RESOURCE CONSERVATION DISTRICT
Greater San Diego County

PRESCRIBED GRAZING PLAN

DALEY RANCH

JAMUL, CA

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List of Acronyms & Abbreviations

AUM	Animal Unit Month
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
cm	centimeter(s)
GHG	greenhouse gas
Grazing Plan	Prescribed Grazing Plan
HCWA	Hollenbeck Canyon Wildlife Area
lb(s)	pound(s)
mL	milliliter(s)
NRCS	Natural Resource Conservation Service
Plan	Prescribed Grazing Plan
RCD	Resource Conservation District of Greater San Diego County
RDM	Residual Dry Matter
RJER	Rancho Jamul Ecological Reserve
SOM	Soil Organic Matter
SR	State Route
USGS	U.S. Geological Survey
WRCC	Western Regional Climate Center

I. Introduction to the Prescribed Grazing Plan

Purpose

Local ranchers, land managers, and the environmental community seek to mitigate climate change impacts to working lands through improved soil health and carbon management, while also improving resilience to drought, wildfire, and other climatic events. This Prescribed Grazing Plan (Grazing Plan or Plan) will demonstrate the benefits of managing livestock on a commercial cattle ranch with a goal to promote soil health and carbon storage, while achieving many other aligned environmental co-benefits. This Plan is presented by the Resource Conservation District of Greater San Diego County (RCD) for the Daley Ranch at Rancho Jamul Ecological Reserve (RJER) in Jamul, California within San Diego County. It will be implemented on property of the California Department of Fish and Wildlife (CDFW), in collaboration with John Austel, Owner of 4J Horse and Livestock Company, and Tracie Nelson, CDFW South Coast Reserve Manager. It was written by Elizabeth Kellogg, President of Tierra Data, Inc., Certified Range Management Consultant through the Society of Range Management, and Certified Range Manager through the State of California Board of Forestry and Fire Protection (CRM #28).

The Grazing Plan is a prerequisite of a proposal entitled "Climate-smart Prescribed Grazing at Daley Ranch (Jamul, CA)," submitted to the Healthy Soils Incentives Program of the Office of Environmental Farming and Innovation (OEFI), California Department of Food and Agriculture (CDFA). This program is funded in part by the state's cap-and-trade proceeds and provides financial incentives for conservation practices that improve soil health and carbon sequestration and reduce greenhouse gas (GHG) emissions. Projects are targeted for California's natural and working landscapes. These lands represent three-quarters of California's land base, and provide food, fiber, and a variety of ecosystem services including important opportunities for climate mitigation. By showcasing the benefits of conservation grazing practices that improve soil health and other ecological and economic concerns related to land management, climate mitigation practices may be more widely adopted. The project results will be disseminated in bi-annual grant reports and at biannual field events, using tools on the local and state levels.

Multiple benefits are served when soil health through carbon-focused management is the overarching goal. This Grazing Plan serves to align and optimize the use of conservation grazing tools to:

- boost soil organic matter and soil stability;
- optimize carbon sequestration;
- improve site hydrology including water retention in soils;
- improve fire and drought resilience;
- improve forage quality and productivity;
- reduce and resist invasive plants;
- promote sustainable, profitable commercial beef production; and
- increase awareness of conservation practices for the livestock and land management communities.

These benefits align with and enhance the potential of these grazing lands to support the desired protection of at-risk wildlife and plants, and public recreation, for which they were set aside.

Grazing Plan Organization

The organization of this Plan aligns with Natural Resource Conservation Service (NRCS) Technical Guide Conservation Practice Standard 528 *Prescribed Grazing and Conservation Practice Physical Effects of Prescribed Grazing on the Environment* (NRCS 2019).

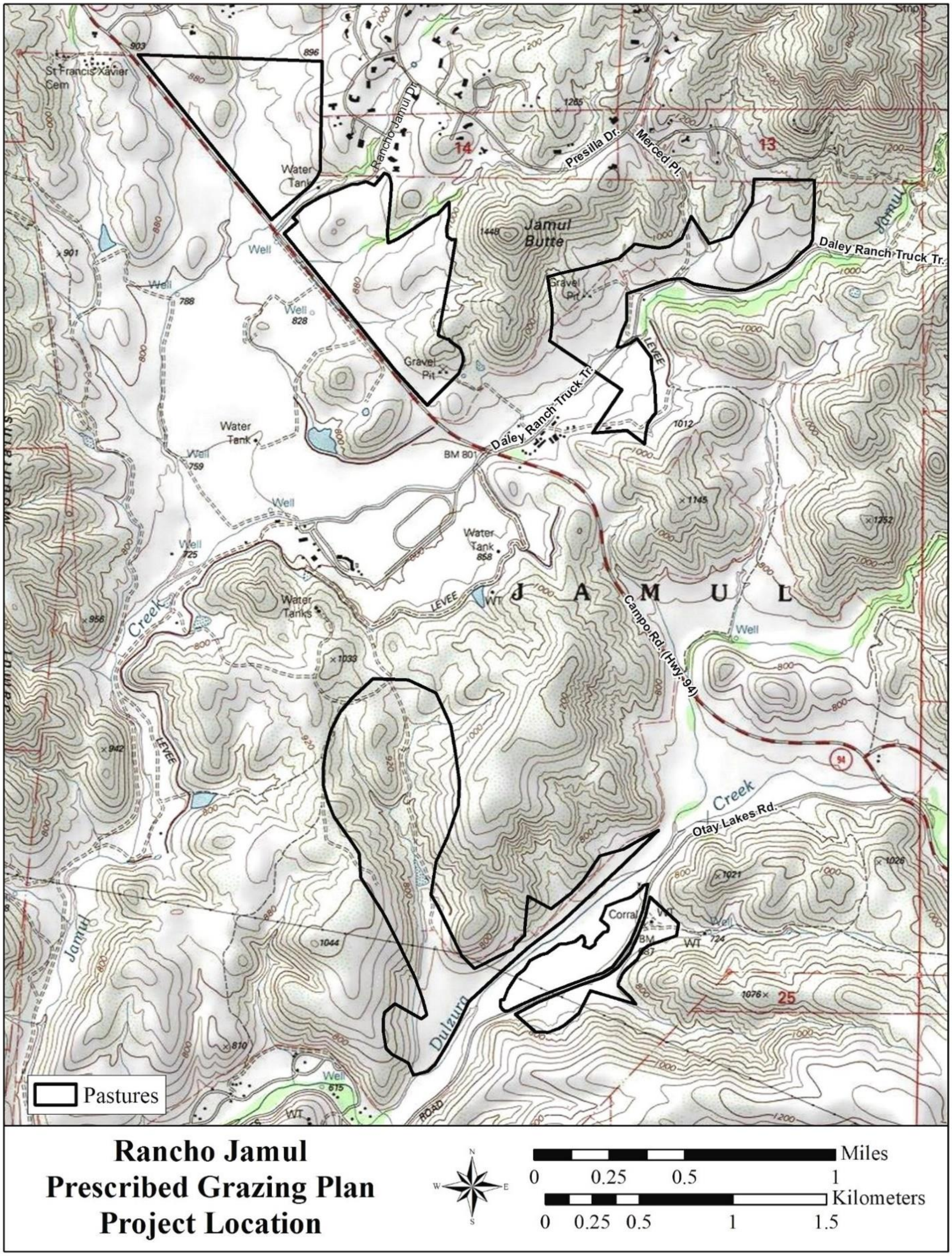
Property Description, Ownership and CDFW Grazing Lease Conditions

The Daley Ranch is located on the Dulzura Creek and Jamul Mountains U.S. Geological Survey (USGS) 7.5-minute quadrangle topographic maps, which are within the USGS 100,000 scale El Cajon quadrangle. It encompasses parcels of CDFW's RJER and the Hollenbeck Canyon Wildlife Area (HCWA), which lies along the northeastern border of RJER, on the eastern side of State Route (SR) 94 (Map 1). The property connects the Jamul and Dulzura Creek corridors. Nearby public lands include the Bureau of Land Management's Otay Mountain Wildlife Management area, a 38,000-acre preserve extending from the southeastern end of RJER to the U.S.-Mexican border, and the Cleveland National Forest, 460,000 acres of U.S. Forest Service land, is located to the east.

A current grazing permit ("Permit for Excess Vegetation Disposal") is issued by CDFW to 4J Horse and Livestock Company (see excerpts in box below). Two of the RJER Grazing Permit pastures 3 and 5 (south of SR 94) contain an easement for a riparian/wetland mitigation bank operated by Wildlands Inc., called the Rancho Jamul Mitigation Bank. Up to 117 acres may be unavailable (or available) for grazing at RJER for the mitigation bank project, or during prolonged drought. Wildlands Inc., a for-profit mitigation and restoration company, will create and monitor a riparian mitigation bank of approximately 412 acres through restoration of the Dulzura and Jamul Creek corridors. The mitigation credits that are sold will provide revenues (a portion of the credits' sales price) to CDFW that can be used for future management needs of the restored wetlands, as well as the remainder of the reserve.

The San Diego County Community Trails Master Plan is intended to establish a system of interconnected regional and community trails and pathways. Existing RJER and HCWA trails connect with the existing and proposed County trail system.

The following information about water rights pertaining to RJER was obtained by reviewing title documents and the California Code of Regulations (Title 23) and through discussions with the CDFW Lands and Facilities Water Coordinator (TAIC 2006): Riparian rights are held by the owner of the land abutting a stream. As such, CDFW holds riparian rights to Jamul and Dulzura Creeks within RJER. Riparian landowners may use natural flows directly for "reasonable, beneficial purposes" on riparian lands without applying for a permit (California Code of Regulations Title 23). The City of San Diego holds the right of way to use Dulzura Creek as a conduit to convey water through the property.



Map 1. Rancho Jamul Prescribed Grazing Plan project location.

Excerpts from CDFW Grazing Permit Operations Plan 2019-2024
Rancho Jamul Ecological Reserve and Hollenbeck Canyon Wildlife Area

Three grazing areas are covered in the permit, two of which overlap the pastures addressed in this RCD Grazing Plan:

- RJER Permit Pastures 1-10 (no overlap with RCD proposed work)
- HCWA Permit Pastures 1, 2, AND 3 (same as RCD pastures 1, 2, and 3)
- RJER Permit Softline Areas (RCD pastures 4, 5, 6)

RJER Permit Pastures 1-10 (no overlap with RCD proposed work)

Focal Species: burrowing owl, short-eared owl, ferruginous hawk, red-tailed hawk, red shouldered hawk, northern harrier, prairie falcon, peregrine falcon, California quail, tri-colored blackbird, white-tailed kite, loggerhead shrike, horned lark, western meadowlark, golden eagle, and other birds.

Estimated Grazing Capacity for Pastures RJER 1-10: 100 AUs. One animal unit (cow-calf pair)/16 acres/year. 1600 acres, 12 months per year for 100 AUs. Deferred pasture rotation based on utilization (stubble height) triggers.

- In Burrowing Owl pastures (RJER 1 and RJER2), Minimum Residual Stubble Height is 3-5 inches as measured October 31 (end of growing season). RJER is the only pasture with spring-only grazing period, January 1 – May 30. Other pastures are year-round.
- In all other pastures, the objective is Upland Birds foraging, and Minimum Residual Stubble Height is 5-7 inches.

Restoration projects in the mitigation bank area may result in the temporary loss of up to 117 acres of grazing area in Pastures RJER 3 and RJER 5. This will be offset by the newly available 400 acres in HCWA during 2019-2024.

HCWA Permit 1, 2, AND 3 (same as RCD pastures 1, 2, and 3)

Grazing Objectives: (1) Fire hazard reduction/public safety and (2) Area use enhancement. Also mentioned is enhancement of habitat for upland birds, and badger foraging (open grassland with mice and squirrels, prefers sandy-loam, diggable soils).

- HCWA 1 (120 acres). Grazing Period March 1 – August 31 for thatch reduction and user enhancement. Residual stubble height 7-9 inches.
- HCWA 2 (140 acres). Grazing Period March 1 – August 31 for thatch reduction and user enhancement. Residual stubble height 7-9 inches.
- HCWA 3 (160 acres. Grazing Period May 1 – October 31 for thatch reduction. Residual stubble height 5-7 inches.

Grazing Capacity Estimate: One AU (cow-calf pair)/20 acres/year. Maximum for the approximately 400 acres is 1440 Animal Unit Months. Deferred pasture rotation within and between RJER and HCWA shall be based on utilization triggers, with excess animals moved from RJER to HCWA in the spring and summer after vegetation conditions at RJER are met.

Background Condition: Non-native annual grassland with sparse native shrub.

Allowable concurrent uses: Year-round recreation. Upland game hunting Sept 1 – Jan 31. Hunting dog training units 1 and 2 Sept 1- Feb 28. For hunting dog training: "Residual vegetation must be of height and volume to facilitate training activities … patch and/or clumpy" appearance of residual vegetation is preferred."

