North Bay Vital Signs

An Integrated Ecosystem-Climate Monitoring Framework for Sonoma County

Lisa Micheli (Pepperwood) and Deanne DiPietro (Point Blue Conservation Science)
Co-chairs, North Bay Climate Adaptation Initiative (NBCAI) Science Working Group

A report prepared for
Community Foundation Sonoma County
December 2013

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1. Executive Summary

This report summarizes the North Bay Climate Adaptation Initiative (NBCAI)'s progress towards designing and implementing a Sonoma County-wide network capable of detecting local changes in climate and biodiversity, and of feeding into regional, state and national networks designed to support natural resource management decision-making at multiple scales.

The strategy outlined here advances the following NBCAI *Vital Signs* objectives.

- To maximize the input of advising technical experts on an indicator framework
- To utilize protected lands as potential "hubs" of an integrated climate-biota monitoring network
- To establish a sustainable, long-term set of combined climate-hydrology-biology measuring stations
- To define data structure, collection protocols, stewardship, statistics, sharing, and reporting needed to regularly assess the status of key climate-ecosystem indicators
- To explore the appropriate role of citizen scientists
- To assess the feasibility of monitoring implementation recommendations with voluntarily participating conservation land managers

NBCAI's science working group has accomplished the following first steps towards these objectives, as described in more detail in this report.

- Inventorying existing monitoring programs and locations
- Integrating input from multiple individuals and organizations on monitoring priorities and key indicators, including those shown in the attached appendices developed in the course of science working group meetings
- Coarse-level mapping of County-wide habitats (defined by vegetation cover) and climate zones (as estimated by climatic water deficits)
- Identification of a preliminary set of conservation lands that are relatively evenly spatially distributed and representative of Sonoma County landscape diversity
- Defining preliminary ecosystem-specific criteria for screening indicators including development of ecosystem conceptual models
- Piloting a subset of proposed methods at Pepperwood's *Sentinel Site* field station

The work ahead of us includes:

- More rigorous assessment of spatial statistics needed to monitor effectively, to be achieved through partnership with the experts (SCWA, NOAA, Pont Blue Conservation Science)
- "Nesting" considerations-integration with other networks at varying spatial scales
- Translating what we do know into clear communication tools for use by the stewardship and policy working groups
- Streamlining biological monitoring into a subset of indicators and designing monitoring pilots
- Advancing monitoring pilot programs

2. North Bay Vital Signs - purpose and objectives

The purpose of this Sonoma County biodiversity vital signs project is to develop a monitoring framework capable of both enhancing our scientific understanding of relationships between biodiversity, habitat, and management and to support and evaluate the implementation of active conservation programs. This project supports the Sonoma County Biodiversity Action Plan (CFSC 2010) which defines overall conservation objectives for the County and the current state of our knowledge about general relationships between natural system drivers, human threats, ecological stressors, and benefits of conservation programs both proposed and underway. The Biodiversity Action Plan vision statement summarizes our targeted long-term outcome:

> *A Sonoma County with resilient, biologically diverse natural systems that provide lasting ecosystem functions and services into the future.*

The Biodiversity Action Plan (BAP) delineates the following set of general objectives for conservation.

- Set measurable goals for species and habitat recovery
- *Track species viability ("vital signs") and threats in real-time*
- Prioritize conservation actions that sustain local biodiversity and ecosystem function through an adaptive management framework

The *Vital Signs* program described here comprises objective two above and is critical to supporting the overall goal of the BAP by creating a concrete and quantitative framework for understanding the baseline conditions of biodiversity in the County and ultimately measuring relationships between management and habitat characteristics and species' distributions, abundance, and reproductive success. These indicators provide a measure of our conservation success.

BAP Priority actions include:

1. Educate our community about the value of Sonoma County's biodiversity and how to protect it
2. *Implement an overarching "vital signs" monitoring framework (that defines what to measure, where, and how often) via a County-wide coordinated multi-agency team*
3. Promote conservation on private lands via landowner outreach and economic incentives
4. Protect land via acquisitions and easements in a manner targeted to maximize ecological value and connectivity
5. Conduct a regional climate change vulnerability analyses for species and ecosystems
6. Perform cost-benefit analyses of restoration and development projects in terms of ecosystem services to inform County planning and policies.

Successful implementation of our vital signs project is specifically called for under BAP priority action 2 (in italics), and we have integrated into this plan the first steps of priority action 5 by taking a close look at the climatic diversity of the County in concert with habitat distributions and by integrating climatic indicators into the overall design in order to better understand moving forward the impact of climate on our watersheds and ecosystems. However this project ultimately supports all of these action items by strengthening the empirical basis for conservation planning in the County.

The following excerpted BAP sections provide direct guidance for the vital signs effort.

"(We need) coordinated monitoring to evaluate species, habitats, and ecosystems that directly addresses identified threats to biodiversity (i.e., habitat loss and fragmentation, invasive species, degradation of natural water cycles, air and water pollution, global climate change, and data gaps)…

Recommended Actions

- *Inventory and apply existing data resources (e.g., Bay Area Uplands Habitat Goals)*
- *Consult local experts to further define priority areas based on expert opinion*
- *Conduct formal analysis (e.g., species and habitat distribution maps including climate change)*
- *Identify current level of habitat connectivity*
- *Create a conservation GIS to identify areas for conservation action"*

3. North Bay: a climate adaptation context

The mission of the Biodiversity Action Plan (BAP) team is now being advanced by the North Bay Climate Adaptation Initiative (NBCAI) which formed as a result of the Laguna de Santa Rosa Foundation's 2009 science symposium focused on the potential impacts of climate change on the watersheds and ecosystems of the North Bay (the majority of

BAP contributors, both organizations and individuals, are now NBCAI participants). A collaborative ensemble of experts drawn from conservation research and management organizations are working on the problem of climate adaptation for conservation lands and local communities, using Sonoma County as a model that can ultimately scale up throughout the North Bay counties. In this context climate adaptation is defined as understanding the potential impacts of climate change on ecosystems and identifying strategies to minimize the negative impacts on our natural resources and human communities. Like the BAP, this collective effort is facilitated through the leadership of Community Foundation Sonoma County, which provides administrative oversight and key funding to support NBCAI's organizational capacity.

The NBCAI science working group facilitated a series of workshops from 2010-2012 to develop this *Vital Signs* project. Biologists and other natural resource experts from around the County have generously volunteered their time to advance this project. NBCAI also coordinated directly with the Sonoma County Water Agency (SCWA), which is pursuing a strategy of increasing the density of rainfall and weather stations in its services area, to identify areas of mutual interest and to define an "integrated hydrology monitoring station" design that would suit both *Vital Signs* and SCWA objectives. This document reflects our progress as of December 2013 and delineates the additional work to be done to complete the monitoring plan design and move into project implementation.

The challenge of managing our natural resources in the face of climate change provides a classic opportunity for the application of an adaptive management framework (Figure 1). Since there is a real dearth of baseline data specifically on the distribution and abundance of plants and wildlife in the region, the *Vital Signs* monitoring effort has two purposes: 1) provide a scientific baseline and improve our understanding of controls on the spatial distribution of biodiversity by allowing us to compare indicators over time and 2) to empirically test the cumulative effectiveness of conservation actions to date in order to prioritize conservation actions moving forward. By consistently collecting data over time we can collectively advance our understanding of relationships between drivers, threats, and natural assets.

There is a significant body of literature on monitoring and adaptive management. Using the monitoring classification framework of Nichols and Williams (2006) our goal is to design a hybrid system that monitors for both science and active conservation. Although there is significant uncertainty in some parameters, we are able to frame testable hypotheses based on our current understanding about both natural controls on the distribution of biodiversity and intended outcomes of conservation actions. Following the program defined here we aim to both refine our fundamental understanding and

create a sustainable framework for evaluating conservation success for the decades to come.

4. Conceptual framework – physical factors shape habitat

In order to integrate the multiple perspectives of participants it was important to define an overarching framework of relationships between a-biotic drivers and biotic response (Figure 2). Our working hypothesis is that it is largely the diversity of topography, climate, and hydrology that generates the globally-significant biodiversity of our region. The implication of this hypothesis is that if climate change shifts weather and hydrology patterns, the distributions of species are likely to change as well (Ackerly et al 2010). Clearly this framework is highly oversimplified, as there are many documented examples of biological feedbacks to physical systems, but assuming that physical parameters drive patterns of landscape biology provides an important starting point and is based on our "30,000-foot" perspective at this stage of the *Vital Signs* program.

While we lack detailed information on individual species' occurrences across the County, thanks to the Upland Habitats Goals project that supported the design of the Bay Area Conservation Lands Network we do have a continuous map of ecosystem types across the county based on vegetation cover (BAOSC 2011). Thanks largely to the efforts of Pepperwood's Terrestrial Biodiversity Climate Change Collaborative (TBC3), we also have historical and projected climate and hydrology maps for the region (Flint and Flint 2012a, 2012b; Flint et al 2013). This allows us at a coarse scale to understand the distribution of ecosystems relative to climate. The objective of phase 1 of this project was to collect and assess this data for Sonoma County in order to start shaping a spatial framework for measuring *Vital Signs.*

Working County-scale hypotheses

- Biodiversity is greatest on designated preserve lands and other natural areas typified by undisturbed vegetation cover and other attributes typical of "protected areas."

- Habitat value and permeability to wildlife decrease as a function of proximity to high density urban development and roads, both indicators of habitat fragmentation threat (Merenlender et al 2009, Reed and Merenlender 2011).

- Ecological stress due to climate change will increase with increased distance from coast or Bay, due to the mitigating influence of fog and the coastal inversion layer and decreases with increased topographic relief and microclimate diversity (Loarie et al 2009).

- Habitat "connectivity" increases habitat and climatic diversity and in turn should support greater biodiversity (Merenlender 2010, BAOSC 2013).

5. Conservation lands as monitoring platforms

Soon after we embarked on this endeavor, a consensus emerged among our science working group that the most practical and effective approach would be to concentrate on identifying a subset of protected lands within Sonoma County that could serve as a platform for long-term coupled climate-ecosystem monitoring. While at first we concentrated on existing locations of long-term weather stations, it became apparent that the majority of these were located in highly developed/urbanized areas, such as airports, that generally would not prove suitable sites for biological monitoring. Further, when we explored gaps in the current climatic monitoring network, places that needed weather stations were located in relatively remote montane regions, conditions that often coincide with protected land locations. Since the cost of installing a weather station continues to decrease over time due to improvements in technology, we decided it would be cheaper and more effective to bring weather stations to preserves than to try to locate biologically intact areas near existing weather stations.

We thus utilized the Bay Area Open Space Council protected areas database to map and evaluate candidate preserves for monitoring (Map 2). Areas under consideration include public lands, private reserves, and properties protected by an easement per an agreement with an open space district or land trust. We set the following criteria below to provide a preliminary framework for prioritizing preserves for consideration. The candidate preserves shown in attached maps provide a starting point only: as referenced below, finalizing a set of preserve sites will require evaluating the feasibility of monitoring on a case-by-case basis and better defining what an adequate network looks like.

- Preserve size exceeds 200 acres. Since a working hypothesis is that the greater the buffer between a protected location and adjacent development, the greater the potential biodiversity, we set an arbitrary size threshold of 200 acres for preserves under consideration, unless a preserve was located in an area not represented by another preserve greater than 200 acres, or if a preserve had an exceptionally long record of biological data (see below) which would bump it up in priority.

- History of biological, watershed, or weather monitoring. Preserves with a history of collecting environmental data were given priority.

- Representation of climate and habitat biodiversity. As a first cut, preserves were selected by eye to provide an evenly spaced distribution relative to distance from coast or Bay and north-south latitude (Map 4). We then characterized the diversity of climate and habitat in the County as a whole (Maps 1 and 3), and aimed to have the set of candidate preserves as a whole represent the breadth of values displayed by the County data set (see Figure 3).

- Access likelihood. We subjectively reviewed data on managing agencies for candidate preserves and put priority on organizations who have been actively involved with this project and therefore were assumed to be more open to participation. This is the least documented part of our selection process, as only a few agencies were contacted directly to confirm the feasibility of monitoring on-site. We anticipate that access restrictions will likely be the largest cause of adjustments in the preserve monitoring network moving forward.

Map 6 shows the candidate preserves plus the full set of preserves exceeding the acreage threshold. Map 7 shows the set of candidate preserves with labels.

6. Mapping habitats and biodiversity

The Biodiversity Action Plan defined the following habitat categories for Sonoma County based on plant communities, as shown in Map 1.

- Riparian Habitats
- Wetlands
- Grasslands
- Oak Woodlands
- Oak Savannah
- Mixed Evergreen Forest
- Coniferous Forest
- Chaparral
- Coastal and Nearshore Habitats
- Agriculture

We used the vegetation map produced by the Upland Habitat Goals project to characterize the habitats of Sonoma County (BAOSC 2011). Since the Upland Habitat Goals vegetation classification system was comprised of 55 categories, it was necessary to lump multiple Upland Habitat Goals classifications into the broader Biodiversity Action Plan habitat units. Land surfaces mapped as barren, rock, or open water were excluded from our mapping exercise. With the natural and agricultural area of County as a whole comprised of approximately 950,000 acres, candidate preserves totaled 98,000 acres or approximately 10% of the total area to be sampled. Figure 3 shows that

the natural vegetation categories (excluding agriculture) within candidate preserves are represented in distributions comparable to the County as a whole.

7. Mapping climatic diversity and estimating future climate stress

Our project benefits from recent research that links current and future climate to watershed hydrology using a Basin Characterization Model developed by Lorraine and Alan Flint of the US Geological Survey. Thanks to the support of the North Bay Watershed Association, this methodology was first piloted in North Bay drainages to the San Francisco Bay estuary (NBWA 2010b, Micheli et al 2012). The model produces historic monthly summaries of precipitation and temperature at a scale of 270 m using PRISM data (Daly et al 2008), and estimates hydrologic variables for the historic period at the same scale including runoff, recharge, evapo-transpiration, and changes in soil moisture based on topographic, geology, and soil maps available for the region. Using projected estimates for temperature and precipitation derived from global circulation models (Meehl et al 2007, IPCC 2013, Thrasher et al 2013), the model also estimates climate and hydrology for a range of future climate change scenarios (Flint and Flint 2012a). Application of this approach to Sonoma County enabled us to map current and future potential climate across the region and to compare this climate-hydrology data set with current habitat distributions.

A key finding of this work was that the variable defined as "climatic water deficit", which can be calculated as the difference between potential and actual evapo-transpiration, or "excess evaporative capacity," turns out to be a strong indicator of potential vegetation cover. A simple way to summarize climatic water deficit is as the "drought stress" experienced by plants. What this modeling is showing is that climatic water deficit may increase more rapidly over time than air temperatures, and that for a range of rainfall scenarios, climatic water deficit is projected to increase over time for the end of the growing season (Micheli et al 2012).

Maps 2 and 3 display the elevation distributions and climatic water deficit distributions for candidate preserves. The average climatic water deficit per preserve is approximately 700 mm/y over this historic period. Using a climate scenario based on "business as usual" emissions (the GFDL A2 scenario), the average projected increase in preserve water deficit is 155 mm/y, or approximately a 23% increase projected by the end of the century. The implications of this is that to maintain the same vegetation cover, affected plants may need 23% more water than will be available. This means that land cover on conservation lands may be prone to transition to more xeric (drought-tolerant) vegetation types or to higher fire frequencies.

Figure 4 displays the range of climatic water deficit values (one standard deviation) associated with different vegetation communities defined by the Biodiversity Action

Plan. As might be anticipated, the lowest water deficits occur in areas mapped as salt marsh, coastal, and water features. The highest water deficits are associated with oak woodlands and chapparal/serpentine habitats. The lower panel of Figure 4 compares projected water deficits in current habitat zones, and in all cases the future climate is projected to shift all habitats into a drier regime, significantly drier relative to historic conditions. The purpose of coupling our climatic indicators, which would include soil moisture, with biotic measures is to assess whether the climate change "hypothesis" projected by this scenario is valid and what might be the biological response. All data created by this project, including historical survey results, can be found at http://sfcommons.org/NBCAI_MonitoringPlan.

8. Integration with regional planning and monitoring efforts

An important part of our approach is to avoid "reinventing the wheel" wherever possible in terms of monitoring plan development. The science working group has benefited from expert presentations on the part of the National Park Service (which established a "Vital Signs" project for its Northern California holdings) and the California Department of Fish and Game (which has been developing multi-species monitoring programs in Southern California for endangered species habitat management purposes). Below is a list of regional efforts that we plan to "dovetail" with wherever possible. Part of our next steps will be to further evaluate these in detail to identify potential indicators for inclusion.

- North Bay Watershed Association Indicators: this report defines water supply, quality and riparian and fisheries indicators (NBWA 2010a).

- Bayland Goals and San Francisco Bay Joint Venture Monitoring and Evaluation Plan: this team is working on coastal, esturarine, riparian, and freshwater wetlands indicators, including climate change/sea level rise indicators.

- Bay Area Ecosystem Climate Change Consortium (BAECCC): hosts a working group considering how to integrate climate-ecosystem monitoring across 9 bay area counties.

