Science Advisors' Recommendations To Guide Development of the City of Antioch Habitat Conservation Plan and Natural Community Conservation Plan

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Acronyms and Abbreviations

Advisors	Science Advisory Panel
Antioch Plan	Antioch HCP/NCCP
BGOs	Biological Goals and Objectives
CDFW	California Department of Fish and Wildlife
CEM	conceptual ecological models
Conservancy	East Contra Costa County Habitat Conservancy
CRPR	California Rare Plant Rank
DRERIP	Delta Regional Ecosystem Restoration Implementation Plan
EBRPD	East Bay Regional Park District
ECCC Plan	East Contra Costa County HCP/NCCP
HCP	Habitat Conservation Plans
HISD	high intensity, short duration
NCCP	Natural Community Conservation Plan
USFWS	U.S. Fish and Wildlife Service
WUI	wildland-urban-interface

I. Background and Role of Science Advisors

A. Background

Habitat Conservation Plans (HCP) and Natural Community Conservation Plans (NCCP) are important tools to meet federal and California regulations, respectively, regarding mitigation of impacts to threatened and endangered species from development activities. Together, these conservation planning processes are designed to mitigate impacts to the targeted threatened and endangered plant and animal species and their habitats within the region while streamlining the permitting processes for compatible and appropriate economic activities on developable lands. NCCPs in California require a broader ecosystem approach than the individual species approach of the state and federal Endangered Species Acts. Impacts are typically mitigated by protecting, enhancing, and/or restoring lands outside of the sites being developed.

The East Contra Costa County HCP/NCCP (hereafter ECCC Plan) was permitted and began implementation in 2007. The ECCC Plan was designed to mitigate impacts from development within eastern Contra Costa County, and ultimately to protect and enhance ecological diversity and function within the county and larger region. The ECCC Plan covers development activities permitted by Contra Costa County, and the cities of Pittsburg, Clayton, Oakley, and Bentwood, but the 2007 plan did not include the City of Antioch. In 2017, the City of Antioch initiated development of its own HCP/NCCP (hereafter Antioch Plan) that is closely related to the ECCC Plan but is restricted to impacts within the proposed Antioch urban development area, which is the boundary of all urban development impacts that will be covered by the Antioch Plan and includes most but not all of the current city limits. The Antioch Plan will be based heavily on and implemented concurrent with the ECCC Plan but will be a separate document that will undergo a federal Endangered Species Act and California Natural Community Conservation Planning Act (NCCP Act) review separate from the ECCC Plan. Covered species and land cover types within the Antioch Plan vary slightly from the ECCC Plan. The Antioch Plan is intended to be implemented in a consistent manner with the ECCC Plan and is expected to be implemented by the East Contra Costa County Habitat Conservancy (Conservancy). Lands, once acquired, may be managed by the East Bay Regional Park District (EBRPD), or other land management agencies in the region.

The area of estimated impacts to be covered by the Antioch Plan includes approximately 3,315 acres (18 percent of the urban development area), with the ultimate acreage dependent on the final impact analysis.

B. Role of Science Advisors

Consistent with the requirements of the NCCP Act, Contra Costa County established a Science Advisory Panel (hereafter Advisors) to provide scientific review and recommendations regarding conservation strategies, including reserve design principles, management principles, conservation goals, and monitoring approaches. Further, the Advisors were asked to identify information gaps and uncertainties. Specifically, the Advisors were sent a set of questions developed by the HCP/NCCP development and implementation team that, at a minimum, Advisors were asked to address through review of background documents and through participation in a workshop conducted February 7–9, 2018.

Advisors were selected who had expertise related to principles of conservation strategies, California grassland ecology and management, and the ecology of covered species and associated habitats, such as ephemeral wetlands. Further, Advisors were chosen who were independent of the ECCC Plan, the Antioch Plan, and of the Conservancy.

The three-day workshop consisted of a field trip, presentations and discussions. The field trip provided an overview of the landscapes that the existing reserves occupy, a chance to view ECCC Plan acquisitions, and visit several of the targeted habitat types impacted and mitigated through the HCP/NCCP process. Presentations on each plan were provided for the ECCC Plan by its development and implementation team and for the Antioch Plan by consultants to the Conservancy (ICF). The remainder of the workshop consisted of discussions among Advisors and others present at the workshop, including staff and consultants of the Conservancy and City of Antioch, California Department of Fish and Wildlife (CDFW) and the U.S. Fish and Wildlife Service (USFWS). Finally, the Advisors discussed among themselves each question posed for the Antioch Plan. Questions were based on previous reports, including the *ECCC HCP/NCCP Science Advisor Report* (2004) and *Santa Clara Valley HCP/NCCP Science Advisor Report* (2006). California's Brown Act requires the workshop to be open to the public. Each Advisor expressed their own opinion and there was an open exchange of ideas.

In the sections below, Advisors respond to questions posed to the panel, arranged by relevant topic.

II. Covered Species

Are you aware of any new or pending taxonomic revisions or other issues that would affect the list of species proposed for coverage?

The list of "Special-Status Species Proposed for Coverage" under the Antioch Plan is only slightly different from those covered by the ECCC Plan. The Advisors had no significant concerns with regards to the process by which species to be covered by the Antioch Plan were selected. The Advisors concurred with the rationale for removing several species covered by the ECCC Plan (i.e., giant garter snake, longhorn fairy shrimp, Mount Diablo manzanita, showy madia, and adobe navarretia) due to the information provided that appeared to support absence of these species from the urban development area.

The Advisors recommended including two additional plant species to the list: Mount Diablo buckwheat and shining navarretia.

Proposed Additions to the Covered Species

Mt. Diablo Buckwheat (*Eriogonum truncatum*)

This plant species was first described in 1862 near the current location of Brentwood, California and observed on several more occasions between 1862 and 1936. After a described occurrence on Mt. Diablo in Contra Costa County in 1936 (Calflora 2018), the species was presumed extinct for several decades. In 2005, a small population of approximately 20 individuals was discovered in Mt. Diablo State Park by a UC-Berkeley graduate student, Michael Park (https://www.berkeley.edu/news/media/releases/2005/05/24_buckwheat.shtml). In 2016, Heath Bartosh of Nomad Ecology discovered a population of approximately 2 million individuals on land included in the Black Diamond Mines Regional Preserve, which is about 10 miles north of the Mt. Diablo site (https://www.sfgate.com/bayarea/article/Long-lost-wildflower-seen-near-Antioch-9208869.php#photo-10883223).

As a California endemic species, *Eriogonum truncatum* is ranked in the California rare plant inventory as “California Rare Plant Rank (CRPR) 1B.1,” which indicates that the species is considered “rare or endangered in California and elsewhere” and “seriously endangered in California” (California Native Plant Society 2018). It is not currently federally listed as an endangered plant species. It is likely that this annual herb relies heavily on a persistent soil seed bank, as do many other native annuals in California, and so population occurrence and size may vary tremendously from year to year based on variation in temperature and precipitation. Because of the uncertainty associated with accurate population estimates, the Advisors recommend coverage of this species under the Antioch Plan to facilitate conservation and minimize risk of extinction of this species.

