Understanding Livestock Grazing Impacts

Strategies for the California Annual Grassland and Oak Woodland Vegetation Series

Wildland Solutions

Elkhorn Slough Foundation

University of California Division of Agriculture and Natural Resources, Publication 21626

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Strategies for the California Annual Grassland and Oak Woodland Vegetation Series

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You can find an online, interactive version of this publication at http://www.grazingimpacts.info/

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Table of Contents

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Introduction

“While there is considerable information on the impacts of livestock grazing, much of it is difficult to locate or in a format that is not user friendly. Understanding Livestock Grazing Impacts assembles and presents this information in a way that is both comprehensive and accessible.”

Photo courtesy of USDA NRCS.

Managing rangelands in the western United States has become much more complex over the last few decades. A century ago the goal was to survive as a livestock producer, and rangeland management involved using forage effectively and overcoming obstacles such as predators and shortages of water and feed. Today the successful rangeland manager also needs to consider the diversity and health of the ecosystem.

Livestock grazing can affect riparian areas, sensitive plants, and endangered wildlife. Livestock grazing impacts are not just either/or, impacts will vary considerably depending on the season, intensity, frequency and class of livestock grazing that occurs.

The health of ecosystems can be assessed by using the "criteria and indicators" concept. This entails identifying individual environmental, economic or social indicators that are affected by livestock grazing and that can be described, evaluated and monitored. Environmental indicators include habitat for endangered species such as the kit fox, oak regeneration and water quality, and economic indicators include forage production and calving rate.

While there is considerable information on the impacts of livestock grazing, much of it is difficult to locate or in a format that is not user friendly. Understanding Livestock Grazing Impacts assembles and presents this information in a way that is both comprehensive and accessible. This makes it easier for ranchers and land managers to analyze, compare and choose the grazing strategies that best achieve the goals for a given grazing unit.

Understanding Livestock Grazing Impacts:

- identifies 30 environmental and economic indicators,
- summarizes existing research data and predicts the impact of grazing strategies on each indicator,
- evaluates three components of grazing strategies: grazing intensity, grazing season-of-use, and livestock class/type,
- evaluates two habitat types: California Annual Grassland and Oak Woodland,
- presents the information visually in grazing impact graphs, and
- shows how the indicators can be measured and monitored.

Part 1

Planning Overview

A Four Step Process

"Monitoring helps identify issues and opportunities that can be analyzed and then used either to adjust the strategy for reaching the goals or to change goals that are not realistic."

Photo courtesy of USDA NRCS.

Livestock grazing management plans for a ranch or property should be developed for each individual pasture or management unit so that unique issues and opportunities are addressed. For example, one pasture may have vernal pools and sensitive aquatic wildlife while another pasture may have oak woodlands and native perennial grasses.

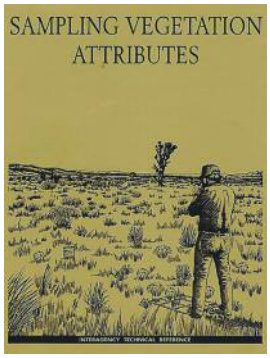
There are four steps to developing a livestock grazing management plan:

1. **Determine the existing condition:** inventory of facilities, issues and opportunities.
2. **Determine the desired condition:** establish goals and objectives for each pasture and the ranch as a whole.
3. **Analyze** predicted impacts, develop measurable goals and select a strategy for achieving your goals.
4. **Monitor** indicators to evaluate progress towards achieving your goals.

Once the grazing management plan is implemented, these steps should be repeated continuously. Monitoring is used to reassess the pasture's condition and progress toward goals, which in turn will show if the selected strategy is still appropriate. In other words, monitoring helps identify issues and opportunities that can be analyzed and then used either to adjust the strategy for reaching the goals or to change goals that are not realistic.

Photo courtesy of USDA NRCS.

STEP 1: Determine the existing condition: inventory of facilities, issues and opportunities.



The extent of this step will depend on the information that is already available and the potential issues associated with the property. When possible, the inventory of issues and opportunities should rely on information that is already available. However, when historic information is unavailable or is not reliable, new field surveys and public involvement meetings may be needed. Additional surveys should be relevant to the issues identified and the decisions to be made. For example, detailed soil surveys would be appropriate if restoration seeding is anticipated, soil surveys would not be needed if seeding is not anticipated. If good livestock actual use records are available, there is no need to prepare a detailed carrying capacity analysis.

Only collect information that is needed to address your issues.

Inventories typically include:

- Estimating the amount of forage available, which can be based either on historical livestock use records or calculated by determining the average forage produced and the area utilized by livestock. Average forage production is often reported in the USDA soil survey.
- Determining the condition or health of the rangeland, methods such as those presented in "Interpreting indicators of rangeland health." ITR 1734-6 can be used.
- Mapping existing livestock facilities such as water sources, fence locations and access roads.
- Identifying the potential issues and conflicts created when implementing a livestock grazing program for a particular pasture or property, such as:
  1. Conflicts with recreational use, and
  2. Effects on:
     - wildflowers
     - oak regeneration
     - native grasses
     - noxious weeds
     - threatened and endangered wildlife
     - riparian areas
     - fire hazard
     - water quality and
     - soil erosion.

For more information:

Holechek, J. L., R. D. Pieper, and C. H. Herbel. 2000. Range management: principles, and practices. 4th ed. Prentice-Hall Inc., Englewood, NJ.

U.S. Department of Agriculture, Forest Service. 1997. Pacific Southwest Region Rangeland Analysis and Planning Guide. R5-EM-TP-004.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1997. National range and pasture handbook. 190-VI. U.S. Department of Agriculture, Washington DC.

U.S. Department of Interior, Bureau of Land Management. 1999. Utilization studies and residual measurements. Interagency Technical Reference 1734-3. U.S. Department of Interior, Bureau of Land Management, National Business Center, Denver, Colorado.

U. S. Department of the Interior, Bureau of Land Management. 2000. Interpreting indictors of rangeland health. Interagency Technical Reference 1734-6. U.S. Department of Interior, Bureau of Land Management, National Science and Technology Center Information and Communications Group, Denver, Colorado.

STEP 2: Determine the desired condition: establish goals and objectives for each pasture and the ranch as a whole.

Clear, concise goals and objectives must be developed before selecting a management strategy for a property's rangeland resources. For planning purposes, goals are typically general while objectives are typically specific and measurable. Examples of goals include "improve forage production", "make a profit", and "protect endangered species habitat", and examples of objectives for a specific site may include "retain 1,000 lbs/acre of RDM", "develop 5 water sources", "establish riparian stream cover of 80%" and "maintain 50% cover of perennial grasses". In addition, objectives should include a timeline, as some can be accomplished in 1-2 years while others may take 10-20 years to accomplish.

Because goals and objectives are seldom of equal importance, it is best to prioritize or group them as essential, important and desirable. For example, a goal statement could be worded: *"The goals for the property are to increase A, B and C; to maintain D and E; and to avoid conflicts or problems associated with F, G and H".*

Factors to consider when setting goals for a property include:

- the individual rancher's personal goals or an agency's mission statement and 5-year plan,
- site-specific issues and opportunities such as habitat for sensitive plants and wildlife, riparian areas, oak trees, noxious weeds, and reducing fire risk,
- opportunities for potential lessees to complement their existing grazing operations, which are often overlooked by agencies.

The goals do not need to be elaborate or extensive, just appropriate for the property or individual pasture.

Opportunities to resolve issues associated with livestock grazing can include:

- Producing a vegetative cover that enhances flowering forbs by grazing cattle in the early winter
- Decreasing the need to provide supplemental hay by adopting a different grazing strategy
- Continuing local agricultural endeavors
- Reducing fire risk
- Creating a vegetative pattern of low stature grasses favorable to Burrowing owls or Bay Checker-spot butterfly by grazing during the winter
- Enhancing a riparian area by avoiding use during the hot summer months

For more information:

Savory, Allan. 1999. Holistic management, a new framework for decision making. Island Press, Washington D.C.

U.S. Department of Agriculture, Forest Service. 1997. Pacific Southwest Region Rangeland Analysis and Planning Guide. R5-EM-TP-004.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1997. National range and pasture handbook. 190-VI. U.S. Department of Agriculture, Washington DC.

STEP 3. Analyze predicted impacts and select a strategy for achieving your goals.

Each livestock grazing plan comprises a set of management practices that best achieves the goals and objectives for a pasture or property. There are four management practices that need to be considered when developing a livestock grazing plan:

1. Intensity of livestock use
2. Season of livestock use
3. Type or class of livestock
4. Frequency of use

Each component includes practices that are measurable and can affect individual indicators in various ways, sometimes positive and sometimes negative. To help rangeland managers analyze the impacts of livestock grazing, this publication summarizes 30 environmental and economic indicators. Each summary predicts how the indicator will be affected by the first three components of a grazing plan. While grazing plans also need to include frequency of use, this fourth component is not evaluated as not enough is known to reliably predict the impact of the rest interval between use periods.

Analyzing the grazing impacts and selecting the best management practices can be relatively simple if there are only one or two goals. However, the process is generally more complex. There are often numerous goals and these can conflict with each other, which means there is seldom an ideal combination of practices that achieves all of the goals and objectives. For instance, livestock management practices that achieve short-term goals can conflict with those that achieve long-term goals (see example below). In addition, there may be more than one combination of practices that achieves all of the essential goals. A good approach is to ask first if all the essential objectives are being met and then how well the other desired objectives are being met.

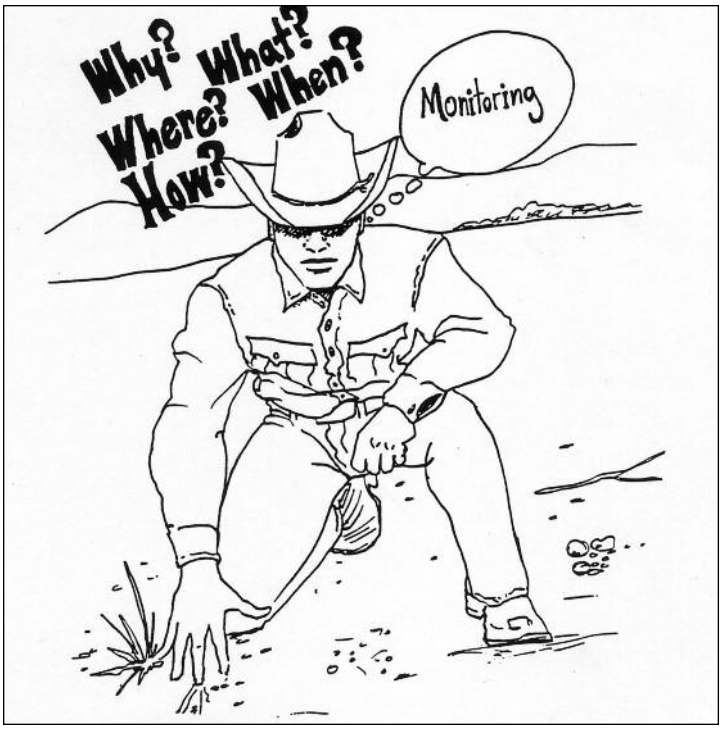
Example of conflicting goals: A pasture could have the goals of reducing yellow star thistle, a noxious weed, and protecting riparian hardwood vegetation. Grazing livestock between late May and early July would help reduce yellow-star thistle but could adversely affect the riparian hardwood vegetation. This may mean deciding which goal is more important. However, there may also be an opportunity to meet both goals: fencing could exclude livestock from the riparian area while allowing them to graze the yellow star thistle.

STEP 4: Monitor the results

Every livestock grazing management plan should include a well-defined monitoring plan. Monitoring will provide the information to determine if desired goals are being met, or if some management practices need to be modified.

Monitoring plans need to be realistic and achievable. A common mistake is to develop a monitoring plan that is so elaborate and detailed that it is impossible to implement fully. When only part of a monitoring plan gets done, information that could be the most useful may not be gathered.

For more information, see the monitoring section.



Part 2

Criteria and Indicators Concept

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Understanding Grazing Impacts is a reference guide that uses the indicator concept to predict direct and indirect grazing impacts based on grazing strategies selected.

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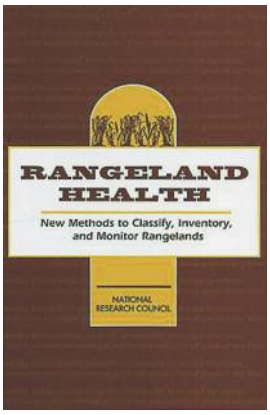
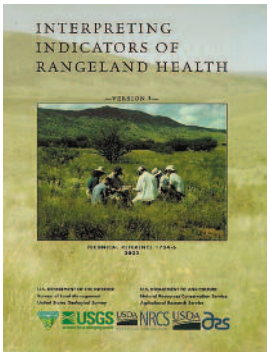
Photo courtesy of USDA NRCS.

The condition of rangeland has traditionally been evaluated with indicators such as bare soil and forage plant occurrence. Now rangeland managers can expand this process to assess ecosystem health based on different grazing management strategies. Evaluating rangeland health with environmental indicators is similar to evaluating people's health by measuring factors from blood pressure to white cell count to cholesterol.



The criteria and indicators concept is widely recommended and used for evaluating ecosystem health. In a 1994 report called Rangeland Health, the National Research Council recommended that federal agencies coordinate developing a process to evaluate rangeland health using the criteria and indicators concept.



In February 1995 the U.S. government agreed in principle to the "Santiago Declaration", a UN-sponsored conference on the environment that adopted using the criteria and indicators concept to measure sustainable forest management practices.

In October 1995 the USDA Forest Service produced a draft publication called A Report to Facilitate Discussion of Indicators of Sustainable Forest Management, which included many indicators that would also be appropriate for sustainable rangeland management.

In 2000 the U.S. Departments of Interior and Agriculture issued an interagency publication called Interpreting Indicators of Rangeland Health (TR 1734-6), which uses 17 indicators to evaluate how the ecological processes on a site are functioning. www.ftw.nrcs.usda.gov/glti/

In 2001 the Sustainable Rangelands Roundtable was established as a consortium of organizations, agencies and universities to identify criteria and indicators for describing and evaluating sustainable rangelands. In February 2003 the consortium proposed 5 criteria with 67 environmental, economic and social indicators. www.SustainableRangelands.cnr.colostate.edu/

Understanding Grazing Impacts is a reference guide that uses the indicator concept to predict direct and indirect grazing impacts based on grazing strategies selected. To help ranch and land managers predict the positive and negative effects of livestock gazing on rangeland ecosystems, this guide focuses on environmental indicators that can be measured and that are relatively well understood.

The use of indicators allows managers to effectively evaluate the impact of different livestock grazing strategies on several facets of ecosystem health simultaneously. Using indicators to predict grazing impacts is not a precise process. Evaluating and predicting the impacts of livestock on rangeland environments are complicated by unstable weather patterns, vegetation changes, wildlife interactions and, in many cases, soil types that vary in a single grazing management unit. Moreover, some indicators such as litter and annual production may be more important than other indicators such as non-native annual grass cover which typically dominates this vegetation series regardless of the grazing strategy. A single indicator such as vernal pool habitat, a sensitive wildlife species or a specific noxious weed may not be important unless it exceeds, or fails to achieve an established level.

Managers can use the indicators presented here to measure progress towards the objectives established during planning, and can evaluate multiple impacts related to livestock grazing. Information on additional indicators and the ability to develop tables with grazing impact charts using selected indicators can be found at www.grazingimpacts.info/.

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Part 3

Indicators

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The summary of each indicator includes:
1. a description of the indicator, 2. the significance of the indicator,
3. the predicted livestock impacts on the indicator: rationale and grazing impact graphics,
4. measuring and monitoring techniques 5. references

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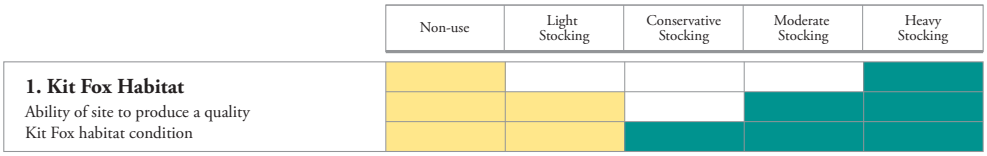


The indicators included in Understanding Livestock Grazing Impacts represent a broad range of environmental and economic values. Additional indicators can be found on the www.grazingimpacts.info website.

The summary of each indicator includes:

1. A description of the indicator
2. The significance of the indicator
3. The predicted livestock impacts on the indicator: rationale and grazing impact charts
4. Measuring and monitoring techniques
5. References

1. DESCRIPTION OF THE INDICATOR
The indicator is briefly described and defined.

2. SIGNIFICANCE OF THE INDICATOR
The significance of the indicator is provided. For example, some indicators are threatened, endangered or state-listed species. In addition, some indicators are referenced to similar indicators in Interpreting Indicators of Rangeland Health (TR 1734-6) or Sustainable Rangelands Roundtable (SRR).

3. PREDICTED LIVESTOCK IMPACTS ON THE INDICATOR
The indicator's expected responses to various grazing strategies are both discussed and presented visually in grazing impact charts.

The reference point for discussing expected impacts is a functioning healthy ecosystem.

These expected changes are not absolutes and typically also depend on a variety of other factors including weather, past grazing history and fire. However, the predicted changes for each indicator are useful for evaluating how well various grazing strategies will meet the established goals.

A livestock grazing plan has four important components: grazing intensity, grazing season-of-use, livestock class/type and frequency of use. The first three components are evaluated for each indicator. The fourth component, frequency of use, is too variable to predict its impact. A good guideline for frequency of use is to allow adequate rest for the vegetation to recover between use periods. For annual grassland, this rest period can vary from two weeks to two years, depending on the condition of the pasture, the season of use and resource issues. For example, a long-rest period of several years may be beneficial to enhance woody vegetation on one site, but would be encouraging a growing noxious annual weed infestation on another site.

Grazing Intensity

Grazing intensity can vary from non-use to extreme use that degrades the environment. Evaluating the impacts of grazing intensities that are between the extremes can be difficult due to the influences of other variables, such as weather, rainfall amounts and timing.

The summary of each indicator compares the impacts for five levels of grazing intensity.

These levels are defined for a California Annual Grassland or Oak Woodland site that is capable of producing 2,000 pounds of Residual Dry Matter (RDM) in a typical year. It should be recognized that some sites are not as productive. On these sites the amount of RDM on the ground prior to fall rains may not represent an actual grazing intensity. The impacts of livestock grazing on annual grasslands producing more or less than this amount can be determined by adjusting the stocking level definitions accordingly.

The five stocking levels represent a range of typical grazing practices used on California annual grasslands:

1. **Non-use:** livestock are not permitted or are only occasionally and insignificantly used. Therefore, vegetation responses and changes would be related to weather, fire, and wildlife use. RDM in a non-use site may vary greatly depending on how much dry matter accumulates from year to year.

2. **Light Stocking:** removes approximately 25% of the forage each year, retaining an estimated 1,500-2,000 pounds of RDM on the ground just prior to fall rains.

3. **Conservative Stocking:** removes no more than 50% of the forage each year, retaining 1,000-1,500 pounds of RDM on the ground just prior to fall rains.