- NOAA Hydro-Meteorological Testbed (HMT) for the Russian River: in partnership with the Sonoma County Water Agency, NOAA is looking for opportunities to increase the density of weather stations in the Russian River basin.

- Conservation Lands Network/SF Bay Area Upland Habitat Goals: set habitat conservation targets for County, and also convened experts to identify target species for conservation (birds, mammals, and amphibian reptiles). We recommend using these species lists as a starting point for Sonoma County indicators.

- Point Blue Conservation Science long-term bird monitoring via CA Partners in Flight and the Environmental Change Network for the CA Landscape Conservation Cooperative. These efforts include both extension historic bird monitoring results using established protocols and the development of a statewide indicator-based monitoring network.

- The Gulf of the Farallones National Marine Sanctuary Advisory Council convened a working group that released a set of ocean and coastal indicators of climate change in 2013 (Duncan et al 2013).

- The Santa Rosa Junior College with Pepperwood have proposed to NSF a network of three stations in Sonoma County (Pepperwood, Shone Farm, and Fairfield Osborne Preserve) where student interns will help implement weather station and plant phenology measurements.

The science working group has scoped these efforts and determined that with the extensive work being done by other entities on coastal, estuarine and wetland indicators, it would be best to adopt these indicators as they emerge for Sonoma County rather than starting a parallel effort for those resources. It appears the demand for more original work lies within the area of upland/terrestrial monitoring frameworks to be developed by our grassland, chapparal, woodland and forest teams.

9. Climate monitoring considerations and preliminary recommendations

We developed a set of recommendations for sensors and other equipment as a first step in designing platforms and protocols that can be used throughout the study area. A summary of proposed general climate-ecosystem indicators is provided in Table 1. The goal is to install sensor systems on a subset of selected reserves spaced according to an approximately 10-20 km grid across the County that captures the diversity of microclimates and potential range of climate stress over time.

Sensors

This effort will define a common set of sensors to facilitate comparisons between sites and minimize installation and maintenance efforts. It is also desirable to have a scalable design that allows for both single, stand-alone stations as well as multi-station networked systems. Finally, cost is always a factor in finding the best solutions. Coupling biotic responses to climate changes requires sensors to monitor the factors most important to the biosphere. To date, critical climatic indicators identified include:

o solar radiation
o rain
o soil moisture
o soil temperature
o air temperature
o humidity
o wind speed and direction

It is possible to have stations with a partial set, but a complete sensor suite provides the most information. There are many suppliers of these sensors. As a next step we will finalize sensor recommendations and packages capable of capturing high quality data in partnership with NOAA, SCWA and other experts.

Data

Data storage and processing is required in addition to the proper sensors. Data can be stored on-site with the sensors or off-site through a communication link. On-site data-loggers can support both stand-alone systems as well as expandable networked systems. Companies like Campbell Scientific and Onset Computers provide a range of data-logger solutions at different price points.

It will be a critical next step to define how multiple sensor data flows can be compiled into one knowledgebase. Presently NOAA hosts upload systems that could be used for long term archiving and integration of weather data with other stations in the region. However, the *Vital Signs* team will need to address how to integrate the biological data streams with the a-biotic databases. Our current strategy for creating a common system for aggregation, analysis and access for multiple agency use is to follow the draft design of the California Landscape Conservancy Cooperative (CA LCC) Environmental Change Network (ECN). A description of the ECN can be accessed at http://data.prbo.org/apps/ecn/.

10. Key cross-ecosystem measurement strategies

We anticipate that final selection of protocols will be accomplished within work groups dedicated to individual BAP habitat types. However in discussions with the working group, the following considerations are likely to apply across habitat types.

- Long-term plots will need to be established that are consistent across preserves.
- Vegetation monitoring: one system will be needed for grasslands while a different system will need to be applied to communities dominated by woody species (chaparral through woodland and forest).
- Maximize utility of remote sensing, especially for tracking changes in land cover over time, maximizing the opportunity to utilize the updated County vegetation map and LIDaR datasets under development by the Sonoma County Agricultural Protection and Open Space District, ideally integrating remote sensing with field surveys.
- Capture key processes of primary productivity and reproductive success
- Capture plant and wildlife phenology, a sensitive indicator of climate change, using vetted protocols developed by the California Phenology Project.
- The Wildlife Picture Index pilot currently underway at Pepperwood and Mayacamas-Modini reserves offers a model for a cross-ecosystem strategy capable of capturing quantitative wildlife occupancy indicators.

- Consider emerging technologies that allow quantification of wildlife occupancy to extent feasible: test utility of the Wildlife Picture Index, bat boxes, and similar technologies.
- Maximize contributions of citizen scientists, consider tools such as the iNaturalist.org framework.
- Identify species sensitive to drivers and threats.

11. Ecosystem-specific indicator species selection

Appendix 1 is comprised of ecosystem-specific indicator development sheets that were developed by ecosystem working groups convened under NBCAI's science working group. These sheets inventory critical species and processes critical to ecosystem health. Moving forward we will be working to better define relationships between species, to define working hypotheses regarding controls on ecosystem health, to refine potential indicators using published materials, and to identify of a subset of indicator species for inclusion in monitoring pilots.

12. Action Plan/Next Steps

In 2013 NBCAI developed the first funding proposal for implementation of the *Vital Signs* project. This National Science Foundation proposal focused on the two aspects that the Science working group felt were the most implementation-ready: monitoring weather and plant phenology using national protocols developed by NOAA (for weather) and the National Phenology Network (for plant phenology). NBCAI partnered with the Santa Rosa Junior College on this proposal to include a component of student engagement, including research internships, to staff the phenology component of the *Vital Signs* project. In partnership with SCWA three monitoring sites were selected: Pepperwood, Shone Farm, and Sonoma State University's Fairfield Osborne Preserve.

The following additional next steps have been defined based on our work together to date.

- Refining biological data collection and indicators design.
- Analyzing iNaturalist.org's Bay Area BioAtlas results for Sonoma County—evaluate species lists for candidate preserves, analyze existing biodiversity data to detect spatial trends.
- Evaluate Upland Habitat Goals candidate indicator species—define where potential indicator species are distributed relative to mapped preserves in BioAtlas.
- Secure higher resolution map products for wetlands and riparian forest, currently in development by Sonoma County Agricultural Protection and Open Space District.
- Evaluate applicability of inventoried monitoring efforts in Sonoma County to date—results and implications, protocols to adopt?

- Track SFBJV progress on coastal-estuary-riparian-wetlands—dovetail indicators as they become available.
- Reconvene ecosystem work groups to refine ecosystem conceptual linkage model, working hypotheses for testing, indicators, protocols.
- Develop implementation plans for biological indicator pilots.

Climate monitoring network/hardware recommendations

- Consult NOAA/SCWA HMT team regarding climate monitoring spatial gaps and feasibility of preserve locations helping to fill those gaps
- Consult NOAA/SCWA HMT team regarding within-preserve monitoring site considerations
- Coordinate with Point Blue Conservation Science's Environmental Change Network team on stationing considerations, and nesting of regional networks within statewide network
- Fundraising for plan and climate station hardware

Preserve network capacity-building

- Outreach to candidate preserve managers to assess access feasibility, interest in participation
- Develop solutions to shared data collection and stewardship logistical challenges; research existing networks and plug into as feasible
- Program budget and possible funding sources

NBCAI will continue to advance these next steps in phases with partnerships as opportunities arise. In 2014 NBCAI will continue to seek funding opportunities to support *Vital Signs* and will be utilizing Pepperwood as a location where we can pilot proposed techniques, evaluating protocols for implementation, the meaningfulness of the data collected, and the cost-effectiveness of the hardware, software, and staffing solutions employed.

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Tables

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Table 1 - NBCAI Vital Signs Indicators Table

Terrestrial/Upland Habitat Goals-Geographic domain

LM and DD 1/31/13

ATTRIBUTE	SENSOR or METHODS	INDICATORS or METRICS	BENCHMARK	PRIMARY DRIVERS	THREATS	HABITAT AFFECTED	Notes
WEATHER/CLIMATE						all	
Air Temperatures	weather station	degrees C, max, min, av Temp	1896-1980 PRISM records	climate	climate change	all	need to finalize recommended weather station, use NRCS SCAN setup?
Solar Radiation	weather station	kW	?	climate	climate change	all	"
Humidity	weather station	%	?	climate	climate change	all	"
Leaf Wetness	weather station	area of saturation	?	climate	climate change	all	finalize withTBC3 Pacific Coastal Fog team
Wind speed and direction	weather station	velocity, azimuth	?	climate	climate change	all	
Precipitation	weather station	Inches, 15 min intervals	1896-1980 PRISM records	climate	climate change	all	
SOILS/HYDROLOGY							
Soil moisture	soil probe	conductivity, volumetric water content	HST BCM model	climate, topo, cover	climate change	all	need to finalize recommended weather station, use NRCS SCAN setup?
Soil temperature	soil probe	degrees C, max, min, av Temp	?	climate, topo, cover	climate change	all	need to finalize recommended weather station, use NRCS SCAN setup?
Subwatershed stream flow	stream gage	discharge (vol/t), cumulative flow (vol)	Stream flow records	climate, topo, cover	climate, hydrologic degradation	streams	USGS protocols/SCWA support
LIVING RESOURCES-VEGETATION							
Phenology	field surveys	time of: bud break, bloom, senescence	CA Phenology Project	climate, topo, cover	climate, N Dep	all	CA Phenology Network (woody only), National Phenology Network, Shawn Brumbaugh wants forbs/wildlflower
Woody vegetation	field surveys, cameras	plot data: composition, cover/native cover, growth rates, vigor, seed production, sapling recruitment/survival.	Forest reference data sets	climate, topo, cover, invasives, mgt	climate, N Dep	woodland, chapp, forest	Ackerly, Thorne, NPS, ...
Grassland/forbs	field surveys	species composition/cover-line transects or plots	Grassland reference data sets	climate, topo, cover, invasives, mgt	climate, N Dep	grasslands	Numerous-Christian, Nelson, Cushman, PW
Riparian/Streams	field surveys	riparian corridor width, diversity	Riparian reference data sets				
Lichen	field surveys	diversity	CA Lichen Project	climate, topo, cover, invasives, mgt	air Q/N, S deposition, climate	woodland, chapp, forest	SoCo Lichen Indicator Methods expert Shelly Benson (cit sci protocol)
LIVING RESOURCES-INVERTEBRATES							
Butterflies (& Damselflies)	field surveys	number, diversity	Schapiro/ICE	climate, cover	habitat fragmentation	all	Contact SoCo Lepidoperist, S Weiss, Art Schapiro, UC Davis
Ants	field surveys	number, diversity	Schapiro/ICE	climate, cover	habitat fragmentation	all	CalAcad new ento?
Ground dwelling beetles	field surveys	number, diversity	Schapiro/ICE	climate, cover	habitat fragmentation	all	?protocols, parallell to UK?, difficulty in ID
LIVING RESOURCES-VERTEBRATE							
Wildlife Photo Index	cameras	biodiversity metric, occupancy by species	range maps	climate, topo, cover	habitat fragmentation	all	WCS protocol, PW Pilot, S Townsend
Birds	field surveys	# species, # of individuals, reproductive success	PRBO CADC-time period	climate, topo, cover	habitat fragmentation, climate	all	PRBO defines protocol-breeeding bird surveys? Vs area counts?
Fish	screw traps	salmonid smolt production	SCWA Fish counts	climate, topo, cover	hydrologic degradation	coastal, rip/strms	
Bats	sonar boxes	bat boxes, number of fly-bys	range maps	climate, topo, cover	habitat fragmentation, climate	all	
Amphibians	field surveys	# species, # of individuals, reproductive success	range maps	climate, topo, cover	habitat fragmentation, climate	upland	
DISTURBANCE PROCESSES							
Floods	stream gage	flood magnitude, frequency/return interval	USGS Gage records	climate change	climate change, land use	riparian/strms	
Droughts	weather stations, stream gage	climatic water deficit	USGS, NWS records	climate change	climate change, land use	all	
Fire	fire surveys	fire intensity, frequency/return interval, geographic extent,	CalFire records	climate change	climate change, land use	upland	
Biotic invasions	field surveys, remote sensing	plants and animals, multi	BAEDN records	invasives, mgt	climate change, land use	all	BAEDN, CalFlora, National Invasive Species Council, CalIPC
"UPLAND" HABITATS-may require habitat specific indicators in addition to the above							
Vegetation Community Distribution (of categories below)	vegetation mapping	track landscape change/change in distribution over time via episodic vegetation maps (remote sources, 5-10 yr recurrence),	Upland Habitat Goals vegetation map, historical ecology				
Food webs? (basis of conceptual models for each hab type)							Thorne
Grasslands/savannah							
Oak/Hardwood Woodlands							
Conifer forest							
Chapparral							
Riparian/instream							
Serpentine							
Freshwater/brackish marsh							
Coastal scrub/dune							
Agriculture							

FIGURES

Figure 1. Adaptive management framework (Conservation Measures Partnership 2011)

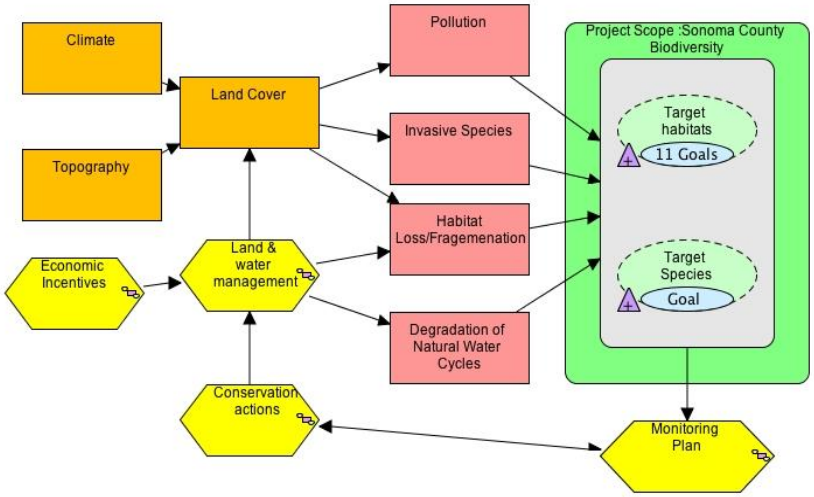


Figure 2. Relation of Biodiversity Action Plan natural drivers, threats, and conservation actions to monitoring targets