Shining Navarretia (*Navarretia nigelliformis* ssp. *radians*)

Recent taxonomic investigation by Heath Bartosh (2016) for the ECCC Plan inventory area concludes that adobe navarretia, which was originally included as a covered species in the ECCC Plan, is not as likely to occur in the inventory area as is shining navarretia. Bartosh (2016) recommends that:

- “The Conservancy track occurrences of both adobe navarretia (*Navarretia nigelliformis* subsp. *nigelliformis*) and shining navarretia (*Navarretia nigelliformis* subsp. *radians*) as they are found in the Preserve System and on Covered activity project sites.

- In the Planning Survey Report, indicate that populations of shining navarretia, in addition to populations of adobe navarretia, should be reported.
- To assist with the surveying, add text to the Planning Survey Report to indicate that shining navarretia occurs as grasslands in clay soils."

A California endemic species, *Navarretia nigelliformis* ssp. *radians* is ranked in the California rare plant inventory as "California Rare Plant Rank (CRPR) 1B.2," which indicates that the species is considered "rare or endangered in California and elsewhere" and "fairly endangered in California" (California Native Plant Society 2018). It is not currently federally listed as an endangered plant species. Because of the likelihood of population occurrence of shining navarretia within the Antioch Plan inventory area is based on historical observations, the Advisors concur with Bartosh's recommendations regarding surveys of this species and further recommend that shining navarretia be included on the list of covered species for the Antioch Plan.

Recent Work Relating to Potential Taxonomic Changes Affecting Covered Species

Alameda Striped Whipsnake (*Masticophis lateralis euryxanthus*)

The genetic boundaries and distinctness of the Alameda striped whipsnake (*Masticophis lateralis euryxanthus*) relative to the California striped whipsnake (*M. l. lateralis*) have been recently explored but the authors did not propose any changes to the existing status of that subspecies (Richmond et al. 2016).

Western Pond Turtle (*Emys marmorata*)

Spinks et al. (2014) proposed elevating the two historic subspecies of western pond turtle to separate species with *Emys marmorata* in the Great Central Valley and north of the San Francisco Bay, and *Emys pallida* in the central coast range and south of the San Francisco Bay. Exactly which species of pond turtle would occur in the region covered by the plan is not clear based on the information in this paper. However, the Advisors do not believe this species' determination would affect the coverage of this species by the Antioch Plan nor would it warrant modification of proposed management or monitoring efforts.

Are you aware of data gaps related to covered species life-cycle needs (e.g., California tiger salamander dispersal distance) or landscape-level ecosystem management that should be considered in development of the Antioch HCP/NCCP?

Species-level Management

Research on the specific effects of livestock grazing management on many of the covered species is generally very limited, especially in regard to thresholds to optimize the benefits of grazing under realistic circumstances.

Vernal pool fairy shrimp (*Branchinecta lynchi*) and vernal pool tadpole shrimp (*Lepidurus packardi*)

These species will likely be affected by changes in climate, particularly the amount and pattern of rainfall, given how important seasonal wetland period of inundation is to their life cycle. If current predictions of more frequent drought conditions and more intense rain events holds true for the Central Valley, fairy and tadpole shrimps may be unaffected by such change. Fairy shrimps are able to grow to sexual maturity within a few weeks and produce multiple broods per year in years when pools dry down and refill one or more times. As discussed in Pyke and Marty (2005), livestock grazing management may interact with climate change to affect the period of inundation of vernal pools as well. These factors should be considered especially when designing restored vernal pools targeting fairy shrimp occupancy.

Research on the specific effects of livestock grazing management on these species is generally very limited, especially in regard to thresholds to optimize the benefits of grazing under realistic circumstances. Tadpole shrimp may be more negatively impacted by under-grazing than fairy shrimp. Most of the evidence for this is inferred from research on grazing and annual plants of vernal pools. But the relative effects of grazing at different times and intensities on pool habitats and shrimp viability should be tested.

Habitat distribution model parameters for these species look appropriate though it might be helpful to show critical habitat on the maps.

San Joaquin Kit Fox (*Vulpes macrotis mutica*)

Based on conversations with Dr. Brian Cypher (California State University, Stanislaus Endangered Species Recovery Program), Advisors do not believe there are any data gaps for the San Joaquin kit fox (*Vulpes macrotis mutica)* that would alter proposed management or monitoring. In part, this perspective is because kit fox are rarely observed as far north as in the area of the Antioch Plan and those observed are thought to be dispersers whose survival likelihood is very low.

However, Constable et al. (2009) suggest management that maintains grassland vegetation at a low structure with reduced thatch accumulation may benefit the species. Reduced structure and thatch improves conditions for kit fox prey such as kangaroo rats and ground squirrels and shorter vegetation structure may improve visibility for foxes as a means of prey avoidance.

Western Burrowing Owl (*Athene cunicularia*)

The burrowing owl (*Athene cunicularia*) has been studied in many parts of its range, with many studies conducted in California. Research conducted to date demonstrates a broad range of habitats that provide nesting and foraging habitat. The highest densities are often in irrigated agricultural landscapes where drains or other infrastructure can provide noncultivated nest sites. The habitat distribution models used in the Antioch Plan may underestimate foraging and nesting habitat in pasture and croplands. Although several conservation measures are intended to increase numbers of burrowing owls, the Advisors question the value of installing perches or increasing burrow availability or prey base unless there is clear evidence that these factors are causing low numbers that management can address. Advisors expect these resources to be dynamic with weather variability and ground squirrel population dynamics. Advisors are unaware of data gaps in the species' life cycle that are relevant to the development of the Antioch Plan.

It has been assumed that moderate to very heavy grazing (that results in bare ground) in the areas surrounding occupied burrows is beneficial. Demographic research on burrowing owls has demonstrated that they do well under a broad array of habitat conditions favoring short-vegetation structure, similar to the San Joaquin kit fox, both in natural communities and highly disturbed environments, including urban settings.

California Tiger Salamander (*Ambystoma californiense*)

The Advisors are unaware of data suggesting that the potential dispersal distance used to model California tiger salamander habitat (1.4 miles) should be altered. The models used to assess habitat in the impact analysis seemed reasonable.

The likely effects of climate change on the successful reproduction of California tiger salamander are probably the most important data gap. For larvae to reach metamorphosis, this species requires seasonal wetlands that do not dry until May or optimally later. However, this species has persisted through periods of extended drought and has an adult phase that is completely terrestrial (when not attempting to breed) and can live more than ten years. These aspects of its life history and demographic modeling of population viability (Trenham and Shaffer 2005, Searcy et al. in prep) suggest that, given productive breeding and adequate upland habitats, this species should be resistant to local extinction.