RJER Permit Softline Areas (RCD pastures 4, 5, and 6)

Objective: biomass reduction for fire protection, while minimizing damage to native bunchgrasses, coastal sage scrub, and sensitive habitat and soil areas, as defined by CDFW. Softline Areas (600 acres RCD Pastures 4, 5, and 6) have no Minimum Residual Stubble Height. Grazing period is May 1 – Oct 31. "To facilitate the viability of the grazing program, the Department will designate a minimum of 600 acres to be grazed within the Softline areas during each annual growing cycle."

Monitoring All Areas

- Monitoring of grazing utilization is by stubble height or the required residue left ungrazed. Measurements are of management focus "key" species (or species groups) and representative "key" areas. For this CDFW permit, the Permittee must provide at least 2 utilization estimates for each pasture for each key species (or species group, such as annual grass, perennial grass, etc.). Utilization cage are to be installed to show ungrazed condition, and to help calibrate visual estimates of forage use.
- RJER Softline Areas (RCD Pastures 4, 5, 6). Twice per week, the Permittee will be responsible to ensure native bunchgrasses and coastal sage scrub impacts are minimized while annual grass that is reduced. Long-term monitoring will be done by the CDFW Unit with respect to pre-settlement native community and current status of vegetation and soil in relation to the NRCS Ecological Site Description for the site.

Goal and Desired Future Condition of Grazing Land

Goal

The overarching project goal is to:

Demonstrate the use of conservation grazing practices to improve soil health, and to promote related benefits including total soil carbon storage, as a viable component of a commercial beef operation.

This goal is sought in the context of the benefits listed under "Purpose," and other property goals, which are often compatible but sometimes must be balanced. These have been identified by CDFW in their land management plans and grazing permit specific to the RJER and HCWA as:

- Reduced fire hazard through dead biomass removal
- Support for public access and recreation at HCWA
- Protected native perennial grass stands
- Wetlands and riparian habitat recovered to desired ecological and hydrological function.
- Upland habitats conserved and maintained for native regional biological diversity.
- Populations of threatened/endangered species protected and enhanced.
- Other (non-regulatory) special status biological resources protected, monitored, and enhanced.

These goals converge toward the vision of a climate resilient landscape supporting a ranch operation that practices climate-smart conservation.

Desired Rangeland Condition

As the climate-adapted commercial livestock operation in this landscape achieves this goal, it would begin showing certain attributes, described in this section. The sought-for outcome shows a patchy mosaic of perennial grass stands, as well as annual grasses and annual/perennial forbs. The mosaic has a low-stature and clumpy aspect at the end of the growing season. There may be gaps in ground cover, but only for short distances between vegetation clumps, so litter, sediment, and water are maximally trapped on site. Occasional shrubs or trees dot the bottomlands in a savanna-like aspect, providing exceptional carbon storage in their woody tissues both above and below ground. At the same time, they shade livestock, improve animal distribution throughout the pasture, and build soil organic matter with their own nutrient and carbon cycles. Their deep and extensive roots extend to the water table. Fibrous root systems of some perennial grasses and forbs also extend to the water table, improving soil water balance in this arid environment. This access to stored water ameliorates some of the forage uncertainty when drought hits. While perennials increase, annual grass forage production is sufficient to outcompete undesirable, non-native weeds.

Native bunchgrass stands are protected with their health and natural expansion promoted. Notwithstanding, the need for restored function especially in the post-agricultural bottomlands does not preclude the use of non-natives. They can provide benefits such as forage quality, quantity, and reliability, as well as hydrologic function of rainfall capture so it percolates into the soil instead of running off, and improved carbon cycling. No effort is undertaken to remove the naturalized, non-native forage that benefits livestock production, such as filaree, certain annual brome grasses, and legumes. Some forage plants that promote carbon and other goals may be introduced in the formerly cultivated lands to meet goals; whether or not they are native, they serve key ecosystem functions. However, weedy non-native forbs (such as mustards, wild radish, and tumbleweed) that compete efficiently for soil nutrients and preclude establishment of beneficial plants are targeted for extirpation, even though they may be better at below-ground carbon storage than annual forage grasses.

The landscape is more resilient to fire. Compared to annual grasses, which die each year and leave a layer of deep dry mulch when ungrazed, the perennial grasses produce less litter in a single year, and their plant tissues are less dry even when dead or dormant. So, fire spreads less rapidly, thus reducing carbon emissions and ecosystem damage from a more extreme fire regime.

Native wildlife support in the grasslands improves due to the supply of grass seed and leafy legumes for the small mammal prey diet. The open, patchy, low height of the pastures allows visual foraging by native raptors.

The soil surface begins to show organic matter accumulation. There are indications that soil aggregate formation and stabilization (by fungal mycelia, bacterial filaments and polysaccharides) are taking place. Stable aggregates improve water and oxygen flow in the soil and resist erosion. Water infiltration is unimpaired by compaction.

Below ground, soil structure is improving. The soil profile is aerobic, showing evidence of active decomposition associated with carbon and nutrient cycling, and abundant fine root biomass. The belowground microflora and fauna is biodiverse with its own food chain from low-order bacteria to invertebrates. Stable humus is accumulating. The developing organic matter shows the benefit of grazing perennial grasses to promote carbon cycling: root sloughing underground offsets the loss of photosynthetic energy topside when a ruminant consumes the green grass. The sloughed roots are processed by soil microbes. With rest and recovery, the grass regrows to continues the cycle. While grazing of annual grasses is believed to stimulate some belowground productivity, the annuals store carbon primarily above ground; thus, their stored carbon is more volatile and contributes less towards long-term soil health.

Grazing standards provide guidance to livestock timing, distribution, stocking rate, and duration on a pasture. The standards are keyed on reducing the accumulation of exceedingly dry dead fine fuel; protecting the soil surface from erosion; promoting perennial grass vigor and seed reproduction; and achieving a desired below-ground condition for soil health. The standards are also planned for livestock weight gain, and contingency such as drought and fire.

The ranch as a whole is a model of carbon sustainability and conservation stewardship, with many ecosystem services beyond beef production. Lower volumes of hay are imported to supplement livestock health, even in periods of drought. There is a lower need to import inorganic fertilizer, because biologically-active soils are storing and cycling nutrients, with manure inputs and enzymes from bacteria and fungi are acting on organic matter produced on-site to release soluble nutrients for plant growth. Local markets and restaurants benefit from sustainably-sourced, grass-fed beef that is not shipped to a distant slaughterhouse with significant food miles attached to its sourcing. One day, these sustainability practices might demonstrate a ruminant's lowered methane production because they have more digestible feed available to them from actively growing forage.

Finally, the ranch by its example is an agent of change. It educates and inspires through its honest appraisal of practices that work both economically and ecologically, catalyzing the adoption of climate-smart soil health practices by others on California's working lands.

Grazing Land Constraints, Challenges and Opportunities

The following are challenges and opportunities for adopting the grazing prescriptions of this Plan.

Challenges

- Degraded soil and vegetation condition in bottomlands that were formerly cultivated. By many measures, dominance by invasive plants with areas of bare ground.
- Minor changes in management are likely insufficient to reverse degradation on these sites. On grazing lands, vegetation and soil properties are closely linked, in that they reflect the inherent capacity of a site's ability to recover a semi-natural condition without intensive inputs typical of cultivated agriculture. There is a time lag, sometimes a decades-long one, between management actions and vegetation change, whether beneficial or inappropriate, and a longer time lag to detect a change in soil health. This implies that a solely soil-based monitoring assessment will be unlikely to detect changes in a timescale relevant to adaptive management.
- The entrenched stream has probably led to a lowered water table, as well as other impaired functions. The condition is most like due to historic cultivation and possible overgrazing.
- There are access limitations to RCD/HCWA Permit Pasture 3.
- Cited in the HCWA Master Plans for the properties are erosion and water quality impacts and recreational user conflicts.
- There are multiple challenges to adoption of conservation grazing practices, including slim profits, limited resources, loss of critical facilities, and rancher skepticism.
- There can be skepticism regarding the use of non-native plants in a biological preserve setting, even when the non-natives achieve many beneficial functions.
- Just as for any habitat restoration, the needed weed control, changing the mix of desired species, and improving soil health requires all available tools, including prescribed grazing. Seeding, herbicide spraying, cultivation, and prescribed fire should remain part of the tool box.

Opportunities to Enhance Grazing Land Condition

- Besides soil health and offsetting GHG emissions, many convergent goals favor the enhancement of a grassland towards an open, short-statured mosaic condition with a mix of desired perennials, especially deep-rooted herbaceous perennials, and desired annual grasses and forbs, as described above.
- There is keen interest, openness and enthusiasm for evidence-based practice and learning in the local stakeholder community. The lessee is forward-thinking, willing, and able to adopt practices on a proof-of-concept scale.
- Livestock-handling facilities in large part exist due the property's history as a ranch enterprise; however, intensive grazing to meet objectives may require cross fencing or electric fencing.

Terms Used in This Plan

Terminology Used in This Plan

Animal Unit (AU). A 1,000-pound cow or its equivalent in potential forage intake. A mother cow with calf is considered 1 AU. A steer/heifer 1-2 years old is considered 0.8 AU, weaned calf to yearling 0.5 AU, and mature bull 1.35 AU.

Animal Unit Day/Month (AUD, AUM). The potential forage intake of one animal unit for a period of 1 day (animal unit day or AUD) or 30 days (animal unit month or AUM). Based on 750 pounds (lbs) of dry matter, 1 AUD equals the amount of forage required to sustain an AU for one day (about 30 lbs of forage or about 3% of the body weight of a 1,000-lb cow; actual consumption is about 26 lbs per day plus waste). Some range managers use 1,000 lbs of forage for 1 AUM, which accounts for wasted forage. Others use a rate based on actual consumption (26 lbs per day per AU) and apply a "grazing efficiency rate" to account for wasted forage.

Baseline Condition. This is the soil health, vegetation cover, and mix of species at the beginning of the project, measured in the same way it will be assessed over time for comparison.

Browse/Browsing/Browser. Browse is leaves and twigs from shrubs and trees consumed by herbivores. A browser is an herbivore whose primary foraging method is browsing.

Carbon Sequestration. The long-term storage of carbon in plants, soils, geologic formations, and the ocean. Land management that explicitly considers the effects of management on carbon storage and sequestration has the broad goal of enhancing the removal of GHGs from the atmosphere through increased carbon sequestration, avoided emissions, or both. Biological carbon capture and sequestration in plants and soils is commonly distinguished from the storage of carbon dioxide emissions in geological features.

Carrying Capacity/Grazing Capacity. The amount of forage (in AUMs) available for grazing compatible with management objectives without causing resource damage. Carrying capacity can be used synonymously or it can refer to the capacity of land to support wildlife and other resources in addition to livestock. In addition to site characteristics, it is a function of management goals and management intensity (SRM). The amount of forage produced annually in a management unit is only one attribute used to determine carrying capacity, since some areas are inaccessible to grazing animals.

Deferment. The delay of grazing to achieve a specific management objective, aimed at providing time for plant reproduction, establishment of new plants, restoration of plant vigor, or the accumulation of forage for future use. Deferment is usually from the beginning of forage growth within a year (fall in California) until after seed set (late spring). A practice sometimes used to enhance seed production of perennial grasses.

Ecosystem Services. Ecosystem services have been defined by the CDFA Environmental Farming Act Science Advisory Panel as "the multiple benefits we obtain from farming." These benefits have been organized into 13 different categories including food production, nutrient cycling, soil health, water quality, biodiversity conservation, and creation of wildlife habitats among others (OEFI 2019a).

Grazing System. The manner in which grazing and nongrazing periods are arranged within the maximum feasible grazing season, either within or between years. Continuous Grazing is the simplest grazing system and is common in low-elevation California. Short-Duration grazing involves short periods (days) of grazing alternated with non-grazing periods based upon plant growth characteristics.

Greenhouse Gases (GHGs). Gases that absorb solar radiation and increase the trapping of heat in the Earth's atmosphere, giving rise to the "greenhouse effect." The most common GHGs are carbon dioxide, methane, nitrous oxide, sulfur dioxide, perfluorocarbons, hydrofluorocarbons, and sulfur hexafluoride.

Key Area. Indicator areas that are able to reflect what is happening on a larger area as a result of management, because they are representative of the area as a whole. Selection of a Key Area is done after first breaking down a grazing area into "strata" that respond similarly to grazing, such as a certain class of slope or soil texture (Bureau of Land Management [BLM] 1734-3).

Key Species. A plant or group of plants that may be directly ties to management, usually an important forage plant. They are indicators of change. In some cases, problem plants may be selected as key species. Key species may change from season to season or year to year (BLM 1734-3).

Nutrient Supplement. Placement of protein and mineral supplements can be used to attract livestock into an area targeted for grazing

Overgrazing. Heavy grazing which exceeds the recovery capacity of the forage plants and causes deterioration of soils.

Peak Standing Crop. The stage at which the year's forage crop (grassland vegetation) is at peak maturity and before seeds drop. Forage production is generally described in units of weight per unit area (pounds per acre or kilograms per hectare). The unit of weight would be measured at peak standing crop, then dried to determine its dry weight.

Plant Functional Group. groups of plants that play a similar role in soil or plant ecology, such as response to disturbance and site resiliency, or resistance to invasion. Examples are warm-season sod-forming grasses; deep-rooted cool-season grasses; annual legumes; fire-following annual forbs; non-native cool season annual grass; etc.