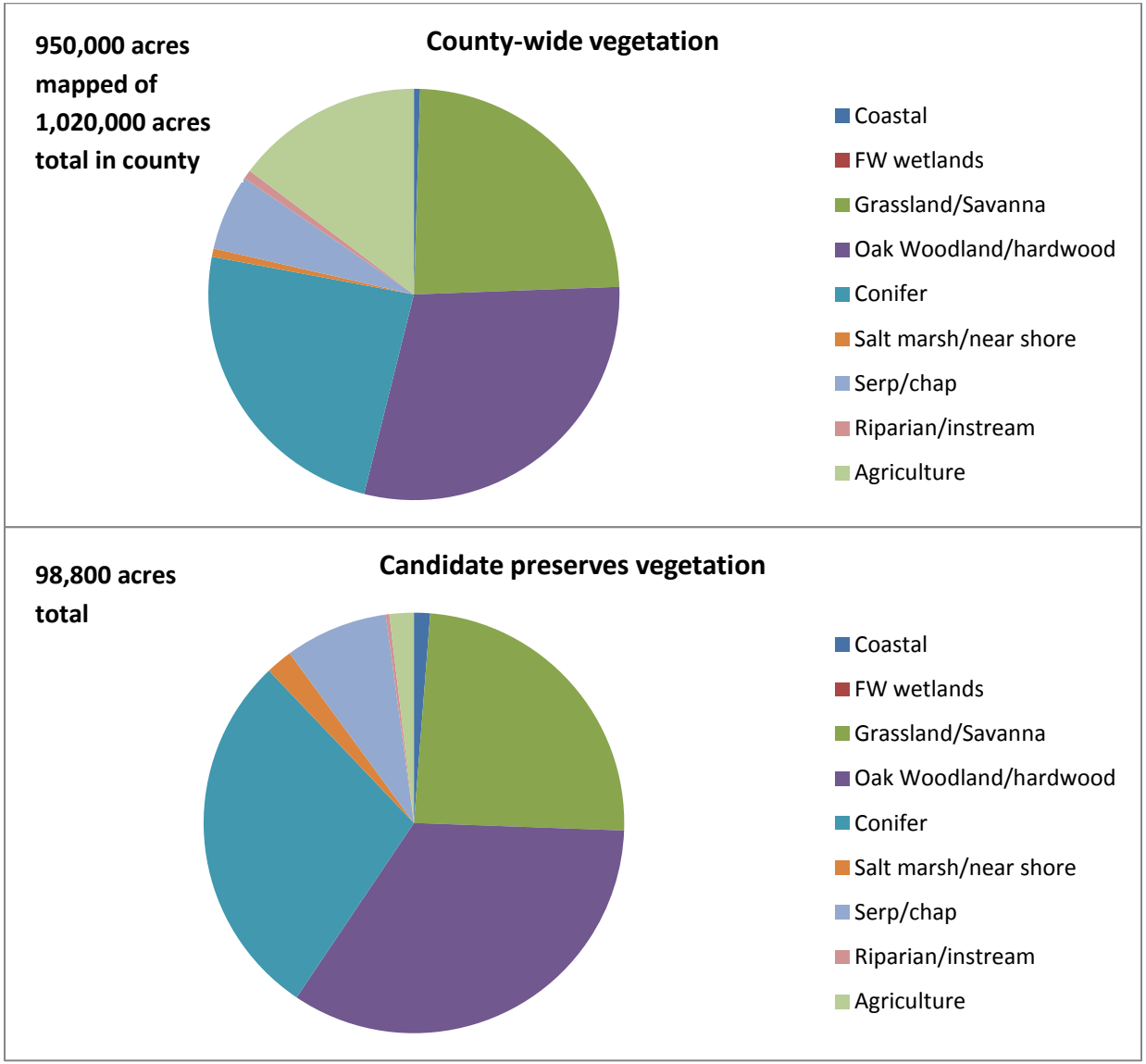
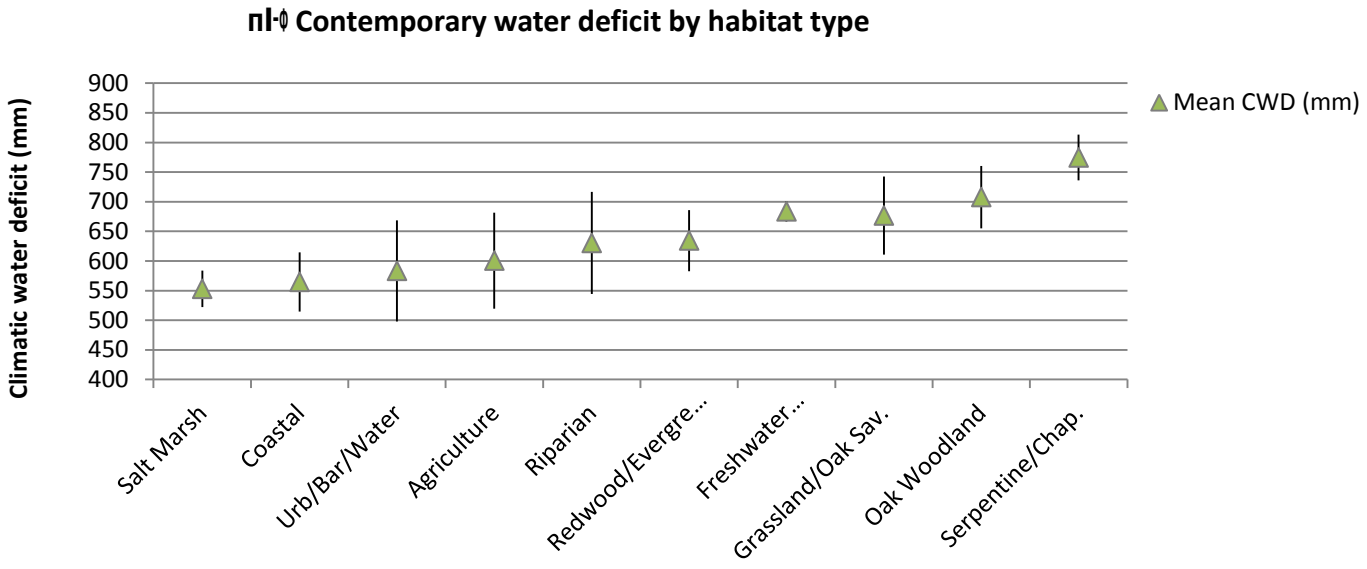
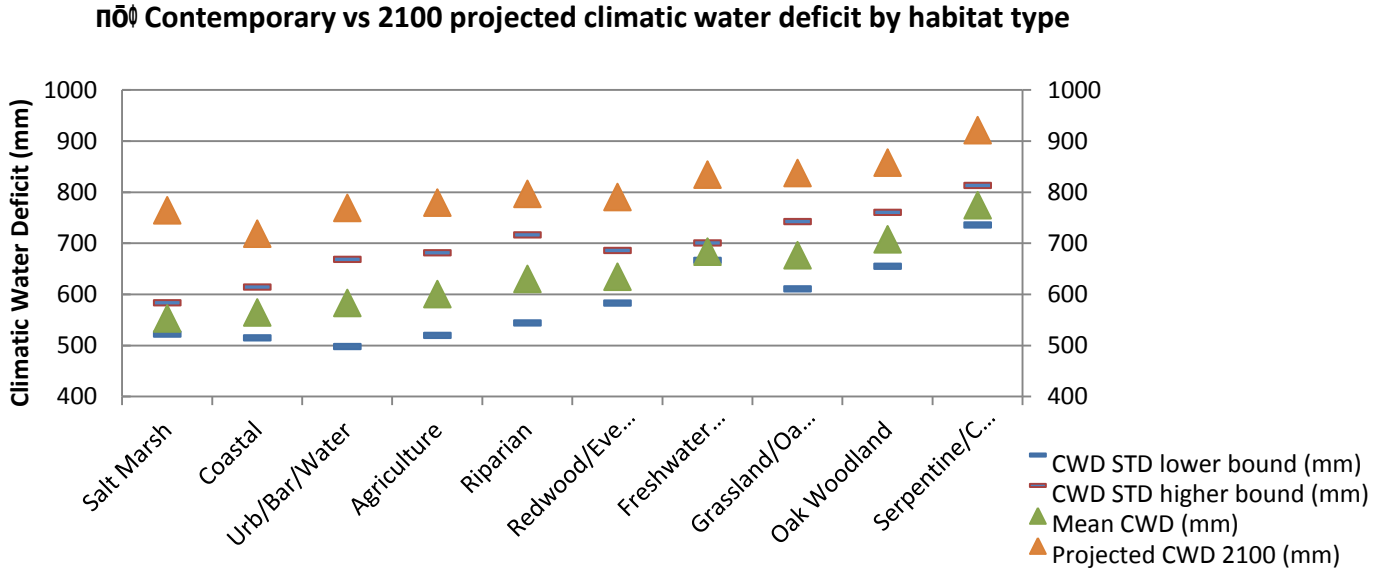


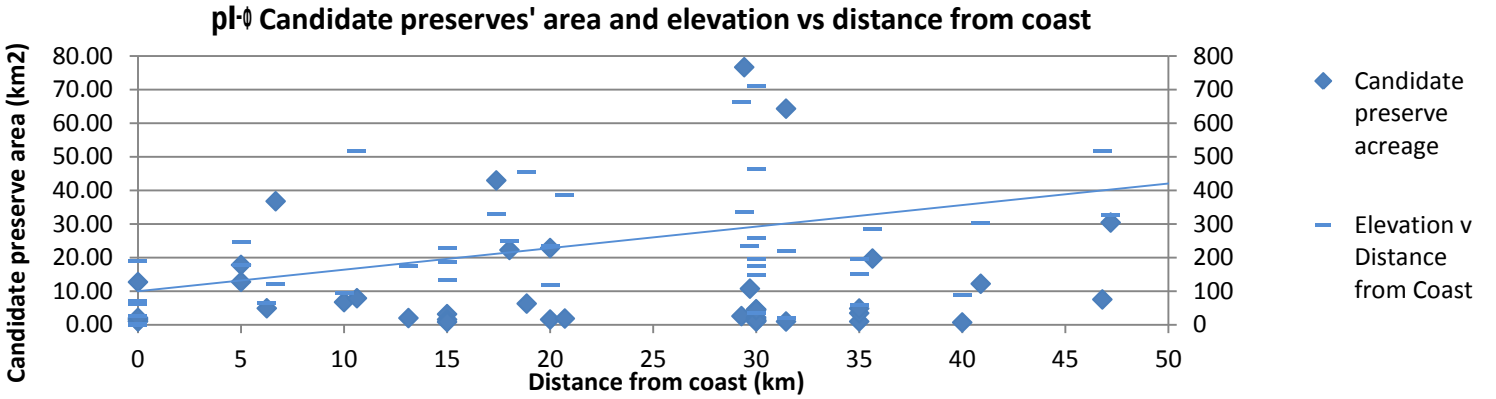
Figure 3. Vegetation cover for Sonoma County and candidate preserves using BAP habitat categories

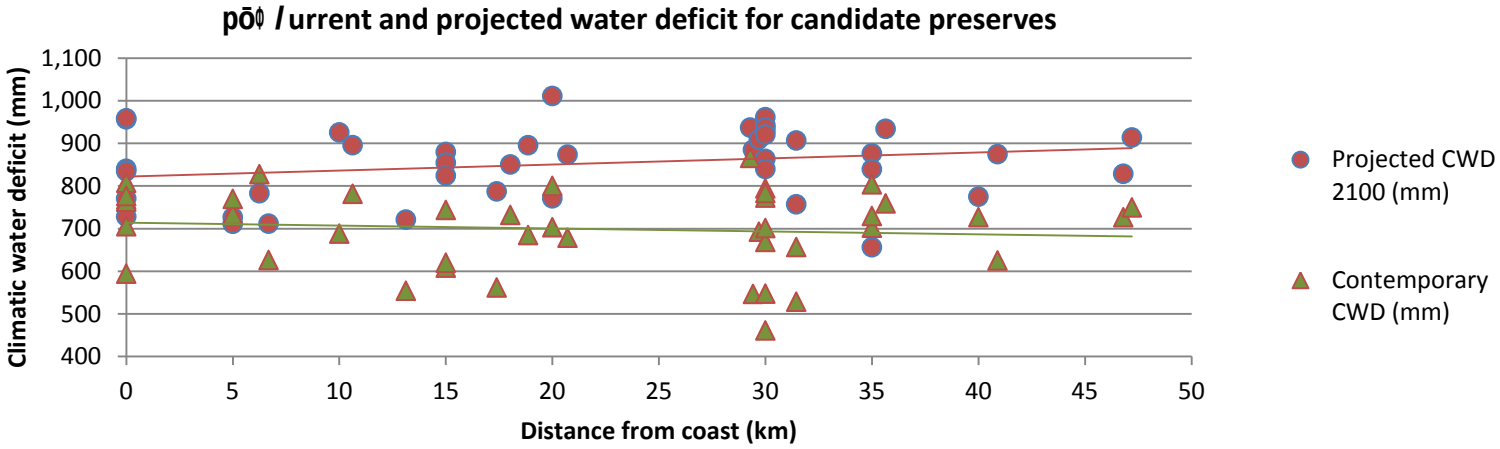
Figures 4a and 4b. Current and projected water deficit per habitat type



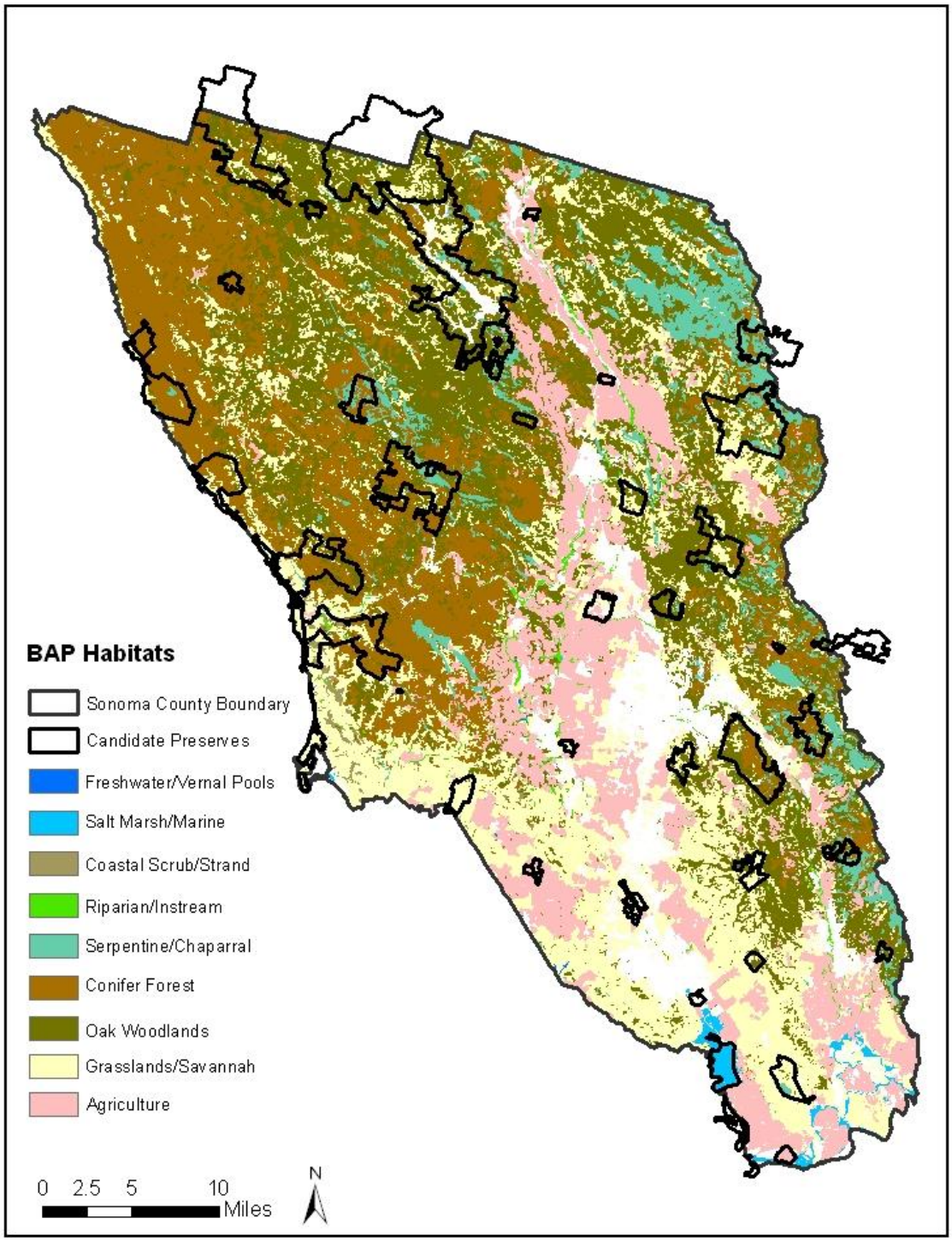


Figures 5a and 5b. Candidate preserves' area , elevation, current and projected climatic water deficit distributions