The degree to which grassland vegetation can pose a barrier to movement for this salamander has not been tested (Ford et al. 2013). Further, the effects of grazing on movements through such barriers have not been evaluated in the kinds of landscape positions (such as uplands surrounding ponds) that the salamander is more likely to use.

Northern California Legless Lizard (*Aniella pulchra*)

The true current distribution of this species seems like a significant data gap. The habitat distribution map for this species in the Antioch Plan shows just one occurrence record. The ECCC Plan map showed five records. It is not clear why these records are omitted from the newer map, but it suggests that most of those records were found to be unreliable. Four of the five records are from within a few miles of the San Joaquin River, whereas most of the modeled habitat is far inland and without any occurrence records. The habitat model for this species is based mainly on soil type. Without validation that this map has predicted some areas that actually support this species it is not clear that protecting these areas from development would benefit this species.

Foothill Yellow-Legged Frog (*Rana boylii*)

The Antioch Plan map for this species shows no occurrence records within the inventory area whereas the ECCC Plan map included just one record. This raises concerns that the species may not occur in the Plan area. Because the habitat needs for this species are well understood, the modeled habitat is likely suitable and its protection would benefit the species if it were present or could be reintroduced.

Landscape-Level Ecosystem Management

There is scientific evidence that supports the general idea that the composition and configuration of the landscape surrounding habitat patches may strongly influence plant and animal species composition within patches. Thus, management of this "matrix" habitat will be more likely to achieve conservation goals if it is compatible with species' ability to thrive. For example, urban development adjacent to preserve lands in southern California has been shown to have negative impacts on some bird populations due to enhanced predation of birds by domestic cats that are allowed to roam onto preserve lands. Thus, the conditions of the surrounding "matrix" should be considered in management actions designed to achieve conservation goals in any HCP/NCCP planning process.

Livestock Grazing

Managing livestock grazing to maintain or increase native grass and forb populations is a common goal on California grazing lands. Unfortunately, research on this subject has not provided many clear and consistent findings. The literature on grazing's impacts on grassland biodiversity is limited and often conflicting, and in many cases findings are not readily or broadly applicable (D'Antonio et al. 2002; Bush 2006; Stahlheber and D'Antonio 2013). However, there are some general patterns and reasonable conclusions to make.

Native diversity of California Mediterranean grassland plants is mainly driven by weather and soil (Gea-Izquierdo et al. 2007; Jackson and Bartolome 2007). Soils limited in phosphorus or other nutrients are linked to native plant occurrence, apparently by reducing the competitive advantage of non-native annuals (Gea-Izquierdo et al. 2007). These soils can occur in small-scale patches, smaller than that reflected in soil surveys. Soils with a history of cultivation also appear to significantly limit suitability for native grasses and forbs (Robertson 2004; Huntsinger et al. 2007).

Because weather and small-scale soil differences are so important to native plant distribution, these factors likely swamp out or interact with the effects of different grazing regimes (Jackson and Bartolome 2007). This is probably a major factor in why the research has been so conflicting. The best indicator (without extensive soil testing) that conducive soils are present is the occurrence of native plant species. This means that management efforts are most likely to be beneficial in areas where native plant species are already present in low density (high density generally would indicate little need or potential for enhancement.

Grazing is generally beneficial to California's Mediterranean grassland biodiversity (Bartolome et al. 2014). Grazing during the growing season of annual grasses, and the rainy season in particular, appears generally beneficial in increasing native plant species cover and richness, and reducing non-native forage plant cover (D'Antonio 2002; Stahlheber and D'Antonio 2013; Gennet et al. 2017).

Grazing to provide spatially and temporally heterogeneous conditions is expected to favor native plant and animal diversity in California Mediterranean grasslands. Structural heterogeneity at the patch scale is important for many plants. Conventional livestock grazing generally provides environmental variation due to variation in livestock distribution and in the amount and timing of grazing (traffic and consumption of forage), within and/or between fields. That variation is often reduced in high intensity, short duration (HISD) grazing systems, which tends to increase evenness of use across species and space due to reduced selectivity (Fuhlendorf and Engle 2001).

Table 1. Potential Effects of Livestock Grazing on Covered Plant Species, East Contra Costa County

Species		Habitat and Occurrence	Potential Effects of Livestock Grazing and Associated Threats	Significant Grazing Concern
Common Name	**Latin Name**			
Brittlescale	*Atriplex depressa*	Grassland, Meadows and seeps, Chenopode scrub, Vernal pools	CNPS 2018: Threatened by grazing and trampling	Vulnerable
Big tarplant	*Blepharizonia plumosa*	Valley and foothill grassland	CNPS 2018: Historical occurrences probably extirpated by agriculture and non-native plants; threatened by urbanization. Reliable information on grazing effects was not found	?
Round-leaved filaree	*California macrophylla*	Grassland, oak woodland, oak savanna, scrub/chaparral	U.S. Forest Service 2018: Other species in this genus are palatable and nutritious forage for livestock and wildlife, and recover from grazing	Not likely

Species		Habitat and Occurrence	Potential Effects of Livestock Grazing and Associated Threats	Significant Grazing Concern
Common Name	**Latin Name**			
Mount Diablo fairy lantern	*Calochortus pulchellus*	Chaparral, Cismontane woodland, Riparian woodland, Valley and foothill grassland	CNPS 2018: Threatened by grazing, urbanization, horticultural collection, and feral pigs. Potentially threatened by road maintenance EBMUD 2001: Moderate impact of grazing: genus of 20-30% palatability, early foliage; highest use by goats, and least by horses; monitoring of grazing impact and management or protection justified	Vulnerable
Recurved larkspur	*Delphinium recurvatum*	Alkaline--Chenopod scrub, Cismontane woodland, Valley and foothill grassland	CNPS 2018: Many occurrences historical; need current information on status. Much habitat converted to agriculture; also threatened by grazing, trampling, and non-native plants. U.S. Forest Service 2018: Other species in this genus are palatable, but can be poisonous to livestock; defer grazing until after flowering and seed set; some species recover and increase where grazed	Possibly vulnerable
San Joaquin spearscale	*Extriplex joanquiniana*	?	Reliable information on grazing effects was not found.	?
Diablo helianthella	*Helianthella castanea*	Usually rocky, axonal soils; often in partial shade. Broad-leafed upland forest, Chaparral, Cismontane woodland, Coastal scrub, Riparian woodland, Valley and foothill grassland	CNPS 2018: Threatened by urbanization, grazing, and fire suppression. Possibly threatened by road maintenance, recreational activities, and non-native plants Reliable information on grazing effects was not found	?
Brewer's dwarf flax	*Hesperolinon breweri*	Usually serpentinite. Chaparral, Cismontane woodland, Valley and foothill grassland	Reliable information on grazing effects was not found.	?

Occurrences of the covered plant species should be defined and mapped as a Special Management Area. Grazing exclusion could be more detrimental than continuing to graze as it has been recently, especially the timing and intensity of that historic grazing. Until more research or expert opinion is developed, grazing should continue on an extensive basis following the principles of Adaptive Stewardship Grazing (Ford et al. 2018). Any major changes to management should be made with caution, introduced to only a fraction of the known population (pilot studies), and monitored closely. This is especially valid where a covered plant species appears to be doing well ("if it ain't broke, don't fix it"), and especially important for extremely rare species.