4. **Moderate Stocking:** removes 50-75% of the forage each year, retaining 500-1,000 pounds of RDM on the ground just prior to fall rains.

5. **Heavy Stocking:** removes more than 75% of the forage each year, retaining less than 500 pounds of RDM on the ground just prior to fall rains.

Grazing Season-of-Use
The timing of forage use can have significant impacts on both livestock productivity and plant species composition.

The summary of each indicator compares the impacts for six season-of-use grazing strategies. These are defined for a California Annual grassland or Oak woodland site that is capable of producing 2,000 pounds of Residual Dry Matter (RDM) in a typical year.

The six seasons-of-use represent a range of typical practices in research and management plans:

1. **Non-use:** livestock are not permitted or are only occasionally and insignificantly used. Therefore, vegetation responses and changes would be related to weather, fire, and wildlife use. RDM on a non-use site may vary greatly depending on how much dry matter accumulates from year to year.

2. **Early Season Use (November-March):** livestock are grazed in the fall and early winter, when annual species are beginning to germinate and are growing slowly, and the weather is cool and wet. The forage may be of high nutrient content, but the high water content may result in rapid passage through the rumen and incomplete nutrient extraction. The quantity of new growth may also be limiting.

3. **Late Season Use (April-May):** livestock are grazed in the late spring and early summer, when most annual grass and forb species are still green and maturing, prior to turning dry in the summer. Although the forage's quality is beginning to decline, during this season of use there is generally adequate green forage.

4. **Season-long Use (November-May):** livestock are grazed throughout the growing season, when annual grasses and forbs are typically green.

5. **Dormant Season Use (June-October):** livestock are grazed during the summer, when annual grasses and forbs are dry and cured. The forage is dry and typically has a low nutrient value.

6. **Yearlong Use (January-December):** livestock are grazed for the entire year. The forage changes accordingly as annual species germinate, cure and go dormant.

Livestock Class/Type

Although cattle are the predominant type of livestock grazing California's annual grasslands and oak woodlands, other types of livestock may be used and sometimes will be more effective at achieving specific resource goals. It should be noted that all classes of livestock in addition to grazing plants also create impacts through hoof action i.e. trampling.

Five classes of livestock use are evaluated for each indicator:

1. **Sheep.** Sheep were once found grazing grasslands and oakwoodlands throughout California. Sheep prefer broadleaf plants (forbs) over grasses. They can be managed with an on-site herder when adequate fencing is not available. They can also be managed with temporary electric wire. Protection from predation by coyotes, mountain lions and dogs must be considered in many areas.

2. **Goats.** Although goats can be found throughout California, their has never been a significant commercial industry for meat, milk or hair goats in California. Demand for goats to graze woody plants has helped to create a goat grazing industry in California where landowners pay goat producers for their goat grazing service. Goats like sheep prefer broadleaf plants (forbs) over grasses. They will also browse on woody plants. They can browse quite high into the canopy of tall brush as they can climb and stand on their hind legs. Goats can be herded or controlled by wire or electric fencing. As with sheep, protection from coyotes, mountain lions and dogs should be considered.

3. **Horses.** Horses can graze grass and broadleaf plants. They are able to graze closer than cattle and tend to be more selective.

4. **Cow/Calf.** Cows are predominantly grass eaters. They will graze broad leaf plants and woody plants particularly during summer and fall months when the dried grass may not provide an adequate level of nutrition. Cow/calf producers can be found through out the state. They typically calf once a year in the fall or spring. Cows that are familiar with a site will retain knowledge of the site from year to year i.e. locations of water, better forage, shade. A cow's nutritional requirements during the year vary depending on her production status i.e. dry or providing milk.

5. **Yearling Cattle.** Yearling cattle are predominantly grass eaters. Since they are still growing cattle they have high nutritional requirements year around. Since they are young, they are typically unfamiliar with a site and will distribute more evenly across the landscape than a mature cow herd as they become familiar with water, forage and bedding locations.

Grazing Impact Graphs

Each indicator summary includes three bar graphs of the expected impacts of each grazing strategy:

an open bar means the grazing strategy has no expected impact on the indicator,

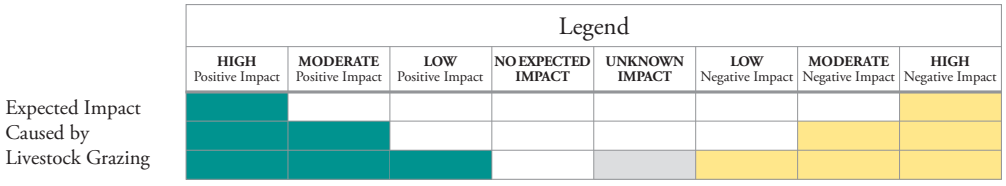
a gray bar means the impact is unknown

a blue bar means the impact is positive:

- 1/3 blue means low positive impact
- 2/3 blue means moderate positive impact
- all blue means high positive impact

a yellow bar means the impact is negative:

- 1/3 yellow means low negative impact
- 2/3 yellow means moderate negative impact
- all yellow means high negative impact



4. MEASURING AND MONITORING TECHNIQUES

Ways to measure and monitor the indicator are provided. For more information, see the monitoring section.

5. REFERENCES

References that support the discussion and predictions for each indicator are provided.

Indicators evaluated:

Wildlife Species Indicators:
1. Kit Fox
2. Burrowing Owl
3. Bay Checker Spot Butterfly
4. Tiger Salamander
5. California Ground Squirrel
6. California Quail

Vegetative Environmental Indicators:
7. Annual Production
8. Riparian Hardwoods Inclusions
9. Vernal pool grassland Inclusions
10. Oak Regeneration

Plant Species Indicators:
11. Annual Forb/Flowering Plant
12. Perennial Flowering Bulbs
13. Medusahead and Barbed Goatgrass
14. Yellow Star Thistle
15. Exotic Annual Grasses
16. Exotic Perennial Grasses
17. Purple Needlegrass
18. Coyote Brush
19. Creeping Wildrye
20. Pine Bluegrass

Non-Vegetative Environmental Indicators:
21. Fire Severity
22. Water Quality
23. Water Infiltration
24. Litter

Economic Indicators:
25. Forage Production
26. Fall Forage Availability
27. Supplementary Feeding Needed
28. Calving Rate
29. Livestock Gains Per Animal
30. Recreational Use

1. Kit Fox *(Vulpes macrotis mutica)*

1. Description: The San Joaquin kit fox is a small (4.5-5 pound) fox native to the scrublands and grasslands in the San Joaquin valley and the adjacent foothills and valleys. This habitat is arid and tends to be relatively open.

2. Significance: Kit fox are federally endangered.

3. Rationale for predictions shown in grazing impact graphics: The kit fox's primary habitat is the semi-open, arid scrubland that was common in the San Joaquin valley prior to farming and development. Grazing strategies that result in a semi-open habitat are considered beneficial to the kit fox.

- **Grazing intensity:** In many instances, livestock grazing has modified California grasslands to produce a habitat that is acceptable to kit fox. Since kit fox prefer habitats that are relatively open, livestock grazing that provides a Residual Dry Matter (RDM) level that is at or below 500 lbs/acre is beneficial for the kit fox. For example, kit fox were present in an area that had been heavily grazed for several years with less than 500 lbs/acre RDM, but the fox disappeared when livestock were removed and the ungrazed grass accumulated to levels above 2,000 lbs/acre RDM (USFWS, 1988).
- **Season-of-use:** Grazing season-of-use strategies that provide a consistent quantity of ground cover are considered more beneficial than those that allow a large accumulation of RDM during the growing season, even if it is later removed by grazing.
- **Livestock class:** All classes of livestock using the forage are assumed to have a positive impact: reducing vegetation levels can improve the quality of kit fox habitat. Grazing with cattle and horses will produce a higher level of forbs than grazing with sheep or goats; grazing with sheep or goats is assumed to be less beneficial for kit fox prey species such as kangaroo rats and ground squirrels.

4. Measuring/monitoring techniques: Kit fox are monitored with den surveys or night-time spotlight surveys. Reference the USFWS recovery plan for the monitoring protocol. RDM can be used as a proxy measure of the potential quality of kit fox habitat.

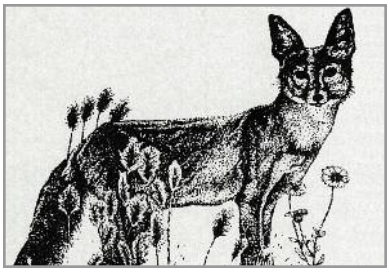
5. References: Bartolome, J.W., W.E. Frost, N.K. McDougald, M.Connor. 2002. California Guidelines for Residual Dry Matter (RDM) Management on Coastal and Foothill Annual Rangelands. Publication 8092. Division of Agriculture and Natural Resources, California.

Guenther, Keith. 1998. Residual Dry Matter (RDM) Monitoring Photo-guide. Wildland Solutions. 16 pp.

U.S. Fish and Wildlife Service. 1998. Recovery plan for upland species of the San Joaquin Valley, California. Region 1, Portland, OR. 319 pp.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
1. Kit Fox Habitat Ability of site to produce a quality Kit Fox habitat condition					



Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
1. Kit Fox Habitat Ability of site to produce a quality Kit Fox habitat condition						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
1. Kit Fox Habitat Ability of site to produce a quality Kit Fox habitat condition					

2. Burrowing Owl *(Speotyto (Athene) cunicularia hypugaea)*

1. Description: In California, the Western burrowing owl is a year-round resident of grasslands, lowland scrub, agricultural lands (particularly rangelands), coastal dunes, desert floors, and artificial open areas including golf courses, cemeteries, airports, vacant lots, and irrigation ditches. The state has four primary nesting areas: the Imperial Valley, the Central Valley, the San Francisco Bay, and the southern California coast.

These owls have two major habitat requirements: large, sparsely vegetated areas of gently rolling or level terrain; and abundant, active small mammal burrows. The owls use these burrows for roosting and nesting. Burrowing owls have disappeared from much of their range in the last 15 years, and nearly 60% of the breeding groups that were known in the 1980s had disappeared by the early 1990s. The primary causes of the owl's decline are habitat conversion and eradication of burrow-generating mammals such as ground squirrels and badgers.

2. Significance: While the burrowing owl is a year-round resident in California, it migrates in other parts of its range and is protected under the Migratory Bird Treaty Act (MBTA) of 1918. Under federal and California law, the burrowing owl is also a Species of Special Concern due to the declines in its suitable habitat and populations, both at the local and statewide levels.

3. Rationale for predictions shown in grazing impact graphics: The owls prefer burrow sites with good horizontal visibility and little grass coverage (less than 4 inches). However, one of their favorite food sources, voles (Microtus), prefers tall, dense vegetation. Thus, good owl habitat ideally has short grass habitats mixed with patches of tall vegetation.

- **Grazing intensity:** The burrowing owl prefers moderate to heavily grazed grasslands for nesting and roosting. Short vegetation also makes it easier for the owls to detect predators and to hunt, since they travel by short flights or running along the ground. Heavy grazing may remove the patches of tall vegetation that provide habitat for the owl's prey.
- **Season-of-use:** Grazing season-of-use strategies that provide a consistent quantity of ground cover are considered more beneficial than those that allow a large accumulation of RDM during the growing season, even if this is later removed by grazing.
- **Livestock class:** All classes of livestock using the forage are assumed to have a positive impact: reducing vegetation levels can improve the quality of burrowing owl habitat. However, grazing with cattle and horses will produce a higher level of forbs than grazing with sheep or goats, and this is assumed to be more beneficial for prey species.

4. Measuring/monitoring techniques: Surveys should be done on four separate days a couple of hours before or after sunrise or sunset. More monitoring information is available at Burrowing Owl Consortium (http://www2.ucsc.edu/scpbrg/survey.htm).

5. References:

Coulombe, H.N. 1971. Behavior and population ecology of the burrowing owl, Speotyto cunicularia, in the Imperial Valley of California. Condor 73: 162-176.

Haug, E. A., B. A. Millsap, and M. S. Martell. 1993. Burrowing Owl (Speotyto cunicularia). In Martin, D. C. 1973. Selected aspects of burrowing owl ecology and behavior. Condor 75: 446-456.

Thomsen, L. 1971. Behavior and ecology of burrowing owls on the Oakland Municipal airport. Condor 73: 177-192.

Trulio, L. 1997. Burrowing owl demography and habitat use at two urban sites in Santa Clara County, California. Journal of Raptor Research Report 9:84-89.

Zarn, M. 1974. Burrowing Owl, Report No. 11. Habitat management series for unique or endangered species. Bureau of Land Management, Denver. 25 pp.

Zeiner, D. C., W., F. Laudenslayer, Jr., K. E. Mayer, M. White. Editors. 1990. California's Wildlife. Volume 2. Birds. State of California, Department of Fish and Game. Sacramento, California. 731 pp.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
2. Burrowing Owl Ability of site to produce a quality Burrowing Owl habitat					

Photo courtesy of USDA NRCS.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
2. Burrowing Owl Ability of site to produce a quality Burrowing Owl habitat						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
2. Burrowing Owl Ability of site to produce a quality Burrowing Owl habitat					

3. Bay Checkerspot Butterfly *(Euphydryas editha bayensis)*

1. Description: The Bay checkerspot butterfly is restricted to serpentine sites in the San Francisco Bay Area. Serpentine soils, which are thin, rocky and nutrient-poor, have dense stands of the butterfly larva's host plants (Plantago erecta and Castilleja ssp.) as well as nectar sources (Lasthenia californica, Layia Platyglossa, Allium serratum, Muilla maritime, and Lomatium spp.) Serpentine sites are susceptible to invasion by exotic annual grasses, which can decrease the Plantago erecta cover and so lead to local extinction of the butterfly.

2. Significance: The Bay checkerspot butterfly is listed as threatened under the U.S. Endangered Species Act and serves as an "umbrella species" for the serpentinitic grassland ecosystem.

3. Rationale for predictions shown in grazing impact graphics: The nutrient-poor serpentine sites are susceptible to invasion by exotic annual grasses when nutrients are added via nitrogen deposition from nearby vehicle traffic. Cattle selectively graze the exotic annual grasses in preference to forbs, and can also break down the thatch by trampling and feeding during the dry season. In addition, grazing cattle tend to remove nitrogen from serpentine sites as they harvest forage, redeposit nutrients in the form of manure, gain weight and/or are removed from the site. Given the significance of annual variation and its impact on forage production, a diversity of grazing regimes (intensity and season of use) across the habitat may be better than a single "optimal" one.

- **Grazing intensity:** Non-use and light stocking will result in a high level of exotic annual grasses that compete with the desirable native forbs used by the butterfly larvae. Heavy use is expected to negatively impact the desirable native forbs.
- **Season-of-use:** The native forbs will be favored by grazing during the late spring, when the annual non-native grasses are growing most actively.
- **Livestock class:** Sheep and goats tend to prefer the native forbs over the non-native grasses and so would likely have a negative impact. Cattle will tend to use the non-native annual grasses and so would provide a positive impact.

4. Measuring/monitoring techniques: Survey the Plantago erecta and annual grass cover using a cover frequency procedure during the spring.

5. References:
Weiss, Stuart. 1999. Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient Poor Grasslands for a Threatened Species. Conservation Biology 13(6) pages 1476-1486.

United States Department of Interior, Bureau of Land Management. 1996. Utilization studies and residual measurements. Interagency Technical Reference. BLM/ST-96/004+1730.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
3. Bay Checker Spot Butterfly Ability of site to produce a quality Bay Checker Spot Butterfly					

Photo courtesy of Stuart Weiss.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
3. Bay Checker Spot Butterfly Ability of site to produce a quality Bay Checker Spot Butterfly						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
3. Bay Checker Spot Butterfly Ability of site to produce a quality Bay Checker Spot Butterfly					

4. Tiger Salamander *(Ambystoma californiense)*

1. Description: The California tiger salamander is found only in the state's coastal grasslands and in the Central Valley and its bordering foothills. This salamander is well adapted to the Mediterranean climate of cool, moist winters and hot, dry summers, and lives in grassland, oak woodland, and coastal sage scrub communities. These amphibians generally breed in ephemeral pools, vernal pools and/or stock ponds, but rarely use permanent ponds due to the presence of introduced predators such as crayfish, bullfrogs and bass. The adult salamanders live/take refuge in burrows created by ground squirrels and other small mammals.

2. Significance: The California tiger salamander is a State of California Species of Special Concern and is a candidate for the federal Endangered Species List. The primary threat to this salamander is human activities that fragment and isolate their breeding pools and upland burrows habitat. This indicator can be considered as part of SRR indicator 15.

3. Rationale for predictions shown in grazing impact graphics: The California tiger salamander is usually found in areas that have both ponded water and upland dominated by grazed or sparse grass. Grazing operations with stock ponds can provide the salamanders with breeding sites.

- **Grazing intensity:** Livestock grazing is assumed to encourage stock pond maintenance, which provides salamander breeding sites, and produces a condition favorable for ground squirrels, which create burrows that adult salamanders can use. Livestock grazing may also maintain a more open rangeland, which salamanders can transverse.
- **Season-of-use:** Grazing around natural ponds may be key to increasing water runoff and maintaining an adequate inundation period for metamorphosis (at least 3 months). Grazing during the late spring is considered beneficial because livestock typically make stock ponds murky, which may reduce predation of young salamanders.
- **Livestock class:** Cattle and horses graze annual grassland vegetation more effectively than sheep and goats.

4. Measuring/monitoring techniques: Survey the California tiger salamander with dip net surveys of ponds.

5. References:

Jennings, M.R., and M.P. Hayes. 1994. Amphibian and reptile species of special concern in California. Final report to California Dept. of Fish and Game. Pp. 12-16.

Loredo, I., D. Van Vuren and M.L. Morrison. 1996. Habitat use and migration behavior of the California tiger salamander. Journal of Herpetology 30(2): 282-285.

LSA Associates, Inc. 1994. California tiger salamander distribution: 1994 survey results. Pt. Richmond, California. 54 pp + maps.

Trenham, P.C., H.B. Shaffer, W.D. Koenig, and M.R. Stromberg. 2000. Life history and demographic variation in the California tiger salamander (Ambystoma californiense). Copeia 2000(2): 365-377.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
4. Tiger Salamander Ability of Tiger Salamanders to grow and reproduce					
				■	■
			■	■	■

Photo courtesy of Sally Reynolds, USFWS.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
4. Tiger Salamander Ability of Tiger Salamanders to grow and reproduce						
			■	■		■
		■	■	■	■	■

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
4. Tiger Salamander Ability of Tiger Salamanders to grow and reproduce					
			■	■	■
	■	■	■	■	■

5. California Ground Squirrel *(Spermophilus beecheyi)*

1. Description: California ground squirrels are found nearly everywhere in the state except the Owens Valley and southward into the desert regions. They live in a wide variety of natural habitats but usually avoid thick chaparral, dense woods, and wet areas. Populations may be particularly high in grazed rangelands and in areas disturbed by humans such as road or ditchbanks, fence rows, around buildings, and in or bordering many crops. Ground squirrels live in colonies of up to several dozen in a complex of burrows, which they use for sleeping, resting, rearing young, storing food, and avoiding danger.