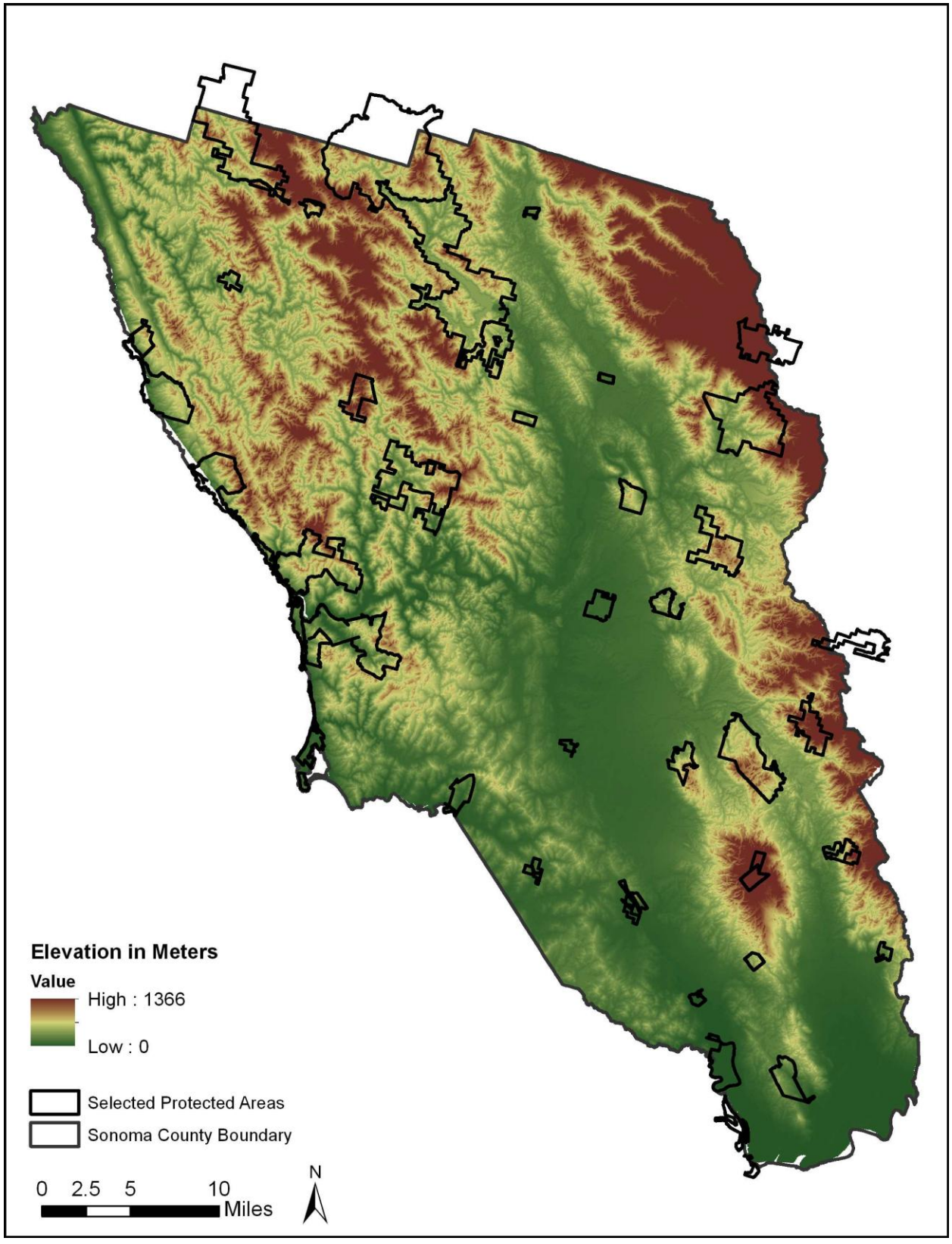




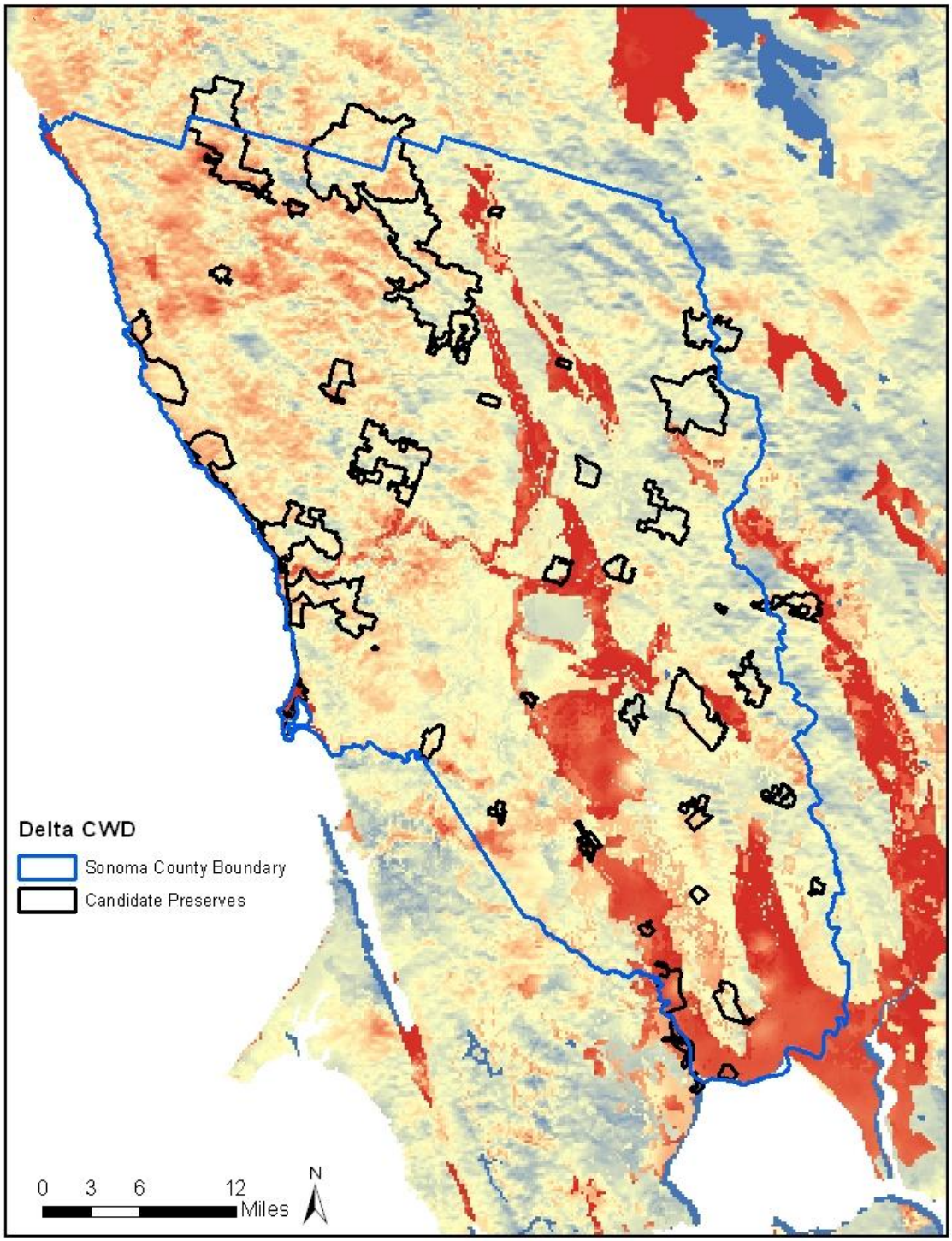
Map 1. Sonoma County displaying Biodiversity Action Plan habitat type distributions and candidate preserve boundaries



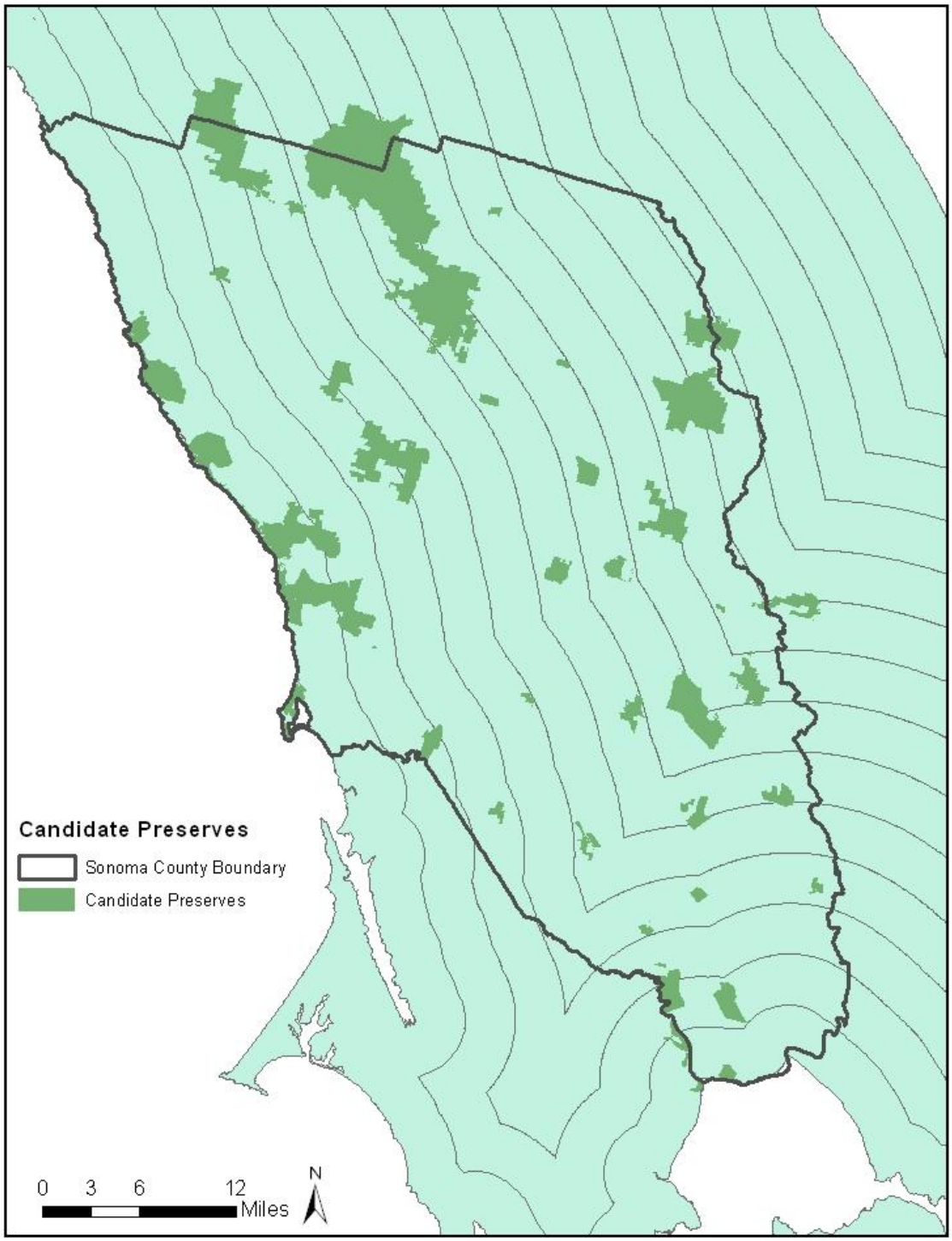
Map 2. Sonoma County displaying elevation distributions and candidate preserve boundaries



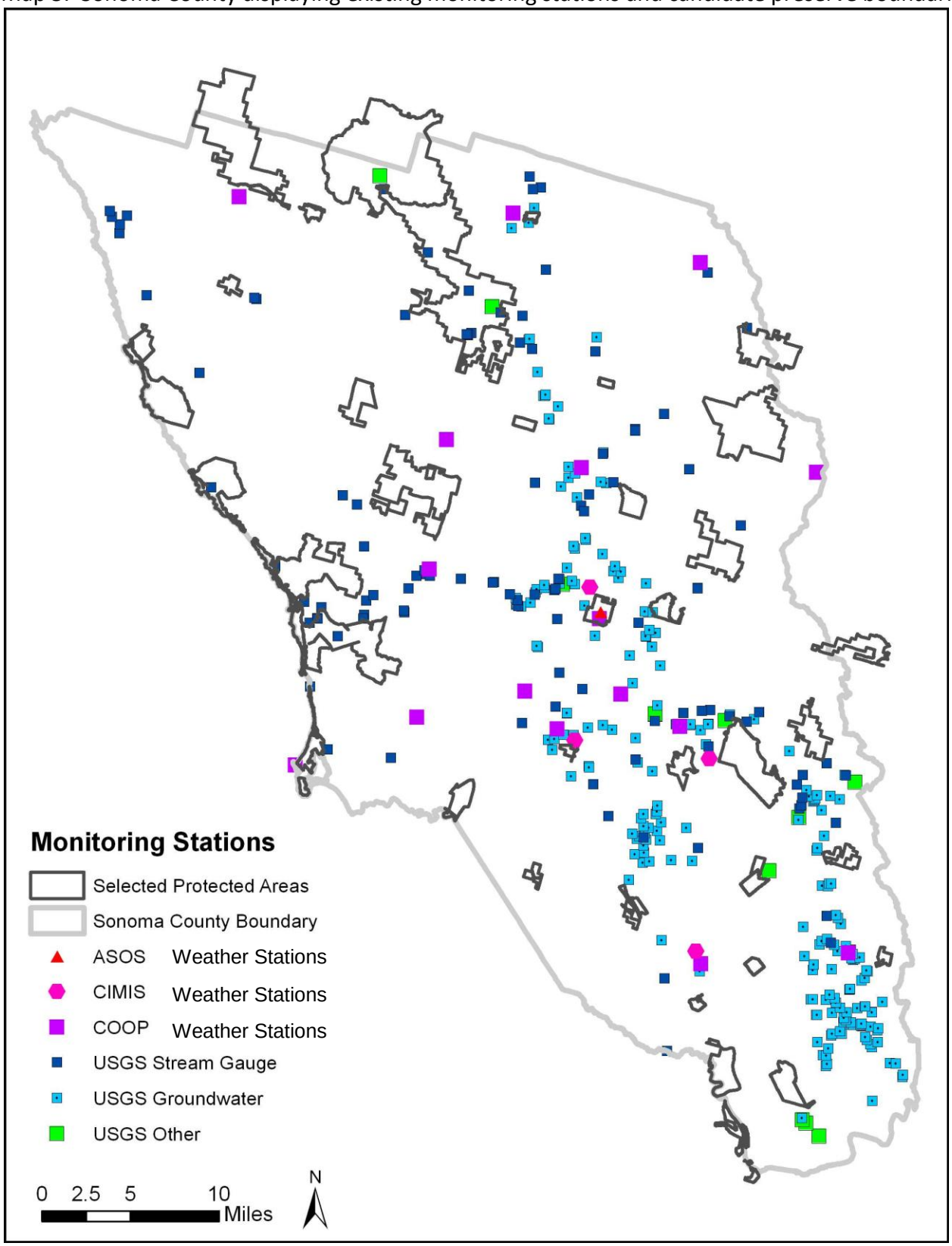
Map 3. Sonoma County displaying potential change in climatic water deficit (an indicator of future climate stress, comparing 1971-2000 to 2071-2100) and candidate preserve boundaries



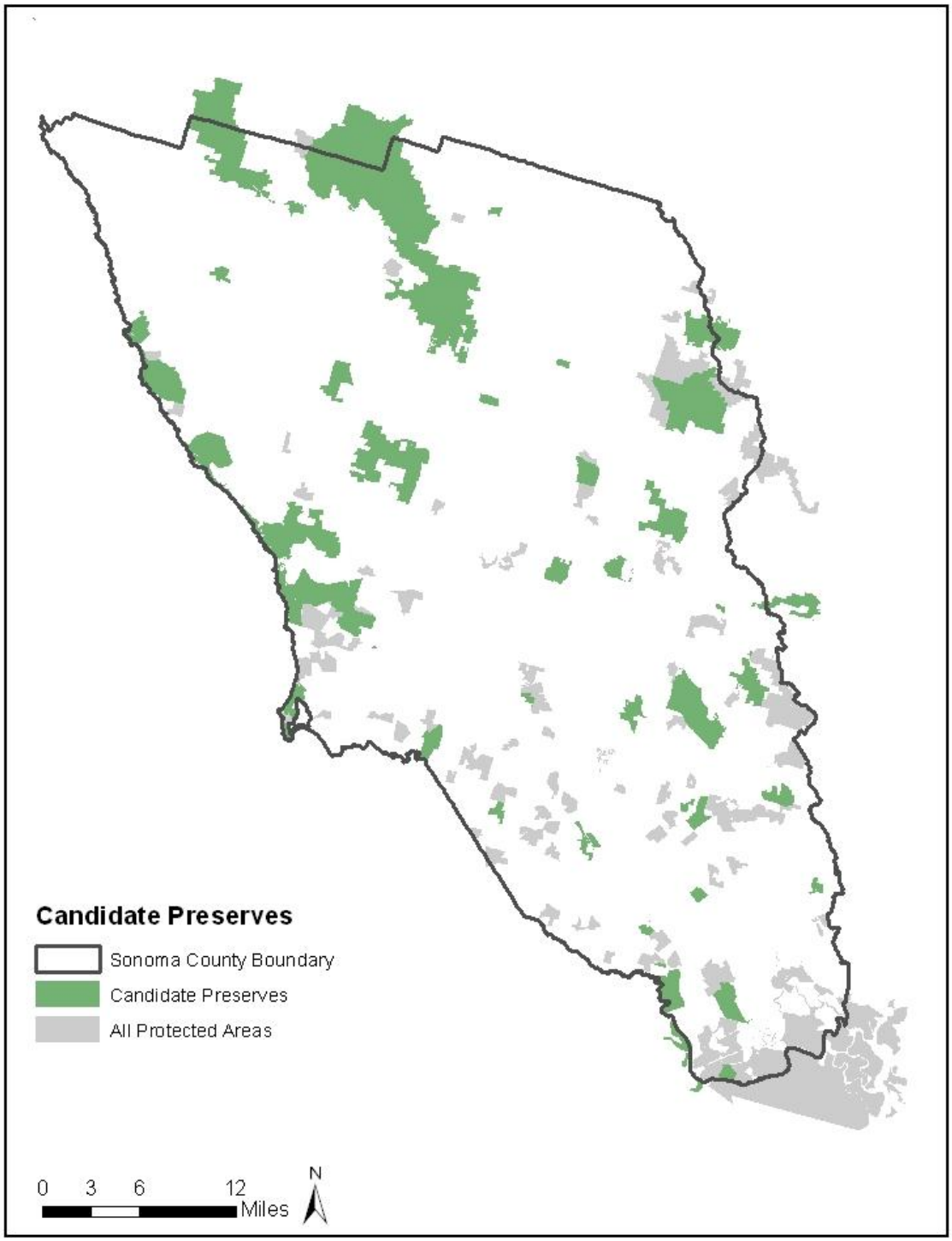
Map 4. Sonoma County displaying candidate preserve boundaries relative to distance to coast or bay (5 km contours)



