



## **Introduction**

Oak woodlands and annual grasslands make up a large portion of the vegetation community in the state. It is an area of approximately 14.5 million acres, and includes the Sacramento/San Joaquin Valley, the Sierra Foothills and the Coast Range, although annual grasses can be found in most parts of the state.

Use this assessment tool when there is a soil survey and either provisional ESDs or range sites available and the conservationist has the technical skills and abilities to complete a reference sheet. This document addresses the 17 indicators in relation to California's Mediterranean climate with its dominance of annual grasslands and associated ecological features.

Use the *Technical Reference 1736, Interpreting Indicators of Rangeland Health* when a soil survey, ecological site descriptions and reference sheets are completed for the site.

Use the *Rangeland Health Field Assessment* where there are no reference sheets available.

The 17 indicators of rangeland health are identified below in three categories:

- Indicators that can easily be evaluated in annual grassland/oak woodland ecosystems.
- Indicators that are rarely seen or have little application to California's annual grassland, but should be evaluated if perennial species exist;
- Indicators that have applicability and can be evaluated with an explanation of how they apply to a functioning annual grassland community

Record assessments on the Rangeland Health Indicator Evaluation Worksheet. Utilize the Rangeland Health Indicator Evaluation Matrix which describes the details of each indicator as they apply to the California annual grassland/oak woodland plant communities.

**Indicators that can be easily evaluated in the annual grassland/oak woodland ecosystem:**

**Indicator 4 – Bare Ground** – Assessed using Line Point Intercept. Assessments in the fall will have the highest percent of bare soil. This can be done when residual dry matter monitoring is done.

**Indicator 5 – Gullies** – Common throughout the annual grassland/oak woodland plant community. These can include streams, intermittent or ephemeral channels.

**Indicator 8 – Soil Surface Resistance to Erosion** – Use Soil Stability Kit to assess or the Bottle-cap method, (described on page 13).

**Indicator 9 – Soil Surface Loss or Degradation** – Refer to the soil survey map unit description and compare to the field observation of soil surface conditions.

**Indicator 11 – Compaction Layer** – Can be common in the annual grassland/oak woodland depending on livestock management in past years. Must be assessed by digging a small hole.

**Indicator 12 – Functional / Structural Groups** – Assess variety and type of functional structural groups that occupy the site, i.e. perennials, legumes, forbs, cool season/warm season species, etc.

**Indicator 16 – Invasive Species** – Species should be those that are considered noxious/invasive to California's rangeland.

**The indicators that are rarely seen in the annual grassland, but should be evaluated if perennial species exist:**

**Indicator 3 - Pedestals and/or terracettes** – These are characteristically seen in perennial grass systems where bare spaces between plants can erode by forces from wind or water. It is usually not seen in the solid vegetation cover of annual grasslands, but may be seen where sufficient slope, bare soil and erosive forces exist between perennial plants.

**Indicator 6 - Wind scoured, blowouts and/or depositional areas** – Because of the solid vegetation cover in annual grasslands, and wind erosion of any kind is rarely seen.

**Indicator 13 – Plant mortality/decadence** – In annual grassland systems, plants die on an annual basis. This indicator only applies if perennial plants exist (either herbaceous or woody).

**Indicator 17 – Reproductive capability of perennial plants** – Only applies if there are perennial plants that can be evaluated.

**Indicators that have applicability and can be evaluated with some explanation of how they apply to a functioning annual grassland community include:**

**Indicator 1 – Rills** - If rills exist, they are usually very short (< 18 inches long; < ½ inch wide and deep; non-depositional) and usually the result of very low residual dry matter and/or steep slopes combined with fine textured erodible soils.

**Indicator 2 – Water flow patterns** – Annual understory usually prevents water flow patterns. Litter is an important driver to prevent water flow patterns from occurring. Water flow patterns follow micro-topography may or may not have sediment movement associated with them.

**Indicator 7 – Litter Movement** – Amount of vegetation in the annual grassland limits litter movement to very short distances.

**Indicator 10 – Cover of plants that help increase water infiltration and reduce runoff** – This indicator is difficult to assess unless information is known on the historic plant community. It should be based on the assumption of a stable threshold annual grass plant community or desired reference plant community.

**Indicator 14 – Litter Amount** – Litter amount will depend on grazing use as well as type and extent of invasive species. Litter amounts can be very low if excessive grazing use occurs and little residual dry matter remains. Litter amounts can be very high if unpalatable invasive species occupy the site or very light grazing use occurs. Neither condition is desirable to a fully functioning rangeland site.

**Indicator 15 – Annual Production** – Varies greatly in an annual grassland system and is dependent on amount and timing of precipitation as well as temperatures during the growing season. This is a weak indicator of rangeland health in the annual grassland community.