III. Data Gaps Beyond Covered Species

What gaps in the existing information create the greatest uncertainties for planning, analyzing, managing, and monitoring an ecosystem reserve in this setting? Are there cost-effective methods to address these data gaps?

One of the data gaps that may create great uncertainties for planning and managing reserves in this setting is the extent to which the close proximity of urban development affects the viability of certain populations, communities, or ecosystems, such as vernal pools and ephemeral wetlands. Cost-effective methods to address these data gaps include relying on research obtained in other ecosystems for similar species, or making field observations of changes in variation in habitat quality in relation to distance from certain land uses or types of development.

The inability to know what species actually occupy the area before acquiring properties for the reserve is the largest gap, but it appears there is no solution to this.

Advisors strongly encourage that preserved habitat areas are large enough to allow for appropriate management. Small (<100 acres) vernal pool preserves are challenging to manage with livestock grazing and/or fire. Without management, vernal pools and the surrounding grassland become decadent with thatch and pool inundation periods decline (Marty 2015a). Clark et al. (1998) provide a long list of other considerations from a case study of two very small vernal pool preserves.

IV. Conservation Strategy

What modifications would you suggest to the original reserve design principles in the ECCC HCP/NCCP to update them to current best practice?

The reserve design principles used in the ECCC Plan generally reflect current best practices (ECCC Plan p. 5-10). That lands are only acquired from willing sellers reduces the flexibility to fully realize these reserve design principles. The Advisors urged the Conservancy to consider conservation easements to achieve these reserve design goals when acquiring fee title to land was not likely for particular parcels. Further, because of the greater recognition of the impact of climate change to vegetation communities since the ECCC Plan was created, the Advisors recommend a goal of resiliency be further emphasized in the Antioch Plan. For example, acquiring lands that increase heterogeneity in wetland distribution, landscape contexts, wetland types, wetland depths, and elevations would promote greater resiliency for a changing climate.

The Advisors also recommend increased incorporation of vegetated buffers for developed areas, particularly streams, to add greater conservation value to the core protected habitats.

Advisors were concerned that the current strategy may not realize the goal of "no net loss" where habitat creation is the proposed mechanisms for preventing loss. Creation of habitats is often unsuccessful, so there would be a net loss if a target habitat is developed and the intended habitat creation fails. Examples of such failures include attempted creation of ephemeral wetlands and/or failure of created wetlands to support populations of the desired species.

What are some recommended tools and models for the HCP/NCCP to evaluate the potential effects of climate change on the covered species, and incorporate strategies to allow for adaptation to climate change?

The Advisors recommend that the Antioch Plan consider potential effects of climate change on covered species using projections of changes in temperature and precipitation for the inventory area. There is a highly useful, integrated database that can be used for this purpose: http://cal-adapt.org/. This tool can be used to project changes in climatic variables to 2080 for a particular grid cell on a map. This could be a useful tool for anticipating impacts of climate change on covered species in the inventory area that are highly dependent on annual variation in temperature and precipitation (e.g., most annual plants).

According to the California Landscape Conservation Cooperative Climate Commons (http://climate.calcommons.org/article/central-valley-change), climate trends for California's Central Valley and Central Coast suggest these shifts in future conditions:

1. warming air temperatures;
2. more aridity;
3. more intense droughts and extreme heat;
4. increased fire risk;
5. more flooding;
6. less agricultural acreage; and
7. more urban acreage.
8. livestock issues, including: increased livestock deaths, escapes onto roadways, reduced access, and safety problems

These predicted outcomes (along with any future refinements) can be incorporated into the conceptual ecological models (CEM), discussed in Section IX**.** *Conceptual Models for Management and Monitoring,* to help understand how these changes may affect the ecological and human processes across the Antioch Plan. These potential changes could significantly affect the viability of resident covered species as well as the grazing operations that are essential for managing the grassland habitats. All of these predictions can be planned for in grazing leases and grazing management plans, but rarely are.

More extreme weather, in the forms of more intense and frequent rain storms, high temperatures, or drought, can be expected under any climate change model. Such weather can lead to significant short- and long-term problems for habitat as well as livestock operations. Therefore, a Plan for Extreme Weather Responses should be prepared by the property management staff (Ford 2014). The plan should be distributed each year to all agency staff, consultants, grazing lessees, and other constituents who might get involved in management.

Working Landscapes

The ecosystem services provided by healthy rangelands in California, such as watershed, wildflowers, habitat for birds and butterflies, and aesthetic values are largely dependent on livestock grazing managed by ranchers (Barry et al. 2015). Gaining the interest and support of ranchers to help achieve conservation goals is dependent on the social and economic benefits that ranchers perceive and realize. The availability and effectiveness of ranchers in performing grazing management services for conservation in the region is dependent upon the general sustainability of their community and industry supporting their grazing operations.

The peri-urban buffer is not a new concept in the social sciences, but it is new in the context of land management for conservation. It refers to the urban influences on the rural zones outside of urban zones. In this case it refers to the historical shift from rural culture and resource management to urban values and influences on the lands outside of urban zones. The concept of the wildland-urban-interface (WUI) is similar. But here Advisors refer to the rural culture being or having been replaced by ex-urban culture as the urban zones spread into the formerly rural zones. The disinclination of the remnant ranch owners on the margins of Antioch to sell a conservation easement and continue ranching rather than their preference to sell the ranch in fee title (A. Fateman, pers. comm.) indicates this transformation in the region. Ranch families with vested interests in rangeland health and ranching culture are being displaced by recreational developments and people representing urban needs and sensibilities in the new peri-urban zones. Grazing lessees will eventually use those lands, if invited and if they can make a sustainable profit in doing so. Nonetheless, the buffering of the peri-urban zone can be designed to protect biodiversity and minimize fire hazards by continuing or reintroducing livestock grazing.

The concept of ecosystem services has often been too narrowly interpreted as not requiring management (Huntsinger and Oviedo 2014). That doesn't work with California's Mediterranean grasslands, which are dominated by ruderal Mediterranean annuals. Bringing in the concepts of cultural or social roles in managing the ecosystems to produce those services is more realistic and effective, and adds the management planning dimensions (Plieninger at al. 2015). If the regional opportunities for grazing are reduced or the community of available grazing operators is reduced enough, then it's likely that conservation landowners (such as the Conservancy) will have to pay for cattle grazing services as they would already for sheep and goat grazing services. Maintaining the sustainability of regional rancher economies and cultures through partnerships is likely to be less costly to conservation agencies than the opposite.

V. Threats

Are you aware of any new threats to any of the proposed covered species? If so, what is the nature of those threats and how might the HCP/NCCP respond to them?