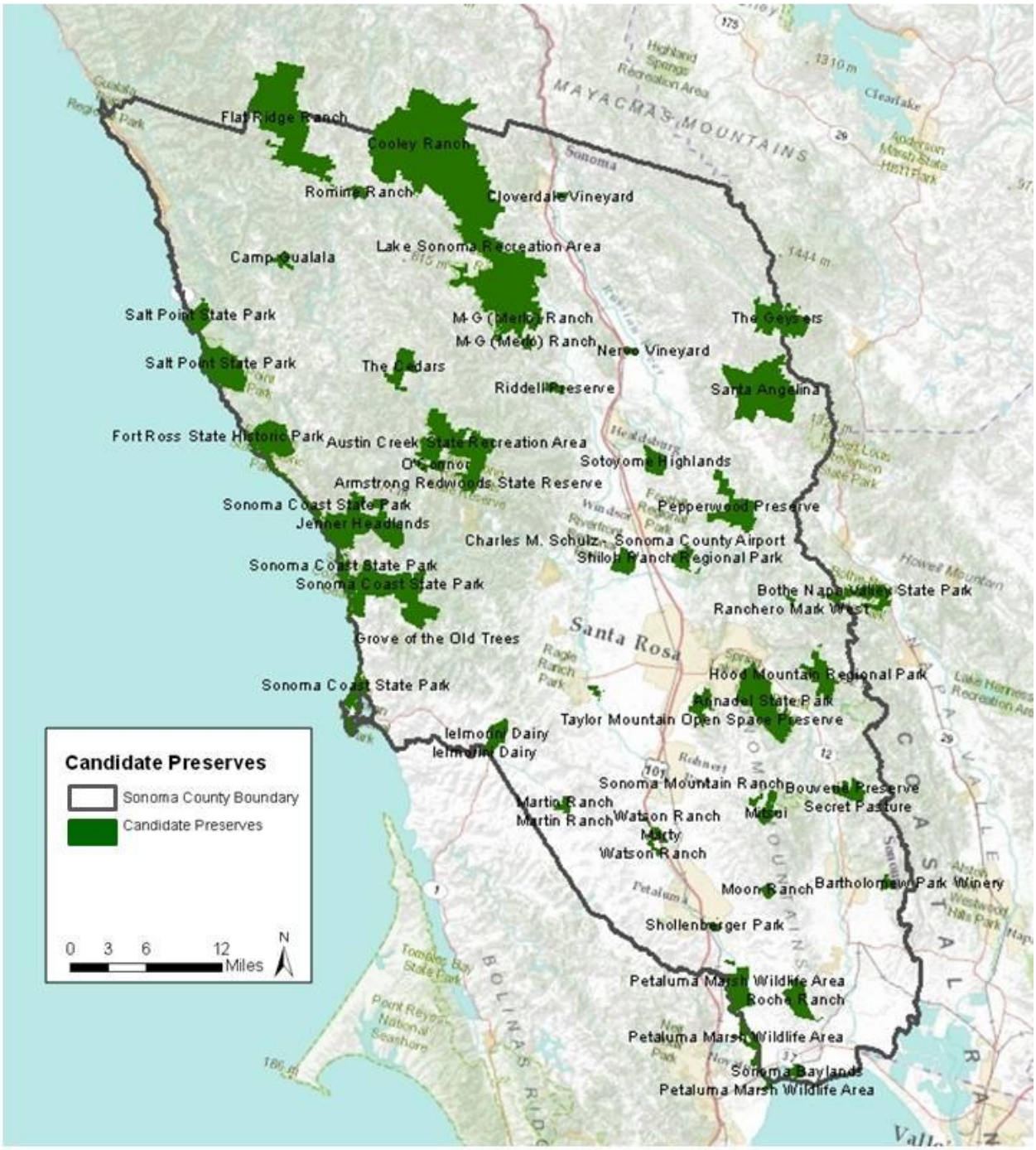
Map 5. Sonoma County displaying existing monitoring stations and candidate preserve boundaries



Map 6. Sonoma County displaying candidate preserves and full set of protected areas greater than 200 acres in area



Map 7. Sonoma County displaying candidate preserves with labels



Appendix 1. Ecosystem-specific indicator worksheets

A. Habitat Type: Tidal Marsh

NBCAI Sonoma County Monitoring Plan- Indicator Development Worksheet
Participants: Christina Sloop, Suzanne Olyarnik, Karen Taylor, Julian Meisler

1. Species Information

Note: other groups focused on plant functional groups rather than specific species. Their decision to go this way was based largely on the idea that 1) changes in functional group composition would be a good indicator of overall changes in ecosystem processes, and that 2) it is more practical/easier to monitor on a large scale with volunteers. Not sure if this would apply with tidal marsh plants.

VASCULAR PLANTS:
Grass – Native
Grass – Perennial / Non-native
Grass – Annual / Non-native

Forb – Annual / Native
Forb – Annual / Non-native
Forb – Perennial / Native
Forb – Perennial / Non-native

Woody – Native
Woody – Non-native

NON-VASCULAR PLANTS:
None

PROTISTS & FUNGI:
Mycorrhizae (very important, difficult to monitor)

VERTEBRATES:

- Birds- clapper rails, black rails; burrowing owls possible special concern-also see *PRBO bird list*
- Mammals- salt-marsh harvest mouse.

INVERTEBRATES:

- Insects – aquatic
- Insects – herbivores (?)

Tidal Marsh, cont'd

2. Habitat Disturbances, rated as high (H), moderate (M) or low (L) with comment
Rather than indicate whether specific disturbances had +/- impacts, we opted instead to indicate whether each disturbance type had high, moderate or low importance.

Disturbance Type	Importance	Comments
Grazing/herbivory	L	
Animal movement/ trampling	L	
Pollution	H	Methylmercury, selenium
Soil loss/degradation	L	Sea level rise
Disease/pathogens	M	West Nile virus (???)
Weather variation	H	Extreme storm events
Fire	L	
Flood	H	
Storms	H	
Drought	M	Effects on upper marsh?
Frost	L?	
Fog	L?	
Earthquake/slides	L	
Sedimentation	H	
Invasive species	H	Non-native Spartina, Pepperweed
Dams	L	
Human disturbance	H	agriculture; recreation
Other -		

3. List and evaluate important biotic interactions

Interaction	Species/Functional Grp	Cont.	Seasonal	Comments
Predation	Raptor/Fox -birds/mice	X	X	Mainly @ high tides
Competition	All plant funct. groups	X		
Pollination	?		X	
Herbivory	?	X		

4. Connectivity Linkages
High marsh to low marsh ecotone is important

Tidal Marsh, cont'd

5. Important Energy Transfer Processes:

Here, we had difficulty fitting the linkages with the provided categories. Instead we've listed how changes in plant functional groups (due to climate change, grazing pressures, agricultural pressures, etc would likely affect the following ecosystem attributes.

- Productivity (total, above-ground, below-ground)
- Standing biomass (total, above-ground, below-ground)
- Rooting depth
- Above-ground cover
- Litter accumulation

Important Processes

- Flood protection
- Sediment accretion
- Primary productivity
- Evapotranspiration
- Carbon uptake and storage

B. Habitat Type: Riparian Forest and Wetlands

NBCAI Sonoma County Monitoring Plan - Indicator Development Worksheet

1. For this habitat type in Sonoma County, please list the following species information
Subtypes: Perennial, Ephemeral

VASCULAR PLANT SPECIES

	Characteristic (defines subcategory)	Dominant	Wide-ranging	'keystone' 'engineer' (ecological function)	Invasive Non-native	Endemic	Special status
Red alder	X						
White Alder			X				
Redwood							
Willow	X		X				
Carex							
Oregon ash							
Buckeye							
Himalayan blackberry							
Vinca							
Giant reed							
Polygonum species							

Maples							*Riparian, cont'd*
Elder							
Black Walnut**							X
Spicebush							
Snowberry*							
Cottonwood **							
CA Bay**							

Overstory: **
Understory: *

NON_VASCULAR PLANTS

	Characteristic (defines subcategory for analysis)	Dominant	Wide-ranging	'keystone' 'engineer' (ecological function)	Invasive Non-native	Endemic	Special status
Bryophytes							

PROTISTS & FUNGI

	Characteristic (defines subcategory for analysis)	Dominant	Wide-ranging	'keystone' 'engineer' (ecological function)	Invasive Non-native	Endemic	Special status
Algae							
Lichens							
Fungi							

VERTEBRATES

	Characteristic (defines subcategory)	Dominant	Wide-ranging	'keystone' 'engineer' (ecological function)	Invasive Non-native	Endemic	Special status
Birds – *see PRBO bird list*							

Amphibians							*Riparian, cont'd*
Pacific Chorus frogs							
Red-bellied newt							
Reptiles							
Western Pond turtle							
Fish							
Steelhead							
Coho							
Western roach							
Mammals							
Racoons							

INVERTEBRATES

	Characteristic (defines subcategory for analysis)	Dominant	Wide-ranging	'keystone' 'engineer' (ecological function)	Invasive Non-native	Endemic	Special status
Terrestrial							
Willow-specific insects							
Aquatic							
Crayfish							
CA freshwater shrimp							
macroinverts (get key ones)							

2. Please evaluate the types of Habitat Disturbances characterizing and challenging the function of this habitat type in maintaining species diversity in Sonoma County. Please rate the importance, benefit and threat level of the disturbance on a scale from low to high in each category (i.e. a grassland grazing level of M is important and beneficial, but it can be harmful at levels H or L). Indicate n/a if the disturbance is not applicable to the habitat type (see table next page)

Disturbance Type	Important (H,M, L)	Beneficial Ecosystem Process (H,M, L)	Harmful Threat (H,M, L)	Comments
Grazing/herbivory	L			Beneficial to birds in some cases at 1-2 ?
Animal movement/trampling	Yes			
Pollution (i.e. nutrients, soot)	Yes			
Soil loss or degradation	Yes			
Disease/Pathogens	L			
Weather variation & Extreme events	Yes			Timing of rainfall, flows
Fire	L			
Flood	Yes			
Storms	L			
Drought	Yes			
Frost	L			
Fog	L			
Earthquake/ Landslides	n/a			
Sedimentation	Yes			
Invasive Species	H			
Dams	H			
Human disturbance	H			Veg removal for flood capacity, Pierce's disease, bank stab, groundwater withdrawals, changes in streamflow - hydrograph
Other:				

3. Please list and evaluate the important Biotic Interactions in this habitat type to maintaining biodiversity in Sonoma County. Please list dominant species or functional groups that interact in the following categories and indicate the frequency/intensity of the interaction. Also, please comment on how this interaction benefits biodiversity (see table next page).

Biotic Interactions

Interaction Type (i.e. dispersal, pollination, competition, parasitism,…)	Interacting Species or Functional Group	Continuous/ Permanent Interaction	Seasonal Interaction (indicate season)	Comments
Light competition	Overstory & understory	X	X if deciduous	
Recruitment processes	dispersal			
Parasitism (nest)	Song birds & galling insects		X	
Predation (nest)	Song birds & raptors, mammals, snakes???		X	
Allochthonous	Overstory species to stream system	X		
Competition	Natives vs non-natives			
Herbvory	Rodents			
Spatial competition	Ie frogs (sites to lay eggs), turtles (basking sites)			
Large woody debris	colonizers			
Competition for water				
Landscape level – with upland				

4. Please evaluate the important Connectivity Linkages provided by this habitat type important to maintaining biodiversity in Sonoma County. Please list species or functional groups that benefit from the linkage and check main reason(s) for linkage function (*What are the aspects of the habitat (ecosystem) that provide linkage & what does group of organisms need to stay connected? We are defining this as elements within habitat elements that need to be maintained for organism connections. Distinguish linkages within habitat vs. between habitats. For within habitat key features for organisms may be size/width of habitat zone and the longitudinal continuity of habitat. Add what breaks connectivity. Also, look at sensitivity of species to lack of connectivit*y)

Riparian, cont'd

Use broader groups in matrix to inform the process of deciding on specific indicator candidates as we 'put it all together in the conceptual model' - habitat specific important parameters

Species or Functional Group Requiring Linkage	**Linkage Description (i.e. road crossing, riparian/ hedgerow corridor…) What creates connectivity**	**Corridor function**	**Need for movement (i.e. Reproduction / Gene flow, foraging,…)**	**Rate or Scale (I.e. permanent, seasonal rate or landscape, habitat, micro scale)**
Large mammals i.e. Mountain lion, Coyote	Riparian vegetation	cover connectivity	Reproduction/gene flow, foraging	Permanent, landscape
Salmonids	stream	flow connectivity Shade canopy/water temperature	Reproduction/gene flow, foraging	Seasonal, habitat & landscape scale
Birds	Riparian vegetation	cover connectivity	Reproduction/gene flow, foraging	Permanent & seasonal depending on species
Raccoon	Riparian vegetation	Cross-habitat connectivity Shade, food	foraging	habitat
Amphibians	Shore vegetation	Aquatic to riparian	foraging	
Western pond turtles	Riparian vegetation	Riparian to upland	reproduction	Seasonal, landscape

Riparian, cont'd

5. Please evaluate the important Energy Transfer Processes in this habitat type important to maintaining biodiversity in Sonoma County. Please list dominant species or functional groups that provide/are involved in the process. Also, please list potential threats that could impact this process in the habitat type and affect biodiversity. Make this physical factors only.

Energy Transfer Process	Species or Functional Groups	Threats	Impacts
Nutrient Cycling			
Photosynthesis			
Biotic transfer (herbivory, carnivory…)			
Decomposition			
Water Cycling/Watershed function			
Precipitation			
Natural flow/flood patterns			
Water Quality			
Storage			
Evapotranspiration			
Groundwater recharge	Important function		

Key question: how and when does water move through the habitat? And how much? Seasonal fluctuations in water levels, low to none in summer/fall and medium to high in winter/spring

C. Habitat Type: Grasslands

NBCAI Sonoma County Monitoring Plan- Indicator Development Worksheet
Participants: Shawn Brumbaugh, Tony Nelson, Steve Barnhart

1. Species Information

We decided that we would focus on plant functional groups rather than specific species. Our decision to go this way was based largely on the idea that 1) changes in functional group composition would be a good indicator of overall changes in ecosystem processes, and that 2) it is more practical/easier to monitor on a large scale with volunteers.

VASCULAR PLANTS:
Grass – Native
Grass – Perennial / Non-native Grass – Annual / Non-native

Grasslands, cont'd

Forb – Annual / Native
Forb – Annual / Non-native
Forb – Perennial / Native
Forb – Perennial / Non-native

Woody – Native
Woody – Non-native

NON-VASCULAR PLANTS:None

PROTISTS & FUNGI:
Mycorrhizae (very important, difficult to monitor)

VERTEBRATES:

- Birds- consult with PRBO (*see attached PRBO list*); burrowing owls possible special concern
- Mammals- pigs, gophers, rodents spp., rabbits, badgers.

INVERTEBRATES:

- Insects – pollinators (with focus on bees and butterflies)
- Insects - herbivores

2. Habitat Disturbances, rated as high (H), moderate (M) or low (L) with comment
Rather than indicate whether specific distubances had +/- impacts, we opted instead to indicate whether each disturbance type had high, moderate or low importance.

Disturbance Type	**Importance**	**Comments**
Grazing/herbivory	H	
Animal movement/ trampling	L	pig tilling, grazing compaction
Pollution	M	Nitrogen addition
Soil loss/degradation *Grasslands, cont'd*	L	possible slumping
Disease/pathogens	L	
Weather variation	L	
Fire	H	
Flood	L	
Storms	L	
Drought	H	
Frost	L	
Fog	L	
Earthquake/slides	L	
Sedimentation	L	

Invasive species	H	*Grasslands, cont'd*
Dams	L	
Human disturbance	H	agriculture; recreation
Other – soil digging	H	Pig tilling, small mammal burrowing

3. List and evaluate important biotic interactions

Interaction	Species/Functional Grp	Cont.	Seasonal	Comments
Competition	All plant funct. groups	X		
Pollination	Forbs – insects Woody plants - insects		X	
Herbivory	Grazers – all plant funct. groups	X		Would also be good to include root herbivores, but more difficult to monitor.
Predation	Raptor-rodents/rabbits Coyote/Fox-rodents/rabbits	X		

4. Connectivity Linkages

We had difficulty/questions with this one, so we decided to leave it for another time.

5. Important Energy Transfer Processes:

Here, we had difficulty fitting the linkages with the provided categories. Instead we've listed how changes in plant functional groups (due to climate change, grazing pressures, agricultural pressures,… would likely affect the following ecosystem attributes.