## DESCRIPTIONS OF THE 17 INDICATORS of RANGELAND HEALTH for CA

The remainder of this document describes each of the 17 indicators and addresses them in relation to our Mediterranean climate, dominance of annual grasslands and associated ecological features.

**1. Rills** - Rills are small rivulets that form as a result of water flowing across the soil surface, moving soil causing small erosional areas. In annual grassland after the plants flower, our summer drought begins and plants die. As they go through the decomposition process, plant parts fall to the soil surface and begin to oxidize and breakdown. This process produces what is called "residual dry matter". Bartolome et al. defines residual dry matter as the old plant material left standing or on the ground at the beginning of the new growing season".<sup>1</sup> This material produces an organic layer on the soil surface. This material accumulates and breaks down at the soil surface and can become embedded litter. Because of this decomposing material on the soil surface, rills rarely occur in annual grasslands. In properly managed rangelands, if rills do occur they are rarely longer than 3". The exception to this is when plant material has been removed almost completely due to grazing intensity, fire or cultivation combined with slopes that exceed 30% on soils that are highly erodible.



Dense plant cover makes rill formation difficult in most annual grasslands

Rill formation and water flow patterns post brush removal on slopes greater than 30%.

(Note, this a chaparral site with annual grass understory. Brush removal would not be recommended here due to the resource concerns shown that may occur post treatment)



<sup>1</sup> Managing Residual Dry Matter on California's Annual Grassland and Coast Range. UCCE Publication 8092.

**2. Water Flow Patterns** – Water flow patterns are the path that water takes as it moves across the soil surface. Water flows will follow micro-topography. It does not have to be with sediment movement. Concentrated flow or ephemeral gullies can occur when rills connect during rainfall events causing soil to move off-site. Usually in annual grasslands and oak-woodland understory vegetation prevents runoff from achieving a high velocity that leads to discernable water flow patterns. Sheet flow can occur during large rainfall events, but erosional forces from water flow patterns are rare.



**Water flow pattern in a steep slope with erodible silty soil**



**Typical annual grassland with high biomass cover where water flow patterns do not occur**

**3. Pedestals and Terracettes** are important indicators of the movement of soil by water and/or wind. Rocks or plants appear elevated as a result of soil loss giving the appearance of pedestals. Terracettes are benches of soil deposition behind obstacles caused by water movement. Active terracettes will have bare ground on the top side. When perennial plants do not occur and little soil movement occurs as is the case on annual grasslands this indicator is not very useful. Where perennial grasses do occur, then there may be application of this indicator.



Location in which *Poa secunda* occurs on erodible soil on slopes over 30%

Location where “push” erosion has occurred in a clayey soil causing the appearance of terracettes. This is common in MLRA 14, 15, 18 when trailing occurs on wet soils with sufficient clay content to support deformation and slopes are greater than 30%. This can cause soil movement and should be noted and evaluated during the assessment process.



**4. Bare Ground** is exposed mineral or organic soil that is susceptible to raindrop splash erosion, which is the initial part of water related erosion. In the annual grassland, bare soil can occur and can commonly be up to 15% while the site remains stable. Bare ground percentage is measured using the Line Point Intercept. Frequently in annual grasslands/oak woodlands bare soil is a result of rodent activity. Bare ground is an indicator of soil/site stability and hydrologic function. It is a useful indicator of rangeland health in the annual grasslands.



Common appearance of bare ground in annual grasslands - Isolated to rodent activity or during low vegetation production years and high grazing use.



Typical bare ground within a low precipitation zone. Early evidence of trailing is present.

**5. Gullies** form as channels are cut into the soil by moving water through natural drainages though not all natural drainages are gullies. Gullies are a common site in the annual grasslands. Gullies are assessed based on their observation of active erosion or stability. Active erosion is indicated by incised channels with vertical cuts showing bare soil while healing gullies are indicated by rounded banks with vegetation growing on the side-slopes and in the channel bottom. Active erosion is a sign of accelerated erosion and are attributes of soil/site stability and hydrologic function. Signs of active erosion include: sharp edges; plunge pools; undercuts; tension cracks; recent deposited sediments; flow marks.



**Gully with active erosion**



**Gully showing rounded banks with vegetated side-slopes**

**6. Wind-scoured, blowouts, and/or depositional areas** are not seen in annual grassland systems where near solid vegetation cover occurs across the landscape. In isolated areas throughout the driest portions of the west San Joaquin valley where shrubs occur and soils are subject to wind erosion, this soil movement pattern can occur. For most of California this indicator would not be applicable.