Prescribed Grazing. A conservation management system to achieve specific ecological, economic, and management objectives by way of season, frequency, intensity, and duration of grazing in accordance with site production limitations, rate of plant growth and physiological needs of vegetation. By managing the kind of animal, animal numbers, grazing distribution, length of grazing periods and timing of use, sufficient deferment from grazing is provided during the growing period, adequate vegetation cover on sensitive areas, and protection of soil, air, water, plant and animal resources. Prescribed grazing increases harvest efficiency and helps ensure adequate forage throughout the grazing season. It is often designed around multiple objectives that support the livestock, protect soil and water quality, and promote forage amount and composition to a desired, sustainable condition.

Range Condition. traditional definition: The present state of vegetation of a range site in relation to the potential natural (or climax) plant community for the site based on kinds, proportion, and amounts of plants present; suggests current productivity relative to natural productivity potential. This term is being phased out. Preferred terms are successional status and range similarity index. author's note: The concept of "range condition" should be related to specific management goals for a given property.

Range Degradation. An irreversible reduction in capability of a site to produce its potential natural vegetation.

Rangeland Health. SRM: The degree to which the integrity of the soil, the vegetation, the water, and air as well as the ecological processes of the rangeland ecosystem is balanced and sustained. Integrity is defined as maintenance of the structure and functional attributes characteristic of a particular locale, including normal variability. The BLM and NRCS use 17 indicators of soil health. It is important to use state-and-transition models when integrating rangeland health indicators in support of soil health application and assessment.

Reference Condition. An untreated (ungrazed, or grazed without a prescription such as continuously year round) condition at a location selected for the purpose of separating the effects of weather from the treatment for improved soil health. Reference sites should be selected on the same soil type as the treated areas. When selected for their potential natural vegetation, they serve as a model of the community of organisms that can be expected when not changed by human activity or land use history.

Residual Measurement. The determination of herbage material or stubble height left behind after a grazing period. It is independent of the amount of annual production. It requires the determination of which species to evaluate and the proper use levels that will leave the appropriate residual stubble height.

Residual Dry Matter (RDM). The old plant material left standing or on the ground at the end of the grazing season or beginning of the new growing season (the fall in California). Plant material included in RDM measurements is typically limited to forage species.

Rest. To leave an area ungrazed or unharvested for a specific time, such as a year, or a growing season to achieve a management objective. To protect and improve range condition, rest and grazing periods are prescribed to correlate with the growth and reproduction requirements of the key species of a specific pasture or allotment

Rest-Rotation. A multi-pasture system in which a full growing season's rest is scheduled among the pastures. Rest periods for individual pastures are incorporated into a grazing sequence, generally allowing a full year's rest.

Rotational Grazing. Includes two or more pastures between which grazing animals are moved in sequence, resulting in grazing periods being followed by nongrazing periods. Rotational Rest grazing incorporates rotations with planned rest periods. This is slightly different than simple rotational grazing as the term rest implies longer nongrazing periods between the grazing periods. **Rotational Deferment** is the systematic rotation of deferment among pastures within a grazing management unit in a single growing season.

Soil Health. Soil Health is "the capacity of a soil to function as a vital, living ecosystem that sustains plants, animals, and humans" (NRCS 2014). All definitions have three components: capacity to function, sustainability, and meeting human needs (Brown and Herrick 2016). Soil health is not a single trait and is best evaluated by using multiple tests with known association and relevance to healthy soil functioning.

Stocking Rate. Number of animals per unit area of land over a specified period of time. Expressed as AUs per time period.

Stubble Height. A utilization monitoring method to ensure adequate plant material is left behind at the end of the growing season to maintain plant vigor and protect soil and water resources. Focus "key" species (or functional groups) are selected in "key" areas. Stubble height standards must be developed for each plant community and key species. Most commonly used in riparian areas, a stubble height standard of 4 inches might be specified to protect streambanks, trap sediments, and rebuild degraded stream channels. Stubble height can also be used to trigger a move to a new pasture. Other objectives can be incorporated such as a certain stubble height for key species related to wildlife benefit. Utilization cage are installed to show ungrazed condition, and to help calibrate visual estimates of forage use.

Supplemental Feed (also called Maintenance Feeding). Harvested forages and concentrates provided to livestock to meet minimum daily animal maintenance requirements, partially or completely replacing grazing of the standing forage crop.

Targeted Grazing. A grazing prescription for a single vegetation or landscape objective, such as brush removal or control of tumbleweed. It is the application of a specific kind of livestock at a determined season, duration, and intensity to accomplish usually a narrow vegetation or landscape objective. Targeted grazing refocuses outputs of grazing from livestock production to a specific vegetation and landscape condition. With targeted grazing, the land manager must have a clear vision of the desired outcome for the vegetation, and the livestock manager must have the capability to aim livestock at the target to accomplish the objective.

Thatch. Dead plant biomass accumulated on the ground surface and covering the herbaceous plant community.

Utilization. The proportion of the current year's forage that is consumed or destroyed by grazing animals (including wildlife, insects, etc.). Can refer to a single species or to the vegetation as a whole. Expressed as percent utilization. A grazing plan might call for removing animals after 50% utilization of purple needlegrass. Compares the amount of herbage left to the amount of herbage produced in a given year.

II. Resource Inventory

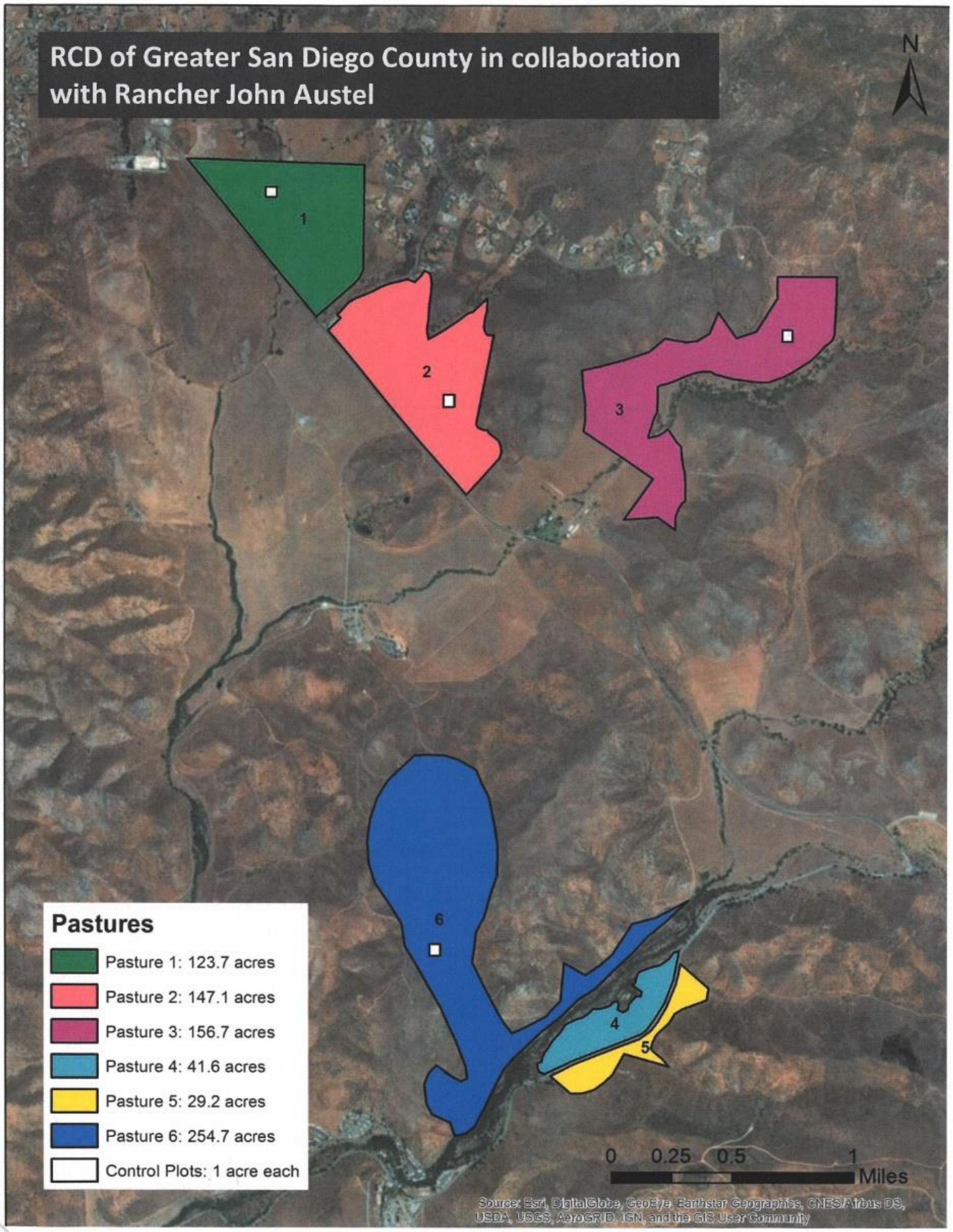
Pastures, Property Access and History of Land Use for Farming and Grazing

The RJER main entry gate is on the southwest side of SR 94, about three miles southeast of the intersection with Jefferson/Proctor Valley Road. Ingress and egress from HCWA parcels, according to the Grazing Permit, is by several locked gates located on both sides of SR 94. Opposing gates are used to move cattle across SR 94. Permittee will coordinate with California Highway Patrol for traffic break assistance.

Both the RJER and HCWA were part of the 1831 Rancho Jamul land grant (de Barros et al. 1998) to Pio Pico, the former governor of California. Granted was 9,000 acres of the Jamul Valley. The property was primarily used for grazing and farming since this time, with cattle and other livestock operations occurring into the 1990s, with some interrupting years. During the late 1890s, John D. Spreckels, San Diego entrepreneur and sugar fortune heir, gained control of the land and formed the Southern California Mountain Water Company. This venture helped capture rainfall from the watersheds of southern San Diego County's backcountry with the construction of Morena, Barrett, and Otay Dams. In 1929, George R. Daley bought the property and returned it to a cattle ranch (de Barros et al. 1998). Donald Daley inherited Rancho Jamul from his uncle and continued the ranching and agricultural business. The flatter areas of the property were farmed with irrigated crops. Ponds, wells, levees, piping, and an aqueduct system supported both livestock distribution and irrigated agriculture (described below under Ranch Infrastructure) and remain on the property today. Agricultural and livestock operations were removed from the properties in the 1990s prior to being sold into conservation (TAIC 2008). The California Department of Fish and Game (now the CDFW) acquired RJER in 1998 and HCWA in 2001.

Table 1. RCD Pasture (and equivalent CDFW permit pasture identification) acreages, access, surface soil textures, and preliminary condition reported by rancher.

RCD Pasture 1 (HCWA 1) Acreage: 123 acres Access: Highway 94 Surface Soil: Fine Sandy Loam – 18 acres; Sandy Loam – 94 acres Preliminary Conditions: Some bunchgrass present, formerly cultivated	**RCD Pasture 2 (HCWA 2)** Acreage: 147 acres Access: Highway 94 Surface Soil: Sandy Loam – 60 acres; Fine Sandy Loam – 86 acres Preliminary Conditions: Goats head/puncture vine present, portions formerly cultivated
RCD Pasture 3 (HCWA 3) Acreage: 157 acres Access: Poor Surface Soil: Coarse sandy loam – 8 acres; Sandy loam – 66 acres; Fine sandy loam – 83 acres Infrastructure: Cattle finishing structure Preliminary Conditions: Streambed erosion, fencing needed, formerly cultivated	**RCD Pasture 4 (RJER Softline Area)** Acreage: 42 acres Access: Otay Lakes Road Surface Soil: Fine sandy loam – 2 acres; Silt loam – 39 acres Preliminary Conditions: Cultivation 1990s, adjacent Dulzura Creek entrenched compared to natural conditions
RCD Pasture 5 (RJER Softline Area) Acreage: 29 acres Access: Otay Lakes Road Surface Soil: Silt loam – 7 acres; Fine sandy loam – 22 acres	**RCD Pasture 6 (RJER Softline Area)** Acreage: 255 acres Access: Otay Lakes Road Surface Soil: Sandy loam – 11 acres; Loam – 19 acres; Silt loam – 22 acres; Very fine sandy loam – 41 acres; Fine sandy loam – 164 acres Infrastructure: historic northern drainage (some ponding 2019), wells Preliminary Conditions: Formerly cultivated, dominated by non-native forbs. Adjacent riparian entrenched from natural channel



Map 2. RCD Pastures proposed for climate-smart grazing to improve soil health and provide carbon sequestration benefits. This recent aerial photo shows substantially greater riparian vegetation compared to 1953 aerial photo reviewed for comparison.

Ranch Infrastructure

Grazing Permit Ranch Context

Perimeter fences for pastures are in place. The Permittee has provided electric “hot wire” fencing for the Softline areas (J. Austel, pers. comm.). The Grazing Permit states that perimeter fencing repair by the Permittee is authorized as needed to control livestock. The Permittee is responsible for installing wildlife friendly fencing, gates, and watering facilities as needed to facilitate grazing.