- Productivity (total, aboveground, belowground)
- Standing biomass (total, aboveground, belowground)
- Rooting depth
- Aboveground cover
- Litter accumulation
- Phenology (growing season peak and duration)

T*hese factors would likely affect…*

- Groundwater recharge
- Water storage
- Water quality (associated with topsoil erosion)
- Evapotranspiration
- Carbon uptake and storage

D. Habitat Type: Live Oak Woodland (Coast Live Oak Alliance- CNPS)
NBCAI Sonoma County Monitoring Plan- Indicator Development Worksheet

1. Species Information

Vascular Plant Species:
Native Trees:

- Coast Live Oak (Quercus agrifolia)
- Pacific Madrone (Arbutus menziesii)
- California Bay (Umbellularia californica)

Native Shrubs:

- Creeping snowberry (Symphorocarpus mollis)
- Poison oak (Toxicodendron diversilobum)
- Toyon (Heteromeles arbutifolia)
- Woodland manzanita (Arctostaphylos manzanita)

Non-native Shrubs:

- French broom (Genista monspessulana)

Native grasses/forbs:

- Melic grass (Melica sp)

Non-native grasses/forbs:

- Numerous annual grasses

Parasites:

- Mistletoe (Phoradendron villosum)

Non-vascular Plant Species:

- Moss cover collectively

Protists and Fungi:

- Lichen cover, particularly dominants
- Mushroom cover, include phenology, major guilds

Vertebrates:

- Birds- *see PRBO bird list attached*, "Oak Woodland Bird Conservation Plan", Turkeys
- Mammals- pigs, gray squirrel, white tail deer
- Amphibians- monitor all, particularly arboreal and slender salamanders

Invertebrates:

- Oak galls (specific for different cynipid species)
- Acorn weevils
- Tent caterpillars
- Oak moths

2. Habitat Disturbances, rated as high (H), medium (M) or low (L) with comment

Disturbance Type	Importance	Comments
Grazing/herbivory	H	all stages of oak development
Animal movement/trampling	H	pig tilling, grazing compaction
Pollution	L	
Soil loss/degradation	L	
Disease/pathogens	H	SOD
Weather variation	L	
Fire	H	
Flood	L	
Storms	L	
Drought	M	
Frost	L	
Fog	L	
Earthquake/slides	L	
Sedimentation	L	
Invasive species	H	
Dams	L	
Human disturbance	H	clearing; recreation

3. List and evaluate important biotic interactions

Interaction Type	Species/F Grp	Continuous	Seasonal	Comments
Dispersal of acorns	squirrels, jays, Woodpeckers		X	
Acorn predation	pigs, turkeys, Weevils		X	
Herbivory	deer, tent cat. oak moths	X		
Competition	annual grasses,	X		

	canopy for light	
Parasitism	mistletoe, SOD, Galls	X
Mycorrhizal fungi	mutual/parasites	X
Decomposers	litter decomposition	X

4. Connectivity Linkages- not sure here; need further explanation

5. Important Energy Transfer Processes:

1. Water Cycling- Dominant trees primarily responsible
   - Loss of tree cover primary threat
   - Increased runoff primary impact
2. Groundwater recharge- primarily controlled by tree cover
3. Carbon Sequestration- all plants; reduction of biomass- increased CO2
4. Decomposition rates of litter

E. Bird species recommended per ecosystem type

T. Gardali, PRBO Conservation Science, 10 September 2010

The following are species that should be considered for monitoring by the Sonoma County Biodiversity Monitoring project. These species lists were compiled from three sources (1) California Partners in Flight Focal Species (culled to only include those species that breed in Sonoma County), (2) special status species (state and/or federal Threatened and Endangered and California Species of Special Concern), and (3) suggestions by T. Gardali.

I advocate for multi-species bird monitoring however, including developing vegetation (e.g., riparian) or vegetation-type (e.g., early seral-riparian) aggregate indices. These indices would include species not listed below. Additionally, it did not make sense for me to list specific species for other groups of birds such as shorebirds and other waterbirds since they should just be monitored as a group.

Species-specific monitoring should only happen in special cases – e.g., Northern Spotted Owl populations are not being monitored in the county and hence this imperiled species may be slipping through the cracks.

Disclaimer: This is not a complete list of all special status species that are known to occur or have occurred in Sonoma County (e.g., species that are primarily transient or species with very few known records, etc.). I could supply that list but it would take more time and is likely not that useful for monitoring purposes.

RIPARIAN
California Partners in Flight
Black-headed Grosbeak
Common Yellowthroat
Song Sparrow
Swainson's Thrush
Tree Swallow
Warbling Vireo
Wilson's Warbler
Yellow-breasted Chat
Yellow Warbler
State and / or Federal Threatened and Endangered **-** None
CA Bird Species of Special Concern
Yellow-breasted Chat
Yellow Warbler
Tom's Additional Picks- None

OAK WOODLAND & SAVANNAH
California Partners in Flight
Acorn Woodpecker
Blue-gray Gnatcatcher
Lark Sparrow
Nuttall's Woodpecker
Oak Titmouse
Western Bluebird
Western Scrub Jay

State and / or Federal Threatened and Endangered **-** None
Tom's Additional Picks
White-breasted Nuthatch
Ash-throated Flycatcher

SERPENTINE - None

COASTAL HABITATS
California Partners in Flight **-** see lists from other habitat types; they should mostly work here as well.
State and / or Federal Threatened and Endangered **-** see lists from other habitat types; they should mostly work here as well.
Western Snowy Plover
CA Bird Species of Special Concern **-** see lists from other habitat types; they should mostly work here as well.
Suisun Song Sparrow
Tom's Additional Picks
Osprey (also occurs inland and is a good species for tying terrestrial and aquatic habitats)
Black Oystercatcher

WETLANDS
California Partners in Flight - Not covered by California Partners in Flight
State and / or Federal Threatened and Endangered
California Black Rail (tidal marsh)
California Clapper Rail (tidal marsh)
CA Bird Species of Special Concern
Tricolored Blackbird
San Francisco Common Yellowthroat
Tom's Additional Picks
Shorebirds
Waterfowl
Herons and Egrets

GRASSLANDS
California Partners in Flight
Grasshopper Sparrow
Northern Harrier
Savannah Sparrow
Western Meadowlark
White-tailed Kite
State and / or Federal Threatened and Endangered - None
CA Bird Species of Special Concern
Burrowing Owl (former breeder, still found in other seasons)
Northern Harrier
Short-eared Owl
Loggerhead Shrike (and in open oak savannahs)
Grasshopper Sparrow
Tom's Additional Picks

FORESTS (Coniferous & Mixed Evergreen)
California Partners in Flight
Brown Creeper
Black-throated Gray Warbler
Dark-eyed Junco
Golden-crowned Kinglet
Olive-sided Flycatcher
Pileated Woodpecker
Red-breasted Nuthatch
Vaux's Swift
Western Tanager
State and / or Federal Threatened and Endangered
Northern Spotted Owl
CA Bird Species of Special Concern
Vaux's Swift
Olive-sided Flycatcher
Tom's Additional Picks

CHAPARRAL
California Partners in Flight
Nuttall's White-crowned Sparrow
Mountain Quail
Rufous-crowned Sparrow
Sage Sparrow
Wrentit
State and / or Federal Threatened and Endangered - None
CA Bird Species of Special Concern - None
Tom's Additional Picks

OTHER – incomplete list of species with special status that don't fit well into any one of the habitat categories
Bald Eagle
Peregrine Falcon
Brown Pelican
Western Yellow-billed Cuckoo (extirpated)
Willow Flycatcher (transient only)
Purple Martin

For California Partners in Flight Conservation Plans:
http://www.prbo.org/calpif/plans.html

For info on how California Partners in Flight Focal species were chosen:
Chase, M., and G. R. Geupel. 2005. The use of avian focal species for conservation planning in California. Pp. 130-142 in Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference (C.J. Ralph and T. D. Rich, Eds.). General Technical Report PSW-GTR-191, USDA Forest Service, Albany, CA.

For the California Bird Species of Special Concern:
Shuford, W.D., and T. Gardali. 2008. California Bird Species of Special Concern: a ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds No. 1.

http://www.dfg.ca.gov/wildlife/nongame/ssc/birds.html

Appendix 2. Upland Habitat Goals Report Conservation Targets

Upland Habitat Goals Report Amphibian, Reptile, and Invertebrate Conservation Targets							
Common Name	**Scientific Name**	**Legal Status***	**Critical Habitat**	**Recovery Plan**	**Covered by Coarse Filter CLN?**	**Habitat**	**Notes / Management Issues**
Amphibians							
California Tiger Salamander	*Ambystoma californiense*	FT, CA SSC	YES	YES	YES	Grassland, oak savanna, and edges of mixed woodland and lower elevation coniferous forest.	CLN will cover species with local adjustments to cover ponds, see pond gap analysis description, occupancy rates (Chapter 8), and Areas for Further Consideration (Chapter 10).
Northwestern Salamander	*Amybstoma gracile*	--	--	--	YES	Moist habitats along the Pacific coast, including grasslands, woodlands, and forests.	Range Limit NW Sonoma Co. and much of region is covered by revised CLN.
Black Salamander	*Aneides flavipunctatus flavipunctatus*	--	--	--	YES	Uses a wide range of habitats including lowland forests, under rocks and logs or in wet soil along streams or in grassy meadows, pastures, and burned areas, and in talus slopes.	Sonoma, Napa, San Mateo, occur in areas that receive > 75 cm annual precipitation , habitat types are well-conserved in the CLN.
Arboreal Salamander	*Aneides lugubris*	--	--	--	YES	Scrub, oak woodland.	Very common and widespread, but declining live oak populations and loss of oak woodlands could impact populations.

Gabilan Mountains Slender Salamander	*Batrachoseps gavilanensis*	--	--	--	?? SEE NOTES	Redwood forests, gray pine and mixed evergreen forests, oak woodlands, chaparral, and open grasslands with scattered oaks.	Western Santa Clara Co, co-exists with B. attenuatus at Hecker Pass. Probably covered but better data needed to confirm.
California Toad	*Bufo boreas halophilus*	--	--	--	YES	Ponds and streams.	Added by Steve Bobzien at 2/24 meeting, widespread.
California Giant Salamander	*Dicamptodon ensatus*	--	--	--	YES	Streams and adjacent forest in wet coast ranges (San Mateo-Marin-Sonoma).	Bay Area near-endemic.
Yellow-eyed Salamander	*Ensatina eschscholtzi xanthoptica*	--	--	--	YES	Streams and adjacent forest/woodlands.	Habitats well-covered by the CLN.
Foothill Yellow-legged Frog	*Rana boylii*	CA SSC	--	--	YES	Rocky streams and rivers with rocky substrate and open, sunny banks, in forests, chaparral, and woodlands.	Covered by general riparian goals and increases to stream priorities where present. Planning watershed gap analysis shows high protection levels in most watersheds with CNDDB records.
California Red-legged Frog	*Rana draytonii*	FT, CA SSC	YES	YES	YES	Ponds in humid forests, woodlands, grasslands, coastal scrub, and streamsides with plant cover.	Covered by CLN with local adjustments for ponds, NWI and NHD ponds mapped, occupancy data from EBRPD analyzed, gap analysis done. Areas for Further Consideration increase local pond networks and connectivity.
Western Spadefoot	*Spea hammondii*	--	YES	YES	YES	Seasonal wetlands and vernal pools.	Covered by CLN and Vernal Pool Recovery Plan. South Santa Clara Valley, Eastern Alameda County, management issues regarding maintaining seasonal wetlands/vernal pools.
Rough Skinned Newt	*Taricha granulosa*	--	--	--	YES	Ponds and streams.	Southern range limit, Santa Cruz Mountains, found in common habitats that are well covered by CLN.

Red-bellied Newt	*Taricha rivularis*	--	--	--	YES	Ponds and streams.	Diverse habitats in NW Sonoma Co. well represented in CLN.
Coast Range Newt	*Taricha torosa torosa*	CA SSC	--	--	YES	Forests, woodlands, and streams in coastal mountains.	Habitats covered by CLN.
Arachnids							
California Tarantula	*Aphonopelma sp.*	--	--	--	YES	Grasslands.	Covered by extensive grasslands in CLN.
Incredible Harvestman	*Banksula incredula*	--	--	--	YES		North slope of San Bruno Mountain, review of CNDDB indicates it is covered.
Marin Blind Harvestman	*Calicina diminua*	--	--	YES	YES	Serpentine habitats.	Appears covered by CLN after review of 59 FR 60119 60124 species profiles for Eleven Petitions to List Three Blind Harvestmen, Three Micro-Blind Harvestmen, One Spider, Two Butterflies, One Moth, Two Crickets, Three Katydids, and Five Grasshoppers, covered by Serpentine Recovery Plan.
Edgewood Blind Harvestman	*Calicina minor*	--	--	YES	YES	Serpentine habitats.	Covered by serpentine habitats in CLN, and Serpentine Recovery Plan, same reference as above.
Edgewood Park Microblind Harvestman	*Microcina edgewoodensis*	--	--	YES	YES	Serpentine habitats.	Covered by serpentine habitats in CLN and Serpentine Recovery Plan. Edgewood Park already protected. Same reference as above.
Hom's Microblind Harvestman	*Microcina homi*	--	--	YES	YES	Serpentine habitats.	Covered by serpentine habitats in CLN and Serpentine Recovery Plan. Same reference as above.

Jung's Microblind Harvestman	*Microcina jungi*	--	--	YES	YES	Serpentine habitats.	Covered by serpentine habitats in CLN and Serpentine Recovery Plan. Same reference as above.
Lee's Microblind Harvestman	*Microcina leei*	--	--	--	YES	Serpentine habitats.	Covered by serpentine habitats in CLN. Same reference as above.
Lum's Microblind Harvestman	*Microcina lumi*	--	--	YES	YES	Serpentine habitats.	Covered by serpentine habitats in CLN and Serpentine Recovery Plan. Same reference as above.
Tiburon Microblind Harvestman	*Microcina tiburona*	--	--	YES	YES	Serpentine habitats.	Covered by serpentine habitats in CLN and Serpentine Recovery Plan. Same reference as above.
Ubick's Gnaphosid Spider	*Talanites ubicki*	--	--	--	YES	Serpentine habitats.	Mt. Burdell, covered by serpentine in CLN, same reference as above.
Crustaceans							
Midvalley Fairy Shrimp	*Brachinecta mesovallensis*	--	YES	YES	YES	Vernal pools.	Vernal Pools covered in CLN and Vernal Pool Recovery Plan, Solano, Eastern Contra Costa.
Longhorn Fairy Shrimp	*Branchinecta longiantenna*	FE	YES	YES	YES	Vernal pools.	Vernal Pools covered in CLN and Vernal Pool Recovery Plan, Eastern Contra Costa, Alameda Counties.
Vernal Pool Fairy Shrimp	*Branchinecta lynchi*	FT	YES	YES	YES	Vernal pools.	Vernal Pools covered in CLN and Vernal Pool Recovery Plan, Eastern Contra Costa, Alameda, Solano Counties.
Tomales Isopod	*Caecidotea tomalensis*	--	--	--	YES	Slow-moving freshwater.	Sonoma to San Mateo Counties.

Isopod	*Calasellus californicus*	--	--	--	??? SEE NOTES	Freshwater springs, seeps.	1 locality each in Napa (within urban city limits, 1969), and Santa Clara Co. (West of Lexington Reservoir, 1967) in A Fragmented Area of CLN.
Vernal Pool Tadpole Shrimp	*Lepidurus packardi*	FE	YES	YES	YES	Vernal pools.	Vernal Pools covered in CLN and Vernal Pool Recovery Plan. Found in Contra Costa, Alameda, Solano, possibly Napa.
California Fairy Shrimp	*Linderiella occidentalis*	--	YES	YES	YES	Vernal pools.	Vernal pools covered by CLN and Vernal Pool Recovery Plan.
Califonia Freshwater Shrimp	*Syncaris pacifica*	FE, CE	YES	YES	YES	Streams.	Stream segments with shrimp are mostly Priority 1, stream segments in Recovery Plan and other documents are noted. Certain stream segments which drain directly to the Pacific Ocean, including Tomales Bay, in Marin and Sonoma Counties, Sonoma Creek, lower Napa River, Tolay Creek and Petaluma River, all of which drain to the San Pablo Bay, Certain lower tributaries of the Russian River including the Laguna de Santa Rosa and certain tribs such as Blucher Creek.
Insects - Butterflies							
Oplers Long-horned Moth	*Adella oplerella*	--	--	YES	YES	Serpentine grasslands.	Covered by serpentine grassland and Serpentine Recovery Plan, requires grazing management.
Lange's Metalmark Butterfly	*Apodemia mormo langei*	FE	--	YES	YES	Antioch Dunes.	Antioch Dunes endemic, covered by Antioch Dunes NWR, requires intensive management.

	Apodemia mormo subspecies	--	--	--	??? SEE NOTES		Different subspecies outside Antioch Dunes, no current data to determine, likely covered by Hot Grasslands and Semi-Desert Scrub.
Western Meadow Fritillary	*Boloria epithore epithore*	CA SSC	--	--	YES		Mosaic of habitats in Santa Cruz Mountains well covered by CLN.
Johnson's Hairstreak	*Callophrys johnsoni*	--	--	--	YES	Sargent cypress.	Berryessa area, feeds on mistletoe that grows on Sargent cypress.
San Bruno Elfin Butterfly	*Callophrys mossii bayensis*	FE	--	YES (old)	YES		All known localities in protected lands. Covered by San Bruno Mountain HCP.
Marin Elfin Butterfly	*Callophrys mossii marinensis*	--	--	--	YES		Occurs on Mt. Tam which is protected.
Muir's Hairstreak	*Callophrys muiri*	--	--	--	YES	Sargent and McNab cypress.	feeds on mistletoe on Sargent and McNab cypress, covered by coarse filter serpentine targets.
Green Hairstreak	*Callophrys rubi*	--	--	--	YES	Coastal scrub.	Can exist in urban areas.
Sonoma Arctic Skipper	*Carterocephalus palaemon magnus*	--	--	--	??? SEE NOTES	Forest openings.	Sonoma Co., likely covered at southern edge of range, Fort Ross, need exact localitiy information to add as fine filter if necessary in CLN 2.0.
California Dog-face Butterfly	*Colias eurydice Boisduval*	--	--	--	YES	Oak woodland, chaparral.	State butterfly, widespread.
Monarch Butterfly	*Danaus plexippus*	--	--	--	YES	Eucalyptus groves near coast, some in urbaized areas.	Overwintering sites in CNDDB, requires intensive management for long-term viability, add in as points post-Marxan in CLN 2.0.