2. Significance: Although California ground squirrels are sometimes considered a troublesome pest by landowners, their presence in California's annual grasslands is important to several special-status species. They are a primary prey for golden eagles and San Joaquin kit fox (Vulpes macrotis mutica). In addition, ground squirrel burrows are often used by burrowing owls (Athene cunicularia), several species of kangaroo rats, and some endangered amphibians and reptiles including California tiger salamanders. Ground squirrels are classified as nongame mammals by the California Fish and Game Code, which means that they can be controlled in any legal manner by the owner or tenant if they are injuring growing crops or other property.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** The level of grazing intensity does not appear to affect ground squirrel populations, except heavy grazing which seems to favor ground squirrels. Voles become more abundant in the absence of grazing.
- **Season-of-use:** Season-of-use is not known to affect ground squirrel populations.
- **Livestock class:** All livestock are considered to be similar.

4. Measuring/monitoring techniques: Survey ground squirrels by counting the burrow entrances along a belt transect.

5. References:

Fehmi, J.S., S.E. Fusso, and J.W. Bartolome. 2005. The effects of livestock on California Ground Squirrels (Spermophilus beecheyii). Rangeland Ecology & Management 58(4):352-359.

Fitch, H.S. 1948. Ecology of the California ground squirrel on grazing lands. The American Midland Naturalist 39(3):513-596.

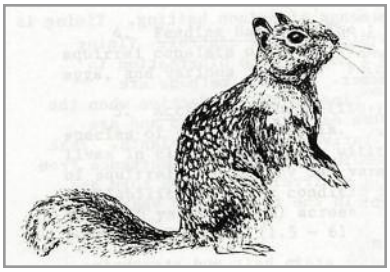
Horn, E.E. and H.S. Fitch. 1942. Interrelations of rodents and other wildlife of the range. California Agriculture Experiment Station Bulletin 663:96-129.

Linsdale, J.M. 1946. The California ground squirrel. University of California Press. Berkeley, Ca.

Tomich, P. Q. 1982. Ground squirrels. In J. A. Chapman and G. A. Feldhamer, eds. Wild Mammals of North America: Biology, Management, and Economics. Baltimore: Johns Hopkins Univ. Press. pp. 192–208.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
5. California Ground Squirrel					



Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
5. California Ground Squirrel						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
5. California Ground Squirrel					

6. California Quail *(Callipepla Californica)*

1. Description: California quail are found in scrubby habitat primarily in California, Oregon and Washington. In California's annual grasslands, the quail are associated with riparian, oak and foothill woodland habitats. The quail require water, open/disturbed spaces for foraging, and cover for roosting, escaping and loafing.

2. Significance: The California quail is a highly esteemed game bird and is the state bird of California. The quail were once numerous in the state's valleys and foothills—in fact, they are the most common fossil bird found in California – but populations declined with the advent of extensive clean farming operations. The quail has also been negatively affected by the loss of grassland which has been invaded by shrubs where wildfires have been reduced.

3. Rationale for predictions shown in grazing impact graphics: Quail prefer areas with a complex mix of habitats that included both heavy cover for roosting and open disturbed areas with an abundance of forbs for feeding. Quail largely feed on seeds and green leafage, especially from legumes such as lotus, clovers, lupines, and filarees. Range improvement practices that remove all of the brush degrade habitat for quail. However, quail cover can be enhanced by planting shrubs or providing brush piles.

- **Grazing intensity:** Conservative and moderate grazing intensity can enhance quail habitat by producing a complex pattern of forbs and grasses. Heavy grazing is assumed to reduce cover to an undesirably low level. Light and no grazing are assumed to produce mostly grass and few desirable forbs.
- **Season-of-use:** Livestock use when the non-native annual grasses are actively growing during the winter and early spring months is more likely to produce a favorable combination of grasses and forbs, as livestock tend to concentrate use on and reduce the palatable non-native grasses.
- **Livestock class:** Cattle and horses tend to graze the dominant non-native annual grasses, which will yield more of the desirable forbs that quail feed on. In contrast, sheep and goats tend to selectively graze forbs.

4. Measuring/monitoring techniques: Survey California quail with spring call counts and brood counts.

5. References:

Bauer, O. 1977. Improving Land for California Valley Quail. CA Department of Fish and Game. Leaflet No. 8.

Calkins, J.D., J.C. Hagelin, and D.F. Lott. 1999. California Quail (Callipepla californica). In: The Birds of North America, No. 473 (A. Poole and F. Gill, eds) The Birds of North America, Inc. Philadelphia, PA.

Fitzhugh, Lee. 1983. How to Increase California Quail Populations. University of California Division of Agriculture and Natural Resources Leaflet 21325.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
6. California Quail					

Photo courtesy of Keith Guenther.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
6. California Quail						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
6. California Quail					

7. Annual Production

1. Description: Annual production is the total amount of aboveground plant biomass produced at a site in a single year. In inland areas, annual production is largely exotic annual grasses, while in coastally-influenced areas, annual production is a mix of native/exotic perennial grasses and exotic annual grasses. In some years, a significant amount of biomass is also produced by late season annual forbs such as tarweed (Duncan 1975). Annual production is influenced primarily by climate, particularly rainfall and temperature.

2. Significance: The timing and intensity of livestock grazing also influences production and so needs to be considered. The level of biomass influences both the plant and wildlife assemblages such as grasses and weedy forbs and hydrological processes such as erosion and water infiltration. In addition, a site can have such low productivity that it can be difficult to recover in the short term. Annual Production is indicator 15 in TR 1734-6, and annual productivity is indicator 2 in SRR.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Livestock can reduce the productivity of a site by removing most of the biomass each year. Removing biomass can also affect the following year's productivity by reducing the number of seeds and the amount of seed bed mulch (Heady 1956). However, ungrazed sites will accumulate thatch that can take 3-5 years to decompose, which slows the nutrient cycling process (Heady et al. 1988).
- **Season-of-use:** Season-of-use is not known to be directly related to the annual productivity of a site.
- **Livestock class:** Livestock class is not known to be directly related to the annual productivity of a site.

4. Measuring/monitoring techniques: Annual productivity can be measured in several ways. For annual grasslands, a common technique is to measure biomass as part of the residual dry matter (RDM) that occurs on a site and is expressed as pounds/acre or kilograms/hectare. Annual productivity is also sometimes measured by clipping and weighing vegetation at intervals throughout the growing season (Bartolome 1993). This is because clipping can stimulate an increase in herbaceous vegetation production under some conditions, such as when there is adequate moisture for plants to regrow.

5. References:

Bartolome, J.W., W.E. Frost, N.K. McDougald, M.Connor. 2002. California Guidelines for Residual Dry Matter (RDM) Management on Coastal and Foothill Annual Rangelands. Publication 8092. Division of Agriculture and Natural Resources, California.

Bartolome, J.W., M.C. Stroud and H.F. Heady. 1980. Influence of natural mulch on forage production on differing California annual range sites. J. Range Management 33:4-8.

Bartolome, J. W. 1993. Application of herbivore optimization theory to rangelands of the western United States. Ecological Applications 3:27-29.

Bentley, J.R., and M.W. Talbot. 1951. Efficient use of annual plants on cattle ranges in the California foothills. U.S. Dept. of Agr. Circular No. 870.

Duncan, D. A. 1975. The San Joaquin site of the grassland biome: its relation to annual grassland ecosystem synthesis. Pages 9-13 in R. M. Love, editor. The California Annual Grassland Ecosystem. Institute of Ecology, University of California at Davis, Anaheim, California.

George, Mel, et al. 2001. Annual Range Forage Production. UCCE publication 8018. http://anrcatalog.ucdavis.edu/pdf/8018.pdf

Guenther, K. 1998. Residual Dry Matter (RDM) Monitoring Photo-guide. Wildland Solutions. 16 pp. www.wildlandsolutions.com

Heady, H. F. 1956. Changes in a California annual plant community induced by manipulation of natural mulch. Ecology 37:798-812.

Heady, H. F., J. W. Bartolome, M. D. Pitt, G. D. Savelle, and M. C. Stroud. 1988. The California prairie. Pages 313-335 in R. T. Coupland, editor. Natural Grasslands: introduction and western hemisphere. Elsevier, New York, New York.

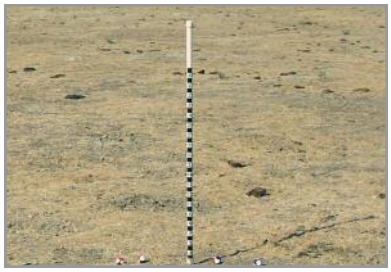
United States Department of Interior, Bureau of Land Management. 1996. Utilization studies and residual measurements. Interagency Technical Reference. BLM/ST-96/004+1730.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
7. Annual Production Ability of site to produce plant biomass			■		
		■	■		
		■	■	■	

Non-use

Conservative Stocking



Heavy Stocking

Photos courtesy of Keith Guenther.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
7. Annual Production Ability of site to produce plant biomass						
		■	■	■	■	■

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
7. Annual Production Ability of site to produce plant biomass					
	■	■	■	■	■

8. Hardwood Riparian Inclusions

1. Description: Riparian means "water loving" and these areas occur as small inclusions along streams and springs within the annual grassland and oak woodland habitats.

2. Significance: Even though small, riparian areas are very important because they provide habitat for fish and wildlife such as quail, kingbirds, warblers and hawks and because they play a critical role in watershed function (Swanson 1996). Degraded riparian areas often have a lower water table, poor water storage, little shade, warm water, poor fish habitat, low wildlife diversity, and little vegetation to protect the stream bank. Conversely, healthy riparian areas have a higher water table, more water storage, higher vegetation productivity, good shade, cool water, good fish habitat, high wildlife diversity, and increased vegetation to protect stream banks (Swanson 1995.) Important values of riparian areas include water quality, biological diversity, wildlife and fisheries habitat, agricultural and ranching productivity, timber production, recreation, and aesthetics (BLM 1997). Hardwood riparian inclusions are similar to SSR indicator 13.

3. Rationale for predictions shown in grazing impact graphics: Depending on the specific grazing practices, livestock can have negative, neutral or positive effects on riparian hardwoods. There are many locations in the Western U.S. where livestock have had an adverse impact on riparian zones, on watershed function and water quality. However, there are also riparian zones that have been grazed properly and that have healthy riparian zones and good water quality (Krueger 1996).

- **Grazing intensity:** Grazing intensity is assumed to be directly related to adverse impacts to riparian hardwood inclusions as high intensity tends to reduce total riparian vegetation.
- **Season-of-use:** During the summer months, livestock tend to utilize riparian zones for their water, shade, higher quality forage, gentle slopes, and cooler microclimates (George 1996). The results in livestock consuming and trampling riparian vegetative cover during the hot season.
- **Livestock class:** Goats and sheep tend to browse hardwood vegetation year-round. In contrast, cattle tend to prefer grasses but will also readily browse hardwood vegetation during the summer months, when the upland grasses have cured and the riparian vegetation is still green and more palatable.

4. Measuring/monitoring techniques: There are many techniques for monitoring riparian vegetation, including the green line method, proper functioning condition, and the NRCS assessment method. These techniques are complex and so usually involve an interdisciplinary team of scientists. Changes in riparian areas over time can also be documented with photo monitoring, which is simple, inexpensive, and rapid (McDougald et. al. 2003).

5. References:

Krueger, B. 1996. Developing an Effective Grazing Strategy for Riparian Vegetation. IN: Livestock Management in Grazed Watersheds: A Review of Practices That Protect Water Quality. ANR Publication 3381. 6701 San Pablo Avenue, Oakland, CA 94608.

McDougald, N.K., B. Frost & D. Dudley. 2003. Photo-Monitoring for Better Land Use Planning and Assessment. ANR Publication 8067. http://anrcatalog.ucdavis.edu

Montana BLM. 1997. Effective Cattle Management in Riparian Zones: A Field Survey and Literature Search. Riparian Technical Bulletin No. 3. USDI BLM Montana State Office, Billings, Monatana.

Swanson, S. 1996. Reading a Streams Need. IN: Livestock Management in Grazed Watersheds: A Review of Practices That Protect Water Quality. ANR Publication 3381. 6701 San Pablo Avenue, Oakland, CA 94608.

United States Department of Interior, Bureau of Land Management. 1998. Riparian Area Management. Technical Reference 1737-15.

Ward, T. A., K.W. Tate, E.R and E.R. Atwill. 2003. Guidelines for Monitoring the establishment of riparian grazing systems. Publication 8094. Division of Agriculture and Natural Resources, California. http://anrcatalog.ucdavis.edu/pdf/8094.pdf

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
8. Riparian Hardwoods Inclusions Hardwood species occurrence					

Non-use

Conservative Stocking

Heavy Stocking

Photos courtesy of Keith Guenther.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
8. Riparian Hardwoods Inclusions Hardwood species occurrence						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
8. Riparian Hardwoods Inclusions Hardwood species occurrence					

9. Vernal Pool Grassland Inclusions

1. Description: Vernal pools are depressions that are inundated by winter rainfall and then are dry in the summer and early fall. Unique to Mediterranean climates like that of California, these ephemeral pools provide habitat for an unusual diversity of native crustaceans, grasses, and wildflowers.

2. Significance: Vernal pools provide habitat for several species of special status, including crustaceans such as the vernal pool tadpole shrimp, fairy shrimp; and plants such as Butte County meadowfoam, Contra Costa goldfields, and Greene's Tuctoria. Vernal pool habitat has been lost to urban development and conversion to agriculture which change a site's hydrology by breaking up the water retaining soil. Invasive species also threaten vernal pool habitats, particularly in California's annual grasslands.

3. Rationale for predictions shown in grazing impact graphics: Livestock can benefit vernal pool habitats by removing annual grasses, which seems to help maintain pool inundation periods. Longer inundation periods are key to maximizing the diversity of vernal pool plants and animals. Grazing vernal pool habitats can also prevent the invasion of exotic plants, which promotes the native plants.

- **Grazing intensity:** When not grazed, most vernal pool sites become dominated by exotic annual grasses. Moderate and heavy stocking with cattle will substantially reduce the exotic annual grass cover.
- **Season-of-use:** Grazing during the early season, when exotic annual grasses are beginning to grow, is highly effective at reducing the exotic annual grasses.
- **Livestock class:** Cattle grazing is especially effective because they tend to prefer exotic annual grasses over the native wildflowers and other annual forbs. Sheep and goats tend to prefer forbs, which include some of the important vernal pool species.

4. Measuring/monitoring techniques: Survey the relative cover frequency of vernal pool plants. This may need to be done more than one time during the year as different species are dominant on a site at different times during the year. More information is available at www.vernalpools.org

5. References: Barry, Sheila. 1996. Rangeland Oasis. University of California Cooperative Extension publication Leaflet No. 21531.

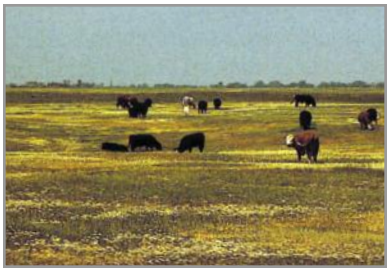
United States Department of Interior, Bureau of Land Management. 1996. Utilization studies and residual measurements. Interagency Technical Reference. BLM/ST-96/004+1730.

Monitoring vernal pools at www.vernalpools.org

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
9. Vernal Pool Landscape Quality of habitat					

Non-use



Conservative Stocking

Heavy Stocking

Photos courtesy of Sheila Barry.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
9. Vernal Pool Landscape Quality of habitat						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
9. Vernal Pool Landscape Quality of habitat					

10. Oak Regeneration

1. Description: Oaks are associated with grasslands in many parts of California, and most of the oak rangelands are grazed by livestock.

2. Significance: Besides being an important visual feature of California's grasslands, oaks provide food and shelter that is critical to the survival of many wildlife species. More than 330 species of terrestrial vertebrates use California's oak woodlands at some time during the year. Oaks are also an important part of California's watersheds, holding soil in place to prevent erosion and sedimentation. It has been reported that certain species of oaks (blue oak, valley oak, and Engelmann oak) do not seem to be adequately regenerating. Coast live oak may also not be adequately regenerating in some areas. Adequate regeneration is necessary for a sustainable population.

3. Rationale for predictions shown in grazing impact graphics: Livestock may browse oak seedlings, as well as consume acorns. However, livestock exclusion alone may not lead to improved oak regeneration because many other factors may inhibit oak regeneration, such as exotic annual plant growth, rodent damage, and suppression of wildland fire. In addition, the effects of grazing on exotic plant competition and rodent populations should be considered. For example, oak seedlings may have a difficult time getting established in thick undergrowth including annual grass thatch or thistles. Thatch accumulation also favors some rodents like vole, which have been known to girdle oak saplings.

- **Grazing intensity:** Heavy grazing, especially over many years, can indirectly affect oak recruitment by increasing soil compaction and reducing organic matter, both of which can make it more difficult for oak roots to penetrate downward and obtain moisture. Light and conservative grazing may reduce the exotic annual grasses that compete with young oak seedlings for moisture and nutrients.
- **Season-of-use:** Grazing during the early part of the growing season is most effective for reducing exotic annual grass cover. Grazing during the dry dormant season may result in livestock eating small oak seedlings.
- **Livestock class:** Sheep and goats tend to browse seedlings year-round. Cattle are assumed to have a potential positive impact during the winter season, when exotic annual grasses are growing actively.

4. Measuring/monitoring techniques: Survey oak regeneration with Tree canopy cover and Stand Basal Area.

5. References:
University of California Integrated Hardwood Range Management Program. 1996. Guidelines for Managing California's Hardwood Rangelands. Publication 3368

McCreary, D. 2001. Regenerating Rangeland Oaks in California. University of California Agriculture & Natural Resources. Publication 21601

McCreary, D. and M. George. 2005. Enhancing Oak Regeneration on Grazed Rangelands. California Agriculture (in press).

Oak references at www. Biogeog.ucsb.edu/projects/oak/oak.html

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
10. Oak Regeneration					

Photo courtesy of Keith Guenther.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
10. Oak Regeneration						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
10. Oak Regeneration					

11. Annual Forb/Flowering Plant

1. Description: Annual forb/flowering plants is a group of plant species that reflects the total cover and species richness of native, annual forbs (dicots) on a site.

2. Significance: Forbs are typically high in protein and nutritious, making them important for livestock forage. In addition, many wildlife species prefer forbs over the less nutritious grasses: California quail, for instance, prefer forb seeds over grass seeds. Annual forbs tend to decompose too quickly to provide good mulch, which means they do little to reduce erosion and water infiltration into rangeland soils. Forbs/flowering plants provide scenic values as well as economic value by supporting indigenous native pollinators that provide pollination services in nearby agricultural areas. Finally, there are many species of threatened/endangered forbs that are protected by environmental regulations.

3. Rationale for predictions shown in grazing impact graphics: Livestock grazing affects annual forbs along a productivity/rainfall gradient that is important to understand when planning for or evaluating a site (see below for details). However; although grazing is frequently listed as a primary threat to legally protected forb species, little is known about how individual species respond to specific grazing regimes. The following describes trends in how this group of plants responds to particular grazing strategies:

- **Grazing intensity:** Grazing intensity studies suggest that annual forbs respond along a productivity or rainfall gradient. Ungrazed grasslands that are very productive can accumulate a large amount of thatch, increasing the canopy height and reducing the diversity and abundance of annual forbs (Hayes & Holl 2003). Less productive sites that are ungrazed may not accumulate large amounts of thatch resulting in less affect to forbs. In very arid areas, grazing may reduce forbs (Kimball & Schiffman 2003). Heavy grazing generally favors short, often unpalatable forbs (McIntyre et al. 1995).
- **Season-of-use:** Season of use studies have shown that grazing earlier tends to decrease the canopy height, thus encouraging forbs. Interestingly, early season annual forbs tend to be short while later season forbs are taller.
- **Livestock class:** Cattle tend to prefer grass, while sheep and goats prefer forbs.