The built infrastructure for the RJER property as a whole (west of SR 94) was reported in the CDFW Land Management Plan for that property (TAIC 2006). They report that artificial ponds, a water tank, wells, pipes, and an aqueduct system were constructed to catch, store, and utilize runoff for use in the ranch house (now the CEC) and by domestic animals. Seven main artificial ponds and two water tanks are used for water storage. Besides those listed below, there are additional, smaller ponds, some of which are named (Hidden Pond, Corner Pond, South Pond). The ponds fill by different means and retain water to different degrees.

- Water Tank 1, on hill southwest of CEC;
- Water Tank 2, same location as Water Tank 1, installed in 2005;
- North Pond (Rancho Pond), at the northern end of the reserve;
- Main Pond (Willow Pond), north of the CEC;
- Cement Pond (Cistern Pond), just northeast of Main Pond;
- Corral Pit Pond, upstream of stream confluence;
- Corral Pond, adjacent to Corral Pit Pond;
- Kiln Pond, south of Corral Pond;
- Canyon Pond, southeast of the Kiln Pond.

Cement and Corral Pit Ponds presumably fill with groundwater and are often dry in the summer. Main Pond is the largest pond and, due to its proximity, can be filled with water flow from Cement Pond, which is connected with underground pipes. The Cement Pond received piped water that is pumped from the Otay Well. This is the source of water into both water tanks that service the CEC and headquarters complex. North and Corral Ponds have the potential for pumping, although the infrastructure is not in place. The rest of the ponds fill from runoff.

An aqueduct system consisting of a network of open trenches, levees, pipeline, pumps, and dams was built by one of the previous landowners to capture and divert rain runoff to the storage ponds. Maintenance roads, located on top of the levee system associated with the aqueduct. These roads also serve as firebreaks. The system is not functional, due to a few washouts, infilling, and overgrowth in various locations. One of the washouts is located at the confluence of the two branches of Jamul Creek.

Approximately 19 groundwater wells have been constructed for agricultural purposes and for use at the main residence; not all are functional. Only a few of the wells (Otay, Creek, and Hill Wells) provide potable water. Potable water delivery to the CEC and surrounding buildings originates at the Hill Well and travels through underground pipes to Water Tank 1, then to the buildings of the CEC. A second system delivers water from the Otay Well by underground pipeline to Cement Pond, and then Main Pond that also connects to the irrigation system surrounding the CEC. The secondary system is augmented by the Tamarisk Well and the Green Well for irrigation and fire suppression purposes at the main residence.

RCD Pastures: Location and Condition of Structural Improvements

East of SR 94, the Grazing Permit states that the cattle corral structures on the south side of the main trail may be used for livestock, provided the main trail remain open and unfenced for visitor passage. The Permittee will need to install gates to allow trail users of a secondary path to pass to/from the main trail to the housing area.

Climate and Weather

San Diego County experiences a Mediterranean climate, which is characterized by wet winters and dry summers. In the winter, the high-pressure zone weakens and moves southward, allowing storms to move into the area. Most rainfall in the area falls from November through March, with March being the wettest month of the year on average (Figure 1; Data Source: Western Regional Climate Center [WRCC], San Gabriel weather station, 6.5 miles from project location). Annually, rainfall fluctuates, with an average annual rainfall of 12.7 inches (Figure 2). Temperatures are characterized by cool winters and hot summers (Figure 3).

One of the most influential weather phenomena in the region is the Santa Ana winds. Usually beginning in the fall and peaking in December, hot, dry winds originating in the Great Basin blow towards the coast. The winds can be quite strong, with gusts up to 100 miles per hour. This scenario, involving strong winds, rapidly increasing temperature, and extremely low relative humidity (<25 percent), is prone to creating an environment highly-conducive to rapidly-spreading wildfires.

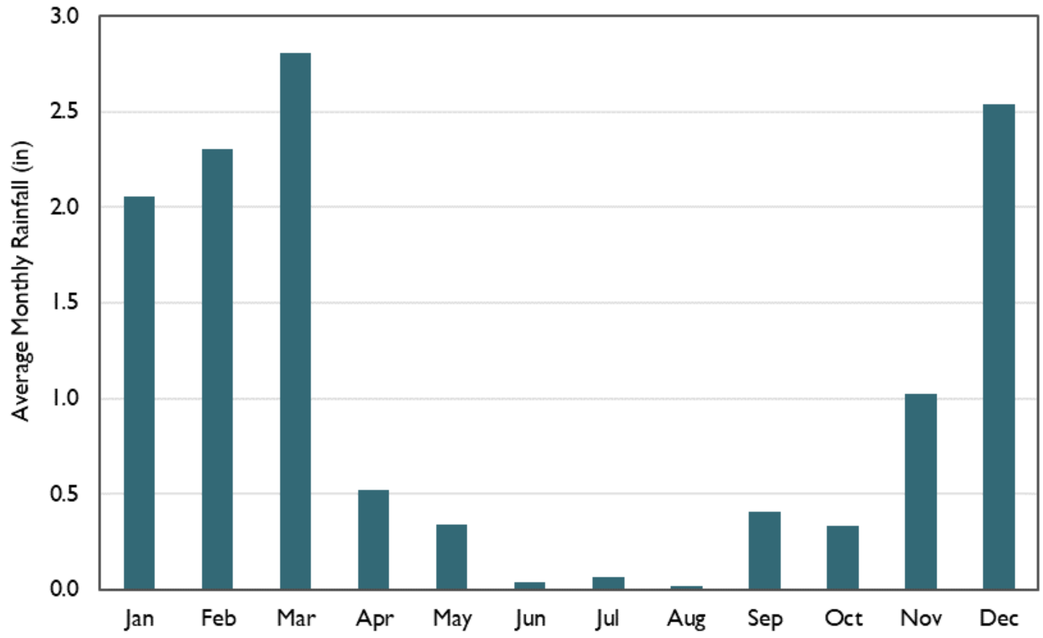


Figure 1. Average monthly rainfall (Data Source: WRCC, San Gabriel weather station).

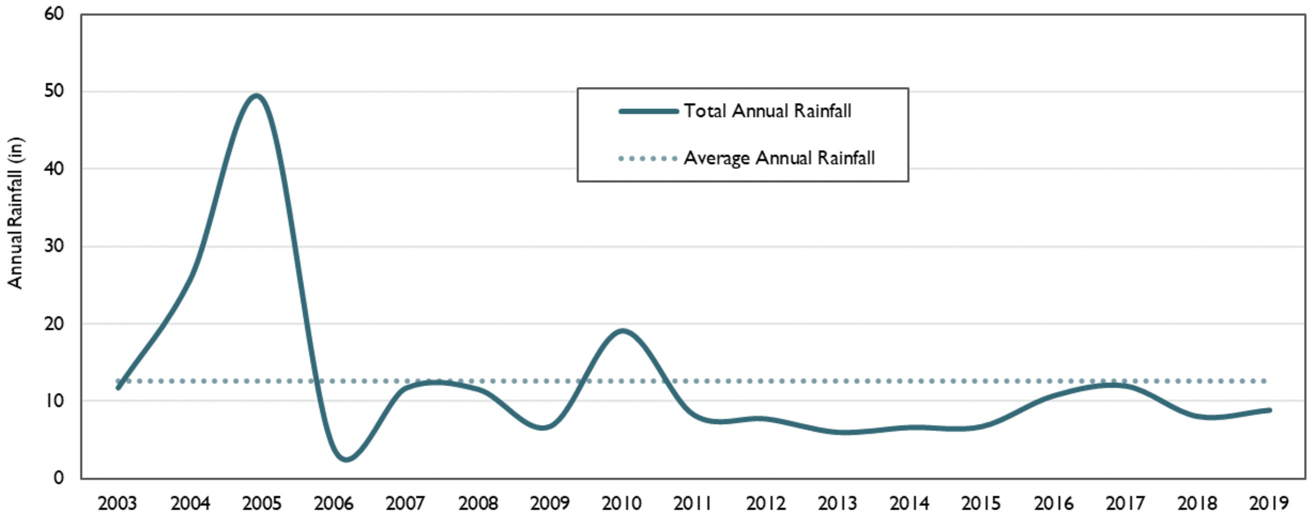


Figure 2. Annual precipitation 2003-2019 (Data Source: WRCC, San Gabriel weather station).

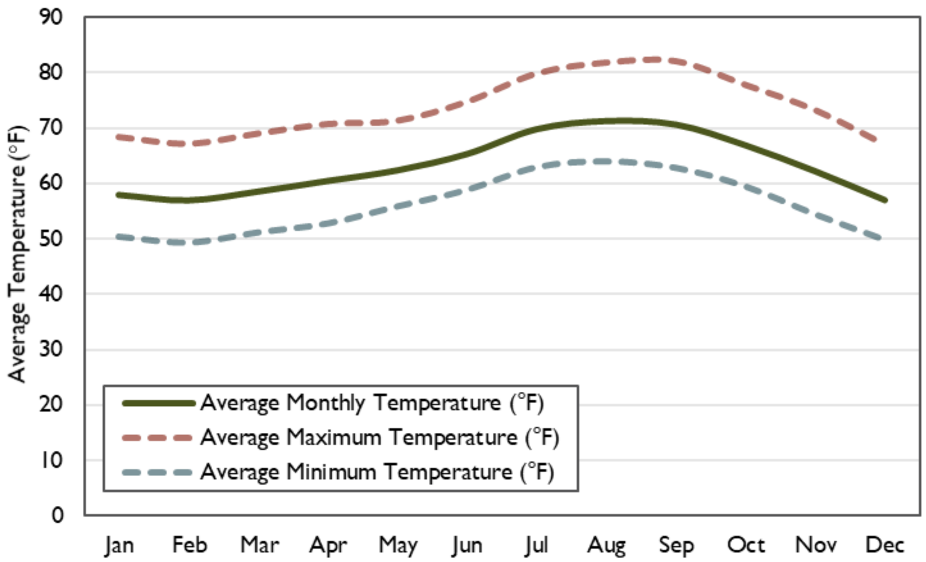
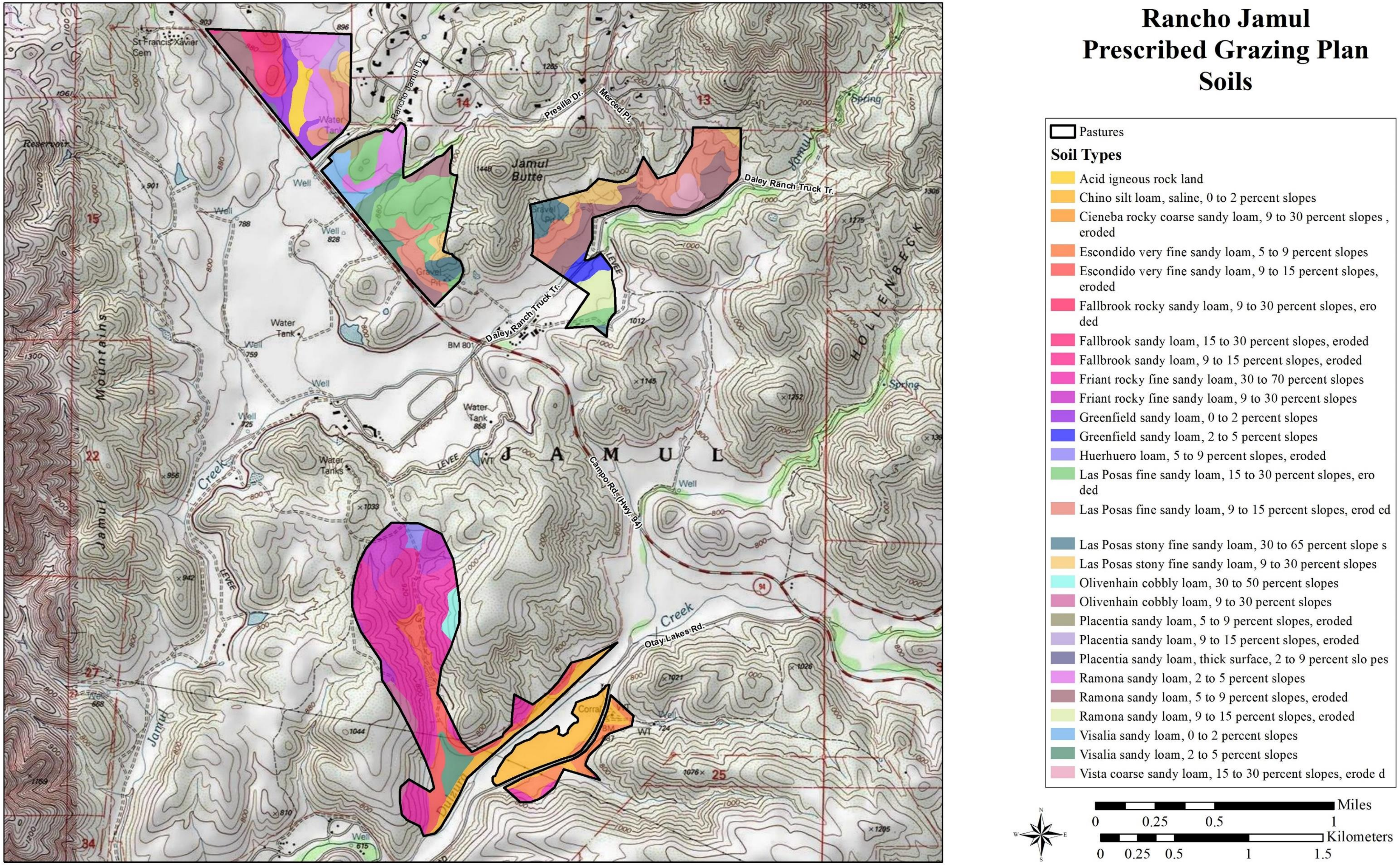


Figure 3. Average monthly temperatures (Data Source: WRCC, San Gabriel weather station).