Smith's Blue Butterfly	*Euphilotes enoptes smithii*	FE	--	--	YES	Coastal dunes, grassland and scrub.	Possible "near" *smithii* in Santa Cruz Mountains, taxonomy uncertain and poorly documented. Likely covered in CLN.
Bay Checkerspot Butterfly	*Euphydryas editha bayensis*	FT	YES	YES	YES	Serpentine grasslands.	Covered by Serpentine Recovery Plan and CLN due to serpentine grassland goals in Santa Clara County, requires grazing management.
(Edith's Checkerspot)	*other Euphydryas editha subspecies (luesterae)*	--	--	--	YES	Serpentine chaparral.	Covered by serpentine habitats included in CLN.
Mission Blue Butterfly	*Icaricia icarioides missionensis*	FE	--	YES (old)	YES	Coastal scrub.	Covered by San Bruno Mountain HCP, remaining habitat nearly all protected.
Pt. Reyes Blue Butterfly	*Icaricia icarioides parapheres*	F SC	--	--	YES	Coastal dunes.	Pt. Reyes, management of coastal succession and invasive weeds needed.
Great Arctic	*Oeneis nevadensis*	--	--	--	??? SEE NOTES	Forest openings.	Sonoma County at southern edge of range, Fort Ross, need exact localitiy information, add as fine filter if necessary in CLN 2.0.
Indra Swallowtail	*Papilio indra*	--	--	--	YES		Napa, Berryessa area.
Myrtle's Silverspot Butterfly	*Speteria zerene myrtleae*	FE	--	--	YES	Cool grasslands.	Coastal Marin, Sears Point, Cool Grasslands in CLN along Sonoma Coast covers Myrtle's and Behren's butterflies.
Unsilvered Silverspot Butterfly	*Speyeria adiaste adiaste*	CA SSC	--	--	YES	Openings in coniferous/hardwood forests.	Mosaic of habitats in Santa Cruz Mountains well-covered in CLN.

Behren's Silverspot Butterfly	*Speyeria zerene behrensii*	FE	--	YES	YES	Cool grasslands.	Salt Point Sonoma Coast, covered by Cool Grasslands in CLN, requires brush management. Covered by draft Behren's Silverspot Recovery Plan.
Callippe Silverspot Butterfly	*Speyeris callippe callippe*	FE	--	YES	YES with AFC	Grasslands.	San Bruno Mountain protected and managed, Solano HCP has map of habitat showing almost all grassland in American Canyon, Pleasanton area has intergrades between *callippe* and *comstocki ssp*, considered protected by USFWS, American Canyon habitat in AFC and Vallecitos AFC includes Callippe, possibly add as fine filter target in CLN 2.0. Grazing important to keep grasses down.
Other Insects							
Ant species	*Formicidae*	--	--	--	YES	Various.	Brian Fisher at CAS suggested review of Bay Area ant diversity hotspot map, after review determined that known ant diversity hotspots are mostly in protected areas. Invasive Argentine ants a major local threat.
Vernal Pool Andrenid Bee.	*Andrena blennospermatis*	--	--	--	YES	Vernal pools.	Covered by vernal pools in CLN.
Antioch Dunes Anthicid Beetle	*Anthicus antiochensis*	FSC	--	--	YES	Antioch Dunes.	Antioch Dunes endemic, covered by Antioch Dunes NWR.
Sacramento Anthicid Beetle	*Anthicus sacramento*	FSC	--	--	YES		

Sacramento Valley Tiger Beetle	*Cicindela hirticollis abrupta*	--	--	--	NO		Likely extinct, last known sighting April 14, 1984 50 CFR Part 17 [FWS–R8–ES–2008–0112; MO 9221050083– B2] Endangered and Threatened Wildlife and Plants; 90-Day Finding on Petition To List the Sacramento Valley Tiger Beetle as Endangered.
Sandy Beach Tiger Beetle	*Cicindela hirticollis gravida*	FC	--	--	YES	Beaches and dunes.	Beaches/dunes well covered by CLN.
Globose Dune Beetle	*Coelus globosus*	FC	--	--	YES	Beaches and dunes.	Beaches/dunes well covered by CLN.
San Joaquin Dune Beetle	*Coelus gracilis*	FC	--	--	YES	Dunes.	Extirpated from Antioch Dunes, present in remnant dune systems on western edge of Central Valley.
Valley Elderberry Longhorn Beetle	*Desmocerus californicus dimorphus*	FT	--	--	YES	Streams and riparian habitat.	Solano County, covered by riparian goals in CLN.
Giuliani's Dubiraphian Riffle Beetle	*Dubiraphia giulianii*	FSC	--	--	YES	Streams and riparian habitat.	Covered by riparian goals in CLN.
Stage's Dufourine Bee	*Dufourea stagei*	--	--	--	YES		SF Peninsula, most likely covered by CLN.
Hairy Water Flea	*Dumontia oregonensis*	FSC	--	--	YES	Vernal pools.	Covered by vernal pools in CLN.
Antioch Efferian Robberfly	*Efferia antiochi*	FSC	--	--	YES		Antioch Dunes endemic, covered by Antioch Dunes NWR.
Delta Green Ground Beetle	*Elaphrus viridis*	FT	--	--	YES	Vernal pools.	Covered by vernal pools in CLN and Vernal Pool Recovery Plan, Jepson Prairie.
Redheaded Sphecid Wasp	*Eucerceris ruficeps*	--	--	--	??? SEE NOTES	Dunes.	Antioch Dunes endemic, possibly extinct.

Ricksecker's Water Scavenger Beetle	*Hydrochara ricksecker*i	--	--	--	YES	Ponds.	Not found for many decades, Hafernik, J.E., 1989. Surveys of potentially threatened Bay Area water beetles and the San Francisco Forktail Damselfly: Final report. Report to the US Fish and Wildlife Service.
Leech's Skyline Diving Beetle	*Hydroporus leechi*	FSC	--	--	YES	Vernal pools.	Center of range taken out by Los Vaqueros Reservior, but extant in local vernal pools and marshes.
Curved-foot Hygrotus Diving Beetle	*Hygrotus curvipes*	FSC	--	--	YES	Alkalai vernal pools.	Covered by vernal pools in CLN.
Middlekauff's Shield-back Katydid	*Idiostatus middlekauff i*	FSC	--	--	YES	Dunes.	San Joaquin Valley, only CNDDB record is from Antioch Dunes.
San Francisco Forktail Damselfly	*Ischnura gemina*	--	--	--	YES	Streams, ponds, and riparian habitat.	Covered by riparian and pond goals, John Hafernik. has data - may have shifted northward due to climate change, Hafernik, J.E., 1989. Surveys of potentially threatened Bay Area water beetles and the San Francisco Forktail Damselfly: Final report. Report to the US Fish and Wildlife Service.
Bumblebee Scarab Beetle	*Lichnanthe ursina*	--	--	--	YES		
Molestan Blister Beetle	*Lytta molesta*	FSC	--	--	YES	Vernal pools.	Covered by vernal pools in CLN.
Hurd's metapogon robberfly	*Metapogon hurdi*	FSC	--	--	YES	Antioch Dunes.	Antioch Dunes endemic, covered by Antioch Dunes NWR.
Antioch multilid wasp	*Myrmosula pacifica*	FSC	--	--	YES	Antioch Dunes.	Antioch Dunes endemic, covered by Antioch Dunes NWR.
San Francisco Lacewing	*Nothochrys a californica*	FSC	--	--	??? SEE NOTES	Monterey cypress trees in urban areas.	Norm Penny, PhD, at Cal Academy says lacewings in general covered by CLN. This species not part of CLN because of urban location.

Antioch Andrenid Bee	*Perdita scitula antiochensis*	FSC	--	--	YES	Antioch Dunes.	Antioch Dunes endemic, covered by Antioch Dunes NWR.
Antioch Sphecid Wasp	*Philanthus nasalis*	FSC	--	--	YES	Antioch Dunes.	Antioch Dunes endemic, covered by Antioch Dunes NWR.
Wilbur Springs Shorebug	*Saldula usingeri*	--	--	--	??? SEE NOTES	Springs or creeks with high concentrations of sodium, chlorine, and lithium, found only in wet substrate of spring outflows.	Not clear if it falls within study area, one CNDDB record in Fairfield North Quad, protected by wetland regulations.
Antioch Dunes Halcitid Bee	*Sphecodogastra antiochensis*	--	--	--	YES	Antioch Dunes.	Antioch Dunes endemic, covered by Antioch Dunes NWR.
dragonfly (full name?)	*Tanypetryx haggini*	--	--	--	YES	Shores of Lake Berryessa.	
(a) Leaf-cutter Bee	*Trachusa gummifera*	--	--	--	YES	Soft, rotted wood.	Mapped occurrence only on Twin Peaks in SF.
Metallic Wood-boring Beetle	*Trachykele hartmani*	--	--	--	YES		
Serpentine Cypress Wood-boring Beetle	*Trachykele hartmani*	--	--	--	YES	Sargent and McNab cypress.	Sargent and McNab cypress well covered in CLN.
Serpentine Cypress Long-horned Beetle	*Vandykea tuberculata*	--	--	--	YES	Sargent and McNab cypress.	McNab and Sargent cypress well covered in CLN.
	honeybees threatened by colony collapse disorder	--	--	--	YES		Well-covered by CLN according to Claire Kremen, PhD, at UC Berkeley.
Western Bumble Bee	*Bombus occidentalis*	--	--	--	YES		Once common but now in decline because of introduced diseases, and not habitat suitability,

Ground beetles	*Carabidae family*	--	--	--	YES		Dave Cavanaugh, PhD, at Cal Academy felt beetles were well-covered by the CLN.
Mayflies and Caddisflies	*Ephemeroptera and Trichoptera* orders	--	--	--	YES	Streams and riparian habitat.	Riparian habitat is well-covered by CLN, per Vince Resh, PhD, at UCB.
Mollusks							
Peninsula Coast Range Shoulderband Snail	*Helminthoglypta nickliniana awania*	FSC	--	--	YES		Only found at Pt. Reyes Headlands in Pt. Reyes National Seashore.
Bridges' Coast Range Shoulderband Snail	*Helminthoglypta nickliniana bridgesi*	FSC	--	--	YES	Open habitats in Contra Costa County.	
Mimic Tryonia (California Brackishwater Snail)	*Tryonia imitator*	FSC	--	--	YES	Coastal lagoons, estuaries, and salt marshes from Sonoma to San Diego County. Found only in permanently submerged areas in a wide range of salinities and sediment types.	Baylands and coastal lagoons/wetlands are the CLN.
Robust Walker	*Pomatiopsis binneyi*	--	--	--	??? SEE NOTES		One CNDDB occurence in Marin Watershed protected, other near Bolinas is not, Bolinas is undated.
Marin hesperian	*Vespericola marinensis*	BLM S, USFS S	--	--	YES		Marin is well-covered by existing protected land and CLN.
Reptiles							
Western/Northwestern Pond Turtle	*Actinemys marmorata*	CA SSC, BLM S, USFS S	--	--	YES	Ponds and streams.	Creeks important, well-covered by CLN with combination of ponds and creeks, but local adjustments may be needed.

Silvery Legless Lizard	*Anniella pulchra pulchra*	FSC, CA SSC	--	--	??? SEE NOTES	Dunes.	Dunes well-covered by revised CLN, Black Diamond mines area, further surveys desirable, vulnerable to Argentine ants, reassess in CLN 2.0.
Glossy Snake	*Arizona elegans occidentalis*	--	--	--	YES	Arid scrub, rocky washes, grasslands, chaparral.	Eastern Alameda County
Western Whiptail	*Aspidoscelis tigris*	--	--	--	YES	Hot and dry areas with sparse foliage and open areas. Found in diverse habitats including forests, woodland, chaparral, riparian areas.	Eastern Alameda County in xeric areas.
Rubber Boa	*Charina bottae*	--	--	--	YES	Diverse habitats including grassland, chaparral, woodland, and riparian.	
Northern Pacific Rattlesnake	*Crotalus oreganus oreganus*	--	--	--	YES	Rocky hillsides and outcrops, rocky stream courses, rocky areas in grasslands, mixed woodlands.	
Nightsnake	*Hypsiglena ochrorhyncha*	--	--	--	YES	Arid grasslands and chaparral.	Eastern Alameda County, extensive arid habitats in CLN.
California Nightsnake	*Hypsiglena ochrorhyncha nuchalata*	--	--	--	YES	Arid grasslands and chaparral.	Mt. Hamilton, Diablo, Mayacamas, Vaca, drier habitats
California Mountain Kingsnake	*Lampropeltis zonata*	CA SSC, USFS S	--	--	YES	Diverse habitats including coniferous forest, oak-pine woodlands, riparian woodland, and chaparral.	Santa Cruz Mtns., Mt. Hamilton, Mayacamas/Vaca Mountains
Coachwhip	*Masticophis flagellum*	--	--	--	YES	Hot rocky areas.	Eastern East Bay, range limit - as far in as Greenville Rd.

Alameda Whipsnake	*Masticophis lateralis euryxanthus*	FT, CT	YES	--	YES	Chaparral, coastal sage scrub, oak savanna	Included as a fine filter target from Swaim Biological, Inc. data.
California Horned Lizard	*Phrynosoma blainvilli*	CA SSC	--	--	YES	Open sandy areas in chaparral and grassland.	Eastern Alameda County.
Coast Horned Lizard	*Phrynosoma coronatum*	CA SSC	--	--	??? SEE NOTES	Conifer, riparian, pine-cypress, juniper, grassland and open chaparral habitats.	14/15 CNDDB records are in CLN, but distribution is wider, Karen Swaim data could flesh out distribution, Argentine ants a threat. Reassess in CLN 2.0
Gilbert's Skink	*Plestiodon gilberti cancellosus*	--	--	--	YES	Grassland, chaparral, woodlands, and pine forests near moisture.	Los Vaqueros, Mt. Diablo, eastern Alameda County.
Long-nosed Snake	*Rhinocheilus lecontei*	--	--	--	YES	Arid grassland and shrubland.	Los Vaqueros, eastern Alameda County.
Northern Sagebrush Lizard	*Sceloporus graciosus graciosus*	BLM S	--	--	YES	Arid shrublands.	Most likely covered because arid shrublands are well-represented in CLN, eastern Alameda County.
Western Black-headed Snake	*Tantilla planiceps*	--	--	--	YES	Grassland, chaparral, oak and oak-pine woodland.	Mt. Hamilton, Diablo (eastern Alameda), very edge of western and northern range.
Western Terrestrial Garter Snake	*Thamnophis elegans*	--	--	--	YES	Mixed woodland, grassland, coniferous forest, dunes, brushland, generally in the vicinity of ponds or flowing water.	Found in fragmented urban wildlands and eastern Alameda County.
Giant Garter Snake	*Thamnophis gigas*	FT, CT	--	draft	YES	Drainage channels and freshwater sloughs in agricultural matrix areas.	California endemic. Eastern Contra Costa Co., not a good CLN species, ESA protections, Recovery Plan in process. Pesticide and fertilizer runoff from agriculture kill prey, including Red-legged frogs. Grazing of vegetation along water sources also a threat.

Common Garter Snake	*Thamnophis sirtalis*	--	--	--	YES	Grasslands, shrublands, forests, pond and stream edges, rocky hillsides, and residential areas.	Eastern Alameda County.
San Francisco Garter Snake	*Thamnophis sirtalis tetrataenia*	FE, CE	--	YES	??? SEE NOTES	Grasslands or wetlands near ponds, marshes and sloughs. May overwinter in upland areas away from water.	Endemic. Ponds on SF Peninsula, additional data would confirm that pond network in Santa Cruz Mountains North is adequate, receives ESA protection.
Side-blotched Lizard	*Uta stansburiana*	--	--	--	YES	Variety of habitats, including sandy, rocky, and loamy areas with chaparral, grassland, and shrublands.	Eastern Alameda County hot zone.
REMOVED FROM LIST							
Arctic Skipper	*Carterocephalus palaemon*						Represented by other target species.
Racer	*Coluber constrictor*						Eastern Alameda County
Ringneck Snake	*Diadophis punctatus*						Eastern Alameda County
Northern Alligator Lizard	*Elgaria coerulea*						
Southern Alligator Lizard	*Elgaria multicarinata*						Alameda and Contra Costa Counties
Western Skink	*Eumeces skiltonianus skiltonianus*						Eastern Alameda County
Common King Snake	*Lampropeltis getula*						Eastern Alameda County
Gopher Snake	*Pituophis catenifer*						Eastern Alameda County
Western Fence Lizard	*Scelopous occidentalis*						Eastern Alameda County

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FT – Federal Threatened	CE – California Endangered	BLM S – BLM Sensitive
FSC – Federal Species of Concern	CE – California Threatened	USFS S – US Forest Service Sensitive
FC – Federal Candidate	CA C – California Candidate	

Upland Habitat Goals Project: Mammal Conservation Targets								
Common Name	**Scientific Name**	**Legal Status****	**CNDDB occurrences***	**MVZ***	**CWHR Hab Model***	**Covered by Coarse Filter CLN?**	**Habitat**	**Notes / Management Issues**
Category 1 - Endemic / At Risk or Species of Concern								
pallid bat	*Antrozous pallidus*	CA SSC, BLM S USFS S	80	YES	NO	YES	Roosts are rocky crevices, bridges, buildings, and most large trees with cavities, especially oak savanna habitats near riparian.	Locally common in low elevations. Non-migratory. Habitat has dwindled. Connectivity is important. Once very common, now is disappearing.
Point Reyes mountain beaver	*Aplodontia rufa phaea*	CA SSC	9	YES	NO	YES	Dense scrub on Pt. Reyes Peninsula.	Protected at Pt. Reyes. Affected by Mt. Vision fire, but should recover.