4. Measuring/monitoring techniques: Forbs can be measured in several ways. A common technique for the annual grassland range type is to measure forbs as part of the Residual Dry Matter (RDM) that occurs on a site and expressed as pounds/acre or kilograms/hectare. Forbs can also be measured for occurrence as cover using a Daubenmire quadrat expressed as per cent cover and frequency of occurrence (Daubenmire 1968).

5. References:

Bentley, J.R., and M.W. Talbot. 1951. Efficient use of annual plants on cattle ranges in the California foothills. U.S. Dept. of Agr. Circular No. 870.

Daubenmire, R. F. 1968. A canopy coverage estimate. Northwest Science 33:52.

Hayes, G., and K. D. Holl. 2003. Cattle Grazing Impacts on Annual Forbs and Vegetation Composition of Mesic Grasslands in California. Conservation Biology 17:1694 - 1702.

Kimball, S., and P. M. Schiffman. 2003. Different effects of cattle grazing on native and alien plants. Conservation Biology 17:1681-1693.

McIntyre, S., S. Lavorel, and R. M. Tremont. 1995. Plant life-history attributes: their relationship to disturbance response in herbaceous vegetation. Journal of Ecology 83:31-44.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
11. Annual Forb/Flowering Plant Ability of site to produce forbs/flowers					■
	■			■	■
	■	■	■	■	■

Photo courtesy of Keith Guenther.

Non-use

Photo courtesy of Grey Hayes.

Conservative Stocking

Photo courtesy of Grey Hayes.

Heavy Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
11. Annual Forb/Flowering Plant Ability of site to produce forbs/flowers						
	■	■				■
	■	■	■	■	■	■

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
11. Annual Forb/Flowering Plant Ability of site to produce forbs/flowers					
				■	■
	■	■	■	■	■

12. Perennial Flowering Bulbs

1. Description: Native perennial bulbs include lilies, lomatium, yellow bells and chloraganum. While the species vary depending on the site, this group of plants is widely found in grasslands and many depend on grassland habitats. Unhealthy or stressed bulb populations may take several years to store enough nutrients to flower. However, many bulbs that don't flower annually can exist for long periods in a vegetative stage and can also propagate themselves vegetatively.

2. Significance: Many native perennial bulbs are species of concern—some are federally—or state-protected. In addition, these plants are important food resources for wildlife: the flowers can produce significant floral resources for pollinators and the bulbs are important food for pocket gophers, pigs and burrowing mammals. However, some species of bulbs are toxic to livestock.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** There has been limited study on perennial bulbs as a whole. Heavy grazing intensity can benefit bulbs by removing woody vegetation and exotic annual grasses (Inyer 1997). Some bulb species are not competitive with dense grasses and so, like annual forbs, may require moderate to high intensity grazing during establishment. However, once established, many flowering bulb species may be more sensitive to more intense grazing because they need their large, succulent leaves to photosynthesize food for the following year.
- **Season-of-use:** Grazing during the early growing season can help bulbs become established by reducing the grasses that compete with them. Once bulbs are established, grazing can be shifted to the late season so they can flower. However, many bulb species may not need to flower and seed set to reproduce because they can also reproduce vegetatively from bulblets.
- **Livestock class:** Sheep prefer forbs over grasses and thereby may selectively graze bulbs whereas cattle prefer grasses over forbs and may thereby benefit bulbs by reducing competitive grasses.

4. Measuring/monitoring techniques: Monitoring bulbs is difficult because their leaves are similar to grasses, which means professional help may be required to key the species unless they are blooming. If permitted by the grazing schedule, the frequency of flower production can be monitored in large, randomly placed plots. Rare bulb species should be monitored using the specific protocols from the appropriate regulatory authority.

5. References: Inyer, D. 1997. Ecology and management of the Endangered Western Lily (Lilium occidentale) in northwestern California. Pages 22-23. Conservation and Management of Native Plants and Fungi. Native Plant Society of Oregon, Corvalis, OR.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
12. Perennial Flowering Bulbs Ability for perennial bulbs to flower and reproduce					
		■	■		
		■	■	■	

Photo courtesy of Grey Hayes.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
12. Perennial Flowering Bulbs Ability for perennial bulbs to flower and reproduce						
		■				
		■	■	■		

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
12. Perennial Flowering Bulbs Ability for perennial bulbs to flower and reproduce					
					■
			■		■

13. Medusahead and Barbed Goatgrass

1. Description: Medusahead *(Taeniatherum caput-medusae)* and barbed goatgrass *(Aegilops truincialis)* are winter annual grasses introduced from Europe and west Asia. Both have become invasive noxious weeds in the western United States. Although medusahead and goatgrass are winter annuals, they are considered late-season grasses since they grow and mature several weeks after most other annual grasses found on California rangelands.

2. Significance: Medusahead and goatgrass plants have a high silica content, which causes two problems. First, the silica makes these grasses less palatable to livestock and wildlife. Second, the silica makes their thatch decompose relatively slowly, and the resulting thatch buildup both increases the amount of vegetative fuel/fire risk and reduces the growth of desirable rangeland plant species. In contrast, medusahead and goatgrass seedlings can survive under the heavy thatch cover. Rangelands severely infested with medusahead and goat-grass tend to have lower plant biodiversity, which can reduce both animal biodiversity and grazing capacity.

3. Rationale for predictions shown in grazing impact graphics: When properly timed, high density grazing can help reduce medusahead and goatgrass populations within one or two years. As with almost any annual weed control measure, the objective should be to prevent the existing plants from producing seeds.

- **Grazing intensity:** Since medusahead and goatgrass are not palatable, livestock will avoid eating them if presented with better forage options. High density stocking reduces forage options, forcing livestock to graze all of the available forage more evenly. High density, short duration grazing entails using a high stocking density for only a few days or a week or two, and then removing the livestock completely. Research has shown that such intensive grazing can reduce medusahead populations up to 90% in two years.
- **Season-of-use:** The key to controlling medusahead and goatgrass with grazing is to use a high stocking density for a short time at the boot stage. The timing of the boot stage can vary by a month from year to year, depending on the weather. Seedheads generally emerge from late March to early April in southern California, and from late April to early May in northern California. If livestock are removed before the boot stage, the plants will recover and produce new seedheads. If grazing occurs after the seedheads emerge, the livestock will avoid eating medusahead and goatgrass because of prickly awns that are part of the seedhead. Medusahead may be controlled by high density grazing every few years, but goatgrass may require two consecutive years. Late summer or early fall grazing may help remove the thatch layer, but this effect has not yet been researched. Unpublished research indicates that early season grazing does not effectively reduce medusahead cover.
- **Livestock class:** Cattle and sheep are best for controlling medusahead and goatgrass because these grazers are less discriminating and typically eat more grasses than forbs and brush. In contrast, browsers such as goats and deer typically eat less grass and more forbs and brush. Yearling cattle may be less effective at grazing medusahead and goatgrass because they are often less experienced grazers and so may be more selective than older cattle. While horses are also grazers, their use in weed control has not been researched.

4. Measuring/monitoring techniques: An effective and relatively fast method for monitoring vegetation changes is to measure the vegetation cover. Rangeland vegetation monitoring usually occurs when most plant species are flowering. However, medusahead and goatgrass can be difficult to identify at that time because they flower several weeks after most rangeland species. This means the rangeland vegetation may need to be monitored twice: once at the peak flowering of most rangeland species and again soon after medusahead and goatgrass have matured. Frost et al. (1991) provide techniques for measuring cover, and many useful tips can be found in the factsheet available at the following web link: http://animalscience.ucdavis.edu/extension/Factsheets/RangelandResources/pdfs/Veg_Cover_Monitoring2.PDF

5. References:
George, M.R. 1992. Ecology and management of medusahead. Range Science Report. Dept. Agronomy and Range Science, Agr. Exp. Station. Series #32.

George, M.R., R.S. Knight, P.B. Sands and M.W. Demment. 1989. Intensive grazing increases beef production. California Agriculture 43(5) pages 16-19.

Young, J.A., R.A. Evans and B.L. Kay. 1970. Phenology of reproduction of medusahead. Weed Science 18(4) pages 451-454.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
13. Medusahead and Barbed Goatgrass Potential of site to resist medusahead and goatgrass infestations					

Non-use

Conservative Stocking

Heavy Stocking

Photos courtesy of Morgan Doran, UCCE.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
13. Medusahead and Barbed Goatgrass Potential of site to resist medusahead and goatgrass infestations						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
13. Medusahead and Barbed Goatgrass Potential of site to resist medusahead and goatgrass infestations					

14. Yellow Starthistle

1. Description: Yellow starthistle *(Centaurea solstitialis)* is a noxious weed on the California Invasive Plant Council's List A, which means it is considered one of the most invasive species plants in the state. Yellow starthistle has a spineless, basal rosette in the winter, bolts in the spring and then produces many sharp spines as it flowers in the summer, June-September.

2. Significance: Yellow starthistle affects grasslands in several ways. This noxious weed can deplete soil moisture reserves, displace native species, and reduce the forage value of rangelands. Yellow starthistle is toxic to horses but is an important floral resource for honeybees, which produce a highly valued honey from its nectar. This weed may occupy up to 12 million acres of California's grasslands.

3. Rationale for predictions shown in grazing impact graphics: When carefully timed and at the correct intensity, livestock grazing, may help control yellow starthistle infestations. This noxious weed can be reduced by two means: encouraging annual grasses that compete with star thistle early in the growing season, and clipping as it reaches the flowering stage.

- **Grazing intensity:** High intensity grazing during late May and early June, when the yellow starthistle is green and bolting and does not yet have sharp spines, can reduce the number of flowers and so the number of seeds.
- **Season-of-use:** Early season grazing from December through April will reduce the taller grasses, which will in turn increase yellow starthistle by reducing the competition for nutrients and light (Thompsen, pers. comm.). Late season grazing can reduce yellow starthistle because soil moisture reserves are low and grazed plants may not be able to recover and produce seed.
- **Livestock class:** Sheep and cattle will eat yellow star thistle before it creates spines. Goats will consume the plants even after they have created spines (DiTomaso, 2004).

4. Measuring/monitoring techniques: Cover frequency surveys will show occurrence. Aerial photography has been suggested as the most effective means of monitoring the species (DiTomaso, 2004), though the species might easily be confused with late flowering, native tarplants.

5. References: DiTomaso, J. 2004. Yellow star thistle information. Accessed via the internet on 5/4/04. Weed Research and Information Center, University of California. http://wric.ucdavis.edu/yst/manage/management3.html

Thompsen, C. 2000. personal communication. UC Davis; Davis, California.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
14. Yellow Starthistle Ability of site to resist Starthistle establishment					

Photo courtesy of UCCE, WRIC.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
14. Yellow Starthistle Ability of site to resist Starthistle establishment						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
14. Yellow Starthistle Ability of site to resist Starthistle establishment					

15. Exotic Annual Grasses

1. Description: Exotic annual grasses such as annual rye, soft chess and tall oatgrass account for most of the annual productivity in California's annual grasslands and oak woodlands. These grasses invaded and spread across California's grasslands and oak woodlands with the arrival of Spanish settlers some 200 years ago. Their dominance accompanied by the decline in native grassland species has been attributed to several causes, including tillage, uncontrolled livestock grazing, fire, climate change and competition from exotic species. While some management controls can affect the abundance of these grasses, their productivity is largely driven by climate (Duncan 1975).

2. Significance: Exotic annual grasses produce a significant amount of forage for livestock. Competition with these introduced species is often cited as the primary reason for the decline of numerous native grassland species, including native perennial grasses (Heady 1988). Exotic annual grasses may reduce soil quality by producing much more biomass above ground than below ground. These species may also help increase the frequency of fire in dry, shrub communities by creating an unnatural, continuous light fuel load (D'Antonio & Vitousek 1992).

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Livestock can reduce exotic annual grasses by removing most of the biomass each year. Removing biomass generally means fewer seeds and less seed bed mulch, which reduces the following year's growth of exotic annual grasses (Heady 1956).
- **Season-of-use:** Research has not demonstrated that season-of-use is directly related to the abundance of exotic annual grasses.
- **Livestock class:** Research has not demonstrated that livestock class is directly related to the abundance of exotic annual grasses.

4. Measuring/monitoring techniques: The abundance of exotic annual grasses can be monitored by plot based abundance data and evaluation of Residual Dry Matter (RDM) on a site.

5. References:

Bartolome, J.W., W.E. Frost, N.K. McDougald, M.Connor. 2002. California Guidelines for Residual Dry Matter (RDM) Management on Coastal and Foothill Annual Rangelands. Publication 8092. Division of Agriculture and Natural Resources, California.

D'Antonio, C. M., and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annu. Rev. Ecol. Syst. 23:63-87.

Duncan, D. A. 1975. The San Joaquin site of the grassland biome: its relation to annual grassland ecosystem synthesis. Pages 9-13 in R. M. Love, editor. The California Annual Grassland Ecosystem. Institute of Ecology, University of California at Davis, Anaheim, California.

Guenther, K. 1998. Residual Dry Matter (RDM) Monitoring Photo-guide. Wildland Solutions. 16 pp. www.wildlandsolutions.com

Heady, H. F. 1956. Changes in a California annual plant community induced by manipulation of natural mulch. Ecology 37:798-812.

Heady, H. F., J. W. Bartolome, M. D. Pitt, G. D. Savelle, and M. C. Stroud. 1988. The California prairie. Pages 313-335 in R. T. Coupland, editor. Natural Grasslands: introduction and western hemisphere. Elsevier, New York, New York.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
15. Exotic Annual Grasses			■		
		■	■		
		■	■	■	

Non-use

Conservative Stocking

Heavy Stocking

Photos courtesy of Keith Guenther.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
15. Exotic Annual Grasses						
	■					

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
15. Exotic Annual Grasses					

16. Exotic Perennial Grasses

1. Description: Exotic perennial grasses include invasive species such as velvet grass *(Holcus lanatus)*, tall fescue *(Festuca arundinacea)*, orchard grass *(Dactylis glomerata)*, Bermuda grass *(Cynodon dactylon)*, kikuyu grass *(Pennisetum clandestinum)*, and canary grass *(Phalaris aquatica)*.

2. Significance: Exotic perennial grasses have been planted extensively for cattle forage and to control erosion in disturbed areas. However, these species can compete with rare native plant species. These grasses often create management challenges to maintain forage production and native wildlife habitat values (Schultz & Crone 1998). They are difficult to manage mostly because they benefit from management techniques used to increase desirable native species.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** High grazing intensity will adversely impact exotic perennial grasses. Reducing litter density may reduce germination in tall fescue (Reynolds et al. 2001) while reducing the ecological impacts of perennial species such as velvet grass.
- **Season-of-use:** Late season grazing reduces exotic perennial grasses most effectively because they tend to be more vulnerable to grazing as the soil is drying.
- **Livestock class:** Cattle effectively select exotic perennial grasses by grazing in such a manner as to remove tillers and new growth. In addition, sheep can crop these grasses closely.

4. Measuring/monitoring techniques: The best way to monitor exotic perennial grass abundance is with plot-based abundance data.

5. References:

Reynolds, S. A., J. D. Corbin, and C. M. D'Antonio. 2001. The effects of litter and temperature on the germination of native and exotic grasses in a coastal California grassland. Madroño 48:230-235.

Schultz, C. B., and E. E. Crone. 1998. Burning prairie to restore butterfly habitat: a modeling approach to management tradeoffs for the fender's blue. Restoration Ecology 6:244-252.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
16. Exotic Perennial Grasses Abundance of exotic perennial grasses					

Photo courtesy of Johnny Nesmith.

Non-use

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
16. Exotic Perennial Grasses Abundance of exotic perennial grasses						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
16. Exotic Perennial Grasses Abundance of exotic perennial grasses					

17. Purple Needlegrass

1. Description: Purple needlegrass (Nassella pulchra) is a native bunchgrass; the Nassella genus was formerly called Stipa. Purple needlegrass is assumed to have been a major component of some California annual grasslands and oak woodlands prior to introduction of exotic annual grasses (Bartolome & Gemmill 1981).

2. Significance: Purple needlegrass is considered good forage for livestock. It remains green and highly palatable for 1-2 months in the summer, after associated annual grasses and forbs have dried up. Reestablishing purple needlegrass is often a key objective of restoration projects in the annual grassland and oak woodland habitats. Purple needlegrass is the California state grass, and stands of this grass are considered a rare community type in the state (Keeley 1990).

3. Rationale for predictions shown in grazing impact graphics: Livestock grazing has been cited as a central cause of the elimination of purple needlegrass and other perennial grasses in many areas (Burcham 1975). It has been suggested that grazing can enhance needle grass seedling establishment by removing competing non-native annual grasses (Dyer et al. 1996). Because of genetic or other site-specific responses, response to livestock grazing may vary considerably, suggesting the need for caution when developing grazing predictions (Hatch et al. 1999, White 1967). In addition, adjusting livestock grazing is unlikely to be enough to restore purple needlegrass at sites where it has been eliminated. Rather, the needlegrass will need to be reintroduced as part of a restoration program.

- ***Grazing intensity:** *Ungrazed annual grasslands produce a heavy thatch that may inhibit purple needlegrass (Fossum 1990). Competition from, annual grasses is a major factor in repressing native perennial grass establishment and growth (Brown & Rice 2000). Some ungrazed areas have had purple needlegrass persist (White 1967). Conservative or moderate grazing appears to reduce thatch and provide a disturbance that encourages purple needlegrass to germinate and become established. Heavy grazing reduces purple needlegrass as livestock seek it out for its large size, palatability and greeness late in the year. Predicting impacts for stocking level is complicated as season-of-use and annual rainfall are also important factors.
- **Season-of-use:** Although response varies between genetically distinct populations, grazing during the winter may decrease the earlier growing non-native annual grasses, thus favoring the later growing perennial needlegrass. Grazing during the late spring and dry season can harm needlegrass by allowing grazing during the period when it is green and non-native annual grasses are dry and relatively unpalatable (Huntsinger et al. 1996).
- **Livestock class:** The effects of livestock class on purple needlegrass are not clear. However, grazing-related disturbance are thought to benefit needlegrass to some degree.

4. Measuring/monitoring techniques: Two main goals for management are increasing both the cover and the frequency of purple needlegrass. Because cover varies from year-to-year due to non-management related factors, monitoring data for cover may be less important. The frequency of purple needlegrass should be monitored randomly in the area where it is established.

5. References:

Bartolome, J. W., and B. Gemmill. 1981. The ecological status of Stipa pulchra (POACEAE) in California. Madroño 28:172-184.

Brown, C. S., and K. J. Rice. 2000. The mark of zorro: effects of the exotic annual grass Vulpia myuros on California native perennial grasses. Restoration Ecology 8:10-17.

Dyer, A. R., H. C. Fossum, and J. W. Menke. 1996. Emergence and survival of Nassella pulchra in a California grassland. Madroño 43:316-333.