Soil and Vegetation Condition

Soil Map

Map 3 depicts the soils for parcels.



Map 3. Soils of the Rancho Jamul project grazing pastures.

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Vegetation Condition

The pastures have been fallow since 1998, after having been grazed, or grazed and farmed, starting around 1830. In the Land Management Plans for the CDFW acquired lands (TAIC 2006; EDAW 2008), a floral inventory mapped vegetation boundaries and qualitatively reported on plant composition. The RCD pastures were classified as Non-native Grassland or Disturbed Non-native Grassland. Their descriptions are as follows:

- *Non-Native Grassland (from RJER Land Management Plan 2006).* These areas have greater than 40 percent cover of grasses and forbs, with greater than 2/3 cover attributable to non-native annual grasses. Foxtail chess (*Bromus madritensis*), wild oats (*Avena fatua*), and ripgut grass (*Bromus diandrus*) are the dominant non-native grass species, although purple needlegrass (*Stipa pulchra*) is sometimes present in very low numbers. Non-native annual forbs such as filaree (*Erodium* spp.), wild radish (*Raphanus sativus*), and mustard may also be present. This vegetation type occurs on the flatter areas of the RJER, areas that have been formerly heavily-grazed or were under agricultural production.
- *Disturbed Non-Native Grassland (from RJER Land Management Plan 2006).* These areas have from 20 to 40 percent cover of grasses and forbs, of which greater than two-thirds of the cover is non-native annual grasses. Characteristic species include wild oats and brome, although the non-native annual forbs may be intermixed. Evidence of mechanical disturbance such as tilling or mowing is present. Significant amounts of bare ground may be present.
- *Disturbed Non-Native Grassland (from Hollenbeck Canyon Land Management Plan 2008).* These areas occur particularly in the west-central portion of the property [east of SR 94]. They were formerly pastures and farmed. Non-native species have their highest relative concentration in areas previously heavily grazed such as the pastures on the flatter terrain. Extensive stands of non-native grasses and forbs such as wild radish, black mustard (*Brassica nigra*), mustard, ripgut grass, foxtail chess, California burclover (*Medicago polymorpha*), and filaree (*Erodium* spp.) are dominant. One of these areas is periodically seeded with cereal wheat (*Triticum aestivum*) and safflower (*Carthamnus tinctorius*) by CDFW to encourage use by mourning doves (*Zenaida macroura*) for hunting.
- *Blended Disturbed Non-Native/Native Grassland.* Areas mapped as disturbed non-native/native grassland have from 20 to 40 percent ground cover of grasses and forbs, with greater than two-thirds relative overall ground cover attributable to native and non-native grasses. Evidence of recent mechanical disturbance may occur. Significant amounts of bare ground may occur. Wild oats, foxtail chess, and purple needlegrass are the common grasses, with filaree the most common non-native forb occuring on the flatter mesa tops. California melic (*Melica californica*), Torrey's melic (*Melica torreyana*), nodding needlegrass (*Stipa cernua*), foothill needlegrass (*Stipa lepida*), and/or purple needlegrass is dominant or characteristically present in the herbaceous layer with other grasses and herbs, including spider grass (*Aristida ternipes*), *Astragalus* spp., *Avena* spp., *Bromus* spp., dense-pine reed grass (*Calamagrostis koelerioides*), *Calochortus* spp., *Calystegia* spp., amole (*Chlorogalum pomeridianum*), *Clarkia* spp., common sandaster (*Corethrogyne filaginifolia*), Turkey-mullein (*Croton setigerus*), *Cryptantha* spp., wild carrot (*Daucus pusillus*), wild hyacinth (*Dichelostemma capitatum*), blue wildrye (*Elymus glaucus*), *Eriogonum* spp., *Erodium* spp., California poppy (*Eschscholzia californica*), California fescue (*Festuca californica*), shortpod mustard (*Hirschfeldia incana*), narrow tarplant (*Holocarpha virgate*), meadow barley (*Hordeum brachyantherum*), prairie junegrass (*Koeleria macrantha*), *Lasthenia* spp., *Plantago* spp., Sandberg bluegrass (*Poa secunda*), *Sanicula* spp., blue eyed grass (*Sisyrinchium bellum*), *Trifolium* spp., and/or *Vulpia* spp. Emergent trees and shrubs may be present at low cover.

Riparian drainages are mostly fenced off from livestock use. However, grazing can support riparian values associated with adjacent riparian vegetation, and the rancher has sometimes been requested to graze within riparian drainages to reduce biomass (J. Austel, pers. comm.). The riparian communities were classified as Riparian Woodland (Sycamore Woodland), Southern Arroyo-Willow Riparian Forest, Mulefat Scrub, Southern Coast Live Oak Riparian Forest, Southern Willow Scrub, and disturbed versions of these mapping units (TAIC 2006; EDAW 2006). The riparian areas appear entrenched from historic land use, mostly the tillage practices, as well as unmanaged grazing. They probably have also been impacted by short-interval fires within their boundaries and in the watershed feeding into them. All riparian drainages appear more vegetated with willows and other woody vegetation than is visible in the earliest available aerial photos (1953). The condition of Jamul and Dulzura creeks has reportedly improved since Wildlands Inc. began their restoration efforts in 2000 (TAIC 2006). Restoration and enhancement efforts expanded the floodplains, established overflow channels, removed exotics, restored native vegetative cover, and increased riparian structural diversity.

Perennial grasses reported on RJER lands west of SR 94 include:

Achnatherum diegoensis	San Diego needlegrass	*Melica imperfecta*	coast range melic
Agrostis pallens	bent grass	*Melinis repens*	natal grass
Aristida adscensionis	sixweeks three-awn	*Paspalum dilatatum*	Dallis grass
Bothriochloa barbinodis	cane bluestem	*Paspalum distichum*	common knotgrass
Bromus carinatus	California brome	*Pennisetum setaceum*	African fountain grass
Cynodon dactylon	Bermuda grass	*Piptatherum miliaceum*	smilo grass
Distichlis spicata	saltgrass	*Sorghum halepense*	Johnsongrass
Koeleria macrantha	prairie junegrass	*Sporobolus airoides*	alkalai sacaton
Leymus triticoides	beardless wild rye	*Stipa lepida*	foothill needlegrass
Lolium perenne	perennial ryegrass	*Stipa pulchra*	purple needlegrass

Perennial grasses reported at HCWA east of SR 94 include:

Melica californica	California melic	*Calamagrostis koelerioides*	dense-pine reed grass
Melica torreyana	Torrey's melic	*Elymus glaucus*	blue wildrye
Stipa pulchra	purple needlegrass	*Festuca californica*	California fescue
Stipa cernua	nodding needlegrass	*Hordeum brachyantherum*	meadow barley
Stipa lepida	foothill needlegrass	*Koeleria macrantha*	prairie junegrass
Aristida ternipes	spider grass	*Poa secunda*	Sandberg bluegrass

III. Grazing Management Plan

Objectives

The specific objectives described here are expected to be ranked differently in the six pastures, and sites within pastures, depending on their starting baseline state. Ranking would also shift based on the direction for each pasture established by the CDFW-RCD management team. When implemented, all objectives are intended to achieve this Plan's stated overarching Goal of *improving soil health,* with all its associated benefits of climate adaptation and sustainably producing food and other ecosystem services.

The objectives are to be applied across the following different baseline conditions. For each starting condition, an ungrazed reference site should be identified and monitored for comparison during the course of grazing treatment.

Annual grassland. Dominated by bromes, wild oats, and other mostly naturalized non-native grasses, with non-native forbs present but not dominating.

Previously tilled, disturbed. High cover of non-native annual grasses and weedy forbs such as mustard, radish, and tumbleweed.

Perennial grassland with 20 percent or more native perennial grasses. Site dominated by annual or grasses overall (annual or perennial). Usually on slopes.

Riparian bottomlands. Portions of pasture containing or adjacent to a riparian vegetation corridor, influenced by higher water table.

Objectives towards the goal of soil health are summarized below, then recommended practices are identified to achieve the objectives, organized around the starting conditions described above.

Nine Specific Objectives

1. Increase the amount and proportion of fine root biomass in the upper soil profile and promote root turnover.
2. Optimize total carbon storage potential above and below ground, including woody component to vegetation, with priority on recovering resilience on formerly tilled lands.
3. Improve the competitive ability of existing native grass populations.
4. Reduce fine fuel loads, control fire spread, and improve fuel moisture in herbaceous fuels to achieve a fire resilient landscape.
5. Suppress invasive weeds, and promote invasion resistance within pastures.
6. Increase the quantity and quality of forage available for livestock year around in these pastures.
7. Reduce the net carbon footprint of ranch-wide beef production.
8. Maintain or reduce the net benefit in cost/acre of producing weight gain on livestock.
9. Promote shared learning and technical experience on climate-smart soil building practices within the internal management team, external stakeholders, and interested parties.

To achieve objectives, all conservation tools should be available in the land manager's toolbox, while supporting and doing no harm to the mission of CDFW and its commitments, as described in the property Land Management Plans and related documents.

Rationale Underlying the Objectives

Building soil health on grazing lands means building soil structure below ground in the root zone of forage plants. This is where the microbiological cycles take place that process carbon produced by photosynthesizing plants into stable, stored carbon in the form of humus. Grassland soils are recognized for their ability to build soil humus due to their (Jackson et al. 2006):

- High productivity;
- Accumulation of above ground and below ground litter and plant root deposits; and
- Stability of byproducts produced by soil biological processes during decomposition.

Grazing that is managed for soil health can promote the turnover of carbon and its long-term storage in the soil. In part, this grazing benefit is because herbivory accelerates the nitrogen cycle (Pineiro et al. 2010; Laca et al. 2010). Rangeland productivity and soil carbon sequestration can be simultaneously increased by management practices aimed at increasing nitrogen retention at the landscape level, especially in Mediterranean grasslands that are nitrogen-limited (Laca et al. 2010). This is because, in the long-term, nitrogen and carbon cycles are interlinked, and nitrogen is often the limiting factor on how productive grasslands are.

Most of this Grazing Plan's objectives align and converge around the goal of soil health by promoting herbaceous perennials, especially deep-rooted ones. By increasing the quantity, density, and vigor of perennial grasses with deep fibrous roots, and the general improvement of nutrient, mineral, and water cycles in a pasture, carbon stocks can be improved. In grasslands currently dominated by naturalized annual grasses, the carbon content of soils can be increased by preventing the accumulation of dead mulch from annual grasses and thus promoting vigor in new-season growth. Managed grazing is key to these improvements, by controlling the timing, intensity, and frequency of animal impact to improve vegetation composition, density, structural diversity, and vigor.

In contrast, cultivation or soil tillage in grasslands decreases soil quality and causes the loss of soil carbon (Woods 1989; Burke et al. 1989; Lal 2002; Jackson et al. 2007). This Plan is taking place in pastures that were formerly tilled and irrigated for crop production and managing these toward improved carbon storage can have high potential by changing vegetation composition. Land that is degraded, or unstable due to soil loss, can sequester much more carbon if it can be restored to a healthy condition, with properly functioning carbon, water, mineral, and nutrient cycles. Conversely, when healthy, stable land becomes degraded or loses vegetation cover, the carbon cycle can become disrupted and will release stored carbon dioxide back into the atmosphere. Grazing land management that encourages properly-functioning chemical, mineral, and hydrologic cycles.

Recommended Strategies and Practices to Achieve Objectives

The strategies presented below are followed by specific grazing practices to achieve them.

A. **Improve the mix of forage plant functional groups with a range of root ecological niches:** cool/warm season grasses; shallow and deep-rooted grasses and forbs; rhizomatous and bunchgrass types.
   - Increase the perennial component of grasslands to at least 20 percent cover of herbaceous perennials, or one perennial grass per square meter.