The Advisors identified two major generalized potential threats that should be emphasized. First is the potential for declining availability and capabilities of livestock grazing operators to provide the needed grazing services. This may occur in response to the continued fragmentation of grazing lands due to development and changes in agricultural uses on neighboring lands. This would lead to increased costs to the Conservancy and EBRPD to apply grazing. Second is the potential large increases in use of preserve lands for diverse recreational purposes.

Sarcoptic mange of kit fox is a recent threat in Bakersfield, California where a dense population of kit fox exists **(**Cypher et al. 2017**)**. Mange in kit fox is unlikely to persist in natural lands due to the lower fox densities (B. Cypher, pers. comm.).

How are the proposed Antioch HCP/NCCP covered species vulnerable to non-native invasive species as new threats?

Aquatic amphibians and reptiles are vulnerable to introduced non-native predators like game fish and bullfrogs. This is more of a concern in habitats that contain water on a permanent or near permanent basis and so mainly a potential concern for California red-legged frogs and western pond turtles within the Antioch inventory area.

A threat to California tiger salamanders in some parts California is hybrids between this native species and non-native western tiger salamanders (*Ambystoma mavortium*) introduced in the 1940's and 1950's. The initial introductions occurred in Monterey County and many populations in that county are now hybrids between the native and introduced species. However, the distribution of hybrids remains largely limited to Monterey County, and there are no known hybrid populations within 100 kilometers of the ECCC/Antioch Plan inventory area (B. Shaffer, pers. comm.).

The greatest threat from non-native species in the area of the Antioch Plan is likely Red Fox (*Vulpes vulpes*). However, red fox tend to be rare in natural lands because of high predation by Coyotes (*Canis latrans*) thus making them an unlikely threat in the inventory area (B. Cypher, pers. comm.).

There is a very good scientific literature on the best-known methods to control most of the existing non-native pest invasive plants in the ECCC region (refer to Cal-IPC[1]and UC Statewide Integrated Pest Management Program[2]). The greatest risk would be introductions of new invasive plants with greater impact than current pest plants.

If landscape-scale disturbances that remove biomass, such as grazing and/or fire, are not used regularly, certain invasive species can invade vernal pools and potentially impact fairy/tadpole shrimp populations. This can also be an issue for some California tiger salamander and California red-legged frog breeding ponds. Annual grasses can proliferate in the pool basins and dry down the pool early and can impact the amount of open water habitat available to the shrimp species (Marty 2005).

VI. Biological Goals and Objectives

Although there were no direct questions posed to the Advisors regarding the biological goals and objectives (BGOs) of the ECCC Plan, the Advisors were concerned that many of those that are related to target species lack focus on biological processes and may result in misguided monitoring efforts. Modifying the BGOs is a first step in developing effective management and monitoring plans, and should be clearly linked to CEMs (Section IX). The Advisors believe the BGOs need to be substantially revised to reflect natural variability in abundance and distribution of plants and animals. We also have concerns about the assumption in the BGOs that "baseline surveys" are a meaningful benchmark from which to evaluate annual changes. The stated goal to either maintain or increase abundance doesn't take into account the expected dynamics of populations. Although the distribution and abundance of all biological populations are dynamic through time, this is particularly true in California grasslands due in large part to the high interannual variation in precipitation and temperature. Rather than stating a goal to "maintain or increase the population size" of a target species, Advisors suggest the goal be restated as "manage habitat to promote and maintain target species populations in areas considered as suitable habitat," a goal that should be easily linked to the species' CEM.

[1] http://www.cal-ipc.org/plants/inventory/
[2] http://ipm.ucanr.edu/NATURAL/index.html

Related to the Advisors' concern over the BGOs is reconsideration of conducting baseline surveys. Although baseline conditions may serve an administrative or legal role in the ECCC Plan, the concept of a static condition for biological populations is a false premise. Consistent with the Advisors' monitoring recommendations (Section VIII), surveys should only be conducted when there is a clear and direct management outcome based on survey results, and the same should be applied to what might be considered "baseline" surveys. A cost/benefit evaluation, even if only qualitative, will be useful to ensure that additional data will provide sufficient benefit relative to other uses of those conservation funds (Maxwell et al. 2015).

VII. Management

What specific management/control strategies should be considered to reduce these new threats?

Although not necessarily new threats, in ponds, non-native species can be controlled by periodic drying which will probably occur naturally in all but the largest ponds. Intentional draining/drying is also an option. Also limiting/discouraging public access to areas where gamefish could be introduced is advisable.

Any new introduction of a particularly virulent and fast spreading new non-native invasive plant in the ECCC region would likely be at least somewhat vulnerable to the same kinds of livestock grazing treatments as used for the existing invasive plants. The UC Cooperative Extension livestock and range management specialists and advisors and Weed Management Area professionals for the ECCC region should be consulted as soon as the new infestations are discovered. It will be unlikely that grazing alone will eradicate these new invasive plants, but grazing is likely to play a substantial role in their control.

Fire can be a particularly useful tool for reducing the threat of certain non-native invasive species in grasslands. In particular, late spring burns are very effective at reducing populations of non-native annual grasses such as barb goatgrass (*Aegilops triuncialis*) and medusahead (*Elymus caput-medusae*) (Kyser et al. 2008, Sweet et al. 2008, Marty et al. 2015). Late spring burning can also increase native plant biodiversity in vernal pools and the surrounding grasslands (Marty 2015b). Summer and fall fires often do not control non-native grasses such as medusahead and barb goatgrass (Marty unpubl. data) but may benefit some native forb species (D'Antonio et al. 2006).

Are there other management principles or conservation goals that can be used in developing the framework?

Measurable management objectives and monitoring performance standards related to grazing, rangeland ecosystem health, and social-ecological services should include the following:

Objective:

- Maintain a positive, sustainable working relationship with livestock grazing lessees that incentivizes partnership.

Performance Standards:

- Livestock grazing infrastructure is maintained in functional condition.
- Incentives for cooperative stewardship are in place and effective, such as mutual invitations to attend educational events and compensation (credits on grazing fees or direct payments) for "extra" services (beyond those normally specified or expected in conventional grazing agreements).

VIII. Monitoring

Which attributes or indicators can serve to monitor population viability of covered species and ecological integrity of natural communities in the inventory area? Are there good indicator or umbrella species that can be monitored as proxies for other species or aspects of ecosystem health?

During the workshop, participants discussed issues related to monitoring species that were rare or as of yet not recently detected in the inventory area. The participants discussed the value of monitoring for the presence of San Joaquin kit fox. The Antioch development team stated that if kit fox were detected in the inventory area, then that would trigger a change in management. If so, then monitoring efforts may be justified. Camera stations provide a relatively inexpensive and effective method to detect foxes at low densities compared to any other technique (B. Cypher, pers. comm.; Westall and Cypher 2017).