Fossum, H. C. 1990. Effects of prescribed fire burning and grazing on Stipa pulchra (Hitchc.) seedling emergence and survival. Page 67. Master's Thesis in the Ecology Department. University of California at Davis.

Hatch, D. A., J. W. Bartolome, J. S. Fehmi, and D. S. Hillyard. 1999. Effects of burning and grazing on a coastal California grassland. Restoration Ecology 7:376-381

Huntsinger, L., M. P. McClaran, A. Dennis, and J. W. Bartolome. 1996. Defoliation response and growth of Nassella pulchra (A. Hitchc.) Barkworth from serpentine and non-serpentine populations. Madroño 43:46-57.

White, K. L. 1967. Native bunchgrass (Stipa pulchra) on Hastings Reservation, California. Ecology 48:949-954.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
17. Purple Needlegrass Ability of Purple Needlegrass to grow and reproduce					

Photo courtesy of Sheila Barry.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
17. Purple Needlegrass Ability of Purple Needlegrass to grow and reproduce						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
17. Purple Needlegrass Ability of Purple Needlegrass to grow and reproduce					

18. Coyote Brush

1. Description: Coyote brush *(Baccharis pilularis)* is a moderately long-lived, woody perennial shrub in the aster family. The seed is wind dispersed from female shrubs. While not tolerant of more arid, inland grasslands, coyote brush but thrives in the range of climates moderated by the Pacific Ocean, from wetlands and even to xeric slopes. Coyote brush is perhaps the weediest of native shrubs, invading grasslands significantly during El Niño years and creating dense stands within 15 years of rest from grazing, fire or other disturbances. (McBride 1974).

2. Significance: Coyote brush quickly replaces productive grasslands unless regularly disturbed by environmental factors such as fire or livestock grazing. While not considered important for forage, coyote brush provides habitat for a variety of invertebrate species, especially because of copious floral resources produced late in the season.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Moderate to high grazing intensity helps limit the invasion of coyote brush.
- **Season-of-use:** Late season and dormant season grazing during May-August, when annual grasses are dry, will reduce coyote brush. High intensity early season cattle grazing can mechanically remove shrubs.
- **Livestock class:** Goats and sheep are more likely to eat coyote brush than cattle, although cattle trampling has been shown to prevent coyote brush from invading grasslands.

4. Measuring/monitoring techniques: Analyzing aerial photographs is the best way to monitor the invasion of coyote brush and other conspicuous shrubs. When the shrub cover reaches a threshold of 20-40%, the site is at a crucial transition from grassland to shrubland and so may lose grass productivity as well as grassland-dependent plant species (Hobbs & Mooney 1986).

5. References:
Hobbs, R. J., and H. A. Mooney. 1986. Community changes following shrub invasion of grassland. Oecologia 70:508-513.
McBride, J. R. 1974. Plant succession in the Berkeley Hills, California. Madroño 22:317-329.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
18. Coyote Brush Ability of site to RESIST coyote brush invasion					

Non-use

Conservative Stocking

Heavy Stocking

Photos courtesy of Keith Guenther.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
18. Coyote Brush Ability of site to RESIST coyote brush invasion						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
18. Coyote Brush Ability of site to RESIST coyote brush invasion					

19. Creeping Rye

1. Description: Creeping rye *(Leymus triticoides)*, also known as alkali or beardless rye, is a tall perennial rhizomatous grass that rarely sets fertile seed, mainly relying on vegetative propagation. Creeping rye is associated with moist sites and was probably once the dominant native grass in much of California's historically moist soils of the Central Valley (Holstein 2001).

2. Significance: Creeping rye is considered a valuable forage plant. Stands are resistant to weed invasion and are valuable for erosion control.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Moderate to light grazing intensity is necessary to maintain dense stands of creeping rye. This grass tolerates more intense grazing, though it does not grow as densely in those conditions.
- **Season-of-use:** Early season of use helps creeping rye compete with exotic annual grasses while conserving soil moisture in some dry years. This grass is dormant until soil temperatures warm sufficiently, and is little used during the cooler winter months.
- **Livestock class:** Goats and sheep can help remove tough forb competitors (shrubs, thistles, mustards) from stands of creeping rye. Cattle help maintain creeping rye in areas of intense competition from exotic grasses.

4. Measuring/monitoring techniques: Monitor randomly selected patches of creeping rye for density: record percent cover and abundance of plant species within the stand.

5. References:
Holstein, G. 2001. Pre-agricultural grassland in central California. Madroño 48:253-264.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
19. Creeping Rye Abundance of creeping rye			■		
		■	■	■	
		■	■	■	

Photos courtesy of David Amme.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
19. Creeping Rye Abundance of creeping rye						
		■				
		■	■	■		

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
19. Creeping Rye Abundance of creeping rye					
	■	■			
	■	■	■	■	■

20. Pine Bluegrass *(Poa secunda)*

1. Description: Pine bluegrass is a small perennial bunchgrass that grows in arid areas of the western United States. It is less robust and coarser than many other native perennial bunchgrasses. Pine bluegrass grows and flowers early in the season and becomes dormant by June, making it very hard to locate and identify after the onset of the summer drought.

2. Significance: Pine bluegrass is tolerant of drought and grazing and so is considered an important forage grass for livestock in the arid western United States. This grass is also considered to be important for wildlife. Pine bluegrass may be the most common native perennial grass in central California grasslands.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Pine bluegrass responds favorably to moderate-heavy grazing intensity (Tueller 1962), which reduces the shrubs and exotic grasses that could otherwise outcompete it.
- **Season-of-use:** Early season of use helps to reduce competition and so favors pine bluegrass, which grows most actively early in the season and often flowers and then goes dormant well ahead of other species.
- **Livestock class:** Research has suggested that sheep grazing favors pine bluegrass over non-native annuals its most important competitor. Cattle may have the opposite effect, favoring non-native annuals over pine bluegrass (Daubenmire 1970).

4. Measuring/monitoring techniques: Monitor the cover and frequency of pine bluegrass. Because cover varies from year to year due to non-management related factors such as weather, monitoring data for cover may be highly skewed. The frequency of pine bluegrass should be monitored randomly in the area where it is established.

5. References:
Daubenmire, R. 1970. Steppe vegetation of Washington. Pages 1-131. Washington State University College of Agriculture; Washington Ag. Exp. Station, Pullman, WA.

Tueller, P. T. 1962. Plant succession on two Artemisia habitat types in southwestern Oregon. Page 249. Oregon State University, Corvallis, OR.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
20. Pine Bluegrass Abundance of pine bluegrass				■	
			■	■	■
		■	■	■	■

Photos courtesy of David Ammic.

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
20. Pine Bluegrass Abundance of pine bluegrass		■				
		■		■		
		■		■	■	■

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
20. Pine Bluegrass Abundance of pine bluegrass					
	■	■			
	■	■	■	■	■

21. Fire Severity

1. Description: Fire severity has several components including burn intensity, cost of suppression, and resource damages.

2. Significance: Fires are a natural part of rangeland ecosystems but uncontrolled wildfires are expensive to manage and can be damaging. This Indicator is similar to the SRR Indicator 12.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Livestock grazing can decrease the severity of fires by reducing the fuels available to be burned. In ungrazed grasslands with 2,000 lbs/acre of dry fuel, flames can be more than 50 feet long and so difficult to control. In moderately grazed rangelands with 1,000 lbs/acre of grassy fuels, flames can be 4-10 feet long and so 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.
- **Season-of-use:** Areas grazed only during the early part of the growing season will tend to regrow during the late spring. Grazing during the late spring is the most effective time to lower flammable herbage levels prior to the dry vegetation period.
- **Livestock class:** All classes of livestock can effectively reduce herbage and associated fire severity.

4. Measuring/monitoring techniques: Potential fire severity can be measured by flame length expected from a given amount of fuel (pounds/acre) and a specific wind and humidity. Potential fire severity can also be indirectly measured based on the amount of RDM as available fuel. In addition, ratings for fire resistance to control and rate of spread can be based on a combination of fuel amount and type, slope, wind speed and humidity. Other measures of fire severity include the costs of suppression and the value of resource damage.

5. References:

Bartolome, J.W., W.E. Frost, N.K. McDougald, M.Connor. 2002. California Guidelines for Residual Dry Matter (RDM) Management on Coastal andFoothill Annual Rangelands. Publication 8092. Division of Agriculture and Natural Resources, California.

Biswell, Harold. 1999. Prescribed Burning in California Wildlands Vegetation Management. 1999. University of California Press.

Guenther, Keith. 1998. Residual Dry Matter (RDM) Monitoring Photo-guide. Wildland Solutions. 16 pp.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
21. Fire Severity Ability for the landscape to have a low fire severity condition					

Photos courtesy of USDA NRCS.

Non-use

Photos courtesy of USDA NRCS.

Conservative Stocking

Photos courtesy of TNC.

Heavy Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
21. Fire Severity Ability for the landscape to have a low fire severity condition						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
21. Fire Severity Ability for the landscape to have a low fire severity condition					

22. Water Quality

1. Description: Water quality has been, and continues to be, one of the most important environmental issues associated with livestock grazing. Pollution is defined as "An alteration of the quality of the State's waters by waste to a degree which unreasonably affects their beneficial uses or facilities which serve their beneficial uses". Beneficial uses include drinking water, irrigation and aquatic habitat.

2. Significance: People want and demand good water quality for uses from drinking to irrigation. Aquatic and terrestrial wildlife need good water quality to survive. For each water body in California, Regional Water Quality Control Boards define the beneficial uses and establish standards for those uses. If a water body does not meet the standards associated with the beneficial use, it is declared to be impaired or polluted. Livestock operations can produce water pollutants, including pathogens, sediment, excessive nutrients and increased water temperature (George 1996). Pathogens from livestock include viruses, fungi, bacteria, and protozoal parasites. Of primary concern are Cryptosporidium parvum, Giardia duodenalis, Campylobacter spp, Salmonella spp, and pathogenic strains of E. coli (Atwill 1997). Cattle can overgraze riparian areas, removing vegetation needed to retain stream bank stability. This leads to erosion of streambanks, which then leads to wider and shallower streams, which in turn can lead to increased water temperature. However, proper grazing can also co-exist with sustainable riparian systems (Krueger 1996).

3. Rationale for predictions shown in grazing impact graphics: Water quality is most affected by the timing, intensity, and duration of grazing (Buckhouse 1996).

- **Grazing intensity:** Light and conservative use provides adequate litter and good water quality. Heavy use is more likely to reduce water quality, as little cover is left and livestock concentrate around water sources. Non-use limits a land manager's ability to manage annual vegetation which can impact water qualtiy as it dies and decays.
- **Season-of-use:** Grazing during the dry dormant season minimizes the impact on soil; however, during this season livestock may concentrate in riparian areas which may have adverse impacts on vegetation and stream banks leading to water quality impacts. Livestock concentration in riparian areas may also increase pathogen and nutrient loading.
- **Livestock class:** All livestock classes are assumed to have similar impacts on water quality.

4. Measuring/monitoring techniques: Water quality on rangelands is typically monitored indirectly. Uplands can be monitored by assessing Residual Dry Matter (RDM) (Bartolome et. al. 2002), while streams and riparian vegetation can be monitored photographically. The threat of pathogens can be reduced by maintaining a healthy herd with medication and nutrition programs.

5. References:

Allen-Diaz, R.D. Jackson, J.W. Barolome, K.W. Tate, L.G. Oates. 2004. Long-term grazing study in spring-fed wetlands reveals management tradeoff. California Agriculture 58:3:144-148.

Atwill, E.R. 1997. Pathogens Excreted by Livestock and Transmitted to Humans through Water. UC Agricultural Issues Center. UCD, One Shields Ave. Davis, CA 95616.

Bartolome, J.W., W.E. Frost, N.K. Mcdougald and M. Connor. California Guidelines for Residual Dry Matter (RDM) Management on Coastal and Foothill Annual Rangelands. DANR Publication 8092. http://anrcatalog.ucdavis.edu.

Buckhouse, J.C. 1996. Controlling Season, Intensity, and Frequency of Grazing. IN: Livestock Management in Grazed Watersheds: A Review of Practices That Protect Water Quality. ANR Publication 3381. 6701 San Pablo Avenue, Oakland, CA 94608.

George, M.R. 1996. Livestock Management in Grazed Watersheds: A Review of Practices That Protect Water Quality. ANR Publication 3381. 6701 San Pablo Avenue, Oakland, CA 94608.

Krueger, B. 1996. Developing an Effective Grazing Strategy for Riparian Vegetation. IN: Livestock Management in Grazed Watersheds: A Review of Practices That Protect Water Quality. ANR Publication 3381. 6701 San Pablo Avenue, Oakland, CA 94608.

Thompson, L.C. and R. Larsen. 2004. Fish Habitat in Freshwater Streams. DANR Publication 8112.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
22. Water Quality Ability of site to meet water quality guidelines					
		■	■		
		■	■	■	

Should Exceed Water Quality Standards	Should Meet Water Quality Standards	May Not Meet Water Quality Standards
Non-use	Conservative Stocking	Heavy Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
22. Water Quality Ability of site to meet water quality guidelines						
		■	■	■		■
		■	■	■	■	■

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
22. Water Quality Ability of site to meet water quality guidelines					
	■	■	■	■	■

23. Water Infiltration

1. Description: Infiltration is the process of water moving into soil, and the infiltration rate is the quantity of water that moves through the soil surface in a given unit of time. Percolation is the process of water moving down through the soil profile. Infiltration rates and percolation are largely determined by vegetation cover and soil factors such as texture, structure, porosity or bulk density, and aggregation. The latter occurs when by-products of soil microbial activity and organic matter decay "glue" clay, silt and sand particles together; the stronger these bonds, the greater the infiltration rate.

2. Significance: Infiltration is important because water needs to infiltrate the soil before plant roots can use it to grow and develop. Infiltration also plays a key role in proper watershed function, which entails capturing, storing and safely releasing water. Greater infiltration means less surface runoff, which in turn means less erosion and subsequent sedimentation.

3. Rationale for predictions shown in grazing impact graphics: Falling raindrops have an enormous amount of associated energy and this can be detrimental to infiltration if the raindrops fall directly onto soil particles. The energy from falling raindrops can break soil aggregates, which decreases porosity and infiltration. Vegetative cover can absorb the energy from raindrops, thus protecting the soil aggregates and enhancing infiltration (Thurow 1991). Vegetation, both live biomass and litter, also act like tiny dams to slow the raindrops and subsequent surface flow, thus allowing a longer period for water to infiltrate.

- **Grazing intensity:** In general, any grazing level decreases infiltration rates. Non-use and light use provide high levels of litter and ground cover, which allows a high rate of water infiltration. There are no statistical differences for water infiltration between moderate and conservative grazing rates. Heavy grazing results in low levels of litter and reduced infiltration (Gifford and Hawkins, 1978). Long-term heavy grazing can lead to decreased cover and organic matter, deteriorated soil structure and finally decreased infiltration.
- **Season-of-use:** Depending on the soil type, grazing during the wet season may increase soil compaction which can reduce infiltration. Livestock trampling can break soil aggregates and increase bulk density, which in turn decreases infiltration.
- **Livestock class:** All livestock classes are assumed to have similar impacts on water infiltration.

4. Measuring/monitoring techniques: The best ways to measure water infiltration directly are to use: 1) a sprinkler-type rainfall applicator (for both small and large plots), 2) artificial flooding or ponding (e.g. ring infiltrometers), or 3) natural rainfall. Any equipment used should duplicate natural conditions and rainfall patterns as closely as possible.

However, measuring water infiltration directly is complex and expensive (Branson et. al. 1981). A site's potential for water infiltration can be measured indirectly based on the litter as (RDM) and plant cover.

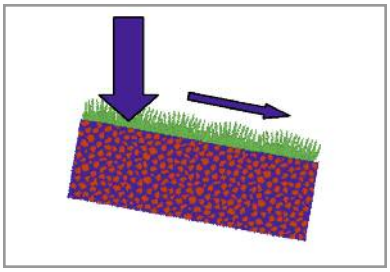
5. References: Branson, F.A., G.F. Gifford, K.G. Renard, and R.F. Hadley. 1981. Rangeland Hydrology. Kendal Hunt Publishing Co. Dubuque, Iowa.

Gifford, G.F. and R.H. Hawkins. 1978. Hydrologic Impact of Grazing on Infiltration: A Critical Review. Water Resources Research 14(2): 305-313.

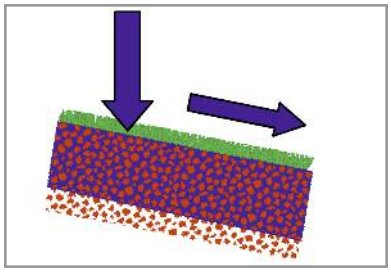
Thurow, T.L. 1991. Hydrology and Erosion. IN: Heitschmidt R.K. and J.W. Stuth. Grazing Management An Ecological Perspective. Timber Press. Portland, Oregon.

Grazing Intensity Impacts

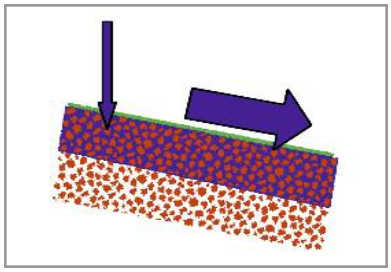
	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
23. Water Infiltration Ability of water to infiltrate into the soil					



Non-use



Conservative Stocking



Heavy Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
23. Water Infiltration Ability of water to infiltrate into the soil						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
23. Water Infiltration Ability of water to infiltrate into the soil					

24. Litter

1. Description: Most land management agencies use litter, or Residual Dry Matter (RDM), to assess the level of grazing on annual grasslands in California. RDM is the dead plant material left standing or on the ground at the beginning of the new growing season.

2. Significance: The amount of RDM left at the beginning of the new growing season (along with site conditions and variations in weather) affects the following year's species composition and forage production. RDM can protect soil from erosion and nutrient losses (Bartolome et. al. 2002). RDM eventually decomposes and enters the soil, adding organic matter and nutrients. This then enhances the soil structure and improves infiltration. The improved soil structure also helps improve the soil fauna and the nutrient cycling process, which improves subsequent production (Thurow 1991). This is the same as Interpreting Indicators of Rangeland health indicator 14. This might also be related to SRR indicator 13.

3. Rationale for predictions shown in grazing impact graphics: The current year's production has the potential to become litter. After the peak production, herbaceous material is lost to grazing by livestock, wild ungulates and insects, and to decomposition. Decomposition rates can be about 10% per month (Bartolome et. al. 2002).

- **Grazing intensity:** Non-use results in a high level of litter, while heavy use can effectively remove all the litter from a site.
- **Season-of-use:** Proper use levels are needed regardless of the season of grazing. Vegetation can re-grow following grazing during the wet season if there is significant moisture.Vegetation losses in the absences of grazing are about 10% per month during the dry season. Proper utilization is needed to insure adequate residual dry matter for soil protection during the rainy season.
- **Livestock class:** All livestock classes can effectively remove litter.

4. Measuring/monitoring techniques: RDM should be measured in the fall just prior to any significant rainfall. The most common method for estimating RDM is to clip and weigh the litter in square foot plots. The litter should be clipped as close to the ground as possible without including any dirt, rocks, or any other foreign material. Another common method is visual estimation, which is done using reference photos and known amounts of RDM as standards (Bartolome et. al. 2002).

