37 mg methane-carbon per $m^2$ per hr. The soil water content averaged – 39.66 + -2.29 over the study. A significant increase in methane gas from the springs was observed in the grazed system compared to the ungrazed treatment. It is important to note that methane loss is directly correlated with temperature.

In summary these springs were found to be incredibly stable, resource-rich systems. The results showed that vegetative cover decreases with moderate grazing over time, while lightly grazed springs maintain cover. There was no change in the relative amounts of native and non-native species on any treatment. Water quality and channel morphology did not respond to any treatment. Springs act as nutrient filters. High herbaceous plant production is a key factor for maintaining these ecosystems. Cattle grazing influences both productivity and species composition in the following ways; removal of livestock increases nitrate levels, removal of livestock decreases plant diversity, and the removal of livestock decreases the methane flux. In conclusion, proper livestock grazing intensity can be utilized to achieve an optimal mix of objectives; in this case light grazing as dictated by RDM in the uplands seemed the best way to accomplish a wide range of goals.