The Advisors are concerned about the stated Antioch strategy to wait for San Joaquin kit fox or any other covered species to be found before taking actions to protect habitat. In the case of kit fox, management of the lands is likely to be less important than prior acquisition of corridors and designation of zones without excess recreation or other human impacts. Advisors strongly recommend that areas intended to allow for kit fox connectivity but that may reduce the likelihood of the use of those areas by kit fox, such as recreational uses, not be dependent on confirming kit fox use. The Antioch Plan should instead require CDFW to declare the area unsuitable for kit fox and other covered species before designing and managing the habitat lands in any way known to reduce chances for their colonization and occupation.

Is the monitoring and adaptive management framework in the ECCC HCP/NCCP sufficient for the Antioch HCP/NCCP? If not, what additional components do you recommend including?

The Advisors strongly recommend that the Antioch and ECCC Plans share a common monitoring program. However, the Advisors believe that many aspects of the monitoring approach described in the ECCC Plan will not contribute to adaptive management but come at great expense and opportunity cost. The Advisors recommend a much more constrained monitoring effort than proposed in the ECCC Plan with, whenever possible, a focus on metrics related to responses to experimental management trials, conducted in a hypothesis-testing approach. Many of the Advisors concerns and recommendations regarding monitoring were previously addressed in the Science Advisors 2004 report (SAR 2004) for the draft ECCC Plan but were apparently not incorporated into the ECCC Plan.

Most monitoring efforts conducted as part of a conservation strategy, such as within HCPs and NCCPs, have failed to meet the important goal to inform management. The Advisors believe the same will be true with the proposed monitoring program of the ECCC Plan. Monitoring plant and animal populations to guide management is extremely difficult because of the dynamics of populations and the diverse and often interactive factors that affect their distribution and abundance. Typically, there is no stated hypothesis relating monitoring results to an effect upon which management can act (Noon 2002, Nichols and Williams 2006). Without such links, adaptive management cannot be implemented, let alone successful. This is typical of many monitoring programs and is the fundamental reason postulated for failure of monitoring efforts to be effective (Noon 2002, Nichols and Williams 2006).

The primary emphasis in the ECCC Plan monitoring program is status and trends monitoring. Almost without exception, status and trends monitoring leads to monitoring results that describe changes in species abundances over time (Nichols and Williams 2006). Such efforts are both extremely expensive and rarely have informed management (Noon 2002, Nichols and Williams 2006). The primary reason for failure is that even when reliable estimates of abundance are obtained the reasons for trends are unknown and thus do not inform management; or worse, that management changes, including those that cause unintended negative consequences, are made based on flawed assumptions. The premise with so many monitoring efforts is that by monitoring trends, management can take effective remedial action when declines are noted, but this has proven to be false (Elzinga et al. 2001, Noon 2002, Nichols and Williams 2006). The ECCC Plan focuses on this approach to monitoring, but the Advisors conclude that this approach will likely not fulfill the intended programmatic goal of adaptive management.

Based on discussions at the workshop, it is clear there are conflicting perspectives regarding monitoring between regulatory agencies and those who are involved in creation and implementation of the Antioch/ECCC Plans. These conflicting perspectives need to be resolved in a way that leads to effective and efficient adaptive management and considers the costs and benefits of conducting specific monitoring and research studies (Rosenberg et al. 2012, Maxwell et al. 2015). Advisors believe part of the conflicting perspectives has its origins in the statement of biological goals and objectives related to "maintain or increase" (status and trends) populations and the regulatory agencies requirement that monitoring evaluate how well goals and objectives have been met. A large effort would be required to determine simply if populations have changed, and most importantly, these results do not inform management as discussed above. Therein lies what Advisors believe is the key conflict and one that will stifle the monitoring and adaptive management program without changes to both BGOs and monitoring expectations.

In summary, the Advisors believe one of the most important changes that can be made to the ECCC Plan and thus the Antioch Plan is to extensively modify the monitoring program so that it directly links to adaptive management. Development of simple CEMs (see Section IX) is an important first step in planning effective monitoring, as described in the ECCC Plan (7-3, 7-15), but as of yet, not created for covered species. Examining these models will likely reveal that status and trends monitoring for most, if not all, covered species is unlikely to facilitate management decisions. The Advisors believe cause and effect monitoring of restoration and management practices is an approach which provides the greatest likelihood for monitoring to inform management in the ECCC and Antioch Plans. Although the 2004 Science Advisors (SAR 2004) stated that the costs for experimental approaches were higher than status and trends monitoring (and see ECCC Plan Fig. 7-2), the Advisors believe the value of new information to affect management through this approach far outweighs any higher costs that may occur. Furthermore, it is likely much less expensive to focus on experimental studies directly related to management than the currently proposed status and trends monitoring of many species and habitats. The cost savings come in from two angles: first, because of the more controlled nature of experimentation than status and trends monitoring, a smaller sample size is necessary; second, the time period need not be long but only cover the situations that are deemed most likely in terms of seasonal timing and environmental context. The savings in conservation funds and opportunity costs can be considerable by adopting such an approach over status and trends monitoring. Most importantly, the ability to learn and modify management will be much more likely under this approach.

IX. Conceptual Models for Management and Monitoring

The Advisors believe the Antioch HCP planning effort would be greatly facilitated and improved by the further development and use of conceptual models to inform monitoring and management. The ECCC Plan (7-3) emphasizes this approach as a first step prior to determining monitoring and management needs: "Conceptual models will be a cornerstone of the monitoring program…" and several models were developed for natural communities (ECCC Plan Appendix D, Figures D1-D4). Conceptual models are defined as "plausible representations of a dynamic natural resources system" (Williams et al. 2009). Conceptual models represent the current understanding of a species or ecological system and provide a structure for designing monitoring programs, interpreting monitoring and other data, and assessing the accuracy of the understanding of ecosystem functions and processes. They also highlight areas of uncertainty, can help determine the likelihood of success, identify potential restoration actions, and define monitoring needs (Digennaro et al. 2012). These models can also be adapted to incorporate climate change as a driver of ecological change which can highlight potential interactions with various processes and human activities.

Although these basic guidelines were described in the ECCC Plan (7-3; 7-15), the Advisors did not find examples of their use and how they informed monitoring, research studies, or management. The Advisors recommend that the Antioch Plan include CEMs of key species or habitats that may be the focus of monitoring, research, and/or management. Through this exercise, key metrics will be identified that would provide links to monitoring and/or management, and facilitate determining when monitoring may not be fruitful due to the inability to identify factors that management can clearly address.

The Solano County HCP created conceptual ecological models for some of the covered species including for the California tiger salamander, burrowing owl and other species also in the Antioch and ECCC Plans. A slideshow with an example of a CEM for the California tiger salamander and other species can be found at http://www.scwa2.com/Home/ShowDocument?id=1026.

There are a number of other excellent resources available to help develop these models including a USGS manual specifically addressing the development and use of these models in HCP/NCCPs (Atkinson et al. 2004). Additionally, a USGS Report developed for the Great Basin has useful and updated information (Miller et al. 2010). As part of the Bay Delta Ecosystem Restoration Program, a formalized approach to developing conceptual models was developed called the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP). Information about DRERIP can be found at http://www.dfg.ca.gov/ERP/conceptual_models.asp.