**Dense cover of annual grasses where wind scour or deposition areas are not able to occur**



**West Central Valley desert scrub plant communities where wind scour/blow-out or depositional areas can occur.**

**7. Litter Movement** is an indicator of soil/site stability, but on annual grasslands litter is a weak indicator of site stability because litter movement is limited by the high density of surface vegetation (decaying residual dry matter). When it does occur, the amount of movement is very small and is difficult if not impossible to measure. Litter is usually uniformly distributed throughout the site in annual grasslands. Annual grass biomass accumulation usually drops to the soil surface and begins to breakdown and form litter on site. This litter accumulation occurs during the summer drought so there is no opportunity for water erosion to move it off-site until fall rains occur. Circumstances where this can occur is after a high rainfall event on a site that has experienced disturbance from fire or very low residual dry matter and slopes adequate to move litter.



**It is difficult for litter to move off-site with heavy residual dry matter build-up.**



**Litter movement after a storm. Litter movement is minor, usually less than a foot.**

**8. Soil Surface Resistance to Erosion** assesses the resistance of the soil surface to erosion. Most soils on annual grassland that have been assessed during field testing of this tool indicate that rangeland soils in California are very stable. In the annual grasslands of California, high litter and organic matter in the top 3-4 inches of soil results in stable soil aggregates. The exception to this is soil around livestock concentration areas. Use a Soil Stability kit or Bottle Cap method to assess this factor.

Bottle Cap Method:

Drop a small soil fragment (maximum  $\frac{1}{4}$  inch diameter) in a water filled bottle cap.

**Extremely low stability** = fragment will "melt" immediately upon contact with water

**Low stability** = fragment will lose their structure or "melt" within 30 seconds

**Moderate stability** = fragment will retain their integrity until the water is agitated

**Highly stable** = fragment will retain their shape, even with agitated in water



Livestock concentration area where animals are held and fed hay would probably result in low stability.



**9. Soil Surface Loss or Degradation** – Surface soil has the highest percent of organic matter and nutrient content. An intact soil surface assists with water infiltration, nutrient and energy cycling. A fully functional site will have organic matter present and an intact soil structure for adequate infiltration. To complete the assessment of this protocol it is necessary to know and understand the soil as well as have the ability to assess the organic matter content and the soil structure in the top 1/8 – 4" of the soil.<sup>2</sup> If possible bring a soil scientist to the site for this indicator. The evaluator should bring the soil map unit description to the field as well as a shovel so the top layers of the soil can be rated based on the map unit description. Historic soil surface degradation has not been documented within most annual grassland systems due to the high amount of residue which over time is converted to an organic layer.



Soil surface loss, note the loss of organic matter, followed by rills.

**10. Cover of plants that help increase water infiltration and reduce runoff.** This indicator deals with the ability of the site to adequately infiltrate precipitation based on the structural dynamics and growth forms of various plant types, i.e. trees, shrubs, perennial forbs and grasses. In California, the most diverse growth forms are found in oak woodlands or shrub/grass communities. Oak woodlands contain stable tree and shrub layers, annual grasses, forbs and may have trace amounts of perennial grasses. The complexity of the above and below ground structure assists with infiltration and water holding capability of the site. If these areas dominated by annual grasses through tree harvesting, shrub removal or wildfire, the functional characteristics of the site change and the attributes associated with this indicator will depart from the reference

<sup>2</sup> Interpreting Indicators of Rangeland Health, Technical Reference 1734-6, Version 4, 2005.

state. When this assessment is done the evaluator must know if there has been any vegetation type conversion such as that done in oak woodlands and chaparral sites. If the site is a true annual grass system with no trees and shrubs (due to site limitations such as precipitation amount or soil), then it is important to identify whether there are adequate deep rooted forbs or isolated perennial grasses to adequately store water on-site and allow infiltration deep into the soil profile.



**Typical oak woodland showing diverse species composition with various rooting structures associated with this attribute**



**Typical annual grassland where trees are only limited to riparian areas and the site potential in uplands will not support trees. This indicator is not applicable in sites like this.**

**11. Compaction layer** – Annual grasslands of California are typically used for livestock grazing during the green season (November – April). At that time of the year soils are typically wet or they go through wet cycles during and after storm events. This indicator is an important factor for rangeland health in California. This factor affects the rate at which moisture will infiltrate the site, how well roots are able to grow down through the soil profile which can affect plant vigor. It is associated with soil/site stability, hydrologic function and biotic integrity. Assessment of this indicator is based on visible signs of trailing, deep hoof marks on the soil surface and/or a compaction layer (horizontal platy features) in the top 3-4 inches of the soil where root penetration has been inhibited. A small hole must be dug to assess this indicator.