Townsend's big-eared bat	*Corynorhinus townsendii*	CA SSC, BLM S USFS S	11	YES	NO	??? SEE NOTES	Obligate cavernous roosting bat, may roost in caves, boles of large redwoods, abandoned buildings, mines, dams.	Not a good spatial conservation target (D. Johnston pers. comm., 2008). Non-migratory. Habitat fragmentation likely a problem for this species. Very sensitive to development. Should be federally listed. Needs cavernous habitat such as mines; also in dams (Calaveras). Most mine locations outside of urban areas are included in network. Management could help this species; bat conservation plan in development.
Berkeley kangaroo rat	*Dipodomys heermanni berkeleyensis*	FE, CE, CA FP	7	YES	NO	??? SEE NOTES	Open scrubland and grassland.	Alameda-Contra Costa County; thought to be extinct.
Point Reyes jumping mouse	*Zapus trinotatus orarius*	CA SSC	5	YES	NO	YES	Grassland and marsh.	Protected at Pt. Reyes and in Marin. Need to create/protect corridor around Tomales Bay.
Category 2 - Not Endemic / Species of Concern (not necessarily listed as a CA Species of Special Concern) / Globally Rare								
red tree vole	*Arborimus pomo*	CA SSC	27	YES	YES	YES	Douglas-fir and mixed Douglas-fir/ Redwood forests.	Sonoma Coast Range, retreating north. Connectivity important. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN; recommend survey to determine status.
ringtail	*Bassariscus astitus*	CA FP	0	NO	NO	YES	Rocky outcrops or abandoned buildings, structure important.	Widespread, but poorly surveyed; distribution spotty. Highly nocturnal. Home range sizes 0.4-2.5 sq km. Affected by squirrel poisoning. Fully protected in CA. Survey is a data gap.
western red bat	*Lasiurus blossevillii*	USFS S, CA SSC	3	NO	NO	YES	Riparian obligate, breeds in old growth riparian forests, roosts in foliage of riparian trees including eucalyptus.	Winters in coastal CA. Numbers are presumed significantly lower since the loss of riparian forests. Requires management and restoration of riparian forests.

fringed myotis	*Myotis thysanodes*	BLM S, proposed CA SSC but denied	3	YES	NO	YES	Occurs in many undisturbed forests or undisturbed chaparral with rocky cliffs.	Sensitive to development and forest practices. Largely extirpated from developed portions of Bay Area. Proposed by CDFG staff as a CA CSSC, but rejected by Fish & Game Commission.
long-legged myotis	*Myotis volans*	proposed CA SSC but denied	0	YES	NO	YES	Occurs in many undisturbed forests or undisturbed chaparral with rocky cliffs but not directly associated with cliffs.	Not much known about species. Sensitive to development and forest practices; largely extirpated from developed portions of Bay Area. Proposed by CDFG staff as a CA CSSC, but rejected by Fish & Game Commission.
San Francisco dusky-footed woodrat	*Neotoma fuscipes annectens*	CA SSC	10	YES	NO	YES	Many, non-grassland.	Santa Cruz Mountains, possibly also on San Bruno Mtn. Common locally throughout range.
Sonoma Chipmunk	*Neotamias sonomae*	--	0	NO	YES	YES	Oak woodland, chaparral, hardwood, and coniferous forest.	Marin, Sonoma, Napa. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
western grey squirrel	*Sciurus griseus*	--	0	NO	NO	YES	Oak woodland, chaparral, hardwood, and coniferous forest.	Competing with eastern grey and fox squirrels that are moving from urban/suburban to native area (Leslie Jacobs, UC Davis PhD dissertation).
American badger	*Taxidea taxus*	CA SSC	50	NO	NO	YES (with connec -tivity)	Grassland.	Home range of 1-24 sq km. Found in nearly all major landscape units. Associated with ground squirrels, but will prey on gophers. Needs connectivity among subpopulations for demographic and genetic stability. Subject to squirrel poisoning, road kill; sensitive to human disturbance. Population analysis completed.
San Joaquin kit fox	*Vulpes macrotis mutica*	FE, CE	45	YES	NO	YES	Arid grassland.	Eastern Alameda & Contra Costa Counties. A focal species in the East Contra Costa County HCP.

Category 3 - Locally Rare / Unique								
pronghorn	*Antilocarpa americana*	--	0	YES	NO	YES	Open grassland.	Still in Mt. Hamilton area, near San Antonio Valley from a reintroduction in the 1980s. Other possible reintroduction sites could be considered.
tule elk	*Cervus elaphus nannodes*	--	0	YES	NO	YES	Diverse habitat use at various times of year, with an emphasis on open grassland.	Found at Mt. Hamilton, Grizzly Island, and Pt. Reyes. Would like healthier herds in current range but also expand range. Herds in Mt. Hamilton are expanding rapidly. Small amount of hunting for bulls allowed. CDFG has specific requirements for acreage and fencing. Some conflict with ranchers, damage to fences.
western red-backed vole	*Clethrionomnys californicus*	--	0	YES	YES	YES	Coniferous forest.	Marin and Sonoma Coast Ranges. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
California kangaroo rat	*Dipodomys californicus*	--	0	YES	YES	YES	Grasslands, chaparral.	North Bay. Succession management essential. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
Heermann's kangaroo rat	*Dipodomys heermanni*	--	0	YES	YES	YES	Grasslands, chaparral.	South and East Bay. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
porcupine	*Erethizon dorsatum*	--	0	NO	YES	YES	Coniferous forest, primarily Douglas-fir.	Santa Cruz Mtns, Sonoma Coast Range, Northern Mayacamas, Vaca West/Berryessa. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
Merriam chipmunk	*Eutamias merriami*	--	0	NO	NO	YES	Oak woodland, chaparral, hardwood, and coniferous forest.	Added by Mammals Focus Team members.

river otter	*Lontra canadensis*	CA SSC, BLM S	0	YES	NO	YES	Riparian.	Napa, Sonoma, Russian River, and Coastal Marin/Sonoma Co. Santa Clara/Alameda in CWHR . Possibly in Mt. Hamilton Range, at Arroyo Honda. Covered by recommendations of the Riparian/Fish Focus Team.
long-tailed weasel	*Mustela frenata*	--	0	NO	NO	YES	Coastal grasslands, salt marshes.	Widespread, but low population density.
American mink	*Mustela vison*	--	0	YES	NO	YES	Riparian.	North Bay. Conflict with California clapper rail.
San Joaquin pocket mouse	*Perognathus inornatus inornatus*	BLM S	7	YES	YES	YES	Grassland.	Eastern Alameda & Contra Costa Counties. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
brush mouse	*Peromyscus boylii*	--	0	YES	YES	YES	Chaparral.	Sonoma, Napa, Solano, succession management, habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
shrew mole	*Neurotrichus gibbsi*	--	0	YES	YES	YES	Bunch grasses & edge of meadows in wet coniferous forests.	In Santa Cruz Mountains. Outliers (MVZ) in Mayacamas/Vaca West. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
marsh shrew	*Sorex bendirii*	--	0	NO	NO	YES	Freshwater wetlands.	Sonoma County.
fog shrew	*Sorex sonomae*	--	0	YES	YES	YES	Coniferous forest, wet meadows.	Sonoma, Marin. Requires succession management. Habitat suitability analysis completed to determine coverage by Coarse Filter CLN.
western spotted skunk	*Spilogale gracilis*	--	0	NO	NO	YES	Scrublands, woodlands, grasslands with rock outcrops.	Formerly widespread. Region made inhospitable due to feral cats' feline leukemia. Possibly extinct from Bay Area; re-introduction could be considered.

grey fox	*Urocyon cinereoargenteus*	--	0	NO	NO	YES	Generalist.	Widespread. Suffers competition from introduced red fox.
black bear	*Ursus americana*	--	0	NO	NO	YES	Generalist in shrublands, woodlands, and forests.	Home range size 2.6-19.7 sq km (avg 10.6) NW California, 7.4-53.5 sq km (avg 22.4) San Bernardino, occurs in the North Bay. Connectivity is a major issue. Not historically found in Santa Cruz Mtns., brought in by houndsmen, local vineyard impacts.
Category 4 - Regionally Extinct								
Santa Cruz kangaroo rat	*Dipodomys venustus venustus*	--	4	YES	NO	N/A	Mature chaparral.	Not federally or state listed but should be. Extinct in Santa Cruz Mountains north; only remaining population in Santa Cruz Sand Hills. Potential for reintroduction into historic range.
fisher	*Martes pennanti*	BLM S, USFS S	0	YES	NO	N/A	Coniferous forests,	NW Sonoma County; old record indicates southern range limit in Coast Range.
grizzly bear	*Ursus horribilis*	FT (in current range)	0	NO	NO	N/A	Generalist.	Included because it is a species that has been extirpated.
Category 5 - Top Predator/Widespread but Inherently Low Population								
bobcat	*Lynx rufus*	CA FP	0	YES	n	yes, with connectivity	Generalist, but not wide open grasslands.	Population analysis indicates adequate habitat included in Coarse Filter CLN as long as there is connectivity to areas beyond the study area.
mountain lion	*Puma concolor*	CA FP	0	YES	YES	yes, with connectivity	Many non-grassland habitat types.	Habitat suitability analysis and population analysis indicate adequate habitat included in Coarse Filter CLN as long as there is connectivity to areas beyond the study area

Category 6 - Prey Species/Game Animal								
tule elk	*Cervus elaphus nannodes*	--	0	YES	NO	YES	Diverse habitat use at various times of year, with an emphasis on open grassland.	Found at Mt. Hamilton, Grizzly Island, and Pt. Reyes. Would like healthier herds in current range but also expand range. Herds in Mt. Hamilton are expanding rapidly. Small amount of hunting for bulls allowed. CDFG has specific requirements for acreage and fencing. Some conflict with ranchers, damage to fences.
mule deer	*Odocoileus hemionus*	--	0	YES	NO	YES	Diverse habitats, generalist.	Prime game animal. Need to be managed to keep numbers in check (hunting). Found in urban areas. Maintain healthy population for mountain lion. A working landscape species. Has suffered broad decline since 1950's but numbers in wild areas are fairly static.
wild pig	*Sus scrofa*	--	0	YES	NO	YES	Diverse habitats, generalist.	Prime game animal. Widespread. Eradicated from Marin Coast Range. Populations drop during droughts. Hunting provides economic opportunity for ranchers. On-going management issue; fencing or shooting can control or locally eradicate. Locally severe vegetation impacts.
Category 7 - Widespread / Native / Management Concern / Keystone Species								
coyote	*Canis latrans*	--	0	NO	NO	YES	Generalist, highly adaptable.	Home range 5 sq km in oak woodlands. Adapted to urban fringe, even established in San Francisco. Threat to SJ kit fox. Control is counterproductive in many ways, plays key role in supressing smaller predators.

hoary bat	*Lasiurus cinereus*	CA SSC	35	YES	NO	YES	Migrates throughout landscape, roosts in foliage of trees with open space below.	Widespread. Serious risk from wind farms. Need to understand roost routes. Little can be done on landscape level to protect.
silver-haired bat	*Lasionycteris noctivagans*	--	5	YES	NO	YES	Fairly dense coniferous forests, rarely in other dense forests such as dense palm groves, not in oak woodland forest	Fairly common in western portions of the Bay Area such as forested areas of Marin, Sonoma, Napa, San Mateo, and Santa Clara Counties. Has highest rate of rabies among bats
long-tailed weasel	*Mustela frenata*	--	0	NO	NO	YES	Coastal grasslands, salt marshes.	Widespread, but low population density.
California myotis	*Myotis californicus*	--	0	YES	NO	YES	Widespread in oak woodlands, chaparral, eucalyptus, and some coniferous forests, primarily undisturbed oak woodlands, especially near streams.	Common bat in many mountain ranges.
long-eared myotis	*Myotis evotis*	--	0	NO	NO	YES	Occurs primarily in forests and edges of forests including suburbia near oak woodlands or coniferous forests. Also chaparral in association with rocky cliffs.	Common and widespread in forests; works into the edges of suburbia.
grey fox	*Urocyon cinereoargenteus*	--	0	NO	NO	YES	Generalist.	Widespread. Suffers competition from introduced red fox.
Category 8 - Non-Native Species of Management Concern								
Axis deer	*Axis axis*	--	N/A	NO	N/A	N/A		Pt. Reyes.
Fallow deer	*Dama dama*	--	N/A	NO	NO	N/A		Pomponio Creek, Pt. Reyes.

feral cat	*Felis catus*	--	N/A	N/A	N/A	N/A		Widespread. Decreasing populations with distance from development. Transmits diseases, including feline leukemia to western spotted skunk. Predation on birds, small mammals, reptiles, and amphibians.
wild pig	*Sus scrofa*	--	N/A	y	NO	N/A	Diverse habitats, generalist.	Widespread. Eradicated from Marin Coast Range. Populations drop during droughts. Hunting provides economic opportunity for ranchers. On-going management issue; fencing or shooting can control or locally eradicate. Locally severe vegetation impacts.
red fox	*Vulpes vulpes*	--	N/A	y	NO	N/A	Lowlands, possibly spreading.	Baylands in Alameda, Santa Clara, Central Valley. Problem with clapper rail predation.
REMOVED from original draft mammal targets list								
Suisun shrew	*Sorex ornatus sinuosus*	FE, CE, CAFP	1			N/A		Baylands - not included in study area
Salt-marsh harvest mouse	*Reithrodontomys raviventris*	FE, CE, CAFP	11			N/A		Baylands - not included in study area
Salt-marsh wandering shrew	*Sorex vagrans halicoetes*	FE, CE, CAFP	1			N/A		Baylands - not included in study area
San Pablo vole	*Microtus californicus sanpabloensis*	FE, CE, CAFP	4			N/A		Baylands - not included in study area
striped skunk	*Mephitis mephitis*					N/A		Widespread, urban adapted.
big free-tailed bat	*Nyctinomops macrotis*	CA SSC	3			N/A		Vagrant in Alameda County.

Mexican free-tailed bat	*Tadarida brasiliensis mexicanus*			y	n	N/A	Many habitats, including disturbed habitats with anthropomorphic features.	Common and widespread in all habitats.
long-eared myotis	*Myotis evotis*	BLM S	2			N/A		Widespread.
western pipistrellus	*Parastrellus hesperus*			y	n	N/A	Typically dry rocky canyons, other arid situations with rocky outcrops	Occurs primarily in arid easternmost portions of the Bay Area.
big brown bat	*Eptesicus fuscus*	None		y	n	N/A	Many habitats, including disturbed habitats with anthropomorphic features, edges of urban areas.	Common and widespread in forests. Is more sensitive to development than Mexican free-tailed bats
California mastiff bat	*Eumops perotis californicus*	CA SSC, BLM S	1	y	n	N/A	Obligate cliff, tall building (rare) or tall bridge (rare) roosting bat	South and East Bay arid areas with cliff habitat, western foothills of San Joaquin Valley, don't seem to be at risk.
Yuma myotis	*Myotis yumanensis*	BLM S	7	y	n	N/A	Aquatic/riparian obligate; forages on aquatic and riparian emergents.	Widespread, second most common bat in CA.
little brown myotis	*Myotis lucifugus*	None		y	n	N/A	Primarily coniferous forests near water	At the southern edge of the range. In coniferous forests of Sonoma, Napa, Marin. Low to medium on all CWHR habitat, in low number but appear to be doing okay.
western small-footed myotis	*Myotis ciliolabrum*	BLM S		y	n	N/A	Primarily arid habitats with rocky outcrops, cliffs	Easternmost portions of Santa Clara, Alameda, Contra Costa, relatively new species ~10yrs.

***CNDDB Occurrences** = number of records in California Natural Diversity Database

MVZ = UC Berkeley Museum of Vertebrate Zoology

CWHR Hab Veg Model = California Wildlife Habitat Relationships model correlating vegetation types to suitable species habitat

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