X. Concluding Comments

The Advisors were very impressed with the land acquisition to date and that planned under the ECCC Plan, which the Antioch Plan will allow further expansion. Ultimately, Advisors agree that the greatest threat to conservation in the inventory area and in the larger region in which the plans are embedded is habitat loss. Land acquisition, either by fee title or through conservation easements, is the most important component of the Antioch Plan that will contribute to the biological goals and objectives.

The Advisors recommend that the Antioch Plan follow the same monitoring and adaptive management approach as that ultimately chosen for the ECCC Plan. The Advisors recommended substantial changes to the ECCC Plan monitoring and adaptive management program, which are reflected in our recommendations in this report. Key recommendations include:

1. development of simple conceptual models to guide monitoring and management,
2. a focus on experimental management trials rather than status and trends monitoring, and
3. ensure that any planned research or monitoring activity clearly and directly links to making feasible management decisions.

The advisors conclude that adopting these recommendations is critical to realizing the goal of adaptive management. This approach should result in much lower monitoring costs, potentially allowing a greater emphasis on management, and avoiding and reducing threats to conservation goals. To allow for these changes, the Advisors recommend a revision or reinterpretation of the BGOs described in the ECCC Plan to recognize the natural dynamics of the distribution and abundance of covered species. The Advisors suggest that the need for so-called "baseline surveys" be evaluated for how that information will ultimately be used and to avoid such efforts when there is no clear link to management. Finally, the Advisors realize the difficult challenge that the Antioch Plan development team faces in making the monitoring/research program both effective and efficient given various regulatory needs. The Advisors recommend further discussion with the regulatory agencies to ensure a practical, efficient, and effective monitoring/research program is developed so that adaptive management can be realized. The costs and benefits of each element of this program deserve review.

XI. Literature Cited

Atkinson, A.J., P.C. Trenham, R.N. Fisher, S.A. Hathaway, B.S. Johnson, S.G. Torres, and Y.C. Moore. 2004. *Designing monitoring programs in an adaptive management context for regional multiple species conservation plans*. U.S. Geological Survey Technical Report. USGS Western Ecological Research Center, Sacramento, CA. 69 pp.

Barry, S, L. Bush, S. Larson, and L.D. Ford. 2015. *Understanding Working Rangelands: the benefits of livestock grazing California's annual grasslands*. ANR Publication 8517. University of California Agriculture and Natural Resources. 7 pp.

Bartolome, J.W., B.H. Allen-Diaz, S. Barry, L.D. Ford, M. Hammond, P. Hopkinson, F. Ratcliff, S. Spiegal, and M.D. White. 2014. Grazing for biodiversity in Californian Mediterranean grasslands. *Rangelands* 36(5):36–43.

Bartolome, J.W., R.H. Barrett, M. Hammond, P. Hopkinson, F. Ratfcliff, and N. Schowalter. 2013. *Range Ecology Grassland Management and Monitoring options for the East Bay Regional Park District: Final Report 2011 Grassland Monitoring Project (Year 10)*. University of California, Berkeley Range Ecology Lab.

Bartosh, H. 2016. Technical Memorandum: Taxonomic Update for the Covered Species Adobe Navarretia (*Navarretia nigelliformis* subsp. *nigelliformis*) within the East Contra Costa County Habitat Conservation Plan (HCP) Inventory Area. Letter to Abigail Fateman, East Contra Costa County Habitat Conservancy, May 31.

Bush, L. 2006. *Grazing Handbook: A guide for resource managers in coastal California*. Prepared for the Sotoyome Resource Conservation District, Santa Rosa, CA.

Calflora 2018. Information on California plants for education, research and conservation, with data contributed by public and private institutions and individuals, including the Consortium of California Herbaria. Berkeley, California: The Calflora Database. Available: http://www.calflora.org/ (Accessed: Feb 22, 2018).

California Native Plant Society. 2018. Inventory of Rare and Endangered Plants of California (online edition, v8-03 0.39). Available: http://www.rareplants.cnps.org (accessed February 22, 2018).

Clark, T.J., M.J. Van Ess, and N. Wymer. 1998. Pp. 250-254 in C.W. Witham, E.T Bauder, D. Belk, W.R. Ferren Jr., and R. Ornduff (eds.). *Ecology, Conservation, and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference*. California Native Plant Society, Sacramento, CA.

Constable, J.L., B.L. Cypher, S.E. Phillips, and P.A. Kelly. 2009. *Conservation of San Joaquin kit foxes in western Merced County, California*. Report prepared for the US Bureau of Reclamation. 55 pp.

Cypher, B. L., J. L. Rudd, T. L. Westall, L. W. Woods, N. Stephenson, J. E. Foley, D. Richardson, and D. L. Clifford. 2017. Sarcoptic mange in endangered kit foxes (*Vulpes macrotis mutica*): Case histories, diagnoses, and implications for conservation. *Journal of Wildlife Diseases* 53: 46-53.

D'Antonio, C. S. Bainbridge, C. Kennedy, J. Bartolome and S. Reynolds. 2006. *Ecology and Restoration of California Grasslands with special emphasis on the influence of fire and grazing on native grassland species*. A report to the David and Lucille Packard Foundation and the University of California, Berkeley. 99 pp.

D'Antonio, C., S. Bainbridge, C. Kennedy, J. Bartolome and S. Reynolds. 2002. *Ecology and restoration of California grasslands with special emphasis on the influence of fire and grazing on native grassland species*. Report to the Packard Foundation.

DiGennaro, B., D. Reed, C. Swanson, L. Hastings, Z. Hymanson, M. Healey, S. Siegel, S. Cantrell, and B. Herbold. 2012. Using conceptual models and decision-support tools to guide ecosystem restoration planning and adaptive management: an example from the Sacramento-San Joaquin Delta, California. *San Francisco Estuary and Watershed Science* 10(3):1–15. Available: http://escholarship.org/uc/item/3j95x7vt

Elzinga, C. L., D. W. Salzer, J. W. Willoughby, and J. P. Gibbs. 2001. *Monitoring plant and animal populations*. Blackwell Science, Malden, MA.

Ford, L., P. Hopkinson, and P. Van Hoorn. 2018. "Grazing Management Planning for Adaptive Stewardship--in California's Mediterranean Grasslands." Presented Jan 31, 2018 at the Society for Range Management symposium, "Grazing for Biodiversity Conservation in Mediterranean Grasslands: Stewarding California's Iconic Landscape," Sparks, NV.

Ford, L.D. 2013. "Nature conservation paradigms: their evolution and applications to California rangeland landscapes." Presented Oct 13, 2013 at the University of California Cooperative Extension and Center for Forestry conference, "Working for Conservation: Active Engagement in Forest and Woodland Sustainability," Sacramento, CA. Available: http://www.rangelandconservation.com/Presentations.htm

Ford, L.D. 2014. "Planning for variable (and extreme) weather—grazing management for conservation and sustainability in California grasslands." Presented Jun 18, 2014 at the Bay Area Open Space Council, Stewardship Working Group workshop, Livermore, CA.