Platy structure showing a compaction layer



Compaction in a wetland area causing hummocks on the soil surface

**12. Functional/Structural groups** refer to a suite of species, grouped together in their rooting type, nitrogen fixing ability or photosynthetic pathways. Various functional/structural groups include; legumes, perennial grasses, annual grasses, cool/warm season annual or perennial grasses, forbs, shrubs, trees and includes biological crusts. It is important to know what the site potential is for various functional/structural groups to understand if there is a departure from the potential natural community. The amount of various plant groups (either by weight or composition) will influence the biotic integrity of the site. Usually a site with more of the original functional/structural groups will have greater biotic integrity. To properly assess this indicator, the evaluator must visit the site during the growing season when the greatest display of functional/structural groups exists. In California there are numerous plant community types and species associations, even within the annual grassland and oak woodlands. It is important for the evaluator to know what plant community type they are in and the species expected on the site to adequately assess this indicator.



Photo showing various functional/structural groups (annual grasses, perennial grasses, forbs, shrubs and trees).



Highly diverse herbaceous plant community within the annual grassland system

**13. Plant Mortality & Decadence** – This indicator should only be evaluated if you are on a site that includes perennial plants (grasses, shrubs or trees) that are native or introduced. If those species are present an evaluator can assess the portion of dead and dying plants to those that are young to mature. A site that includes various age classes and recruitment of young plants is a display of the health and vigor of the site. If there are only annual species, this indicator should not be evaluated.



Oak seedling heavily browsed, showing signs of die back.

**14. Litter amount** – Litter is the dead, detached plant material that lies on the soil surface. It is an assessment of the hydrologic function and the soil/site stability. In annual grassland system the amount of this will vary based on grazing use, droughts and associated annual production. Because annual grasses die back completely every year, there is usually substantial litter accumulation. In fact, in annual grassland systems litter amount is so important that University of California Cooperative Extension (UCCE) have developed guidelines for ranchers to manage for residual dry matter<sup>3</sup>. This document recommends various levels of dry matter, which becomes litter. This number is based on the percent slope, woody plant production as well as precipitation amount/zone. These guidelines assure adequate cover to protect the site from erosion and create a favorable microclimate for seed germination when the first fall rains occur. Litter on site is important for adding material to the organic layer of the soil and the breakdown of litter assists in nutrient cycling.

On the contrary to this are situations where very high litter accumulates on the site. This is the case with several of the invasive species that occupy thousands of acres of the

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<sup>3</sup> Managing Residual Dry Matter on California's Annual Grasslands and Coast Range. UCCE Publication 8092

annual grassland. Species like medusahead (*Taeniatherum caput-medusae*) and barbed goatgrass (*Aegilops triuncialis*) have limited palatability for livestock and are highly competitive, because of this, plant material from these species will accumulate on site. They have high silica content so do not breakdown very quickly. In this situation, the litter indicator is described in terms of either too little litter or excessive litter amounts. Litter amount will be evaluated based on adequate litter is present to protect the site and provide the proper micro-climate for seed germination in the fall (or) it will assess whether excessive amounts of old plant material (thatch) has built up on the site which inhibits nutrient cycling and does not allow moisture to reach the soil surface to facilitate early fall germination of desirable species.



**Very low litter/residual dry matter**



**Very high amounts of Medusahead thatch where litter amounts are excessive.**

**15. Annual Production** – This indicator is meant to assess the biotic integrity, but in the annual grassland system production is dependent on the amount and timing of rainfall as well as the temperature. This can fluctuate greatly, depending on the year. It should be assessed during peak standing crop and should be compared to the “average production” year, if that is known. If an ecological site description has been developed it will improve the accuracy of the evaluation of this indicator. Because of the high variability in production in the annual grassland system, it is a weak indicator of the biotic integrity of the site and instead a good indicator of the precipitation year. See the Evaluation Matrix to help determine this category.

**16. Invasive Plants** – Invasive species are a common occurrence in California's annual grasslands. Some consider all the annual grasses that occupy the Mediterranean climate to be invasive. In this guideline we are accepting that the annual grasses and forbs are part of the species composition that are expected for this part of the state and would be deemed potential natural vegetation. The proportion of native perennial grasses will be determined based on the history of the site and any reference plant communities that remain on site (if known). The invasive species that will be addressed in this indicator are those that are noxious, highly invasive and may be on California Department of Food & Agriculture (CDFA) A, B or C list or Cal Invasive Plant Council (Cal IPC) list of highly invasive species.



**Barbed goat-grass one of the typical invasive species that would be assessed with this indicator**



**Medusahead**

**17. Reproductive Capability of Perennial Plants** – This indicator would be assessed only if there are perennial species, including woody plants, on site. If there are none, then this would not be applicable. This indicator will evaluate reproductive success of perennial plants and their potential to remain part of the plant community. If continued grazing pressure exists, plants may not have the ability to reproduce and plant vigor will be reduced with a decrease in number of perennial plants over time.



Deer grass plants in an oak woodland site, able to reproduce by tillers and seed



Oak unable to produce acorns due to heavy grazing pressure