  - Increase both cool-season and warm-season perennial grasses.
  - Increase both bunchgrasses and rhizomatous grasses.
  - Expand the perennial grass zone associated with riparian understory or in the flood zone through rest-rotation grazing. If possible, plant these areas.
  - Increase both the annual and perennial grass component of vegetation on previously tilled areas. If possible, introduce perennials in the previously tilled lands by planting them. Since weedy forbs dominate much of these areas, annual grasses may need to be promoted to secure the site from weedy invaders. Targeted grazing would be applied in combination with seedbed preparation, drilling, herbicide, and other approaches.
  - Increase legumes on previously tilled areas, especially deep-rooted legumes that can reach the water table.
  - Maintain and improve the competitive ability of existing perennials through timed seasonal grazing and rest-rotation.
  - Prioritize expansion of perennial grasses in the flood zone of drainages, and along roads for fire protection.
- Graze perennial grasses to promote root sloughing and regrowth, and thus humus building below ground, while also promoting vigor above ground.
- Foster replacement of weedy forbs with palatable forage species in previously tilled lands. Promote desirable annual grasses over weedy broadleaf forbs, even as they are non-native, and may not provide better soil carbon storage than the competitive annual forbs. Annual grasses can increase total carbon storage, however mostly above ground, so it is more volatile and less efficient at soil building and long-term carbon storage than perennials. Some competitive weeds have very deep roots and large tap roots, thus tying up soil carbon and nutrients. An increase in annual grasses will improve soil protection and forage-able biomass production, and potentially total carbon in the long run.
- Increase the woody component of grazing land to promote a more savanna-like aspect. In grasslands, the presence of a few established shrubs or trees enhance restoration and provide erosion control, shade for grazing animals, landscape heterogeneity, and reduction in non-natives (Belsky et al. 1989; Fritzke 1997).
  - Protect oak seedlings and saplings from grazing by browsing by livestock or wildlife until the plants can tolerate these impacts.
  - Introduce other native trees and protect until they outgrow potential for animal damage.
  - Promote riparian health in pastures that contain riparian vegetation or are adjacent to drainages. Retain or add woody components such as sycamores, live oaks, and elderberry and protect from grazing until mature enough to tolerate livestock damage. Restore hydrologic function. Reduce ladder fuels large trees. These trees will shade livestock, potentially improved forage beneath trees, provide wildlife benefit, enhance deeper reserves of carbon, enhance deep soil water retention on the site (slow runoff), etc.

B. Encourage **low-intensity fires of small size (less than 100 acres)**

- Livestock grazing can decrease the severity of fires by reducing fuel load. In grasslands with 2,000 pounds per acre (lbs/acre) of grassy fuels, flames can be more than 50 feet long and difficult to control. In moderately grazed rangelands with 1,000 lbs/acre of grassy fuels, flames can be 4-10 feet long and thus more controllable. In heavily grazed areas with less than 500 lbs/acre of fuels, fires generally burn only in isolated patches because the fuels are usually discontinuous (Barry et al. 2011).

- Perennial grasses, especially deep-rooted ones, sustain higher moisture in their tissue, even when dormant or dead tissue. They are less flammable than annual grasses due to higher fuel moisture, because they are green longer in the growing season, because they produce less litter each year than annual grasses and forbs, and sometimes because they maintain a natural spacing or discontinuity as a fuel bed.
- Graze herbaceous vegetation towards an open, low stature with patchy appearance but as uniformly across pastures as possible.

C. **Use Residual Dry Matter (RDM) as a guide in annual dominated lands**. Use *palatable* forage plants as key species for monitoring RDM. RDM is the old plant material left at the beginning of the new growing season (the fall in California). Ungrazed annual grassland is expected to have less carbon storage potential than grazed annual grassland, due to the stimulating effect of mulch removal, and some evidence that root growth is simulated below ground after grazing annual grasses. Prescribed grazing increases harvest efficiency and helps ensure adequate forage throughout the grazing season. Plant material included in RDM measurements is typically limited to forage species. (See the RDM Chart below.)

Table 2. RDM recommended minimum by slope class, based on score card approach (Bartolome et al. 2006). These RDM levels can be adjusted based on management objectives for a pasture. For instance, in formerly cultivated fields with a high component of weedy broadleaf forbs, no RDM standard is recommended.

Slope Class	RDM Standard (lb/acre)
<10%	300
10-25%	400
25-40%	500
40-60%	600

D. **Facilitate improved stocking distribution** and intensity to achieve objectives, e.g. pasture fencing, stock water development, and handling facilities.

E. **Implement targeted grazing for specific weeds: mustard family weeds, puncture vine, Russian thistle.**

F. **No till on native soils.** Do not till soils that have not been tilled in the past. However, on previously cultivated lands, tillage to control weeds, then planting, may be the best option.

G. **Use Integrated Pest Management** when herbicide or other pest management is needed, protect soil biota as well as other benefits.

H. **Reduce the need to important hay and other inputs**, and total food mile ranch-to-table. For a carbon ranch, there are some key measures of its carbon footprint: energy use; ecological footprint; GHG emissions; eutrophying emissions (i.e. methane). This total is due to chemical fertilizer production, cultivation of feed crops (corn) off site or on-site, feed transport, animal production (fermentation and methane and nitrous oxide emissions), and the transportation of animal products.

I. **Maintain or reduce the net benefit in cost/acre of producing weight gain on livestock.**

J. **Promote shared learning and technical experience on climate-smart soil building practices** within the internal management team and outreach to stakeholders and interested parties.

Vegetation Targets by Species and Functional Group

A selection of key species for monitoring helps focus management on objective indicators of whether vegetation condition targets are being achieved or not. Choosing "functional groups", rather than individual species of plants that provide a range of ecological traits increases the likelihood of invasion resistance (Young et al. 2009; Aigner et al. 2011; Kimball et al. 2014). Also, incorporating a variety of functional groups on grazing lands or in restoration mixes increases the likelihood of maximizing an array of ecosystem services in a restored habitat. Annuals tend to grow quickly producing much biomass starting after first fall rains, bloom early, and have shallower roots. In contrast, perennials grow slower, bloom later, and have deeper roots. A mix of functional group root depths (perennials and annuals, woody and herbaceous) is more likely to saturate niches in the microbial community.

Key Species:

- Cool season perennial bunchgrass
- Warm season perennial bunchgrass
- Perennial grasses with rhizomes or stolons
- Annual and perennial legumes
- Cool season annual grass, naturalized
- Cool season annual forb, naturalized
- Cool season invasive forb
- Warm season invasive forb

Key Areas:

- Fenced off areas that have not been grazed for as long as possible.
- Representative sites in each starting baseline condition, above.

Table 3. Desired species for increase toward improving soil health and carbon storage, and some for decrease or extirpation.

Cool Season Perennial Grasses			
Calamagrostis koelerioides	dense-pine reed grass	*Melica californica*	California melic
Elymus glaucus	blue wildrye	*Melica imperfecta*	coast range melic
Elymus triticoides	creeping wildrye	*Melica torreyana*	Torrey's melic
Festuca Californica	California fescue	*Stipa pulchra*	purple needlegrass
Hordeum brachyantherum	meadow barley	*Poa secunda*	Sandberg bluegrass
Koeleria macrantha	prairie junegrass	*Thinopyrum ponticum*	tall wheatgrass
Leymus triticoides	creeping wildrye		
Cool Season Native Bunchgrasses			
Achnatherum diegoensis	San Diego needlegrass	*Koeleria macrantha*	prairie junegrass
Calamagrostis koelerioides	dense-pine reed grass	*Melica californica*	California melic
Elymus glaucus	blue wildrye	*Melica imperfecta*	coast range melic
Bothriochloa barbinodis	cane bluestem	*Melica torreyana*	Torrey's melic
Festuca Californica	California fescue	*Poa secunda*	Sandberg bluegrass
Hordeum brachyantherum	meadow barley	*Stipa pulchra*	purple needlegrass
Cool Season Native Rhizomatous Grasses			
Agrostis pallens	bent grass, leafy redtop	*Melica californica*	California melic (some rhizomes)
Calamagrostis koelerioides	dense-pine reed grass		
Cool Season Native Annual or Perennial Forbs			
Castilleja exserta	owl's clover	*Vicia sp., Lathyrus sp.*	vetch, peavine
Warm Season Perennial Grasses			
Achnatherum diegoensis	San Diego needlegrass	*Distichlis spicata*	saltgrass
Aristida purpurea	purple threeawn	*Leymus triticoides*	creeping wildrye
Bothriochloa barbinodis	cane bluestem	Muhlenbergia rigens	deergrass
Bouteloua gracilis	blue grama	Sporobolus airoides	alkali sacaton
Warm Season Native Bunchgrasses			
Bouteloua gracilis	blue grama	*Bothriochloa barbinodis*	cane bluestem
Aristida purpurea	purple threeawn		
Warm Season Native Bunchgrasses			
Distichlis spicata	saltgrass	*Leymus triticoides*	creeping wildrye
Desired Natives for Seeding or Sprigging in Formerly Tilled Fields			
Potentially Beneficial Natives for Seeding (or sprigging if rhizomatous)			
Bouteloua gracilis	blue grama	*Calamagrostis koelerioides*	dense-pine reed grass

Distichlis spicata	saltgrass	*Melica californica*	California melic
Leymus triticoides	creeping wildrye	*Acmispon glaber*	deerweed (subshrub)
Hordeum brachyantherum	meadow barley	*Castilleja* sp., *Lathyrus* sp., *Vicia* sp.	Legumes: owl's clover, peavine, vetch
Agrostis pallens	bent grass, leafy redtop		
Desirable Non-natives for Formerly Tilled Fields for Soil Health and Forage			
Non-native Bunchgrass			
Thinopyrum ponticum	tall wheatgrass		
Non-native Rhizomatous Grass ??			
Non-native Annual Grasses. Manage to compete with invasive broadleaf forbs and for persistence, these are valuable as forage and for total carbon sequestration			
Avena barbata	slender oat	*Bromus hordeaceus*	soft chess
Avena fatua	wild oat	*Lolium multiflorum*	Italian ryegrass
Non-native Legume Desirable as Forage and for Soil Health			
Medicago sativa	dryland alfalfa		
Non-native Annual Forbs Desirable as Forage			
Erodium spp.	filaree		
Species Targeted for Reduction by Ground Cover Management and Increasing Perennial Grasses			
Invasives for Reduction or Extirpation			
Brassica nigra	black mustard	*Schismus barbatus*	Mediterranean grass
Raphanus	radish	*Sorghum halepense*	Johnson grass
Bromus madritensis ssp. *rubens*	red brome	*Sisymbrium* spp.	hedge mustard
Bromus diandrus	ripgut brome	*Hirschfeldia incana*	shortpod mustard
Salsola tragus	tumbleweed	*Phalaris minor*	littleseed canary grass
Melinis repens	natal grass	*Phalaris paradoxa*	paradox canary grass
Species Targeted for Extirpation (localized, controllable with herbicide)			
Paspalum dilatatum	dallis grass	*Piptatherum miliaceum*	smilo grass

Grazing Capacity Estimate

Carrying capacity is an average based on long-term records of climate, forage production, stocking rate, and experience. The historic stocking rate of the two main ranches that occupied the ranch in the past was about 25 acres per Animal Unit Month (AUM; John Austel, pers. comm.).

Carrying Capacity Based on Slope Class

For this Plan, we estimated carrying capacity (AUM/acre) using a scorecard that adjusts for slope and canopy cover. This scorecard was adapted from that developed by McDougald et.al (1991). The "scoring" adjusts carrying capacity based on four slope classes (0-10%, 10-25%, 25-40%, and >40%) and several canopy cover classes. A slope class map was generated from a digital elevation model and canopy cover was assumed to be no trees or shrubs, based on recent aerial photos. Table 2 below shows acreages calculated from that map, and Table 3 shows the carrying capacity for each pasture based on the mapped slope classes in ArcGIS™.

Table 4. Slope classes and their acreage on six RCD pastures.

Slope Class	RCD Pasture Acreages						Total
	1	2	3	4	5	6	
10%	84.2	69.2	76.0	35.5	8.7	68.4	342
25%	34.9	72.6	77.2	4.7	16.8	101.1	307
40%	3.8	4.7	3.2		2.8	74.5	89
60%	0.1	0.1			0.4	12.2	13
Totals	**123.0**	**146.6**	**156.4**	**40.2**	**28.7**	**256.3**	**751 acres**

Table 5. Grazing capacity in Animal Unit Months (AUM) by RCD pasture. RDM standard based on Bartolome et al. 2006.

Slope Class	RCD Pasture						RDM Standard (lb/acre)
	1	2	3	4	5	6	
	AUM	AUM	AUM	AUM	AUM	AUM	
<10%	59.0	48.4	53.2	24.8	6.1	47.9	300
10-25%	27.9	58.1	61.8	3.8	13.4	80.9	400
25-40%	1.1	1.4	1.0		0.8	22.3	500
40-60%	0.0	0.0	0.0	0.0	0.0	1.2	600
Total AUM	**88.0**	**107.9**	**115.9**	**28.6**	**20.4**	**152.4**	**513 AUM**

Forage Production Based on Soil Range Site

Range forage productivity estimates from NRCS Soil Descriptions suggest that recent stocking rate has been conservative and below the actual carrying capacity based on soils (and not land use history). The NRCS has estimated forage production for favorable (above average) and unfavorable (below average) production years for the soil classes (Table 4). Forage estimates confirmed the estimates presented in the soil descriptions with a range of about 300-600 AUMs available. Usually, the difference between favorable and unfavorable year production is related to the volume and timing of rainfall.

Table 6. Forage production estimates (pounds/acre) for RCD pastures, soils and range sites during favorable and unfavorable years (San Diego County Soil Survey 1973). Range site classes are used because Ecological Site Descriptions, which are based on peer-reviewed state/transition models, are nor developed for this part of California.