5. References:

Bartolome, J.W., W.E. Frost, N.K. Mcdougald and M. Connor. 2002. California Guidelines for Residual Dry Matter (RDM) Management on Coastal and Foothill Annual Rangelands. DANR Publication 8092. http://anrcatalog.ucdavis.edu.

Guenther, Keith. 1998. Residual Dry Matter (RDM) Monitoring Photo-guide. Wildland Solutions. 16 pp.

Thurow, T.L. 1991. Hydrology and Erosion. IN: Heitschmidt R.K. and J.W. Stuth. Grazing Management An Ecological Perspective. Timber Press. Portland, Oregon.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
24. Litter Litter present on ground					

Non-use

Conservative Stocking

Heavy Stocking

Photos courtesy of Keith Guenther.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
24. Litter Litter present on ground						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
24. Litter Litter present on ground					

25. Forage Production

1. Description: Forage production varies with the soil, amount of rainfall, species composition, residual dry matter (RDM) from the season before, and aspect. Dry fall forage is low in protein, but can provide enough energy for cattle. New germinated grasses while high in protein do not provide a substantial amount of forage.

2. Significance: The amount of forage production per acre affects the cost of management.

3. Rationale for predictions shown in grazing impact graphics: The major controllers of productivity are soils, rainfall and species composition. The productivity of a site (soils and rainfall) and the stocking rate affect the fall RDM, which then affects future production.

- **Grazing intensity:** The amount of RDM from the previous season affects the species composition and the productivity of the next season. Low amounts of RDM shift the composition to less grass and more forbs, which produce nutritious forage but significantly less biomass. In addition, RDM increases forage production by insulating seedlings as they germinate in the fall.
- **Season-of-use:** Forage is most available during the active growing season. Grazing annual grasslands during the dormant or early season increases seed production of highly desirable forage species.
- **Livestock class:** All livestock classes appear to have similar impacts on forage production.

4. Measuring/monitoring techniques: Clipping at standing peak crop or the same stage of plant phenology of ungrazed cages will describe forage production.

5. References:
Bartolome, James W. William E. Frost, Neil K. McDougald, Michael Connor. California Guidelines for Residual Dry Matter (RDM) Management on Coastal and Foothill Annual Rangelands. 2003 http://agronomy.ucdavis.edu/calrng/Publications/8092.pdf

George, Mel, Jim Bartolome, Neil Mc Dougald, Mike Connor, Charles Vaughn, and Gary Markegard. 2001. Annual Range Forage Production. Publication 8018 Division of Agriculture and Natural Resources http://anrcatalog.ucdavis.edu/pdf/8018.pdf

Guenther, Keith. 1998. Residual Dry Matter (RDM) Monitoring Photo-guide. Wildland Solutions. 16 pp.

Heady, Harold. Continuous vs. Specialized Grazing Systems. J of Range Man. Vol. 14, no. 4 July 1961

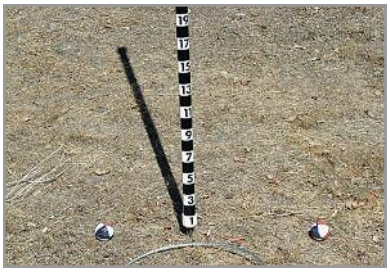
Nader, Glenn http://danrrec.ucdavis.edu/sierra_foothill/research_results.html

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
25. Forage Production The amount of forage produced that is available for livestock use					

Non-use

Conservative Stocking



Heavy Stocking

Photos courtesy of Keith Guenther.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
25. Forage Production The amount of forage produced that is available for livestock use						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
25. Forage Production The amount of forage produced that is available for livestock use					

26. Fall Forage Availability

1. Description: Fall forage availability means the amount of herbage that remains after the growing season. This forage can be grazed from September through November, before the new crop of annuals germinates and grows to provide more forage.

2. Significance: Fall forage is very important because it can reduce or eliminate the need for supplemental hay, and so decrease the cost of livestock production. However, leaving a large amount of forage during the dry summer season can increase the risk of fire.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Fall forage can be retained by conservative and moderate use.
- **Season-of-use:** Fall forage can be retained by early season use, removing the livestock before or at the end of the growing season.
- **Livestock class:** All livestock classes appear to have similar impacts on fall forage availability.

4. Measuring/monitoring techniques: Measure RDM levels in the late spring or fall.

5. References:
Forero, Larry, and Glenn Nader. Northern Sacramento Valley Cow Calf Budgets. http://www.agecon.ucdavis.edu/outreach/crop/cost-studies/BeefCowCalfSV2004.pdf

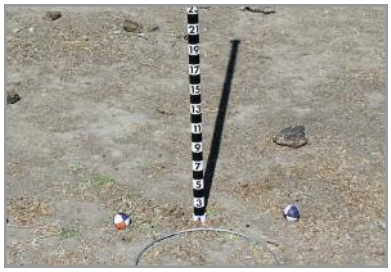
George, Melvin, Glenn Nader, John Dunbar, Neil McDougald, Bill Frost and Mike Connor. Annual Rangeland Forage Quality. Publication 8022. University of California Agriculture and Natural Resources http://anrcatalog.ucdavis.edu/pdf/8022.pdf

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
26. Fall Forage Availability The availability of early fall forage October–December					

Non-use

Conservative Stocking



Heavy Stocking

Photos courtesy of Keith Guenther.

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
26. Fall Forage Availability The availability of early fall forage October–December						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
26. Fall Forage Availability The availability of early fall forage October–December					

27. Supplemental Feeding Needed

1. Description: Supplemental feeding means providing forage or concentrate feeds to add to the nutrition provided from grazing. Livestock need enough nutrients to grow and reproduce at rates that make the operation viable. The main nutrients needed are protein, dry matter, and energy as carbohydrates. Trace minerals (such as copper, iodine and selenium) are provided in the salt or protein supplement.

2. Significance: Depending on an animal's nutritional requirements, supplemental feeding can greatly affect how fast they gain weight and whether they can conceive and produce young. Feeding hay is expensive and time-consuming to provide, costing about $55/month plus considerable labor for each cow. For comparison, producing rangeland forage costs about $15/month per cow and involves far less labor. This indicator is related to SRR indicator 34.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Livestock at heavy stocking rates will most likely need supplemental feeding, while those at a light stocking rate will have little need for supplemental feeding.
- **Season-of-use:** Timing of use can impact the need to provide supplement forage, especially protein that is higher during the green season. Livestock use during the dry season may require supplemental nutrients when available forage may be abundant but of a low quality. Early season may require protein on all grazing intensities and dry matter under heavy stocking. April to June should have the lowest supplementation requirement. Dormant and yearlong have the highest need for feed supplementation.
- **Livestock class:** Goats and sheep browse brush, which can provide sufficient protein and energy during the dry summer and early fall periods when grasses are low in both.

4. Measuring/monitoring techniques: Supplemental feeding can be measured either as the cost or quantity of the supplemental feed provided, or as the number of days of supplemental feeding.

5. References:
George, Melvin, Glenn Nader, and John Dunbar. Balancing Beef Cow Nutrient Requirements and Seasonal Forage Quality on Annual Rangeland. Rangeland Management Series. U.C. Publication 8021. http://anrcatalog.ucdavis.edu/pdf/8021.pdf

George, Melvin, Marya Bell. Using Stage of Maturity to Predict the Quality of Annual Range Forage. Rangeland Management Series. U.C. Publication 8019. http://anrcatalog.ucdavis.edu/pdf/8019.pdf

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
27. Supplement Feeding Needed Ability to manage without purchasing hay or protein supplement					

Photo courtesy of Keith Guenther.

Non-use

Photo courtesy of USDA NRCS.

Conservative Stocking

Photo courtesy of Keith Guenther.

Heavy Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
27. Supplement Feeding Needed Ability to manage without purchasing hay or protein supplement						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
27. Supplement Feeding Needed Ability to manage without purchasing hay or protein supplement					

28. Calving Rate

1. Description: Calving rate is the number of calves born per 100 cows per year. Most herds need to have a calving rate of at least 85% to remain viable. The number of calves born will depend on nutrition, disease, and bull management.

2. Significance: Calf production is the future income source for a cow/calf operation, and the calving rate is a measure of the operation's potential for production and thus income.

3. Rationale for predictions shown in grazing impact graphics:

- **Grazing intensity:** Heavy stocking tends to decrease the calving rate by reducing the nutrients available to cows. Supplemental feeding at the breeding time can mask this effect but also increases the cost of operation. On good condition rangeland, light stocking rates can achieve the same calving rate at a lower cost.
- **Season-of-use:** The calving rate can be increased by timing the breeding season when the forage meets the nutritional requirements for conception. In annual grasslands, most cattlemen breed in the winter to produce calves the next fall. They then supplement the cows' diet to optimize the calving rate. This allows the calves to grow during the spring green grass period and optimize their weight gains.
- **Livestock class:** Calving pertains to cow/calf operations only.

4. Measuring/monitoring techniques: The expected calving rate is measured by pregnancy testing the cows, which can be done by a trained individual three months after conception. The expected calving rate is the ratio of non-pregnant cows to pregnant cows.

5. References: George, Melvin, Glenn Nader, and John Dunbar. Balancing Beef Cow Nutrient Requirements and Seasonal Forage Quality on Annual Rangeland. Rangeland Management Series. U.C. Publication 8021. http://anrcatalog.ucdavis.edu/pdf/8021.pdf

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
28. Calving Rate The projected impact to Calving Rate of various stocking rates					
		■			■
		■	■	■	■

00%	85%	69%
Non-use	Conservative Stocking	Heavy Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
28. Calving Rate The projected impact to Calving Rate of various stocking rates						
			■	■		
		■	■	■	■	■

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
28. Calving Rate The projected impact to Calving Rate of various stocking rates					
				■	
				■	

29. Livestock Gain per Animal

1. Description: Livestock gain per animal is the average amount of weight each growing animal gains per day or per season.

2. Significance: Livestock gain per animal is a measure of an operation's profitability. A small change in this number can have a large impact on profitability as fixed operating costs will not change.

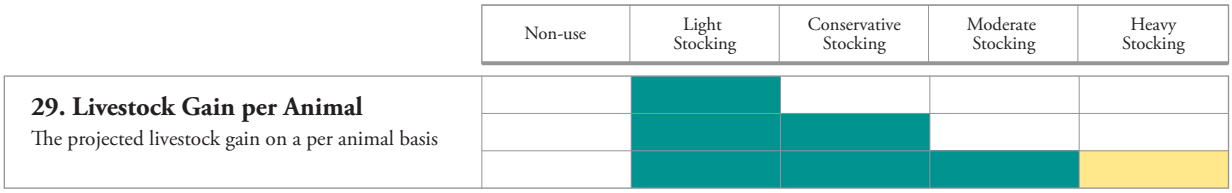
3. Rationale for predictions shown in grazing impact graphics:

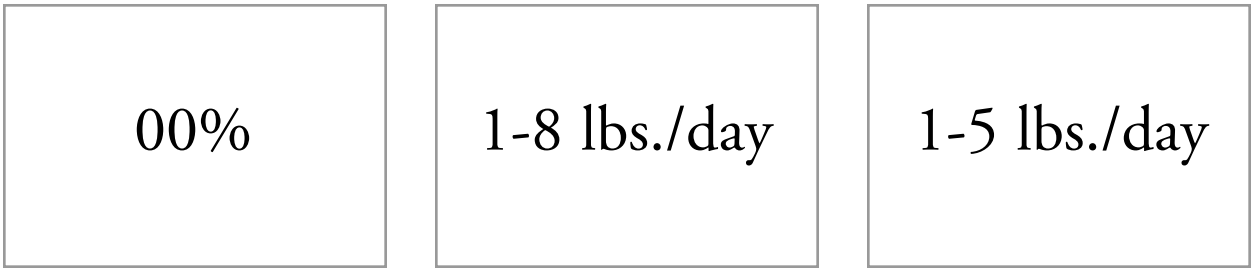
- **Grazing intensity:** In general, the lower the stocking density per season, the higher the weight gain for each animal. Most operators balance the stocking rate to meet both the economy of scale necessary for a rangeland operation and the weight gain for each animal. Heavier stocking rates can achieve increased weight gains with supplemental feeding, but this may yield a smaller net profit.
- **Season-of-use:** The highest weight gains per animal will be produced by grazing them during the green growing season, when annual grassland rangeland is at its highest nutritional state.
- **Livestock class:** The highest gain per animal is in young, growing livestock that is old enough to have a functioning rumen (multi-stomach that ferments forage). Once animals reach their mature weight, it varies only slightly by season and during pregnancy.

4. Measuring/monitoring techniques: Livestock gain per animal is determined by weighing the animals with a balance beam scales before and after grazing them in a pasture or for a season. This can be done by weighing the loaded and empty trucks that haul the animals to and from the pasture or by weighing animals in a corral individually or as a group.

5. References: George, Melvin, Glenn Nader, and John Dunbar. Balancing Beef Cow Nutrient Requirements and Seasonal Forage Quality on Annual Rangeland. Rangeland Management Series. U.C. Publication 8021. http://anrcatalog.ucdavis.edu/pdf/8021.pdf

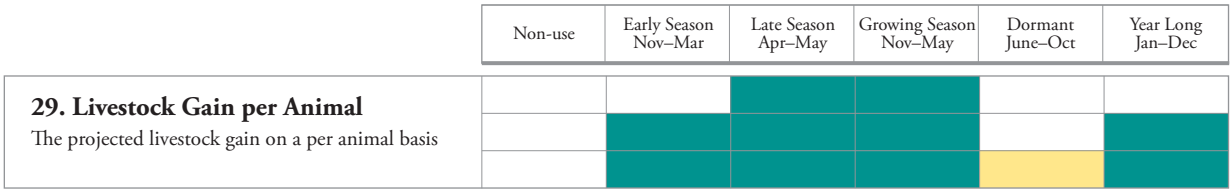
Grazing Intensity Impacts



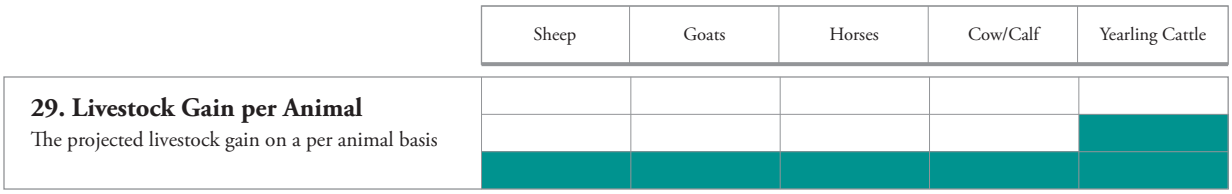


Non-use | Conservative Stocking | Heavy Stocking

Grazing Season-of-Use



Grazing Livestock Class/Type Impacts



30. Recreation Use

1. Description: Recreation use of wildland areas can be affected by livestock grazing. The impact to recreation users is heavily influenced by their expectations.

2. Significance: When rangelands are also used recreationally, livestock managers can spend a significant amount of time dealing with recreation-related conflicts. In some instances, grazing may be eliminated to avoid potential conflicts with recreational users.

3. Rationale for predictions shown in grazing impact graphics: The impact of livestock grazing on recreational use of rangeland areas is little studied but much talked about. This is hard to evaluate partly because different recreational users have different attitudes towards livestock. Grazing can have a positive impact when recreational users expect to find livestock and view them as contributing to a pastoral atmosphere. In contrast, grazing can have a negative impact when recreational users oppose grazing on public lands or fear being harmed by livestock.

- **Grazing intensity:** Light and conservative grazing are more likely to provide a good diversity of plant species including flowering plants, and less likely to conflict with recreational use. Moderate grazing can improve the ability of recreationists to utilize areas of dense vegetation.
- **Season-of-use:** Conflicts are likely to be high during the hot summer months, when both livestock and recreational users prefer the same scarce areas with shade and water. Some areas can have high conflicts during the late spring when large numbers of recreationists visit popular wildflower areas. Conflicts are lowest during the early winter, when forage is green and livestock water needs are lowest livestock tend to be dispersed and recreational use is low due to cold stormy weather.
- **Livestock class:** Conflicts are likely to be lowest with herds of sheep and goats, which can be controlled to avoid interactions with recreational users.

4. Measuring/monitoring techniques: Impacts on recreational use can potentially be measured based on the number of complaints received. However, comments from a small number of users may not be representative, whether they are positive or negative. Periodic user surveys can give a better indication of user satisfaction.

5. References:
East Bay Regional Park District, 2001. Wildland Management Policies and Guidelines. Oakland California.

Grazing Intensity Impacts

	Non-use	Light Stocking	Conservative Stocking	Moderate Stocking	Heavy Stocking
30. Recreation Use Ability for recreationists to have a quality experience					

Conservative Stocking

Grazing Season-of-Use

	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
30. Recreation Use Ability for recreationists to have a quality experience						

Grazing Livestock Class/Type Impacts

	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
30. Recreation Use Ability for recreationists to have a quality experience					

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Part 4

Analysis of Indicators

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The need to know and understand, the problem of information overload, and a technique that focuses on relative information.

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Photo courtesy of USDA NRCS.

THE NEED TO KNOW AND UNDERSTAND

Understanding how environmental, economic or social indicators are affected by livestock grazing practices is essential to determining which ones are likely to help or hinder reaching management goals.

THE PROBLEM OF INFORMATION OVERLOAD

When there are only one or two indicators of interest, it is fairly easy to evaluate and compare grazing practices when developing a management plan. However, when there are several relevant indicators, the amount of information to consider can be overwhelming.

A TECHNIQUE THAT FOCUSES ON RELEVANT INFORMATION

To help rangeland managers focus on the relevant information, *Understanding Livestock Grazing Impacts* provides grazing impact charts that make it easier to compare how various management practices are likely to affect the indicators of interest.