Fuhlendorf, S.D. and D.M. Engle. 2001. Restoring heterogeneity on rangelands: Ecosystem management based on evolutionary grazing principles. *Bioscience* 51:625–632.

Gea-Izquierdo, G., S. Gennet, and J.W. Bartolome. 2007. Assessing plant-nutrient relationships in highly invaded Californian grasslands using non-normal probability distributions. *Applied Vegetation Science* 10:343-350.

Gennet S., Spotswood E., Hammond M., Bartolome J.W. 2017. Livestock grazing supports native plants and songbirds in a California annual grassland. *PLoS One* 12(6): e0176367.

Huntsinger, L., and J.L. Oviedo. 2014. Ecosystem services are social–ecological services in a traditional pastoral system: the case of California's Mediterranean rangelands. *Ecology and Society* 19(1):8.

Huntsinger, L., J.W. Bartolome, and C.M. D'Antonio. 2007. Grazing management on California's Mediterranean grasslands. Pp. 233-253 in: M.R. Stromberg, J.D. Corbin, and C.M. D'Antonio (eds.), *California grasslands: ecology and management*. Berkeley, CA: University of California Press.

Jackson, R.D. and J.W. Bartolome. 2007. Grazing ecology of California's grasslands. Pp. 197-206 in M.R. Stromberg, J.D. Corbin, and C.M. D'Antonio (eds.), *California grasslands: ecology and management*. Berkeley, CA: University of California Press.

Kyser G.B., Doran M.P., McDougald N.K., Orloff S.B., Vargas R.N., Wilson RG, DiTomaso J.M. 2008. Site characteristics determine the success of prescribed burning for medusahead (*Taeniatherum caput-medusae*) control. *Invasive Plant Science and Management* 1:376–384.

Marty, J.T. 2005. Effects of cattle grazing on diversity in ephemeral wetlands. *Conservation Biology*. 19:1626-1632.

Marty, J.T. 2015a. Loss of biodiversity and hydrologic function in seasonal wetlands after 10 years of livestock grazing removal. *Restoration Ecology* 23(5):548-554.

Marty, J.T. 2015b. Fire effects on plant biodiversity across multiple sites in California vernal pool grasslands. *Ecological Restoration* 33(3):266-273.

Marty, J.T., S.B. Sweet and J.J. Buck-Diaz. 2015. Burning controls barb goatgrass (*Aegilops triuncialis*) in California annual grasslands for at least 7 years. *Invasive Plant Science and Management* 8(3):317-322.

Maxwell, Sean L., Jonathan R. Rhodes, Michael C. Runge, Hugh P. Possingham, Chooi Fei Ng, and Eve McDonald-Madden. 2015. How much is new information worth? Evaluating the financial benefit of resolving management uncertainty. *Journal of Applied Ecology* 52:12-20.

McComb, B., B. Zuckerberg, D. Vesely, and C. Jordan. 2010. *Monitoring animal populations and their habitats: A practitioners guide*. CRC Press, Boca Ratan, FL.

Miller, D.M., S.P. Finn, A. Woodward, A. Torregrosa, M.E. Miller, D.R. Bedford, and A.M. Brasher. 2010. *Conceptual ecological models to guide integrated landscape monitoring of the Great Basin.* U.S. Geological Survey Scientific Investigations Report 2010-5133, 134 p

Nichols, J. D., and B. K. Williams. 2006. Monitoring for conservation. *Trends in Ecology and Evolution* 21:668-673.

Noon, B. R. 2002. Conceptual issues in monitoring ecological resources. Chapter 2 *In* Busch, D. E., and J. C. Trexler (eds.). *Monitoring Ecosystems*. Island Press, Washington, D.C.

Peine, J.D. (Ed.). 1999. *Ecosystem management for sustainability: principles and practices illustrated by a regional biosphere reserve cooperative*. Lewis Publishers. 500 pp.

Plieninger, T., C. Bieling, N. Fagerholm, A. Byg, T. Hartel, P. Hurley, C.A. Lopez-Santiago, N. Nagabhatla, E. Oteros-Rozas, C.M. Raymond, D. van der Horst, and L. Huntsinger. 2015. The role of cultural ecosystem services in landscape management and planning. *Current Opinion in Environmental Sustainability* 14:28–33.

Pyke, C.R. and J.T. Marty. 2005. Cattle grazing mediates climate change impacts on ephemeral wetlands. *Conservation Biology*. 19:1619-1625.

Richmond, J. Q., D. A. Wood, K. E. Swaim, R. N. Fisher, and A. G. Vandergast. 2016. Historical habitat barriers prevent ring-like genetic continuity throughout the distribution of threatened Alameda Striped Racers (*Coluber lateralis euryxanthus*). *Herpetologica* 72:202-213.

Robertson, D.M. 2004. *Relationships between historic land use, plant species composition and environmental factors in the foothills south of Mount Diablo, California*. M.S. Thesis, University of California, Berkeley.

Rosenberg, D. K., D. G. Vesely, and J. A. Gervais. 2012. Maximizing endangered species research. *Science* 337:799.

Sayre, N.F., R.R.J. McAllister, B.T. Bestelmeyer, M. Moritz, and M.D. Turner. 2013. Earth Stewardship of rangelands: coping with ecological, economic, and political marginality. *Frontiers in Ecology and the Environment* 11(7):348-354.

Science Advisors Report (SAR). 2004. *Science advisory panel guidance for the East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan compiled during four meetings, May 2002-December 2003*. Unpublished report.

Spinks, P. Q., R.C. Thomson, and H.B. Shaffer. 2014, The advantages of going large: genome-wide SNPs clarify the complex population history and systematics of the threatened western pond turtle. *Molecular Ecology* 23: 2228–2241.

Stahlheber, K.A. and C.M. D’Antonio. 2013. Using livestock to manage plant composition: a meta-analysis of grazing in California Mediterranean grasslands. *Biological Conservation* 157:300–308.

Sweet, S.B, G.B. Kyser, and J.M. DiTomaso. 2008. Susceptibility of exotic annual grass seeds to fire. *Invasive Plant Science and Management* 1:158–167.

The Nature Conservancy (TNC). 2012. *Draft Cosumnes River Preserve Monitoring and Research Plan*. March 26.

Trenham, P.C., and H.B. Shaffer. 2005. Amphibian upland habitat use and its consequences for population viability. *Ecological Applications* 15:1158–1168.

U.S. Forest Service. 2018. Fire Effects Information System. US Department of Agriculture. https://www.feis-crs.org/feis/

Westall, T.L., and B.L. Cypher. 2017. Latency to first detection of kit foxes during camera surveys. *Canid Biology and Conservation* 20:32-37.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. *Adaptive Management: The U.S. Department of the Interior Technical Guide*. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

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