Rainfall Year	RCD Pasture						Total (lbs/acre)
	1	2	3	4	5	6	
Favorable	98,670	152,949	218,534	2,656.0	29,555	115,165	**617,529**
Unfavorable	46,821	74,625	108,673	1,328.0	14,586	43,748	**289,779**

Grazing Practice Recommendations

Annual Grassland, Recommended Practices to Maintain Vigor and Sustain Soils. Grasslands that are comprised mostly of non-native annual grasses are considered a naturalized vegetation community in California. They are generally very productive for livestock due to the biomass of palatable forage produced each year. They are managed primarily by a *minimum RDM standard*, or mulch, left behind at the end of the growing season. This is because there is no need to restrict grazing to protect the flowering period or to restore vigor of these grasses which are prolific seeders and die as soon as the soil profile is depleted of moisture. While perennials store carbohydrate reserves underground to get through winter or drought, annuals put their energy into speedy growth and abundant seed. Annual grasses sequester more carbon when they are alive due to high above-ground biomass but compared to perennials do not store as much long-term soil carbon below ground. They do benefit soil health because they provide ground cover and therefore prevent runoff and sedimentation, and many are valuable as forage. Also, ungrazed annual grassland is expected to have less carbon storage potential than grazed annual grassland, due to a stimulating effect of mulch removal, and some evidence that root growth is stimulated with grazing. Mulch influences moisture, light intensity and temperature at the soil surface, with effects on germination and seedling establishment depending on species ecology (Weaver and Rowland 1952; Heady 1956; Facelli and Pickett 1991). Removal of grazing from California wildlife preserves has been common and has been shown to reduce diversity of herbaceous native and exotic plant species, in some cases to the detriment of rare plants or wildlife that depend on the forb component of the grassland (Weiss 1999; Hayes and Holl 2003; Marty 2005; Pyke and Marty 2005). For all the reasons cited here, livestock grazing benefits the ecology of annual grasslands, including health of its soils.

- ***Manage RDM, primarily, in annual grassland.*** In California annual grasslands, the fall RDM influences the subsequent growing season's species composition and forage production in a direct linear relationship (Bartolome et al. 1970, 2006; George et al. 1996; Jackson and Bartolome 2006). Properly managed RDM can provide a high degree of protection from soil erosion and nutrient losses, and it is used as a proxy for grazing intensity (Bartolome et al. 1980). Moreover, it appears that grazing enhances root growth in annual grasses. In a controlled study, any defoliation in open annual grassland increased the ensuing year's root:shoot biomass Betts (2003). This suggests that grazing annual grassland can improve the potential for soil carbon production. Light to moderate grazing (moderate to high RDM at season's end) tends to maintain a grass-dominated ground cover, whereas close grazing tends to increase low growing forb components of the grassland such as filaree and various legumes. Clipped plots are used to estimate

RDM. The RDM estimate does not include non-forage plant material such as oak leaves and summer annuals like yellow starthistle, turkey mullein, and tumbleweed. While these plant parts do provide soil protection, they do not figure into livestock management and so are not included in the RDM guidelines.

- *Rotating within a single growing season, short duration intensive grazing to reduce weeds, allow grass recovery, stimulate roots and soil carbon.* Depending on the mix of objectives for and annual grassland pasture, such as wildlife habitat, control of broadleaf weeds, or maintenance of perennial grasses, the desired vegetation outcome can vary from a uniform, evenly cropped appearance to one that is a mosaic of heights and patchiness. A uniform and complete use of a pasture can benefit control of broadleaf weeds, by constraining the grazing animal's choosiness about what it eats. Short periods of intensive grazing, while logistically challenging and usually requiring electric fencing, can result in more uniform and complete use of a pasture, including weeds, by reducing the animal's ability to avoid less preferred species (DiTomaso 2002; DiTomaso et al. 2006; Huntsinger et al. 2006). Pastures would be intensively grazed for 3 to 5 days, with the assistance of the electric fencing or other means to concentrate the animals. Then the animals are moved, and the grazed area is allowed to recover for at least a month before grazing is repeated. When grazing animals avoid eating a weed because more palatable forage is available, that can encourage the weed's growth by eliminating its competition, leading to more rapid infestation (Huntsinger et al. 2006). Goats are typically browsers and sheep prefer more forbs; these preferences can effectively control certain weeds more effectively than cattle when changing the class of animal is an option.
- *Rotation year-to-year for a diversity of grassland conditions.* To foster wildlife values in annual grassland, Barry et al. (2011) have compiled grazing practices that may be used to manipulate habitat values and animal populations. Grazing can be used to diversify habitat by leaving a mosaic of herbaceous vegetation levels ranging from closely grazed to ungrazed. A vegetation mosaic ensures that tall vegetation is available for fawning and hiding habitat, while short to moderate vegetation is available to certain rodents and ground dwelling birds. Target vegetation levels can be rotated annually so that each pasture is not grazed every few years; that way some tall herbaceous vegetation is provided. A closely grazed year might be followed by an ungrazed or lightly grazed year to provide for vegetation recovery from the intensive grazing. A mosaic of herbaceous vegetation levels can be achieved using rotational grazing that is planned annually in the Annual Operating Plan.

Grazing Management in areas with a strong perennial grass component, at least 20% cover or one clump per square meter. These areas should be managed to improve the competitive ability of the perennial grasses, as the naturalized annual grassland can exclude and suppress the bunchgrasses. The annuals' earlier and faster growth rate allows them to dominate resources and reduce light and water available for native seedlings. Savelle (1977) found that removing mulch from purple needlegrass bunches resulted in increased seed production. Other experiments suggest that leaving mulch ungrazed can inhibit the establishment of seedlings (Dyer et al. 1996). Dyer and Rice (1999) and Hamilton et al. (1999) demonstrated that when purple needlegrass is growing among non-native annual grasses, it benefits from grazing because diffuse competition from these annuals is reduced (Dyer and Rice 1997b; Malmstrom et al. 2006). The primary purposes of proper livestock management in areas with a strong perennial grass component are is to (1) remove thatch to allow light penetration to new shoots; and (2) timed rest from grazing to allow reproduction and restore vigor both for photosynthesis above and carbon turnover in the root zone. Annual grasses suppress perennial grasses under continuous or unmanaged grazing; however, the influence of managed grazing systems are not well studied, such as reduced grazing intensity, seasonally timed grazing, or rest. Proper grazing practices can maintain and improve the competitive ability of native grasses but increasing density will require other tools, such as seeding or transplanting of native grasses.

- ***Low grazing intensity*** during the growing season is most appropriate for increasing cover of native bunchgrasses. Avoid grazing closely and continuously over many months and years.
- ***Graze early and late(summer-fall), while resting livestock use during tillering and flowering.*** The following recommendations come from the Prescribed Grazing Plan for CDFW's 2016 Knoxville Wildlife Area in the foothills west of Sacramento, California (George et al. 2016).
    - Graze early spring to de-thatch and suppress faster germinating annual grasses reducing the competitive suppression for perennial bunchgrasses or native forbs whose seed germinates later than the grasses (Love 1944; Langstroth 1991; Dyer et al 1996).
        - On productive soils, graze heavily to reduce the invasive species and follow with rest during flowering and hard summer–fall grazing to reduce litter and produce a harsh microclimate for germination and seedling establishment the following growing season. This also reduces fuel load.
        - On less-productive soils, limit heavy spring grazing to high-production years.
    - Rest for at least 4 weeks following spring grazing to allow regrowth and tillering. Rotational grazing can facilitate application of this rest treatment to different pastures.
    - Rest during flowering to allow for seed set before soil moisture is depleted. Depending on the timing of spring grazing, the rest in the previous bullet may have accomplished this purpose.
    - Leave a minimum bunchgrass stubble height of 5–10 centimeters (cm; 2–4 inches) to ensure regrowth and tillering. Close grazing (less than 2.5 cm) throughout the growing season for two growing seasons in a row can result in bunchgrass mortality.
- ***Rotate the Rest Period among pastures and years so that each pasture is allowed seed set and no pasture is closely grazed for a series of years:*** If rest cannot be applied to pastures during flowering and seed set annually, then this rest treatment should be rotated annually so that purple needlegrass has a chance to flower and set seed in each pasture every few years. Rotational grazing that provides for at least 4 weeks of rest following grazing during the growing season, avoids grazing the same pasture during flowering each year, avoids grazing below a stubble height of 5 cm during the growing season, and removes standing litter during the dry season should maintain the vigor and competitive ability of purple needlegrass. By changing the herbage level removed/treated annually (utilization level), no pasture will be closely grazed several years in a row and each pasture will provide a different herbage level over a period of years. When a pasture is targeted for weed control it could be one of the closely grazed pastures in the annual sequence. A calendar of a grazing rotation plan can be developed for pastures assuming an in date of the first week in January and an out date at the end of June. The sequence of pasture use would be changed depending on available livestock numbers and utilization monitoring during the grazing season. If livestock numbers are low, the utilization levels for each pasture may not be achievable unless additional pastures are ungrazed or grazed less than suggested.

Riparian areas and pastures influenced by riparian drainages. Grazing areas within and within the influence of (flood zone or high water table) riparian drainages should be managed to increase the perennial component of the vegetation, both understory perennial grasses and woody trees. Many benefits arise from improving perennial cover for soil health, carbon sequestration, invasion resistance, wildlife, fire resilience, water quality, and forage quality and quantity.

- Riparian areas should be fenced so that, when permitted, the residence time of livestock can be controlled, usually for short durations. As upland forage coarsens and dries, livestock can be attracted to shade and greener vegetation, and overuse them. Placing livestock attractants such as water troughs, salt and protein supplements away from the riparian can help. Rotational grazing among several riparian pastures provides for recovery from grazing. Four or more pastures grazed rotationally in a planned sequence will help provide sufficient rest and recovery time and promote a diversity of herbage levels.
- Protect oak seedlings and saplings, and any riparian trees. Expand the zone of flood tolerant herbaceous perennials and woody plants by planting scattered trees.
- Promote flood tolerant grasses in sandy soils*: Elymus triticoides, Distichlis spicata, Koeleria macrantha, Sporobolous airoides.* Promote flood tolerant grasses in clayey soils: *Agrostis exarata, Bromus carintus, Elymus condensatus, Festuca microstachys, Hordeum brachyantherum, Sporobolous airioides.* Avoid the flood zone for these perennial grasses: *Bouteloua gracilis, Stipa pulchra, Poa secunda, Elymus glaucus.*

Previously Cultivated/Invasive Forb Dominated. These areas have the potential to change the most dramatically with respect to carbon storage and soil health. Their starting condition is predominantly non-native grasses, with a high proportion of weedy broadleaf forbs. Some of the broadleaf weeds have considerable nutrition for livestock; however, their predominance conflicts with other objectives for wildlife and biodiversity. The desired condition is toward a reduction in invasive weeds, increase in desirable forage species, and at least 20% cover herbaceous and/or woody perennials. It is unclear whether the weedy forbs, such as mustard and radish, store more soil carbon than annual grasses due to their deep tap roots; however, an eventual conversion to a high proportion of herbaceous perennials, with scattered woody elements, is expected to improve soil health. An "all available tools" approach would improve the chance of successful improvement in soil health. For example, allowing irrigation would likely increase soil organic carbon, since soil moisture can limit N turnover and, in interaction with N, carbon gains (Austin and Sala 2002). Wed control and seedbed preparation are necessary before planting natives. Weed control can be accomplished by herbicide, burning, disking, mowing and often a combination of these methods. One of the least expensive ways to clear the weeds before planting native grasses is simply to till the soils over a long enough period to exhaust the seed bank, then repeatedly till and kill emergent seedlings before they produce seeds. Alternatively where cultivation is possible, growing a crop of oats for hay or grazing with broadleaf weed control has been used in preparation for perennial grass seedings. Annuals and perennials together in a seed mix or the annuals will decrease the emergence of the perennials (Young et al. 2014). Planting or seeding perennials earlier than annuals is a good way to encourage germination and root development of perennials in the absence of intense competitive pressure from annuals (Abraham et al. 2008; Young et al. 2014). Establishment of new herbaceous perennials is recommended first along roads and to enhance the margins areas influenced by riparian drainages. Livestock can enhance the success of the array of methods used to suppress weeds.

- **Similar guidelines for livestock management to those for annual grassland (**see above) apply to these previously cultivated areas, with enhanced attention to weed control, and to favoring the more palatable annual forage grasses, such as soft chess, as well as forbs such as filaree.
- Grazing can help suppress the invasive weeds but **strategic application of herbicides and seeding** may be required to increase the density and extent of native plant populations. A principle of maximizing as much ecological function as possible in a designed grassland is to diversify the mix of planted species. No one species should constitute more than 35% of a mix, and including some low-lying, tall, shall-rooted, deep-rooted species, legumes, etc. Avoid planting in rows, and use topography to enhance diversity.