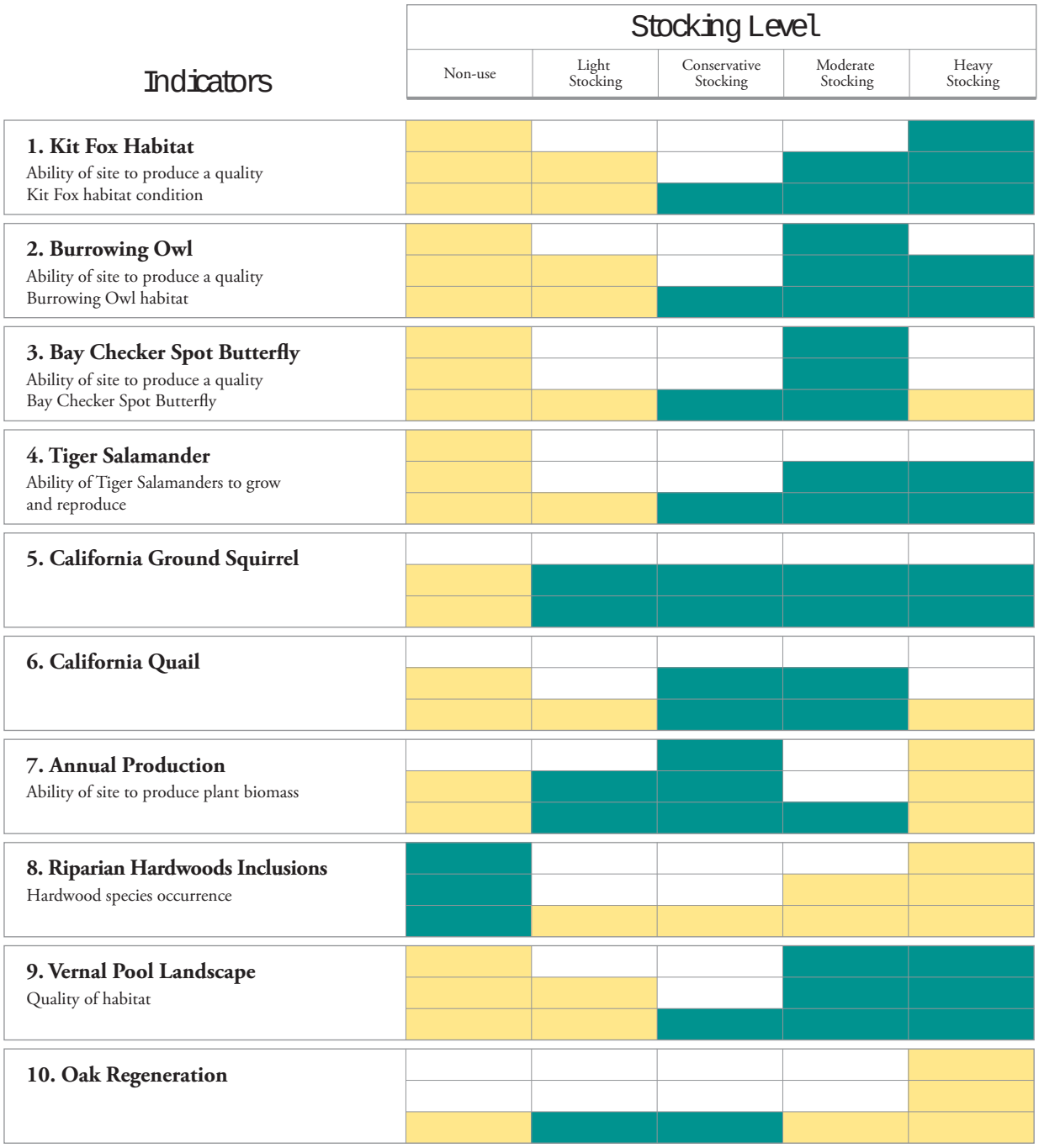
Tables 1–3 let managers quickly compare the expected impacts of three components of a grazing strategy: grazing intensity, season-of-use and livestock class. The tables show whether the grazing component has no impact, a positive impact or a negative impact to specific indicators of interest. The degree of impact ranges from low to moderate to high, qualitative terms that reflect the fact that the impact on some indicators is difficult to describe and measure precisely.

The tables can be used by selecting a grazing strategy: intensity, season of use, or livestock class and then evaluating the predicted impacts to the selected indicators. An alternate approach is to identify the most important indicators and then select a grazing strategy based on the most positive impacts, or least negative impacts.

It is not appropriate to select a strategy by simply adding up the positive and negative numbers for the identified indicators. A single high negative indicator may be important enough to eliminate a strategy that otherwise has many positive attributes. Likewise a strategy that has several slightly negative but acceptable impacts may be selected as the best overall strategy for a management unit. Key issues and indicators should not only be identified but also prioritized before these tables are used to select a grazing strategy.

The predictive information provided by the grazing impact graphics should be used only as a guideline. On the ground monitoring should be implemented with any grazing strategy to be sure it is achieving the desired objectives.

TABLE 1A: Grazing Intensity Impacts



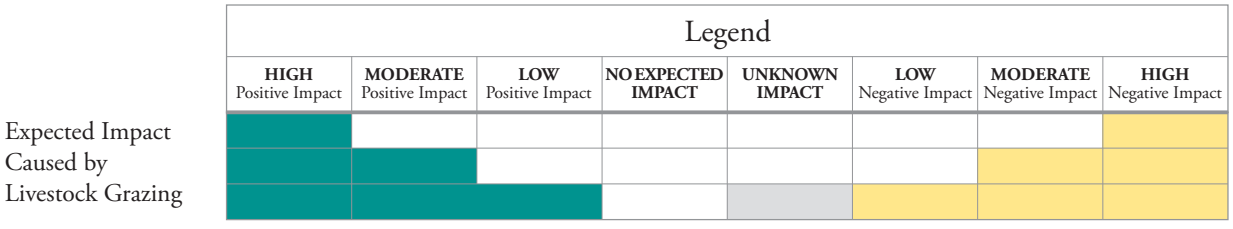
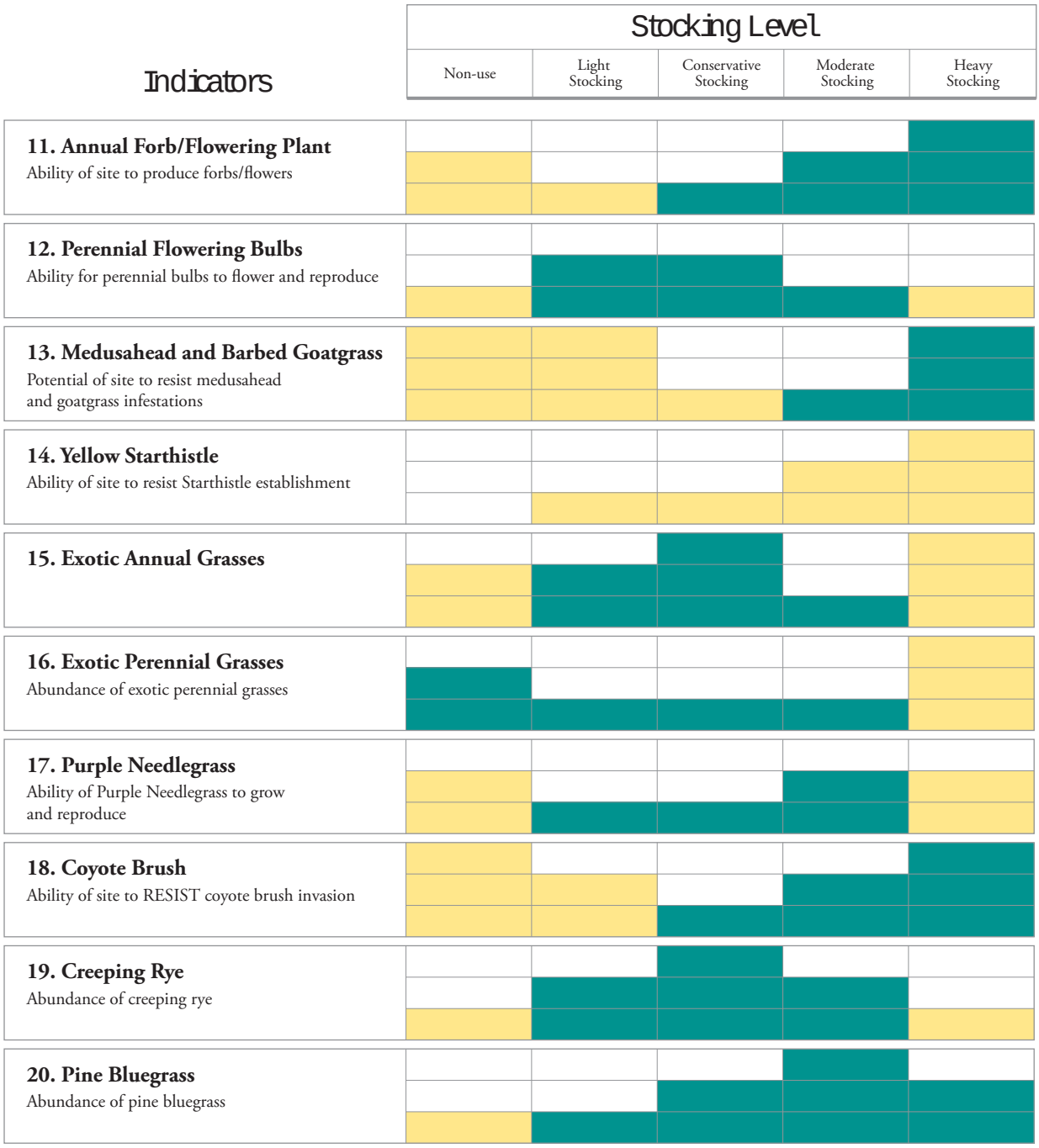


TABLE 1B: Grazing Intensity Impacts



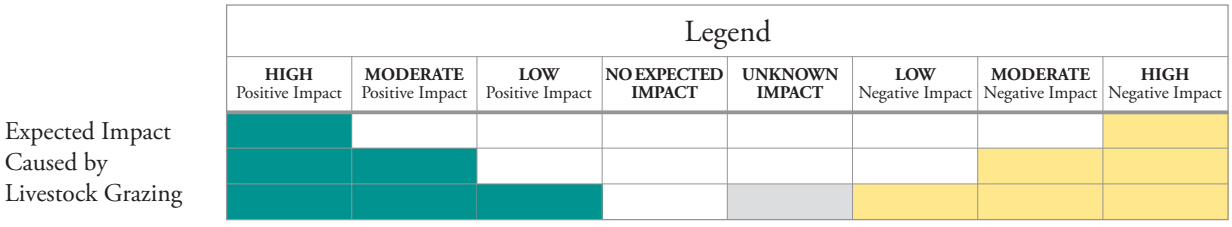
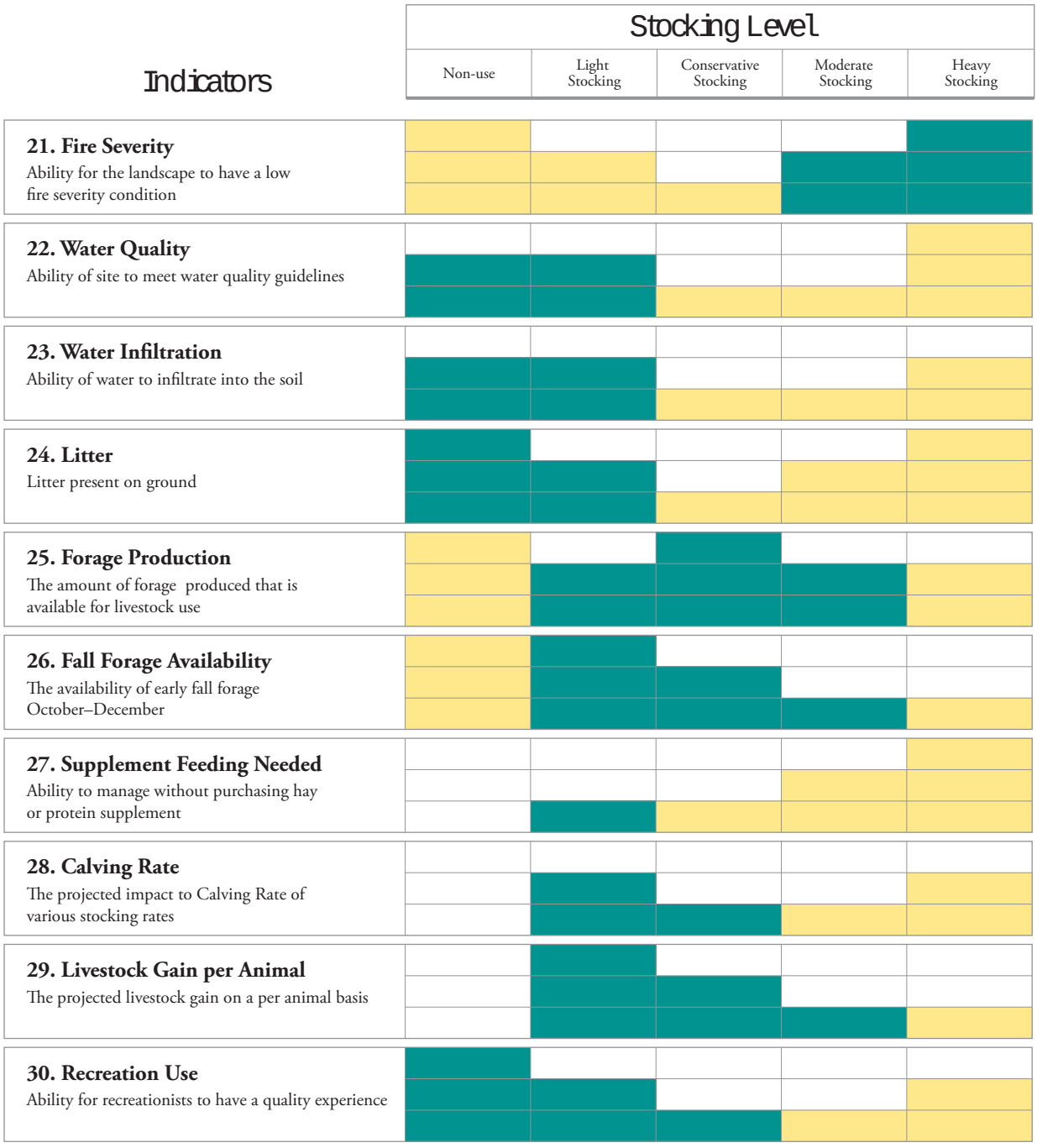


TABLE 1C: Grazing Intensity Impacts



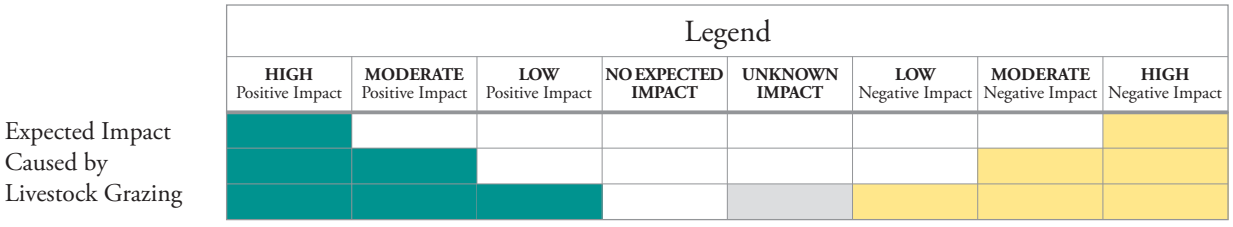
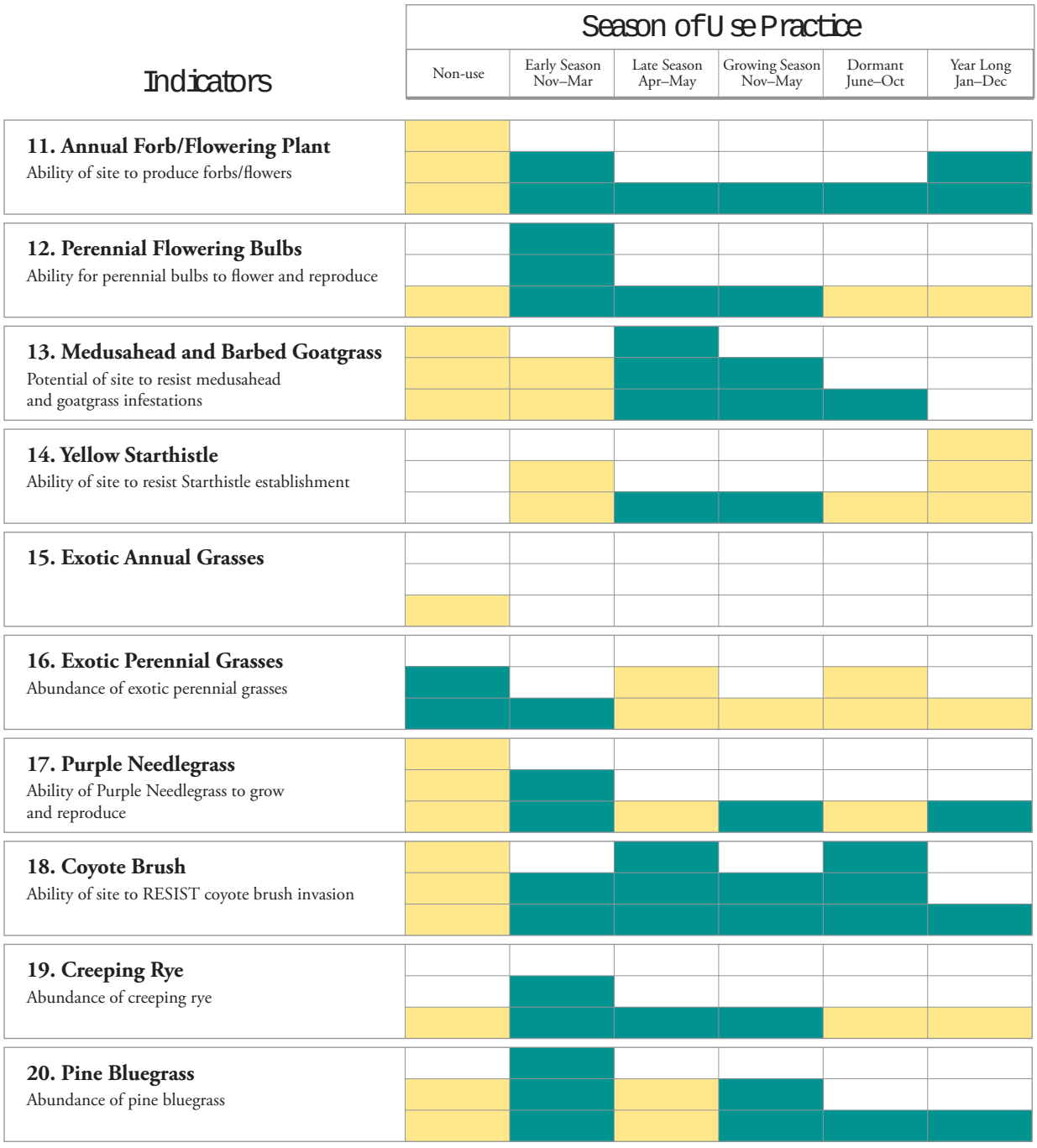


TABLE 2A: Livestock Season-of-Use

Indicators	Season of Use Practice					
	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
1. Kit Fox Habitat Ability of site to produce a quality Kit Fox habitat condition						
2. Burrowing Owl Ability of site to produce a quality Burrowing Owl habitat						
3. Bay Checker Spot Butterfly Ability of site to produce a quality Bay Checker Spot Butterfly						
4. Tiger Salamander Ability of Tiger Salamanders to grow and reproduce						
5. California Ground Squirrel						
6. California Quail						
7. Annual Production Ability of site to produce plant biomass						
8. Riparian Hardwoods Inclusions Hardwood species occurrence						
9. Vernal Pool Landscape Quality of habitat						
10. Oak Regeneration						

Legend							
	HIGH Positive Impact	**MODERATE** Positive Impact	**LOW** Positive Impact	**NO EXPECTED IMPACT**	**UNKNOWN IMPACT**	**LOW** Negative Impact	**MODERATE** Negative Impact	**HIGH** Negative Impact
Expected Impact Caused by Livestock Grazing								

TABLE 2B: Livestock Season-of-Use



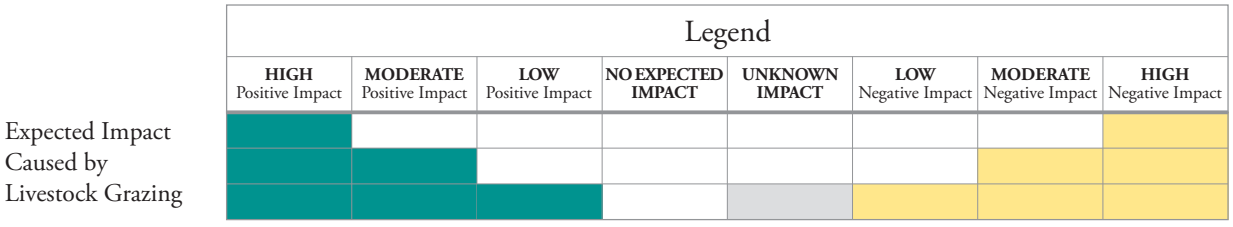
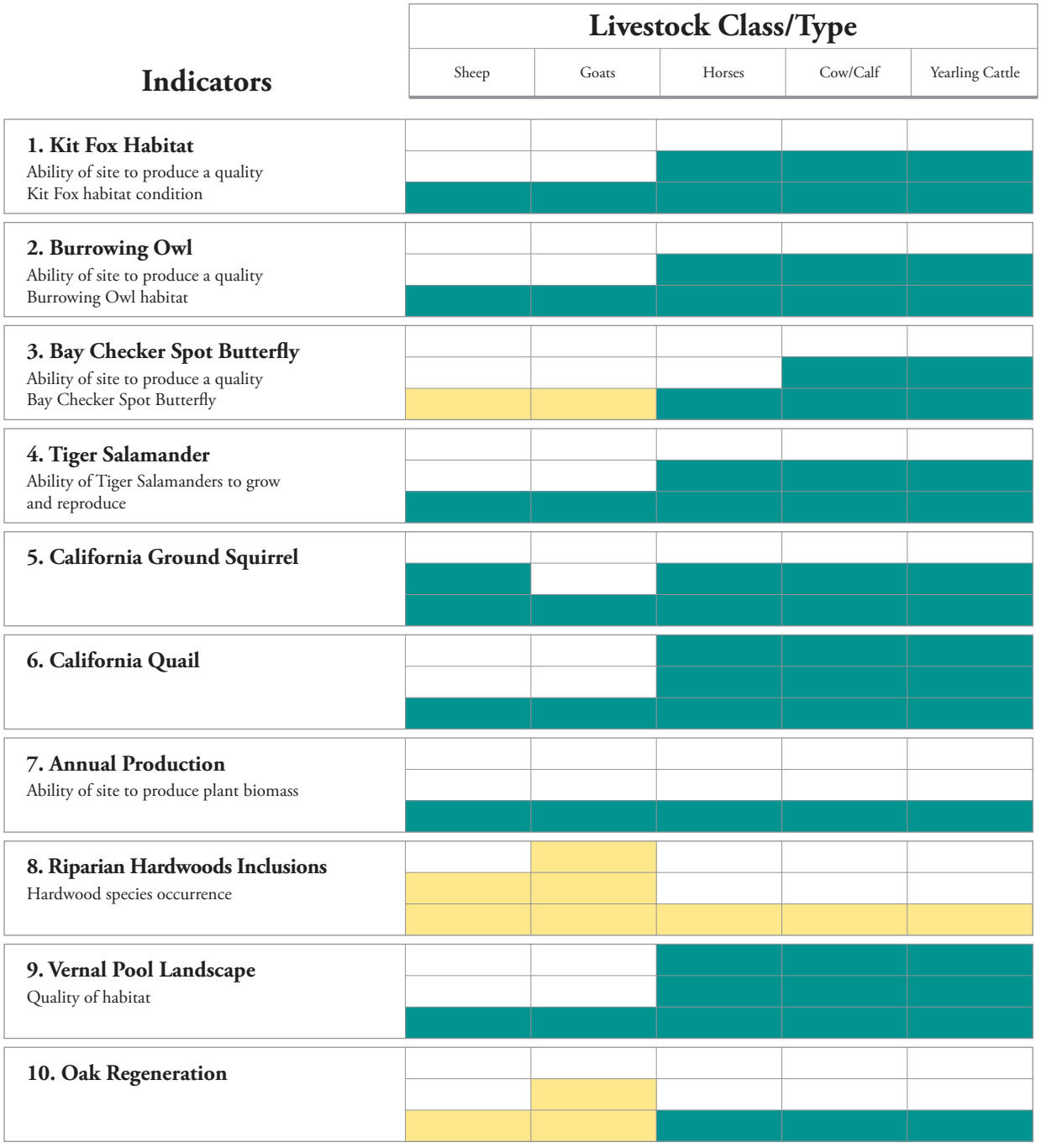


TABLE 2C: Livestock Season-of-Use

Indicators	Season of Use Practice					
	Non-use	Early Season Nov–Mar	Late Season Apr–May	Growing Season Nov–May	Dormant June–Oct	Year Long Jan–Dec
21. Fire Severity Ability for the landscape to have a low fire severity condition						
22. Water Quality Ability of site to meet water quality guidelines						
23. Water Infiltration Ability of water to infiltrate into the soil						
24. Litter Litter present on ground						
25. Forage Production The amount of forage produced that is available for livestock use						
26. Fall Forage Availability The availability of early fall forage October–December						
27. Supplement Feeding Needed Ability to manage without purchasing hay or protein supplement						
28. Calving Rate The projected impact to Calving Rate of various stocking rates						
29. Livestock Gain per Animal The projected livestock gain on a per animal basis						
30. Recreation Use Ability for recreationists to have a quality experience						

Legend							
HIGH Positive Impact	**MODERATE** Positive Impact	**LOW** Positive Impact	**NO EXPECTED IMPACT**	**UNKNOWN IMPACT**	**LOW** Negative Impact	**MODERATE** Negative Impact	**HIGH** Negative Impact
Expected Impact Caused by Livestock Grazing							

TABLE 3A: Livestock Class/Type Impacts



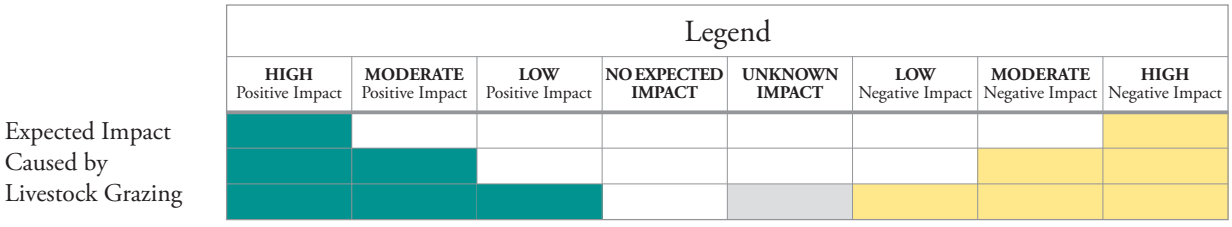


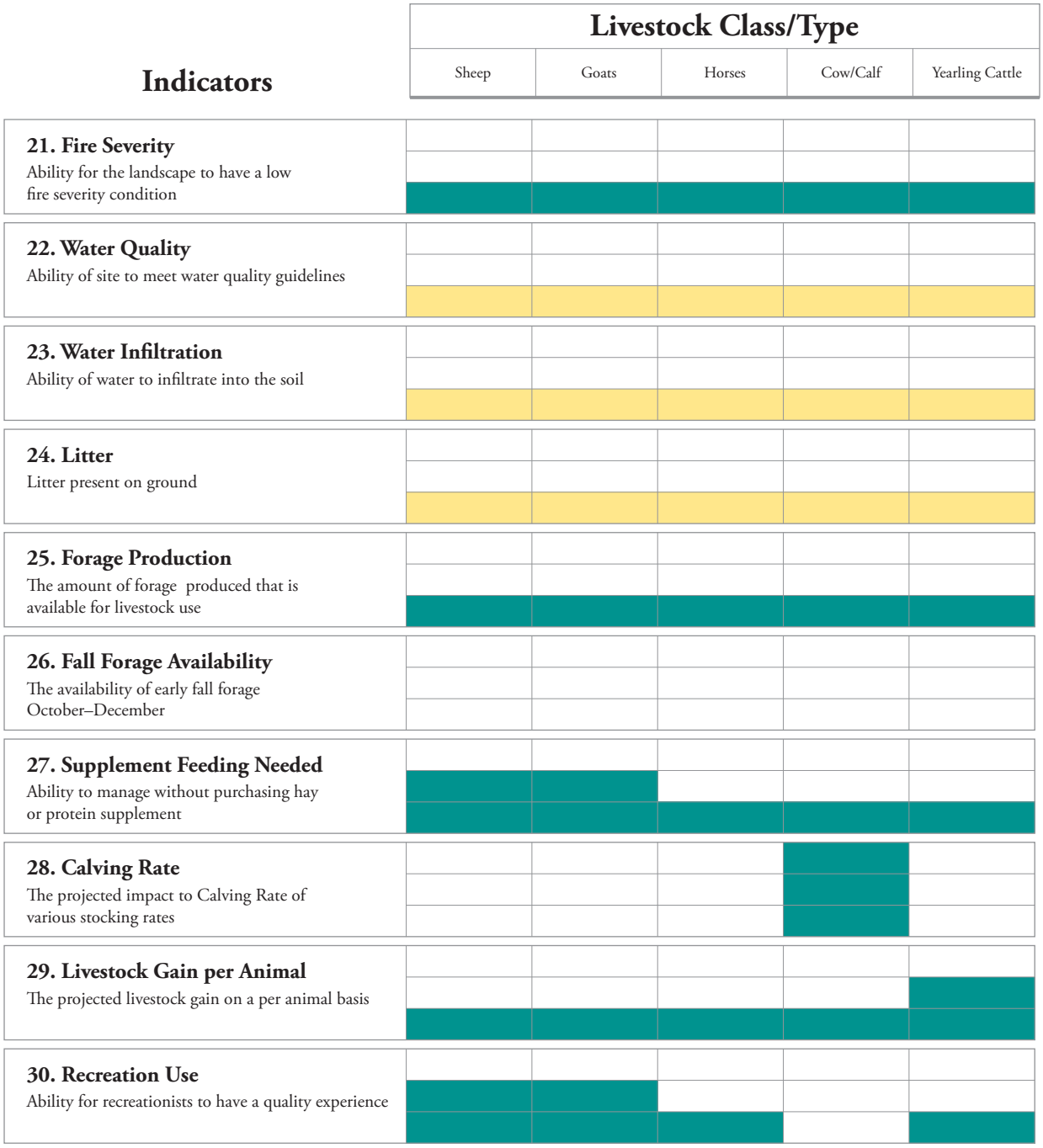
TABLE 3B: Livestock Class/Type Impacts

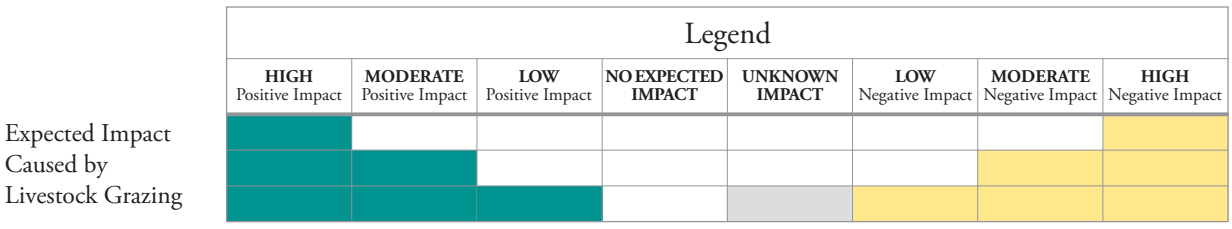
Indicators	Livestock Class/Type				
	Sheep	Goats	Horses	Cow/Calf	Yearling Cattle
11. Annual Forb/Flowering Plant Ability of site to produce forbs/flowers					
12. Perennial Flowering Bulbs Ability for perennial bulbs to flower and reproduce					
13. Medusahead and Barbed Goatgrass Potential of site to resist medusahead and goatgrass infestations					
14. Yellow Starthistle Ability of site to resist Starthistle establishment					
15. Exotic Annual Grasses					
16. Exotic Perennial Grasses Abundance of exotic perennial grasses					
17. Purple Needlegrass Ability of Purple Needlegrass to grow and reproduce					
18. Coyote Brush Ability of site to RESIST coyote brush invasion					
19. Creeping Rye Abundance of creeping rye					
20. Pine Bluegrass Abundance of pine bluegrass					

Legend							
HIGH Positive Impact	**MODERATE** Positive Impact	**LOW** Positive Impact	**NO EXPECTED IMPACT**	**UNKNOWN IMPACT**	**LOW** Negative Impact	**MODERATE** Negative Impact	**HIGH** Negative Impact

Expected Impact Caused by Livestock Grazing

TABLE 3C: Livestock Class/Type Impacts





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Part 5
Monitoring

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Properly designed monitoring will yield information that will help managers decide whether to continue or change management practices.

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Photo courtesy of USDA NRCS.

Monitoring is a key aspect of rangeland management that is often either overlooked or undertaken only when serious problems are discovered.

Why Monitor?
Maybe the question should be, why not monitor? Ranchers, landowners, and agencies spend millions of dollars and thousands of hours every year managing livestock on rangelands. It only makes sense to allocate a portion of that effort to determining what is happening to the rangeland resource, from desired to unwanted or unanticipated effects. Properly designed monitoring will yield information that will help managers decide whether to continue or change management practices.

Types of Monitoring
There is often confusion about what is monitoring and what is not. To be effective, monitoring data must be compared to an objective, a hypothesis, or a baseline dataset. If data is collected without a standard for comparison, this is not monitoring—it is only data collection.

Rangeland monitoring may be conducted for three different purposes:
- implementation or compliance monitoring
- effectiveness monitoring and
- validation monitoring.

Implementation or compliance monitoring determines whether the selected grazing strategies are being implemented as desired. This type of monitoring could include checking to see if a goal of 700 pounds/acre of RDM was met after grazing, if the grazing was done at the designated time of year, or if the designated number of livestock were present. Implementation monitoring may include monitoring of RDM levels, season of use, and livestock numbers.

> *Implementation monitoring needs to be done annually and documented to insure that the stated plan or lease requirements are being met.*

Effectiveness monitoring determines whether the selected livestock management practices and strategies are actually achieving the stated goals. For example, does 700 pounds/acre of RDM provide suitable residual herbage for good Bay Checkerspot butterfly habitat? Does May through July grazing of yellow-star thistle actually reduce the occurrence of this noxious weed? Does excluding livestock from riparian hardwoods during the dry season, result in more riparian vegetation cover?

Effectiveness monitoring requires controlled long term studies and is typically beyond the ability of a single ranch or resource management agency, except for establishing long-term photo point transects that can detect vegetation changes.

Agencies and organizations should develop agreements with research organizations such as UC Cooperative Extension, Universities, and various state and federal agencies to cooperate in the study and evaluation of controversial grazing management practices and strategies being used to accomplish established goals.

Validation monitoring determines if the management goals for a livestock grazing program are still relevant. New issues can arise and old issues can become irrelevant. Goals that could be reevaluated periodically include: Should the land owner/agency continue to use grazing to reduce yellow star thistle? Is the level of conflict with recreational users acceptable? Is the amount of riparian vegetation cover acceptable? Should the RDM level be managed to achieve appropriate levels of RDM for Burrowing owl or Bay checkerspot butterfly habitat? Is livestock grazing the appropriate resource tool to use to reduce fire fuel hazards?

An agency's 5-year plan and its associated public process is a logical forum for addressing and validating grazing issues and goals.

Monitoring References

Publications that provide specific guidance for establishing and managing monitoring programs include:

Guenther, Keith. 1998. Residual Dry Matter (RDM) monitoring photo-guide. Wildland Solutions.

McDougald, N., B. Frost, and D. Dudley. 2003. Photo Monitoring for better land use planning and assessment. Publication 8067. Division of Agriculture and Natural Resources, California.
http://anrcatalog.ucdavis.edu/pdf/8067.pdf

U.S. Department of Interior, Bureau of Land Management. 1999. Utilization studies and residual measurements. Interagency Technical Reference 1734-3. U.S. Department of Interior, Bureau of Land Management, National Business Center, Denver, Colorado.

United States Department of Interior, Bureau of Land Management. 1999. Sampling vegetation attributes. Interagency Technical reference 1734-4. U.S. Department of Interior, Bureau of Land Management ,National Business Center, Denver, Colorado.

Ward, T. A., K.W. Tate, E.R. Atwill. 2003. Guidelines for Monitoring the establishment of riparian grazing systems. Publication 8094. Division of Agriculture and Natural Resources, California.
http://anrcatalog.ucdavis.edu/pdf/8094.pdf

Part 6
Habitat Types/Cover Types

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Predicting the annual growth and composition of vegetation in these series is very difficult because the weather is irregular and unpredictable.

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Photo courtesy of Keith Guenther.

Understanding Livestock Grazing Impacts initially evaluates how livestock grazing affects indicators for the California Annual Grassland and Oak Woodland vegetation series. Future efforts will add indicators for other ecological vegetation types.

Overview of the California Annual Grassland and Oak Woodland Vegetation Series

Both these vegetation types generally cover the Central Coast and Central Valley, with extensions into the moister North Coast and drier Southern California areas. The vegetation is dominated by annual grasses and forbs, most of which are non-natives from the Mediterranean region that have adapted to California's grasslands and oak woodlands during the last 250 years.

These vegetation types coincide with the Mediterranean climate, cool moist winters and hot dry summers. Predicting the annual growth and composition of vegetation in these series is very difficult because the weather is irregular and unpredictable. Notably, the timing and amount of winter moisture varies greatly from year to year. Major winter storms that originate in the Gulf of Alaska are cool and may be relatively dry, while those that originate in the Pacific near Hawaii are warmer and moister. The weather pattern is further complicated by the fact that during many years, winter storms fail to show up from either source. The now well-recognized El Nino ocean warming and cooling patterns help explain these extremely variable weather patterns.

Description of the California Annual Grassland Series

The Society for Range Management (SRM) publication (Shiflet 1994) includes rangeland cover type SRM 215 as Valley Grassland.

The California Native Plant Society (CNPS) publication (Sawyer 1995) includes the California Annual Grassland Series.

Description of the Oak Woodland Vegetation Series

The Society for Range Management (SRM) publication (Shiflet 1994) includes rangeland cover type SRM 201 as Blue oak woodland.

The California Native Plant Society (CNPS) publication (Sawyer 1995) includes the Blue oak series.

Planning and Management Considerations

Few pastures are a uniform California Annual grassland or Oak woodland vegetation type. Many pastures also have chaparral, vernal pool and riparian vegetation types. In addition, vegetation quantity and species composition can change dramatically from one year to the next, depending on the previous years vegetation composition, the timing and amount of moisture, and the amount of residual dry matter (RDM) in the fall just prior to the winter rains.

References

Sawyer, J. O., T. Keeler-Wolf. 1995. A Manual of California Vegetation. California Native Plant Society, U.S.A.

Shiflet, T.N. Editor. 1994. Rangeland Cover Types of the United States. Society for Range Management, Denver, CO.