- ***Residual Dry Matter and Soil Cover.*** In these relatively flat areas, it may be necessary to graze intensively to very low RDM (300 lbs/acre) to change species composition toward preferred annual forage species as well as establish perennial forage. Vegetation cover should not reduce below 60% to protect from soil loss.
- ***Grazing for Weed Control.*** Although grazing is unlikely to be a practical solution for management of large-scale infestations, it can be an effective strategy for targeting nontoxic weeds that can be cost-effective. Sufficient infrastructure must be available such as fencing, access, and water (Kimball et al. 2015) to focus livestock where needed to prevent flowering.
    - Time grazing to reduce flowering on non-native forbs (DiTomaso 2000, 2006a, 2008).
    - When first developing a grazing calendar, designate any pasture targeted for weed control first, as it requires grazing during a specific flowering period (probably March and April) to reduce flowering. The grazing periods for other pastures can be then be designated. Try to ensure that each pasture is grazed at a different time every year, by beginning grazing in a different pasture each season (see above under Annual Grassland). Ensure that the desired grazing level for a pasture is not the same for several years in a row, to promote a diversity of herbaceous conditions for wildlife.
    - Properly timed grazing can reduce flowering in non-native annual grasses such as ripgut brome, and red brome (Savelle and Heady 1970; Germano et al. 2004; McGarvey 2009). Grazing exclusion often leads to ripgut brome dominance (Heady 1968; Heady et al. 1991) whereas livestock can reduce ripgut brome by grazing off the RDM (Heady 1958). If the desire is to reduce the prevalence of less palatable cool season grasses such as ripgut or red brome, time grazing to defoliate these grasses just before seed head emergence. However, very high stock densities are often necessary to get the close grazing required to reduce flowering, and this during a narrow window of treatment of 1 to 2 weeks before the flower emerges. Thus the area that can be treated annually will be small. This method may not be practical because livestock may prefer other species or may not be able to graze all plants prior to seed set. Here is a possible sequence, adapted from George et al. (2016):
        - Graze from late November to February to reduce thatch.
        - Graze from March to June to reduce flowering and seed set, of the less palatable grass. Target an RDM of 300 lbs/acre on these nearly level pastures.
        - In years with late spring rainfall (April-June) the grazing season should be extended beyond June to impact the undesired grass regrowth following late rains.
        - Increase stock density in target areas just before flowering (March-April). Stock density can be increased by decreasing the size of the pasture using electric fencing. Graze the target area as close as possible.
        - Repeat the treatment in year 2.
        - Place protein supplements (e.g. Crystalyx) near weedy patches to increase grazing and trampling in the patch.
    - ***Mustard and radish control.*** The disturbance created by cultivation favors these colonizers. They form dense infestations and may produce allelochemicals that prevent growth of competing species, allowing them to take over large areas. Plants in the mustard family can develop deep taproots allowing them to proliferate on dry sites or in dry years. The deep taproot extends below the zone of root competition of associated annual species and allows growth and flowering to occur well into the

summer, long after other annual species have died and dried up. They regrow after top removal from mowing or grazing. Seed can last 10 years or more in the soil.

- Grazing can enhance other control methods for mustard and radish control, such as herbicide applications. High intensity grazing at bolting can reduce flowering and seed production. Timing is critical to the success of grazing for control. The ideal time to graze is when plants are most susceptible to defoliation or when the impact on desirable vegetation is minimal, then repeated as flowers re-emerge.
- Promoting saltgrass would decrease mustard because of the ground cover provided by the saltgrass.

Stocking Rate: Forage-Animal balance

To ensure forage available meets the demand of livestock and wildlife, actual stocking rate should not exceed carrying capacity. Starting the stocking rate low, and then increase it experience is gained, and monitoring indicates that there is additional grazing capacity.

Distribution of Livestock Grazing

Managing by distribution can improve forage uses more effectively than rotation in annual grasslands. Use strategic placement of water developments or nutritional supplements to manage livestock distribution (Bailey et al. 2001, George et al. 2007, 2008). Alternatively, use electric fencing to facilitate weed management and to refine the creation of grazed and ungrazed mosaics. Large pastures may eventually need to be cross-fenced. Dehydrated molasses protein supplements (e.g. Crystalyx) will attract livestock into an area and increase grazing use up to 600 yards from the supplement site (Bailey et al. 2001; George et al. 2007, 2008). Supplement sites should be moved frequently to minimize trampling impacts. Trampled supplement sites may be good sites for native plant seeding trials (George et al. 2016).

Need for Annual Operating Plan and Example Calendar

An annual operating plan calendar should be developed to accommodate the flexibility needed for adaptive management decisions to meet goals and objectives.

Adaptive Management Contingency Planning

The NRCS Conservation Practice Standard for Prescribed Grazing (Publication 528; NRCS 2017) serves as a guide for adaptive management decisions in grazing prescription adjustments in order to mitigate resource and economic effects. Per the grazing permit, use mitigation bank riparian area as part of a broad contingency plan.

Monitoring monthly precipitation and comparing to averages can help managers determine if the coming forage year is below average. Adjustments in the annual grazing plan including in dates, out dates and stocking rate may need to be considered. If rainfall is adequate during fall to early spring, forage production for the year may reach average levels. However, if rainfall stops early, a prudent decision would be to reduce stocking rate or shorten the grazing season (earlier end date). CDFW and the grazing lessee should jointly develop a drought plan that addresses forage and water constraints and habitat needs at RJER. This may include feeding of hay or other supplements. Low rainfall in November, lack of surface water and poor forage production in the fall may require a delay in the grazing in-date and adjustment in the initial stocking rate. If rainfall in December and January are low, then forage levels will be low during the early part of the growing season and grazing capacity will be reduced. If

February and March rainfall is low, then spring forage production may be low. If there is little rainfall in March/early April, then the growing season could end early.

IV. Monitoring

The challenge of monitoring is to report on movement toward meeting goals and objectives in the context of uncertainty and complexity about trend, cause and effect. It should foster timely management adjustment that are realistic and based on the best science available. In most rangeland situations, the time lag between changes in soil and vegetation properties and grazing are long enough that even intensive monitoring does not detect change with enough certainty to adjust a management practice (Karl and Herrick 2010). Early warning indicators, viewed with the benefit of multiple lines of evidence and some redundancy in selection of indicators, are crucial to recognizing and impending change, determining an effective management response, and evaluating whether the management change worked (Brown 1994).

The following are key to monitoring the effectiveness of practices under this Grazing Plan.

1. Assess **baseline conditions** of vegetation and soil attributes that will be used to report on project outcomes towards objectives.
2. Identify an **ungrazed reference site** for every starting vegetation condition (see Section II *Vegetation Condition*) on a similar soil type to the monitored, grazed site. Reference sites are important to separate out effects of weather and land use history from effects of grazing management. At least these starting conditions should have ungrazed reference sites: sites with 20% or more perennial grasses; sites dominated by naturalized, non-native annual grasses; previously tilled sites comprised of annual grasses and a high percentage cover of weedy invasive forbs; a riparian reference site with an understory of perennial grasses. Additionally, a guide to what the **potential carbon sequestration** is for a given soil/vegetation community could be obtained from a reference site in as native a condition as possible: never tilled, low invasion, and low impact of short-interval fire history. As an example, recovery of a site from cropland to the carbon storage capacity of native rangeland was estimated to be 158 years (Potter et al. 1999) in a tallgrass prairie. Understanding this timeframe means finding locations that substitute for the disturbed and undisturbed condition is better to help inform progress. Another alternative is to select a **reference site that is continuously grazed** to compare with managed grazing.
3. Select meaningful and **multiple indicators of soil health** and other resource conditions. Examples are:
   - CDFA metrics of total Soil Organic Carbon, Total Nitrogen, C:N ratio, and bulk density (OEFI 2019b):

     The RCD proposes analyzing Soil Organic Matter (SOM) content, soil moisture, and water infiltration. They will be measured semi-annually (twice per year) except for SOM content, which will be measured annually. Each variable has a protocol for data collection and analysis that is outlined below. Baseline data for each variable has already been collected.

     - **SOM.** To monitor soil health indicators, SOM will be measured on composite soil samples, i.e. a combination of samples from a pasture into one homogenous sample. One composite soil sample will be collected per pasture (29-254 acres in size), amounting to six samples for the treatment pastures per year. For the control pastures, one composite soil sample will be collected for four pastures (#1, 2, 3, 6), amounting to four samples for the control pastures per year. Following collection, samples will be mailed to a soil testing laboratory (Wallace Laboratories, El Segundo, California) for analysis. Following baseline data, SOM will be monitored annually for three years.

- **Soil Moisture.** To monitor soil moisture, we will use a soil moisture sensor and meter to collect data at 5, 10, and 20 cm depths. Baseline soil moisture data will be collected at the beginning of the project, and then it will be measured twice per year over the grant period. We hope to increase SOM by up to 0.2-0.3% per year by project completion.
- **Water Infiltration.** A 6-inch diameter ring, 444 milliliters (mL) of water, plastic wrap, and a stopwatch will be used. Infiltration measures the speed that water enters the soil; it is performed on soil where it has not rained for at least two days. While minimizing disturbance to the soil surface, the ring is pushed into the soil and lined with plastic wrap, followed by addition of the water to the wrap and removal of the wrap to allow water into the ring. The infiltration rate is the time until half of the surface is absent of water (has drained into the ground); the second infiltration measurement provides a better estimate of the infiltration rate. We will monitor water infiltration twice per year at three sites per pasture, which equates to 18 samples over all 753 acres.

- Soil aggregate stability.
- Relative cover of plant functional groups. Such an approach has been adopted for restoring wetlands by CDFW, using an analog of plant composition change to reflect change in carbon. Since all vegetated lands sequester carbon and are a source of GHGs, methods for estimating carbon stock changes and methane (CH_4) and nitrous oxide (N_2O) emissions from currently occurring lands may be compared to the array of treated lands. Vegetation mapping is used to group lands into acreage categories for analysis based on a detailed, up-to-date floristic baseline. The CALVEG quantitative, dual-dominant floristic inventory methods could be used for mapping, which are the methods recommended by CDFW. For the standing aboveground biomass, down dead wood, and litter , a combination of direct sampling, allometry, and look-up tables are used. To address the carbon sequestered in herbaceous layers, clip plots are used to assess annual peak aboveground biomass. Root to shoot ratios would be used to calculate the mean annual herbaceous biomass carbon stock. Soil organic carbon and processes involving nitrous oxide and methane would be estimated based on the best available soil data in the literature. The total GHG benefit would be calculated using a similar process as the Coastal Tidal Wetlands Restoration calculator, as detailed in the Quantification Methodology for the CDFW Wetlands Restoration Program. These above methods are described in Ogle et al. (2014).
- The 17 Indicators of Rangeland Health often used by the Bureau of Land Management and NRCS (Pellant et al. 2005). They are a semi-quantitative assessment of: rills; water flow patterns; pedestals and/or terracettes; bare ground; gullies; wind scoured, blowouts, and/or deposition areas; litter movement; soil surface resistance to erosion; soil surface loss or degradation; plant community composition and distribution relative to infiltration and runoff; compaction layer; functional/structural groups; plant mortality/decadence; litter amount; annual aboveground biomass; invasive plants; and reproductive capability of perennial plants.
- Microbiological indicator. Plants build soil fertility by releasing root exudates and leaving residues behind for bacterial food. During this process, some carbon is sequestered as humus and some released as carbon dioxide due to microbes eating (carbon dioxide release and sequestration can be seen as two parts of the same process—whatever is not released as carbon dioxide is sequestered). As soil quality declines, food supply for microbes diminishes and the amount of carbon emissions by respiration declines. Declining rates of respiration are principally associated with the absence of plant cover. This can be an outcome of soil tillage.

   - Microbiological indicators can reflect a management shift within one to two years and can be indicators of an array of healthy soil functions. They are constrained by soil texture and depth, as well as temperature and moisture, and can be compared against the potential “attainable” microbial biomass.
   - Carbon from soil microbes changes faster than soil organic carbon with management. Carbon dioxide respiration is a measure of metabolically active soil microbes and indirectly of nutrient release (mineralization of Nitrogen and Phosphorus). The turnover rate of carbon dioxide can improve with management practices including cover cropping and organic amendment. The accuracy of measuring the rate of carbon exchange via soil depends on related factors such as C:N.
4. **Repeat monitoring from the same location, same time of year** to establish trend. Photographic monitoring from a permanently established point is an important start. Sampling should be done at the same time of year in relation to plant growth, such as the peak biomass stage, or the half-cured stage in grasses.
5. Monitor **environmental variables that affect the outcome of grazing practices**. Climate and weather, including the timing of seasonal rains, are believed to be the primary control over the composition of an annual grassland (Heady 1977). A good rain year, a drought, or a fire can overwhelm the effect of managed grazing on vegetation and soil condition.
6. Establish a qualitative **baseline for environmental co-benefits**, such as ranch carbon efficiencies such as the need to supplement hay.
7. Establish a current baseline cost per acre for grazing, for comparison against implementing managed grazing. Establish an approach to assessing **economic co-benefits**.

We aim to demonstrate the benefits of these practices to the land and showcase managed grazing as a compelling practice that will propel San Diego County towards one of many needed solutions to climate adaptation, one on a working landscape. This project will act as a demonstration site for local and state ranchers interested in implementing grazing land practices to boost environmental benefits and safeguarding against frequent and extreme climatic events.

V. References

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